HOMO FABER
Technology and Culture in India, China and the West 1500-1972

PROEFSCHRIFT

TER VERKRIJGING VAN DE GRAAD VAN DOCTOR IN DE TECHNISCHE WETENSCHAPPEN AAN DE TECHNISCHE HOGESCHOOL EINDHOVEN, OP GEZAG VAN DE RECTOR MAGNIFICUS, PROF. DR. P. VAN DER LEEDEN, VOOR EEN COMMISSIE AANGEWZEZEN DOOR HET COLLEGE VAN DEKANEN IN HET OPENBAAR TE VERDEDIGEN OP DINSDAG 9 NOVEMBER 1976 TE 16.00 UUR

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An Apologia as Prelude

The rising generation will inevitably look back over the twentieth century with different priorities from ours. Born into a world in which - as all present indications suggest - the major questions will not be European questions but the relationships between Europe, including Russia, and America and the peoples of Asia and Africa, they will find little relevance in many of the topics which engrossed the attention of the last generation. The study of contemporary history requires new perspectives and a new scale of values.

Geoffrey Barraclough

The unorthodox character of many of the ideas proposed in this thesis is not an inherent quality of the ideas themselves, but stems rather from the unorthodox nature of the framework that has been formulated to contain them. The framework itself might appear to many as being wholly new (and partly audacious), yet on no account can it be considered as being entirely original. It has in fact already been set forth in an earlier work, albeit in an area of scholarly endeavour other than the one with which this thesis is properly concerned.

I have here in mind, of course, Geoffrey Barraclough's An Introduction to Contemporary History (1964/74) and I am certain it would be in the general interest if I did present now, quite briefly, Barraclough's alluring perspective of his field of involvement. For, although our areas of enqui-ry are not identical (they do overlap), our points of refer-ence at least are similar, and Barraclough understood, could (but I am not so sure) make my own central concerns
more comprehensible.

In An Introduction to Contemporary History, Geoffrey Barraclough sets out to argue a case for a new discipline of study: contemporary history, to be understood as a new phase of historical investigation that takes for its canvas a wider field than the restricted, inadequate, Europe-centred preoccupations of modern or conventional history. Contemporary history, he observes, distances itself from its predecessor through the simple discovery that it is world history, "and that the forces shaping it cannot be understood unless we are prepared to adopt world-wide perspectives."

The excuse for Barraclough's proposal for a more inclusive view of history is his charge that modern history, in dwelling too exclusively on Europe, has expended more energy than was warranted on the old world that was dying rather than on the new world coming to life. His charge is unanswerable. Take a random example for illustration: a 1975 edition of Civilizations: Western and World, by historians Lopez, Barnes, Blum and Cameron. Of the thirty chapters in the volume, one is on Asia. It is difficult to deny that the histories of the past couple of decades have restricted themselves too narrowly to "accounts of the two world wars, the peace settlement of 1919, the rise of Fascism and National Socialism, and, since 1945, the conflict of the communist and the capitalist worlds."

The precise nature of Barraclough's proposal should not be misunderstood. He is not merely arguing for more comprehensive accounts of events on a world-wide scale; far less does he mean the hasty, embarrassed addition of a few chapters on extra-European affairs. He is arguing in fact for a new framework and new terms of reference, which implies a re-examination and revision of the whole structure of assumptions and preconceptions on which modern history is based. "Precisely because American, African,
Chinese, Indian and other branches of extra-European history cut into the past at a different angle, they cut across the traditional lines; and this very fact casts doubt on the adequacy of the old patterns and suggests the need for a new ground-plan."

Finally, and this is where our interests coincide, Barraclough suggests that such a new ground-plan concerning nothing less than the globalization of the focus of historians, demands and creates a new scale of values. This question of values we will discuss below, but it is certain that Barraclough has seen clearly enough what is actually involved in the realization of the new ground-plan.

Formerly, a modern historian had one central reference point: Europe. What happened within Europe was significant; extra-European affairs were literally extra — not integral to his concern. Today, European dominance is no longer even theoretically defensible. And any historian consciously setting out to chart the general lines of world history, and at the same time fundamentally convinced that the rise of China, Asia and Africa, and of the communist economies can still be treated as tangentially interesting, will severely test the credibility of his readers. Yet such an historian is faced with the choice of criteria and emphasis, above all, of reference. In place of one point of reference, he now has half a dozen. Perhaps, the problem is not so much a problem as it is an almost impossible demand to be absolutely objective, impartial and neutral. Barraclough has succeeded very well here, by abdicating the European perspective. For that reason alone, he might well prove to be the first universal historian of the twentieth century, which means that universities in India, China, Africa or Europe could prescribe him with little unease.

There is however one crucial difference between Barraclough's intentions and mine, which might well serve to indicate what this thesis is not about. Barraclough
intends to follow up his ground-plan with an actual narrative history of the contemporary world-picture based on it. I am interested in merely establishing a similar ground-plan and the problems it involves in my field of enquiry - technology and culture. The writing of an actual history of technology, for example, is beyond my intentions, and more important, beyond my competence.

This is not to deny that I have used a considerable amount of material from the history of technology, but this material should be seen as illustrating a point or the more general issues of the thesis. The reader should not look for any systematic, even representative treatment of the history of technology. This declaration of intent should immediately convince the reader that while my thesis does seem to be ambitious in theory and aim, it is not so in actual fact.

For, unlike Barraclough, I am not a historian, but a student of philosophy. I therefore consider myself as pre-eminently disposed to enquire into values rather than facts or events, or, to be more to the point, into the manner in which our values or presuppositions determine our approach and selection of facts. On the other hand, I do take for granted (throughout the thesis) a wide acquaintance of facts and studies. For example, I am not interested in repeating the statistical pontifications of the Club of Rome, or the criticisms of the anti-technology school led by Lewis Mumford, Jacques Ellul, René Dubos or Theodore Roszak. If I have wished to make this point clear, it is because I do not wish to be accused later of attempting to parade my library.

Also, at the risk of being obnoxious, I should acknowledge that the formulation of the framework of my thesis has been accomplished independent of Barraclough's influence. I came to his ideas after my principal ideas had settled on paper. Yet, I do confess being relieved in being able to
indicate a precedent and an excellent one at that.

Briefly then, here are my concerns and the manner in which I propose to present them. As I said earlier, I am attempting to formulate a new framework of reference for a more integral understanding of two of man's principal creations: technology and culture, on a world-scale and on two levels, the level of the past and the level of the present. (Of course, this is being done with an eye to the future: re-examine Barraclough's quote inaugurating this apologia). Naturally, if I have set out to formulate such a framework, it is because I have found existing frameworks inadequate; at numerous places in the thesis I shall try to expose these inadequacies. Since most of these deficiencies are easily betrayed most in print, I have in the main focussed my sights on the literature traditionally dealing with the twin issues of technology and culture.

Barraclough is useful here again: he begins with the fact of European-centred studies as a given, then works to avoid it. I delve deeper into the past in order to find some answer to the intriguing question concerning how we ever arrived in a situation when Europe could, with impunity, appropriate to itself the position of absolute referent. I believe that world history began earlier, about 1800 as an average point, when the balance between Asia and Europe turned into European dominance over Asia. I am therefore keen to examine the lateral "spread" of this idea of dominance, from politics to technology and culture. In other words, how did European culture seem superior to the members of other cultures and to its own members.

Here we face the most difficult and serious issue concerning the presuppositions of my thesis. A culture is a system of values - or as Geertz defined it - a web of meanings. Values, by nature, are incomparable; so are the systems based on them. There is, in fact, no independent standard in relation to which one might compare European
(or Western), Indian, Chinese, or African culture in order to come up with a result of one being better or superior to the others. Let me explain this tricky issue within the context of technology, science and cultures.

Random example. In the assemblage, maintenance or overhaul of a machine tool, one of the considerations the engineer has to keep in mind is how to measure the geometrical accuracy of the tool. His task in this regard is made uncomplicated by the existence of international standards that prescribe specifications. His access to these standards and the fact that they exist, enable him, through comparing, to test the corresponding accuracy of his own tools. In other words, there is a point of reference in relation to which his tools might be assessed, found adequate or wanting.

On the level of scientific activity (which is of course different from the measurement of tools) we are already faced with a problem. Not long ago, J R Ravetz argued that it is difficult to measure the "progress" of science simply because there is no absolute measure within science available for the purpose. (Ravetz was very nearly drawing out the implications of Gödel's theorem for the system of scientific ideas). The problem is that the presuppositions of any system cannot be established through any argument that is drawn from the premises of the very same system. Take a simple example: the proposed objectivity of science.

A year ago, I discussed this issue of the objectivity of science with Prof. Jacques Monod (the author of Chance and Necessity, in which the problem is mentioned). I asked him whether by objectivity, he was referring to the actual objectivity of the scientist, which in reverse, would refer to the scientist's anxiety to avoid subjective attitudes from interfering with his work. Monod replied that he had been widely misunderstood in what he had set out
to explain. Here is a pertinent extract from my tape-recorded transcript of my interview:

Let me explain this. I consider as an analytical fact that in order to build what we call science, one has to adopt certain postulates about the validity of scientific demonstration or interpretation. And this is what I call the postulate of objectivity, namely, that all interpretations in terms of teleology or final causes is invalid by definition. Which is a pure postulate. It is impossible to demonstrate such a point.

In other words, the acceptance of the postulate cannot be justified on scientific grounds: it lies outside the sphere of science itself. We have come back to Gödel. Yet, it is not easily understandable (though more than obvious) how the scientific method has come to be proposed as a universally acceptable criterion for what constitutes knowledge. Jean Piaget has argued against this, and the existence of an entire stream of literature on the ideology of science indicates the problem. Though interesting, we must leave it here aside.

The arbitration of cultures raises the issue again but on a practically insoluble level. Unlike the case with machine tools, to put it starkly, there is no a-cultural criterion which would enable us to opt for a cultural system on the basis of rational choice. Yet, it is not so long ago, that educated men were arguing in favour of a Second Genesis, the creation of all man in the image of Western man. In fact, over the past couple of centuries, the unprecedented had occurred: one culture had reached a stage where it considered itself the criterion in relation to which all the others might be assessed. In such a situation, the Europeanization of the world-picture, reflected in the writing of history (Barraclough's complaint) was repeated (and still is) in many other areas of the examination of human experience.

Thus, a history of art turned out to be a history of European art, and a history of ethics, a history of West-
ern ethics. Now, as far as my knowledge goes, there has rarely been a civilization that did not evolve a congruent system of ethics. And recently, Dr Joseph Needham even went so far as to suggest that Western moral philosophers might profit from a serious study of how the Chinese went about creating an ethical system that, unlike the Western one, was not based or dependent on a religious standard.

Finally, the assumption of European primacy has not been without effect on European study of non-European societies. I have used the phrase, an imperialism of categories, to condense the phenomenon of the examination and description of non-Western societies through categories fashioned in the Western context. And to describe an analogous situation in technology discussions, I have spoken of the tyrannization of historical possibility: the refusal on the part of learned men to accept or understand that non-Western societies are theoretically free to choose their own technological futures.

Thus it is through a critical evaluation of historiography itself (in as many areas as my competence permits) that I am enabled to bring out into the open some inkling of a ground-plan that is more in keeping with the exploding perspective of our times. Here, in a very real sense, Barraclough's task is easier than mine: the relativization of the place of Churchill and Hitler is hastened through the weaving of a larger net of human foci: Mao and Nehru and Nkrumah. All that is right now available to me is the possibility of presenting the actuality of a cultural pluralism; or a plurality of cultures. For technology, my task is made easier: there is enough evidence to establish a plurality of technical histories for the past and the possibility of differing technological systems for the present.

In conclusion, I might note that I am aware of the incongruity involved in pursuing this thesis within the very portals of a Western University itself. In my mind,
the incongruity is more apparent than real, for it could be argued quite reasonably that I am ultimately not attempting anything more unusual than carrying through the demands of Western scholarship to their rigorous conclusions. The nature of objectivity is greatly transformed if we assume a world-perspective on human matters; in its new form, it makes larger, perhaps even impossible demands. All the same, that is no reason why these demands should be refused.

Notes
G Barraclough's volume is available in a Penguin edition of 1974. J R Ravetz's discussion of the "progress" of science, titled, *et augebitur scientia*, may be found in R Harré (ed), *Problems of Scientific Revolution: Progress And Obstacles to Progress in the Sciences* (1975)........ My interview with Jacques Monod is published in QUEST, No 99, Jan/Feb 1976. Jean Piaget's *Insights and Illusions of Philosophy* (1971) is a sharp and learned reaction to the blurred identification of knowledge and what he calls, wisdom.......Other volumes implicitly mentioned in this prelude are A MacIntyre's, *A Short History of Ethics* (1974), H W Janson's, *A History of Art* (1970), and *Civilizations: Western and World*, by, Lopez, Barnes, Blum, Cameron (1975)....... A recent UNESCO publication, *Cultures and Time* (1976) is an excellent positive example of the kind of relativity of perspectives I have in mind.......A less positive example is *The Timetables of History: A Chronology of World Events from 5000 BC to the Present Day*, by Bernard Grun, (1975). Despite the general title, the author admits later in an introduction that the focus of the work is actually Western Europe and the Americas.
Terminology

The terms clarified below occur often in the thesis. A careful study of them is important, since I use some of them with new meanings.

MODEL - A skeletal description of the nature of man, abstracted from the human experience of all cultures, emphasizing here his natural predisposition for creating culture and technology.

PARADIGM - Not to be identified with the paradigms of Thomas Kuhn in The Structure of Scientific Revolutions. A paradigm here (to use Plato's terms) is the model reflected in the concrete historical experience of any particular society. There is thus a Chinese paradigm or the Chinese edition of homo faber in culture and technology. There are as many paradigms as there are cultures. But there is only one model: the paradigms participate in it. With the period of Western dominance, the Western paradigm became identified with the model and it consequently became possible for Western culture and technology to assume the role of a universalist standard in relation to which other paradigms could and should allegedly be evaluated. This thesis will attempt to separate once more the model from the paradigm and propose once more a situation that existed before Western dominance: the plurality of paradigms.

TECHNOLOGY - the system of means expressive of man's practical ability to provide for his needs, primary, secondary or created. In such a context, the distinction between advanced and traditional technologies is not acceptable.

INDIGENOUS TECHNOLOGY - Used in place of traditional, even primitive technology. Evolved in a particular area or region. Can be contrasted with alien technologies imported to do the work that indigenous technology has always performed.

CULTURE - though treated in holistic terms in this thesis, caveat lector! the monolithic, organic and coherent nature of cultures is often overrated: a culture may contain contradictions, and, of course, sub-cultures. There is general agreement, however, that
to speak in terms of American, Indian, Chinese or African culture is to make meaningful statements.

APPROPRIATE TECHNOLOGY - One of the wonders of the age, that we have to add that pre-fix.

NEW NATIONS - The nations of Africa and Asia, recently emerged from colonial situations. To include too the countries of Latin America, though their independence from colonial rule occurred decades earlier. The use of the term, the Third World, is refused. So is the use of other terms, in general circulation, including underdeveloped or developing countries. These terms define these new nations in their relation to the northern nations: that is no longer necessary or even desirable.
An Apologia as Preface

Terminology

Introduction

1 Homo Faber: A New Anthropological Model

The idea that there may be alternative technologies in itself implies the idea of technological pluralism in place of the until now almost universally accepted technological monism. In this case each social system and each political ideology, indeed each culture would be free to develop its own particular line. Why should there not be a specifically Indian technology alongside Indian art and why should the African temperament express itself only in music or sculpture and not in the equipment which Africans choose because it suits them better? Why should Russian factories follow Anglo-Saxon patterns? Might there not be an unmistakably Japanese technology, just as there are typically Japanese buildings and clothes? Robert Jungk. 1973.

2 Indian Technology and Culture: 1498-1757

The sciences and technologies of the non-European world had different seekings and developments to those of Europe. Further, in countries like India, their organization was in tune with their more decentralist politics and there was no seeking to make their tools and work-places unnecessarily gigantic and grandiose. Smallness and simplicity of construction, as of the iron and steel furnaces or of the drill-ploughs, was in fact due to social and political maturity as well as arising from understanding of the principles involved. Instead of being crude the processes and tools of eighteenth century India appear to have developed from a great deal of sophistica-
tion in theory and an acute sense of the esthetic.
Dharampal. 1971.

3 Chinese Technology and Culture: 1368-1842

It is logical to look at the Chinese view of China, because they are Chinese and it is their own country and their own history. It is necessary to make what is perhaps a special effort to see the Chinese point of view, because on the whole we have not paid enough attention to it in the past. Indeed there have been many occasions over the last century and a half of regular contact between China and the West when the prevailing attitude towards China revealed more about ourselves than about the Chinese.

4 English Technology and Culture: 1500-1830

All of you who are sixty years of age can recollect that bread and meat, and not wretched potatoes, were the food of the labouring people; you can recollect that every industrious labouring man brewed his own beer and drank it by his own fireside. You can recollect when every sober and industrious labourer that was a married man had his Sunday coat, and took his wife and children to church, all in decent apparel; you can recollect when the young men did not shirk about on a Sunday in ragged smock frocks with unshaven faces, and a shirt not washed for a month, and with their toes pointing out from their shoes, and when a young man was pointed at if he had not, on a Sunday, a decent coat upon his back, a good hat on his head, a clean shirt, with silk handkerchief round his neck, leather breeches without a spot, whole worsted stockings tied under the knee with a red garter, a pair of handsome Sunday shoes which it was deemed almost a disgrace not to have fastened on his feet by silver buckles. I appeal to you all, those of you who are sixty years of age, whether this be not a true description of the state of the labourers of England when they were boys.
William Cobbett. 1820

5 Technology, Culture and Empire: the Colonial Age

To some extent, the mechanical age seems linked to the age of colonialism. Both reached their apogee in the nineteenth century; both were based on the instinct for exploitation. The world was prospected to discover and cultivate raw materials with which to feed the machines. It rarely occurred to the ruling powers that the people whose soil produced these materials, and who sweated to bring them forth, should have any appreciable use and benefit from other pro-
ducts. Whenever the natives made any serious trouble, the usual response was to send a gunboat. K G Pontus Hultén. 1968.

6 The Renewal of Chinese and Indian Technology and Culture

Culture has proved to be the very foundation of the liberation movement. Only societies which preserve their culture are able to mobilize and organize themselves and fight foreign domination. Whatever ideological or idealistic forms it takes, culture is essential to the historical process. It has the power to prepare and make fertile those factors that ensure historical continuity.

The late Amilcar Cabral.

7 The Logic of Appropriate Technology

For three thousand years a dialogue has been going on between the two ends of the Old World. Greatly have they influenced each other, and very different are the cultures they have produced. We have now good reason to think that the problems of the world will never be solved so long as they are considered only from a European point of view. It is necessary to see Europe from the outside, to see European history, and European failure no less than European achievement, through the eyes of that larger part of humanity, the peoples of Asia (and indeed also of Africa).

Joseph Needham. 1969.

Afterword
Introduction
"Through the years," wrote the Argentinian, Jorge Luis Borges, "a man peoples a space with images of provinces, kingdoms, mountains, bays, ships, islands, fishes, rooms, tools, stars, horses and people. Shortly before his death, he discovers that the patient labyrinth of lines traces the image of his own face."

Borges, writing as a Latin American, would certainly not have refused to extend his description of the life of a man to the life of a culture. For, through the centuries, even a culture imperceptibly peoples its geography with the stuff of its own living creations. Natural objects, living beings, and all artefacts, come to be manipulated by a culture's invisible hands and to speak its silent language as they carry the imprint of its forms of expression, its thinking processes and philosophy, its language and technics. With the arrival of maturity, a culture discovers in itself a distinct face, regulated and controlled by a distinct mind.

The American anthropologist, Clifford Geertz, in his recent volume of scintillating essays, *The Interpretation of Cultures*, could thus proceed to define culture as an internally consistent system of meanings. "Believing with Max Weber," he wrote, "that man is an animal suspended in webs of significance he himself has spun, I take culture to be those webs, and the analysis of it to be therefore not an experimental science in search of law but an interpretative one in search of meaning."

Another anthropologist, Ruth Benedict, had early in this science's modern phase, already condensed the implications of such a view as Geertz's, when she had concluded that all cultures should be considered, in principle, with equal value. Human history may be better described not as
a movement of different peoples (although at different speeds and in distinct groups) towards a common goal, but as the experience of many discontinuous cultures, each in itself equally important as exhibiting the variability of the products of human inventiveness, each betraying a system of meanings irreducible to any other.

Thus, Clifford Geertz reported that in Java, cultural opinion decreed that "to be human is to be Javanese". Other fields, other grasshoppers.

But the anthropologist is also a grasshopper, and thereby hangs a tale. The anthropologist rarely questioned the premises of his own culture: the very encounter with an alien community, living quite creatively within the bounds of its own meaning system, should at least have cautioned him to reconsider his own "field" as merely one among many, all more or less fertile to the imagination of man.

I would be the first to acknowledge that the anthropologist was indeed a courageous and heroic man: more often than not, he had to struggle to live in the community he studied. And those laborious catalogues he compiled of genealogies, objects, myths and vocabularies provide ample testimony of the sincerity of his purpose. But at the beginning and end of it all, he allowed the fact of his grasshopperhood to slip beyond the focus of his immediate task. If he documented, faithfully, the ways of life of the alien community, he did it within a framework of mind that located the community as existing at a level below the stage on which he himself, as a member of Western culture, stood and lived.

Gerrit Huizer is editing a volume in which a group of anthropologists born in Africa have set out to analyze the "imperialism of categories" that determined the researches in that continent of a number of leading, non-African, primarily Western anthropologists. Our point, however, is that anthropology is one example. In fact, the all too-eager and indiscriminate subordination of non-
Western human experience and organization to what we shall term the "Western paradigm" can, with little difficulty, be demonstrated in practically every field of study in which Western social scientists have occupied themselves in relation to non-Western cultures. In other words, the African anthropologists' dissection of the Western conceptions underlying the main body of African anthropological literature can be similarly repeated in areas as diverse as political science, economics, art, law, sociology and most important of all, technology and culture, with which this thesis is properly concerned.

This submission of the vast panorama of human cultures and their experience to the tyranny of a monolithic paradigm is not the product of our age. In fact, it first originated in the nineteenth century. Before that, something analogous had taken place within individual cultures themselves. It is not necessary to prove, for example, that dominant classes and races (as the dominant culture today) have often held quite distorted views of those subject to or dependent on them.

Up to 1861, for example, the year the British colonial Government introduced a more uniform penal code in India, a Brahmin murderer (under the old Hindu law) might not be put to death; yet a Shudra, a member of the lowest caste, who happened to cohabit with a woman of a higher caste, usually on the latter's seduction, would automatically suffer execution. In China, as Etienne Balazs observed, traditional Chinese historiography was "written by scholar-officials for scholar-officials". A man who rebelled against the established order was termed fei, which is also a negative particle in classical Chinese grammar.

In Britain, Karl Marx substantiated his critique of traditional political economy by pointing out that the classical economists, in accepting private property as a given, had subordinated their science to the social interests of the ruling, landowning class against the interests of the classes subservient to it, a proposition firmly supported by the minute researches of Brian Inglis, in his
extraordinary study, Poverty and the Industrial Revolution.

These issues are a legitimate part of the larger discipline of the sociology of knowledge, into which we shall not enter here. Our interest is a description of the situation that has come to obtain between cultures, more appropriately, between dominant cultures and those dependent on them; more specifically, between the industrial nations and the countries of Asia, Africa and Latin America. I am not being original in proposing that the political dominance exercised by developed societies, supported by technological power, has made simultaneously possible a parallel dominance of one cultural conception over and against all others unable to integrate themselves within its framework. Let me be concrete and turn to history for details.

In 1498, Vasco da Gama inaugurated the sea-route to India. From that year, and for the three centuries that followed, Asia proved to have a larger and more powerful impact on Europe than is normally recognized. Donald Lach has appropriately titled his first volume in his Asia in the Making of Europe series as The Century of Wonder. Later in the thesis, we shall describe the material and cultural influence of Asia on Europe between 1500 and 1800. Right now, it would suffice merely to remind the reader of China's influence on the minds of the eighteenth century philosophes of France, including Voltaire. Upto his time, in fact, European appreciation of the arts and sciences of Asia remained a tangible and sincere phenomenon.

The reversal of the European image of Asia seems to have occurred however, in a gradual period between 1780 and 1830, by which time the foundations of the industrial revolution in England had already been laid. Voltaire noticed a bit of it. Having once considered India as "famous for its laws and sciences", he felt it necessary to denounce the increasing preoccupations of Europeans in India with the amassing of "immense fortunes", and led him to remark that "if the Indians had remained unknown to the Tartars and to us, they would have been the happiest people in the world."
By 1830, the British had acquired, in what was to be a completely European century, a flattering notion of the nature of their own civilization and a thorough-going feeling of contempt for every other. In India itself, this new found attitude found its climax in Lord Macaulay's famous Minute of the 2nd of February, 1835, a classic example of a Western rationalist approach to Indian civilization:

I have never found one amongst them (orientalists) who could deny that a single shelf of a good European library was worth the whole native literature of India and Arabia. The intrinsic superiority of the western literature is indeed fully admitted by those members of the committee (of Public Instruction) who support the oriental plan of education.

It will hardly be disputed, I suppose, that the department of literature which the Eastern writers stand highest is poetry. And I certainly never met with any orientalist who ventured to maintain that the Arabic and Sanskrit poetry could be compared to that of the great European nations. But when we pass from works of the imagination to works in which facts are recorded and general principles investigated, the superiority of the Europeans becomes absolutely immeasurable. It is, I believe, no exaggeration to say that all the historical information which has been collected from all the books written in the Sanskrit language is less valuable than what may be found in the most paltry abridgment used at preparatory schools in England. In every branch of physical or moral philosophy the relative position of the two nations is nearly the same.

Macaulay went on to note that the Board of Public Instruction would be wasting public funds should it print books of Indian learning "which are of less value than the paper on which they are printed was while it was blank" and that the artificial encouragement to "absurd history, absurd metaphysics, absurd physics, absurd theology" would end in the raising of a "breed of scholars who find their scholarship an incumbrance and a blemish, who live on the public while they are receiving their education, and whose education is so utterly useless to them that, when they have received it, they must either starve or live on the public all the rest of their lives." Little did Macaulay realize that it would be precisely the English system he introduced that would produce the "breed of scholars" so
characteristic of India and other poor nations today: the educated unemployed.

If we have spent some time in the consideration of this Minute, it is because as a document it provides a clear glimpse of new attitudes to Asia on the part of a supremely confident Britain. If Macaulay's interest was educational, the next influential person on our list, Karl Marx, theorized about the role of British industrial civilization in India. "England," wrote Marx, "has to fulfill a double mission in India: one destructive, the other regenerating - the annihilation of old Asiatic society, and the laying of the material foundations of Western society in Asia." He next went on to emphasize that the British were breaking up the village community, uprooting handicraft industry and establishing private property in land, which he termed "the great desideratum of Indian society". Industrialization would wreck the caste system: "Modern industry, resulting from the railway system, will dissolve the hereditary divisions of labour, upon which rest the Indian castes, those decisive impediments to Indian progress and Indian power."

The remarkable fact is that a hundred years later, Peter Drucker would still be theorizing along similar lines. In one of his not so well known books, The Landmarks of Tomorrow, he urged his readers to face "the new reality of the collapse of the East, that is, of non-Western culture and civilization, to the point where no viable society anywhere can be built except on Western foundations. He based this pontification on the perception that:

Every single one of the new countries in the world today - including those that have not yet shaken off colonial status - sees its goal in its transformation into a Western state, economy and society, and sees the means to achieve this goal in the theories, institutions, sciences, technologies and tools the West has developed.

Both Marx and Drucker, in formulating their views or predictions, were running away with the evidence. Predic-
tions (which have a habit of turning into prescriptions) to be even mildly credible, must be preceded by a comprehensive description of what is. And certainly no accurate description of non-Western human experience could ever have been possible with minds convinced, for example, that Western philosophy was the nearest approach to metaphysical truth ever attained by humanity, that the Christian religion contained truth incumbent upon all men everywhere to believe. As Joseph Needham put it, even European painting and sculpture had become "absolute" painting and sculpture, that "which artists of all cultures must have been trying unsuccessfully to attain." European music was music, all other music, anthropology. Methodologies of knowledge acquisition that ignored the scientific frame of reference were now to be permanently judged unreliable or ideological, properly studied as matters of "historical" interest, as the curious, quaint contents of a collection in the museum of mental history.

If Macaulay was one of the first to set out to prescribe how best, in his case - Indians, might save their withered souls, he was also the virtual founder of a movement that would carry on his tradition to the present day. And the history of prescriptions that has to do with how non-Western societies might best achieve Western standards of life is studded with a long list of illustrious names.

Hans Achterhuis recalls how the two great Western philosophers, Bertrand Russell and John Dewey, were invited to China between 1919 and 1921 to dam the rising revolutionary flood through guest-lectures and discussion meetings. One of Mao's earliest articles is, in fact, a strong attack on the thesis of "orderly reforms" that Russell had proposed in a lecture in October 1919 in China. Another time, another place, in America, well before the end of the Second World War, Ruth Benedict and Talcott Parsons sat on a task-force charged with the problem of incorporating Japan within the American productive system. The primary problem, it seemed, was how the anta-
gonistic elements within Japanese capitalism might be de-
mobilized without undermining the entire edifice. And
Parsons was agitated enough to warn about the dangers of
a rural-based revolution if the absorption program were
not handled with care.

The end of the Second World War was followed by the
rise of a new generation of states, and by the time the
world had entered the fifties, a growing concern with the
phenomena of "backwardness" and "underdevelopment" had come
to the fore. The élites constituting the Governments of
the new states were faced with the issues that Latin Ameri-
can countries had faced earlier and African countries would
in a near future: planning for development and the choice
of a suitable strategy to affect it.

These élites, with rare exceptions, had been brought
up in the Western tradition, through their education at
Western institutions of learning. They were also not very
experienced in the art of government. India, is a good
example. On August 15, 1947, Lord Mountbatten formally
handed over the reins of control to an Indian Cabinet head-
ed by Jawaharlal Nehru: within weeks, he was recalled by
the Nehru Government to Delhi to take over again, unoffi-
cially, as the administration found Indian affairs slipping
into chaos. In such a situation, it was natural that the
West as inspirer would soon turn into the West as guide.
American experts sat on committees to formulate the First
Indian Five Year Plan. And in 1960, Walt Rostow, in one
of the most influential books of the decade to follow,
set out to argue the credibility of their prescriptions.

Actually, as is now well-known, Rostow's book, _The
Stages of Economic Growth_, was not concerned at all with
the "backwardness" of the new nations, but merely part of
a tactic designed to aid Dulles against Khrushchev in com-
peting for the allegiance of these nations, still uncommitted
to either of the two power blocks. The subtitle of Rostow's
book, _A Non-Communist Manifesto_, betrayed its nature of be-
ing an overtly political instrument of cold war ideology.
Rostow argued that the key to successful development lay not with the Soviet Union, but with the West, that it was therefore in the interests of the nonaligned nations to jump on the Western band-wagon. Willem Wertheim was one of the few Western thinkers to notice the nature of Rostow's description of Russian industrialization, that the American's famous thesis of a "take-off to sustained growth" provided an "argument for explaining away the specific significance of the Russian Revolution" by claiming that the "take-off" in the Russian economy had occurred twenty-five years before the political revolution in 1917.

It would take fifteen years for more objective and independent scholars to discover the fundamental deficiencies of Rostow's model of economic growth; by the time the critique had been accomplished (and we shall have occasion to examine it in the thesis), the economic and industrial elements or aspects of the Western paradigm, in so far as they might have had significance for industrializing nations, had collapsed. But not before the serious flirtation on the part of the industrializing nations with the model had resulted in a large current of dismay, disillusion and disappointment. Yet, Rostow was not an isolated example. In the area of political science studies, western scholars had been busy accomplishing the construction of similar and impossible dreams, and the dissemination of slanted advice.

These scholars were concerned with the problems of the new states in their attempts not to industrialize (that being Rostow's business) but modernize. The model presented them by these scholars on a platter, so to speak, was the Western one: formal democracy in combination with a rationalized bureaucracy; this, the new states should dispose themselves to attain, since it represented the "summit" of political development. New states not yet incorporated within the model, were to be termed "traditional", or more appropriately, "transitional", still undergoing the throes of modernization. Willem Wertheim again noticed the political implications and pointed out that the chief exponent of
the school, Daniel Lerner, was guilty of strong ethnocentrism in identifying the traits of modernity with those characteristic of American society.

Our point, however, is not this obvious deficiency, gross as it remains. It is not difficult to prove that Lerner, and the two other god-fathers of the gospel of modernization, S M Lipset and Karl Deutsch, and the dozens that have followed them, were influenced in their studies and policy recommendations concerning the new states by categories and historical possibilities fashioned in their own context.

We have a more serious criticism: that the mode of development presented under the generalized package of the "modernization" process undermined, in one continent after another, national independence in the name of economic development and frustrated all attempts at improving the conditions of life of ordinary people in spite of record GNP's and rates of growth. Here we find ourselves indebted to the writings of the Indian political scientist, Rajni Kothari, and it is to his insights that we now turn.

Kothari inaugurated his fundamental criticism of the large body of literature produced by western political scientists by pointing out that its overall perspective was apolitical, for in its search for general principles, it ignored "the crucial problems of political reality, namely, the prevailing pattern of dominance and control in the world at a given time. The world was not simply divided between "developed" and "developing" societies, "modern" and "traditional" nations, but more importantly, between "dominant" and "dependent" powers.

The modernization of traditional societies and the theories dealing with it ignored this fundamental issue by directing attention to other issues, including population growth, economic growth, family planning, literacy, development of the mass media and the transfer of technology. The presumption being, of course, that once the basic social and economic tasks were performed, the necessary "political development" would follow: or, before states and nations
are built, societies ought first to be modernized. There was but one course of modernization open: a high rate of growth in national GNP, increasing urbanization, a "rational" bureaucratic establishment, a manipulative technology and "social mobilization" in which major clusters of social, economic and psychological commitments are eroded or broken and people become available for new patterns of socialization and behaviour.

The consequences of such an empty, context-free model of modernization had indeed been disastrous: it had produced an economic, bureaucratic and technocratic élite intimately tied to the metropolitan areas of the world, treating the vast rural hinterlands in their own countries as colonies that provided cheap food and raw materials and surplus labour (and markets for inferior industrial products); an élite that had achieved high economic status at the expense of large numbers of people huddled in the "countryside", and in the process had lost both its independence and its social conscience.

Thus, politically, western-oriented political science reflected and reinforced a division of the world in which large majorities of the societies politely labelled as nations or states had in their entirety become the "countryside" and a small minority had in their entirety become the "cities", the metropoles. Further, the choices it offered could now be seen to be the false choices they had been all along, for they involved merely the possibility of political forms (democracy, dictatorship and so forth) or of political games (bargaining, coalition-making, power struggle and so on) and not the required fundamental possibility of socio-economic goals and technological alternatives.

In conclusion, as Kothari began to count the number of states (besides, of course, the obvious industrial powers) which could be considered genuine states, where political autonomy and sovereignty were the distinctive features, and which had in the past even asserted their political autonomy and control of their own economic future and
and national security at the cost of reduced growth rates, he found precisely seven (two of which have already disappeared from the list after he wrote his piece): Yugoslavia, China, India, Rumania, Chile, Tanzania and Cuba. And it is exactly with these nations that the prescriptions of the Western world had ceased to be worthily valued.

Within the "prescriptive" tradition represented by Rostow and Lerner lies also the hypothesis of David McClelland, who sees the problem of development as psychological, rather, as psychiatric. For McClelland, the alpha and omega of economic development and cultural change can be totally identified as a high degree of individual motivation or n(eed) achievement, as the phrase has it. I might add here that this psychological approach is also the most far-fetched of the prescriptive theories.

In its most general terms, the hypothesis states that a society with a generally high level of n achievement will produce more energetic entrepreneurs who, in turn, will produce more rapid economic development.....

Thus, the sub-titles of the different sections of the final chapter of McClelland's The Achieving Society, which is devoted to "Accelerating Economic Growth" speak for themselves: what should be effected in the developing countries is the following list of necessities: Increasing Other-Directedness and Market Morality, Increasing n Achievement, Decreasing Father Dominance, Protestant Conversion, Reorganizing Fantasy Life, Utilizing Existing n Achievement Resources More Effectively.

So we end on a practical note: a plan for accelerating economic growth through mobilizing effectively the high n Achievement resources of a developed country to select and work directly with the scarcer high n Achievement resources in underdeveloped countries particularly in small and medium scale businesses located in provincial areas.....

Thus, the social and economic condition of a poor society may be changed simply by having more of its members taught to get a hold of themselves and raise their
need for achievement, or, as Andre Gunder Frank set out to parody it, "by having teachers and parents tell children more hero stories so that when the latter grow up they might be heroic developers themselves."

The most curious part of the tale is McClelland's explaining away of everything worthy of China's attempts to emancipate itself: the Chinese have simply had more Achievement and Power than, say, the Indians. The role of all else is denied or ignored: the radical restructuring of society, the influence of Mao Tse-tung, the revolution itself. Is this social science? S N Eisenstadt, in reviewing The Achieving Society, compared it to the work of Max Weber, to indicate to his public "the measure of the importance of the problems raised by McClelland's endeavour." Where did Max Weber ever lose touch with reality to such an extent?

During the course of this thesis, I shall have occasion to dig deeper into the nature of these prescriptions, including the one of Rostow. Here, I take up a brief overview of the pontifications of the Lerner school on the modernization of traditional societies, so that I do not have to return to them again.

We might as well begin with Max Weber, one of the first social scientists to study the effects of rationalization on the institutional framework of societies engaged in "modernization". Weber shared his interest with the classical sociological tradition in general, a tradition which occupied itself with the construction of a conceptual model revolving round a pair of polar concepts, and then through it, attempted to grasp the structural changes taking place as a traditional society moved into being a modern one. The polar concepts included pairs like status and contract, gemeinschaft and gesellschaft, traditional and bureaucratic authority, sacral and secular associations, informal and formal groups and so on.

Talcott Parsons elaborated further on these to produce his own list of five pairs of alternative value-oriens-
tations or polar choices, which he claimed to be exclusive in that they indicated the contexts of any social action whatsoever, irrespective of the particular or historical context. Parsons had departed from Weber to the extent that his model was a wholly abstract one, not evolved through the study of any existing real society. His five polar choices included:

- affectivity versus affective neutrality
- particularism versus universalism
- ascription versus achievement
- diffuseness versus specificity
- self-orientation versus collectivity-orientation

From Parsons, it was but a small step to argue, as Bert Hoselitz set out to do, that the developed countries all exhibited the polar choices of universalism, achievement orientation, functional specificity and so forth, and that traditional societies were characterized by a total allegiance to the alternate polar choices of particularism, ascription, diffuseness and so on. A smaller step, again, for the description to turn into a prescription: traditional societies need only to eliminate their polar choices and opt for those characterizing Western societies. Development of the new states had become as simple and exciting as a mathematical game: Kindleberger sharply labeled the mode the gap approach: you subtract the ideal or polar features typical of traditional nations from those of the developed societies, and the remainder is your development program. Neat.

One of the crucial points that this thesis will continually emphasize will not be that these "prescriptions" concerning the general development of the new nations have all turned out to be empirically falsified, but that their theoretical proposals contained serious "faults", and this perhaps because they were fabricated on mis-perceptions. In other words, a more thorough investigation of the field itself might have prevented their ever being broached in the first place.

Thus, during the course of this thesis, the reader
will come to discover that a question or inquiry will be immediately false if and when it sets out to ask whether a particular society (say, Guatemala) approximates the standards of the society (say, America) out of which the comparativist arose. We shall indeed take pains to show that it is misleading to attempt to discover whether a non-Western society has or can have or need have such characterological, structural or philosophic features as an achievement ethic, modern bureaucracy, individualism, or an attitude of mastery towards the natural environment as available in the industrial nations. Otherwise, we propose it difficult for any social scientist to avoid the charge of ethnocentrism, of practising in fact an imperialism of categories.

We have already, in the company of R Kothari, set forth the most serious inadequacy of the current theories of modernization. But there are others, equally important and severe. In the first place, there is absolutely no reason for restricting the models of modernity and the processes and sequences of modernization to the experience of the Western nations. If, however, we continue to do so, we must accept the charge that we are subduing vast and various societies, that theoretically should find themselves free to choose their own historical possibility, to the totalitarianism of a single historical pattern. History might pattern itself on the past, but there is no reason it should pattern itself on the Western past. Merely because industrial nations realized conditions like urbanization or literacy before political democracy is no proof that these are always prerequisites of it. Even for the purpose of a more wholesome science it would be best to set no limits to the social imagination.

Moreover, there has never been any conclusive evidence for the idea that traditional societies or new nations carry institutions or norms from their past that could inhibit any increase in the efficiency of their productive systems. The opinion of the Dutch management theorist, P Hesseling, is unambiguous in this matter:
Any culture which has demonstrated survival value for a society over centuries is equally valid as any other culture which has proven its survival. Strategy translated into organization structure for the pursuit of complex work goals (products, service or knowledge) is only a subset of cultural relationships. There is no evidence that a culture successful for a society would be incompatible with an effective work organization applying advanced technology that is consistent with the local or national culture.

Positive evidence is available between the covers of *The Modernity of Tradition*, the brilliant study of Lloyd and Susanne Rudolph, which sets out to show how in India, traditional structures and norms have been adapted or transformed to serve the needs of a society facing a new range of tasks. The Rudolphs' study of the caste system, how its structural, cultural and functional transformation has aided India's peasant society to make a success of democracy by enabling notables and parties to mobilize a popular vote or to achieve fundamental economic goals, goes directly against the common opinion that caste is an absolute impediment to any serious improvement of the Indian situation. The Rudolphs' study of Gandhi describes how he restored the courage and political potency lost in imperial or colonial subjection, through the transformation of Hindu values or norms, as asceticism and non-violence, which he later related to the needs of the freedom movement.

To return to modernization theories, it is not at all difficult to suggest, as further criticism, that the very basis of the "tradition-modernity" dichotomy is false. We have here in mind the different historical contexts of the term "traditional" itself. Before the industrial revolution in Britain, and before the colonial impact, all societies could legitimately be termed "traditional"; after the revolution in Britain, that society took on characteristics that scholars agree deserved a new term or qualification: modern. Non-industrialized societies, on the other hand, that did not escape the disruptive hand of colonialism, were no longer the "pre-industrial" or "traditional" soc-
ieties they had originally been, that is more or less like Britain before the industrial revolution. On the contrary, they had been reduced in the scale of civilization through the process of incorporation into the productive system of another society.

Talcott Parsons once wrote that the modification of the Marxian view of society that his own "modern sociological theory" brought about was significant because in the latter, the "primary structural emphasis no longer falls on.... the theory of exploitation but rather on the structure of occupational roles." Something analogous has taken place in the "tradition-modernity" thesis: it innocently suggests that the developed countries independently raised themselves up from their traditional contexts to modernization processes (which we saw Weber trying to elucidate), and it also suggests how today's "traditional" societies may be guided into similar channels. Ignored is the connection, which this thesis itself will try to expand on: that the industrialization of the modernized societies went hand in hand with the de-industrialization of the "traditional" societies, and that the current structures in the latter societies, social, economic and political, are not age-old traditional qualities, but recent and implanted by the intervention of foreign bodies.

In other words, the dichotomy, tradition-modernity, does away with the entire traumatic experience of the colonial period; in so far as it does so, any literature that deals with it is based on bad scholarship. Or, it is based on a history dotted with large patches of amnesia.

One final observation: American scholars in recent years have devoted a large amount of research to analyzing the survivals of tradition in contemporary American life. Thus, studies of American political behaviour have emphasized the persistence of such traditional influences as local history, ethnicity, race, and religious community. American sociologists have discovered the importance of ethnic and religious solidarities and structures. Organization literature suggests "that the modern corporation attempts with con-
siderable success to create diffuse affective bonds among not only its employees but also their wives, families and neighbours. Corporate concerns and private interest become inextricably entangled. Economic relations among and between employers and employees take on affective dimensions and assume aspects of traditional patron-client relationships." In his chapter on the sociology of development in Latin America: Underdevelopment or Revolution, Andre Gunder Frank provides ample evidence of further "traditional" survivals in developed societies. New urban sociology talks of the metropolis producing collectivities of urban villagers.

Yet, should the reader now turn to the image of American society that emerges from much of the literature comparing it to "traditional" societies, he will immediately perceive a different attitude. The traditional features have disappeared or pictured as residual categories that still hang about due to some inefficiency in the historical process. In this literature, tradition is seen as living on merely in the new nations that stand at the beginning of the historical process that modern Western nations have already traversed.

This apparent paradox may be explained away by some as purely due to the obvious lack of interdisciplinary studies: scholars in the earlier field and scholars explicitly engaged in comparison do not cross each others' paths. I feel the issue perhaps goes deeper: the mirror image of others as the opposite of oneself becomes an element in civilizational, national, and personal esteem. The Rudolphs describe the issue at length:

Africans, including American Negroes, long appeared to Americans as black, lazy, cannibalistic, chaotically sexual, childish and incapable of social organization and government. We liked them that way because it strengthened the mirror image we had of ourselves as white, industrious, self-controlled, organized, orderly, and mature. India seen as a mirror image of the West appears otherworldly, fatalistic, unegalitarian, and corporate. It is as though we would be less ourselves, less this-worldly, masterful, egalitarian, and individualistic if they were less what they are. Occasionally one comes away from a
colleague's work with the impression that he is reassuring himself and his readers of the uniqueness of the Western achievement, a uniqueness that would be endangered by recognition of the cultural, functional, and structural analogues to be found in non-Western, traditional societies.

In conclusion, modernization theories tell us more about the nature of Western social scientists than they do about the actual situation in the new states. This kind of limitation surfaces more often than is realized. To mention an analogous situation: American writing about China during the period of the cold war revealed more about Americans and their collective fears than it did about China itself.

It is the sequel to this "history of prescriptions" that is perhaps so expressly uninspiring. The empirical failure of all these prescriptions has been already obvious to anyone who has kept himself informed about the situation in the new nations: that for the majority of their populations, life has become harder and poorer. At first, attempts were made to discover some consolation in the end-result of all this prodigious amount of developmental activity, and this often took the form of computing favourable aggregates and GNPs of the countries concerned. Some well-meaning "patrons" of the poor (the UNO, for example) churned out tirelessly, endless comparative figures on national and per capita incomes to demonstrate that there had indeed been some success stories: countries like Venezuela, Lebanon, Pakistan, Liberia, South Korea, Thailand and former South Vietnam had after all in fact produced "miracle" growth rates. That these growth rates, however, had bypassed the needs and welfare of large sections of their populations and had compromised their political independence in the polity of nations, was a fact still too embarrassing to dwell upon.

When it was eventually accepted, however, it became all the more necessary to locate a scapegoat that had frustrated every well-meaning attempt at development. Excluded a priori were those experts that had prepared or advised
these general strategies for the eradication of poverty: having laboured of their own free will (with a little bit of help from their computers) in the shouldering of the proverbial white man's burden, it might have been entirely impolite to accuse them of error. On the other hand, it was equally impolitic to accuse the majority of the intellectually bankrupt governments of the new nations for the continued troubled state of affairs. That left open only one, easily available, common target for the abuses of despair: the very low-income, unemployed groups or masses of people everyone had set out to "aid" in the first place: the landless labourer, the small farmer, the unemployed craftsman, and since these could be calculated upon not to react or return the attack, experts and governments set about the task with a will.

Gunnar Myrdal had already santed some respectability to the stereotype of the poor man as "mostly passive, apathetic and inarticulate." Others would follow him now, (with a thesaurus in hand) to announce a list of unflattering epithets expressing "dismay": the poor man in the new states, it was now being generally held, refused positively to be helped out of his miserable condition, he was beyond redemption, a generally pathetic case to be pitied for his ignorance, stupidity and unusual stubbornness in clinging to his traditional and illiterate ways.

Thus, George Foster, researching the underprivileged in Mexico, decried the "image of the limited good" that crippled their scanty aspirations. Banfield, in southern Italy, thought the main responsible obstacle "amoral familism", which in turn produced layers of "political incapacity" to demand and work out progress. Charles Erasmus, again in Mexico, identified the way of life of the people there as characterized by "inconspicuous consumption" and "keeping down with the Joneses", an attitude he found objectionable, even pathological.

It is to the credit of a few scholars in the Dutch social science world that they made systematic attempts to run against the stream of generally inflated invectives.
Gerrit Huizer, for example, was able to paint a different picture of the unprivileged groups in Latin America when he made an attempt to observe the world through their eyes. And Willem Wertheim, in numerous articles and books, expressed his conviction that the principal obstacles set in the path of the emancipation of the poor came, not from below, but from above. But that they have not succeeded in stemming the tide of false perceptions is evident now in the influential opinion spread abroad that the poor, if they must remain poor, must at least be taught to stop breeding more of their kind. A variant of the Marie Antoinette proposal has become the order of the day: if they have no bread, let them swallow pills. And one country in recent years has set about making compulsory sterilization a law.

Therefore, this thesis.

Let there be no grounds for misunderstandings: this thesis carries no intent of defending the attitudes and perceptions of the poor, the large silent majority of low-income, permanently economically insecure groups in the new states. They need neither a defender nor a defense. If, on the other hand, this thesis lays any claim to a semblance of originality, that may lie in its indication precisely of their achievement, the nature of which has less to do with the fact of their remaining poor than with their success in remaining alive.

Let me put it this way:

Consider a man born into a society as poor as India’s. From the moment of his birth till the moment of his vastly hastened death, no welfare economy will aid him ease the tremendous disadvantages thrown into his path. If he needs a house, his lack of savings and credit will lock his need. So he must build one from bits and pieces of cardboard and rusty tin sheets. His life itself will follow a similar pattern, in being put together from a larger range of other bits and pieces. Unemployment is a near-fatal liability, not a social inconvenience as for his counterpart in a protected economy like the Netherlands.
More important, he is born into a society where power, political and economic, is exercised in the interests of protecting the privileges of just about five per cent of the population. He must sell his labour at a continuous disadvantage. If he owns a little land, he has equally little access to the means to improve it. And for the protectors of privilege, he is little more than a burden, the coloured man's burden in a world where colour has made little difference to the nature of exploitation itself.

For those whose idea of what an engineer is, is restricted by the role of the engineer in highly industrialized societies, what comes now may seem difficult to accept. The traditional engineer is a person who uses trained skills and the insights provided by experience in the solution of technical or productive tasks. The engineer solves technical problems, and what is more the case today, exploits a vast arsenal of research possibilities to create new technology. This hides the fact, however, that the engineer, even at this high stage, is still an engineer of necessity: in a market that can only thrive on the principle of built-in obsolescence, the engineer must innovate or the productive system of which he is a part will not survive. Today, the threat of resource shortages has provided one more reason for him to innovate or invite disaster. There is one crucial point however: the engineer is not engaged in a struggle for primary survival, a matter of life or death; if he loses, the most that can happen to him is that he is forced to join the ranks of the unemployed; the degree of his available comforts is decreased, but the welfare system sees he still gets to eat.

The economically insecure man in the new nations, however, is also engaged in the task of survival, only this time we note, this survival is primary. Considering the range of odds against which he must struggle and his experience thus far in using all his wits about him to remain alive, he comes very close to being an engineer par excellence. The technology he uses or creates is not a technology for the maximization of profit, but a survival technology: the
expression is Kwee Swan-Liat's, not mine. And fully half the population of today's world are survival technicians, and they do not come within the pale of the Western technological system. They are craftsmen of necessity and that necessity is in a very real sense rationally engaged.

For, a survival technology only makes sense when viewed in the context of a survival algorithm: a set of rules of farming, for instance, that ensure a tolerable minimum output. Faced with an absence of capital resources and a heavy dependence on climatic conditions, the farmer's principal focus of attention is directed to the minimizing of risk; in economic terms, he prefers to give up some expectation of profit so as to reduce risk. A new, alien cropping system, because it has no history of experience to back it, contains a large component of risk: its failure means ruin, forced sale of land or debt.

The rejection of new ways in preference to the old is the protective reflex of the overwhelming majority of farmers who know very little except that life is a fragile possession, and that tried and true ways, however onerous, have at least proved capable of sustaining it. A mulish perseverance in old ways is not without reason when life is lived at the brink of existence where a small error may spell disaster.

Thus, each family finds, inherits, and defends from experience, farming procedures that ensure survival as a landowning unit. This survival algorithm suits the family's risk aversion, preference between income and leisure, liking for various seldom-traded vegetables inter-tilled with the main crop, auspicious days and dharma (caste duty). In a complex affair that involves life and death, it would be inviting danger needlessly by accepting a new practice that is "improved" only in the context of someone else's algorithm.

In the grand Chinese tradition that recommends a picture to a million words, here is an example: Margaret Mead once wrote of a team of United Nations agricultural experts, who tried some years ago in vain to persuade
The fact that nearly 200 years after the industrial revolution first gather momentum, half the world's population still finds itself bound in its struggle for primary necessities to survival technologies is embarrassing enough, but not important. Disturbing, however, is the idea still at the back of most learned men's minds that the underprivileged part of the world cannot hope to save itself except through the replication of the Western paradigm of cultural and technological development. The basis for such a belief is perhaps the unwarranted and specious assumption that there is but one form of technological development, that which came to fruition in the history of the Western world. The implication of that is worse: the discounting of any suggestion that the non-Western world lacks the technical capacity to solve its present problems.

Therefore, the first chapter, an essay into the philosophy of technology and culture, into philosophical anthropology.

At its most direct, the first chapter describes the changing relationships that have existed between the two principal creations of man, technology and culture, not through the ages, but in different societies or civilizations at different times. At its most precise, chapter one examines the role of technology within different cultures. It therefore examines different technologies: African, Latin American, Chinese and Indian, the earlier two in brief, the later pair, in detail. An important qualification: technology is described in the context of
the cultural program that each society constructs for and through its members over the course of time.

If these technical history-outlines and cultural programs have any significance, they surely indicate that till the pervasive impact of Western colonialism (when the process of historical incorporation, as Darcy Ribeiro puts it, began), these civilizations and cultures survived very well without the necessity or even the news of Western technology. The current impression that the peoples of the new nations live in a sort of technological wilderness first began to gain currency after the beginnings of the colonial period, after the widespread destruction of non-Western, indigenous production systems at the hands of Western man. Thus, the first chapter and the two that follow it may be seen as a concrete historical refutation of the idea of that wilderness.

The traumatization of non-Western capacities with regard to technology is examined at length in the fourth and fifth chapters, where we attempt to show how the industrialization of the British economy went hand-in-hand with the de-industrialization of other, till then, functioning productive economies. The suppression of technical capacities was paralleled by a corresponding weakness of the cultural systems of the colonized lands, and laid the grounds for an eventual, long-lasting and influential notion of the absolute superiority of Western culture itself.

Western man's high assessment of his worth was, of course, made possible by the forces let loose by the industrial revolution in England; and since this revolution came to have such a dramatic impact on the non-Western regions of the world, it is but natural that the fourth chapter contains a detailed examination of the various histories of this unique phenomenon to investigate the reason for its appearance. Here, it is necessary to pause in order to clear up a few confusions of terms.

It is necessary to make a very clear distinction between what are known as the Scientific, Industrial and
Technological Revolutions. Even learned scholars, among whom we have to include the sinologists A C Graham and Joseph Needham, tend to identify all three, which is incorrect. Stephen Toulmin and June Goodfield have been two of the few to notice the differences:

For, however spectacular the influence of science on a few branches of technology, one can easily exaggerate its impact on industry at large. Hero of Alexandria made hydraulic toys for his patrons, Galileo made calculations about the strength of beams, but the age of applied science proper began only after AD 1850. In the interaction between theory and practice, science has again and again been in the position of debtor, drawing on the craft tradition and profiting from its experience rather than teaching craftsmen anything new. It has been said that "science owes more to the steam-engine than the steam-engine owes to science", and the same thing is true more generally. In its early stages, especially, the craft tradition was - so far as we can tell - devoid of anything which we would recognize as scientific speculation.

In other words, though the Scientific Revolution (the discovery of how to discover) preceded the Industrial revolution, it did not contribute to it as much as is normally assumed. The industrial revolution, in fact, was an empirical revolution, evolving in large measure independent of the scientific revolution. On the other hand, both these revolutions should be in turn distinguished from the Technological Revolution, often also called the Second Industrial Revolution, when science turned to improve practice and revolutionized technology. Toulmin and Goodfield again:

Before AD 1850, intellectual advances within the sciences of matter no more led to immediate improvements in the crafts than had Newton's theory of planetary motion at once led to better planetary forecasting.

Another historian of science, Rupert Hall has written in similar terms. "The time-lag in each instance between the establishment of a new craft-skill," observed Hall, "and the effective appearance of scientific interest in it, is of the order of 250 years, and in each
of these examples it appears after the scientific revolution was well under way."

That said, we can return to some of the key elements of the fourth chapter and the industrial revolution. Our interpretation of this revolution follows closely the larger outlines of the new economic history of the seventies, where the role of population growth, earlier ignored, is given its legitimate place as providing the stimulus that enabled the English economy to make the vast resource changes that eventually characterized the nature of the industrial revolution itself. Why this different approach?

Simply because we cannot otherwise explain the wide incidence of poverty during the major part of the period. In 1840, a date usually placed after the first consolidation period of the industrial revolution, a liberal economist had the following picture to describe:

When trade is normal about a third of the population lives in terrible poverty and on the verge of starvation. A second third, perhaps even more, earns little more than the ordinary rural worker. Only one-third receives wages which allow them a fairly reasonable standard of living and a little comfort.

Not until 1875 would the common worker in England earn enough to provide for himself a decent subsistence and comfort. And 1875 is more than a hundred years after the industrial revolution is claimed to have gained its momentum. In a situation like this, it is hard to claim that the majority of the population approved of what was taking place, since they had to bear the burden of events. It is facts like these that have made me unnaturally conservative in my assessment of the nature of revolutions in productive systems. It seems more credible to propose that seen from the eyes of the majority non-élite, any upheaval in the nature of a technological system seems always to have been accompanied by demands for longer labour hours from the common labourer. No élite ever suffers during a period of rapid technological change, and certainly not during the eight different technological re-
volutions that Darcy Ribeiro lists and discusses in his volume on *The Civilizational Process*.

This has always been the case in history even in the most general terms, that is, in periods of gradual technological change too. If we examine the relationship that has always existed between politics or power and a technological system, then, I think, it would be difficult to locate any historian of technology that will deny that in the past, in different cultures too, the larger fruits of a productive system have existed for and been enjoyed by powerful, ruling élites. The point of the fourth chapter is, that during periods of technological change (of the radical variety) exploitation is deepened rather than relieved, and England during the industrial revolution was no exception to that pattern.

(A careful reader of this thesis might, on reaching its end, notice three underlying levels of this "interpretation from below". In discussing past revolutions, technological of course, I seem to be arguing from a perspective that I feel could be identified with the condition of the majority part of a society undergoing those revolutions; at the level of the present, I seem to be confronting a small, influential and powerful Western world through a perspective quite non-Western. Finally, I seem to be arguing at the third level, from the perspective of the survival technicians in opposition to that of new-nation élites and the world-wide industrial system of which they are a part).

Chapter six discussed the Indian and Chinese responses to Western technology, both, during the period roughly after 1850 when they were subject to Western political dominance, and after 1947/49, the period of independence from that dominance.

Chapter seven, of course, contains my conclusions, which I suppose would be absolutely against the spirit of any work of this sort to disclose right now. Though, if there is any logic in the idea of appropriate techno-
logy, readers should be able to reach those conclusions by themselves.

One final point concerns my choice of a specific triangle of cultures (Indian, Chinese, English) to work out the main outlines of my thesis; also, a not unrelated issue, the period limitations selected for the purpose.

I have chosen this particular triangle of nations because among themselves they seem to exemplify the peculiar interaction of civilizations that can be used to illustrate a thesis of this sort. All three have had distinctive technological histories and different cultural systems, constructed in the main independently of each other's experience. After 1800, however, India had become England's colony, under total political control of Empire. China, on the other hand, remained politically independent, yet greatly compromised by the dominance of the Western powers. It was in fact a semi-colony. Thus, though both India and China faced Western dominance, the nature of this alien interference in their societies was different in many respects. On the other hand, both received or declared their independence within two years of each other and then moved in different directions to meet the problems their societies were faced. For comparison and analysis we have here then a near-controlled situation. The nations of Latin America, for example, received political independence earlier, and those of Africa, later, than these two. This is, however, no excuse and I hope a future work will give equal treatment to both these important continents.

Another student engaged in a similar enterprise as this one might well have used another triangle of nations to illustrate his thesis: the Netherlands, Java and Japan. I have stuck to one triangle however for reasons of space and time. I am quite aware, further, that the structure of other triangular interaction histories would not differ very much in essentials from the one examined in this thesis.
This is all in general. More particularly, it would also have been fascinating to examine the different responses to the rise of population (in chapter four) in Japan, America, the Netherlands and Indonesia - but except for listing specific volumes that discuss this question in the bibliography, I must leave it aside for reasons of space.

Finally, the dates.

The years between 1498 and 1947/49 form a period through which the West gradually gained dominance and control of India, and to a lesser extent, China. The Asian historian, Sardar Panikkar termed the period, the "Vasco da Gama" epoch. But a very careful qualification is necessary here to avoid misunderstanding.

Though European contact with Asia begins in 1498, effective dominance over Asian economies came very much later. In India, such dominance dates from 1757, when the British were given control over a district of Bengal. Here again, the British conquest of the sub-continent was only completed in 1848. Even then, about one-third of India continued under the control of indigenous princes. Nevertheless, we have felt it more reasonable to take the period 1498-1757 as a realistic time continuum to describe Indian technology and culture before British disruptive influence. In actual fact, we cross the boundaries of these date-limits more than once.

With China, for example, we begin earlier, with the Dynasty of the Ming (1368) and end our description of Chinese technology and culture with 1842, and the treaty of Nanking accepting foreign domination. Again the boundaries are crossed, indicating thereby that the dates should be understood as psychological points of a new period following on a more indigenously oriented one.

In both China and India, industrialization exploiting elements of Western technology began after 1850. The period 1947/49 to 1972, a quarter century, is I feel adequate and long enough to make comparative assessments and analyze long-term and general trends.
Note: In order to preserve the readability of the introduction, I have dispensed with notes. The bibliography that follows, however, is listed in the order in which authors and volumes appear in the text.

Geertz C, *The Interpretation of Cultures* (1973)
Benedict R, *Patterns of Culture* (1934)
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Panikkar K M, *Asia and Western Dominance* (1953)
Drucker P, *The Landmarks of Tomorrow* (1959)
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Huizer G, *Rural Extension and Peasant Motivation in Latin America and the Caribbean* (1973)
Streeten P & Lipton M, *The Crisis of Indian Planning* (1968)
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(The volumes from Wilkinson to Braudel deal with the role of population growth in the economies of England, China, Japan, America, the Netherlands and Indonesia).
Bronckhorst B van, *Development Problems in the Perspective of Technology* (1974)
Hensman C R, *From Gandhi to Guevara* (1969)
Hesseling Pjotr, *Organizational Behaviour and Culture: The Case of the Multinational Enterprise* (1971)
Chapter One

Homo Faber: A New Anthropological Model

A chapter that is in essence an essay on the central concept of philosophical anthropology, wherein we propose a new anthropological model for understanding the nature of man. The essay begins the task of defining the term (homo faber) by examining what it is not, before moving on to provide a more inclusive description with a little bit of help from Kwee Swan-Liat, Clifford Geertz, Johan Huizinga and Ernst Cassirer. Man is by nature, as homo faber, predisposed to technology and culture. The truth of this description is then examined in different civilizations, briefly in Korea, Africa and pre-Columbian America; in greater detail in China and India, and also Islam. This chapter then, does not stand alone. As a theoretical model it works itself out in the three chapters that follow. Thus, the first four chapters constitute a chain of events in idea and history.

"If you wish to converse with me," said Voltaire, "define your terms." Our terms, homo faber, are Latin ones, and even M Voltaire would have conceded that a line of thought expressed in one language cannot be translated without loss of meaning into any other language: entropy? But the translation is easy. Faber in Latin, means a smith or worker in hard materials, and a faber worked in a fabrica (1. The verb, of course, is facio, to make, and so homo faber means, quite simply, man the maker, which for our purposes is both inelegant and vague. Kenneth Oakley, fifteen years ago, wrote a book, Man the Tool Maker, which described early man's ability to use tools. The Dutch scholar, R J Forbes, embracing
a wider field—the history of invention and engineering—used an abbreviated version of Oakley's title: *Man the Maker*, and his book appeared ten years earlier.

Perhaps, we could translate *homo faber* as man the fabricator; but this is clumsier, and more important, not at all precise. We need an English term or phrase which, while remaining simple, would agree to contain a large reservoir of interconnected meanings, including those identified with man as he makes, builds, constructs, invents, fabricates or creates his world. We are interested in artefacts, and these are not to be restricted to tools and machines. Languages, thought systems and symbols are also artefacts, for they came into existence only after man began to walk the earth. Man extinguished, artefacts fall, meanings disintegrate, only natural events remain. There is no English word that summarises this wide range of meanings, so the living having forsaken us, we return to dead Latin and *homo faber*.

The English historian, Thomas Carlyle, found man to be a "tool-using animal." The American, Benjamin Franklin, more confident, enlarged that to "tool-making animal." This, of course, is not much of an improvement on Oakley, yet the late Jacob Bronowski, who should have known better, was willing to be impressed. In *The Ascent of Man*, he wrote:

> We have to understand that the world can only be grasped by action, not by contemplation. The hand is more important than the eye. We are not one of those resigned, contemplative civilizations of the Far East or the Middle Ages, that believed that the world has only to be seen and thought about and who practised no science in the form that is characteristic for us. We are active; and indeed we know, as something more than a symbolic accident in the evolution of man, that it is the hand that drives the subsequent evolution of the brain. We find tools today made by man before he became man. Benjamin Franklin in 1778 called man "a tool-making animal", and that is right (2.

Such unbounded, embarrassing chauvinism might be
better left ignored, were it not for the fact that too ma-
ny writers suffer a similar jaundice. So I halt here, at
this stage, to attempt to understand, first, why theories
of this sort ever appear in print, and second, to examine
whether the proposition that man is a tool-making-using
animal is any adequate description of him in the first
place.

The first issue can be dealt with in brief, for I
shall return to it continually during the thesis; it con-
sists essentially of the Marxist-inspired recognition of
the insight that the individual consciousness is more of
a social creation than is normally conceded. In our con-
text, the dominant idea of what constitutes the nature of
man at a particular period in history very often reflects
other ideas generally in circulation in that period. John
Cohen has a brief, amusing history of the number of mo-
dels of man broached in this way, in the course, natura-
ally of Western history. (3.

The second century physician Galen, for example,
compared the processes in the brain and nervous system
with the mechanisms operating in contemporary reservoirs,
aqueducts, fountains and baths, a description not so
strange when we remember that Homer spoke in terms of a
"liquid soul", and Thales logically tried to prove that
he saw water everywhere. The activities of the medieval
and later alchemists laid the basis for a metallurgical
psychology, a good example of which was John Pordage, who
wrote:

Accordingly and so that I should arrive at a funda-
mental and complete cleansing from all tares and
earthiness.... I gave over my will entirely to its
(wisdom's) fiery smelting furnace as to a fire of
purification, till all my vain and chaff-like de-
sires and the tares of earthly lust had been burnt
away as by fire, and all my iron, tin and dross
had been entirely melted in this furnace, so that
I appeared in spirit as a pure gold, and could see
a new heaven and a new earth created and formed
within me.

If Francis Galton had a geological model, Spinoza
had his own geometrical one, and one respectable clergyman, in 1859, proposed the application of algebra and the calculus to metaphysical, moral, social and political problems, even to church matters, and translated the eighteenth Psalm into calculus language to demonstrate that

the increase of David's educational excellence or qualities - his piety, his prayerfulness, his humility, obedience etc., - was so great that when multiplied by his original talent and position, it produced a product so great as to be equal in its amount to royalty, honour, wealth, and power etc., in short, to all the attributes of majesty.(4

Everyone is familiar with the 1747 L'Homme-Machine of La Mettrie. Or with the cybernetic approach first presented by Norbert Wiener in our own century, but there are literally a hundred more models of the sort, so is it so extraordinary, that in a primarily technological age, that we should incline to a definition of man in terms of his tool-making activities? Anthropologist Mary Douglas is one of the few to recognize the deeper issue, particularly when we move outside the operative limits of Western society itself.

In her rather splendid introduction to Louis Dumont's Homo Hierarchus, she observed that "it is self-defeating to restrict sociological inquiry to modern industrial societies and so to restrict the very idea of what forms man in society can take." And we might add, of what terms he might use to describe himself, particularly in other cultures.

If we seek objectivity, we must recognize our own fundamental assumptions for what they are: the creation of our place and time. If we mistake our current idea of the nature of man for the eternal laws of nature, we are blinkered by cultural restraints on perception (5.

One philosopher of our times for whom this kind of objectivity comes quite naturally is Lewis Mumford, and here we pass over to our second issue of the aptness, if any, of attempting to pass man off as a tool-using animal.
Indeed, the immediate provocation for Mumford's double-dekker, *The Myth of the Machine*, was precisely this description of man as a tool-using-making animal. In the prologue to this work, he cautioned against overstressing the role of tools in early man's development just because of man's obvious need for tools. Otherwise, we in fact ignore a wide range of other activities in which many other species have for long been more knowledgeable than man. Containers, for example. Insects, birds and mammals had made far more radical innovations in the fabrication of containers, with their intricate nests and bowers, their geometric beehives, their urbanoid anthills, and termite towers, than man's ancestors had achieved in the making of tools until the emergence of homo sapiens. In short, if technical proficiency alone were sufficient to identify and foster intelligence, man was for long a duffard, compared with many other species.

The point that Mumford is making here (and one which Johan Huizinga also made) is that the narrow description of *homo faber* does not immediately serve to distinguish man from animal, from *animal faber*. Admittedly, Köhler's apes have done a great deal to blur the distinction; ethology even more. That animal capacity has long been underrated is now more obvious to those who follow the tremendous research being put into animal nature, (recently summed up in a volume by W H Thorpe) (7). Niko Tinbergen notes:

> It was said that 1) animals cannot learn; 2) animals cannot conceptualize; 3) cannot plan ahead; 4) cannot use, much less make tools; 5) it was said they have no language; 6) they cannot count; 7) they lack artistic sense; 8) they lack all ethical sense.

Tinbergen himself feels that all such distinctions have either been dropped or come to be seen as differences of degree and not as aspects of a fundamental discontinuity. Karl von Frisch has recently written a volume, appropriately titled, *Tiere als Baumeister* (9). The building programs of plants will come as a surprise to those who glance through Felix Paturi's *Nature: Mother of Invention*, the engineering of Plant Life (10). Later, we will attempt to provide a *homo faber* model that takes note
of these elaborations.

Mumford suggests in conclusion, that should we need proof of man's genuine superiority to his fellow creatures we would do better looking for a different kind of evidence than his poor stone tools alone:

Or rather, we should ask ourselves what activities preoccupied him during those countless years when with the same materials and the same muscular movements he later used so skilfully he might have fashioned better tools (11).

A suggestion also recommended by anthropologist, Clifford Geertz, in his recent volume of scintillating essays, The Interpretation of Cultures. Beginning with the observation that most of the available evidence from archaeology and palaeontology firmly places the Australopithecines within the line of the hominids, and that the brain of Homo sapiens is about three times as large as that of the Australopithecines, he concludes that the greater part of human cortical expansion has followed, not preceded, the beginning of culture.

In other words, it makes more sense to believe that culture was ingredient, and that too, centrally ingredient, in the production of the human animal, rather than to think of it in terms of being added on, so to speak, to a finished or nearly finished animal. And by culture, Geertz has in mind much more than the mere perfection of tools. It would also include the adoption of organized hunting and gathering practices, the beginnings of true family organization, the discovery of fire, and most critically, "though it is as yet extremely difficult to trace it out in any detail, the increasing reliance upon systems of significant symbols (language, art, myth, ritual) for orientation, communication, and self-control." All created for man a new environment to which he was then obliged to adapt.

Thus does Geertz lay to rest the restricting theory that tool-making once drove the evolution of the mind:

Because tool manufacture puts a premium on manual
skill and foresight, its introduction must have acted to shift selection pressures so as to favour the rapid growth of the forebrain as, in all likelihood, did the advances in social organization, communication, and moral regulation which there is reason to believe also occurred during this period of overlap between cultural and biological change (12).

The *homo faber* theme has been discussed and debated by a number of other thinkers, all Western, and if this had been a thesis strictly concerned with a Western philosophical anthropology, it would have indeed been necessary on my part to have examined the relevant literature thereby produced. Since this is not the case, however, I must pass these thinkers by, though I should mention that it was Henri Bergson who first threw the *homo faber* concept into the general circulation of ideas. His understanding of it, however, would not escape the criticisms of Mumford and Geertz. Other notables in the Western tradition that have contributed to the debate in no mean terms were Max Scheler, Arnold Gehlen and the late Hannah Arendt. In my opinion, however, only Mumford and Geertz have contributed insights valuable for a transcultural philosophical anthropology, with which this thesis is actually concerned (13).

Besides *homo faber*, a generalized philosophical anthropology offers us two other characterizations that seek to extend the nature of man: *homo ludens* and *homo symbolicus*, and it is to these that we must now turn, particularly if we keep in mind that *homo faber* is a layer of meaning that cuts across these other two.

It was the Dutch historian, Johan Huizinga who first broached the *homo ludens* concept, particularly through the period 1933/37. In the foreword to his volume of a similar title, which speaks for itself and the theme of the volume, he wrote:

A happier age than ours once made bold to call our species by the name of Homo Sapiens. In the course of time we have come to realize that we are not so reasonable after all as the Eighteenth Century, with its worship of reason and its naïve optimism, thought us; hence modern fashion inclines to de-
signate our species as homo faber: Man the Maker. But though faber may not be quite so dubious as sapiens, it is, as a name specific of the human being, even less appropriate, seeing that many animals too are makers. There is a third function, however, applicable to both human and animal life, and just as important as reasoning and making — namely, playing. It seems to me that next to homo faber, and perhaps on the same level as homo sapiens, Homo Ludens, Man the Player, deserves a place in our nomenclature (14).

Homo Ludens translated as Man the Player is dis euphonious, and like our own title, the original Latin was preserved in the English version of Huizinga's work. What robbed the book of its original intention, however, and weakened its force, was the translation of the subtitle. Huizinga, in London, had sub-titled his lecture, The Play Element of Culture. The English insisted (and finally, the translator too) that it should be changed to read, The Play Element in Culture, which as Mumford was quick to point out, is extraordinarily tame and unrevolutionary, even imprecise, since it does not readily express Huizinga's real claim: that culture is play, stark and simple. This claim Huizinga substantiated with illustrations drawn from various cultures, including China.

His conclusion:

It has not been difficult to show that a certain play-factor was extremely active through the cultural process and that it produces many of the fundamental forms of social life. The spirit of playful competition is, as a social impulse, older than culture itself and pervades all life like a veritable ferment. Ritual grew up in sacred play; poetry was born in play and nourished on play; music and dancing were pure play. Wisdom and philosophy found expression in words and forms derived from religious contests. The rules of warfare, the conventions of noble living were built up on play-patterns. We have to conclude, therefore, that civilization is, in its earliest phases, played. It does not come from play like a baby detaching itself from the womb: it arises in and as play, and never leaves it (15).

I have however, a large doubt whether Huizinga's description of man would still be useful to us in our understanding of human behaviour in the industrial countries
of our contemporary world. Later, I shall argue that in-
dustrial man has permitted this important dimension of
his being to suffer a temporary eclipse. A high-consump-
tion society is in my mind incompatible with the play ele-
ment of its culture. And Walter Kerr, the American drama-
tist, was not the first to document "the decline of plea-
sure" in the industrial civilization of which he was a
part, but his account goes deeper into the problem than
any other I have ever known (16. Kerr analyzed the wide
influence of utilitarianism in American culture and the
resulting inability of American man, at least, to play.
In cultures still outside the reach of the industrial
umbrella, Huizinga's *homo ludens* still thrives.

As important as play or tools, is the symbol in the
life of man, and this dimension of the human world was
described and analyzed in detail by Ernst Cassirer in his
monumental work, *The Philosophy of Symbolic Forms*. *Homo
ludens* is also *homo symbolicus*, and there is little evi-
dence to dismiss Cassirer's case.

Cassirer notes that man no longer lives in a physi-
cal universe: he inhabits instead a symbolic world. Lan-
guage, myth, art and religion form parts of this unphysi-
cal world. In other words, they are the diverse threads
out of which the symbolic net is woven, which sits in
turn like a complex web on human experience. All pro-
gress in human thought and belief refines and reinforces
this web.

Man, said Cassirer, is unable any longer to meet
reality directly: between the real and the human mediates
the symbolic. To the extent that the symbolic activity
of man increases, the significance of the physical in-
versely decreases or recedes. The multitudinous world of
languages, of images in art, of mythical symbols and of
religious rites, betrays the fact that man cannot know or
see anything except through the medium of this pervasive
edifice (17).

The reason I have stated that *homo ludens* and *homo
symbolicus may serve as the foci of a generalized, transcultural philosophical anthropology is because there is no culture which does not manifest their existence. On the other hand, homo aequalis, for example, may be considered as a perfect sample of a particular philosophical anthropology (in this case, the Western one), simply because in another particular philosophical anthropology, that of India, precisely the opposite characterization of man obtains, based on reverse assumptions, and which Louis Dumont has termed, homo hierarchus. A scientist or philosopher who sets out to apply the qualities of homo aequalis to his understanding of Indian man is then automatically betraying his ethnocentrism.

THE NEW MODEL

In what went before, I argued that any definition of homo faber merely in terms of his tool-making propensities was woefully inadequate, since such an identification ignored more facts than it used. I also added that any philosophical anthropology that does justice to the essential elements of every culture should also seriously consider the insights of Huizinga and Cassirer. In what follows, I propose a new model of man as homo faber which I hope will take all these points into consideration.

This new homo faber model will also serve to distinguish man from animal, but this in the sense of a figure-ground juxtaposition, in which man is set against animal, so that his figure and character lies heightened against the foil provided by his animal past. But caveat lector. I am wholly at one with Niko Tinbergen's conclusions above. Our "fundamental distinctness" from the animal world, I am concerned to note, because doubtful in theory, has led to inhuman practice: it has allowed us,
with impunity, to make extinct entire species and to in-
flict brutal and senseless tortures on animals in our un-
controlled urge for doubtful scientific research. Every
year, in the United States alone, at least 63 million ani-
mals undergo "experimentation". In England, the number
is 5 million. These are merely two countries with such
programs. The occasional twinge of conscience has dicta-
ted the "devocalization" of some animals, to prevent them
from screaming. Cats have their paws cut (recommended)
to prevent them from scratching in rage. And tests like
the Draize formula, to try out new cosmetics, are carried
out by dripping concentrated solutions of the product
into the eyes, usually of rabbits, to measure the result-
ing injury.(18.

The new model I propose, and elements of which come
from the writings of the Dutch philosopher, Dr Kwee Swan-
Liat, may enable us to see, not just man, but even animals
differently. For, if this model does help us to distin-
guish homo faber from animal faber, it is because it can
propose that any such differentiation is possible precise-
ly because of a similar base in animal and man; and fur-
ther, sees the cultural pluriformity of the human species
again as a fundamental outgrowth from a structure that
is again very similar to both animal and human nature.

Kwee's writings on the subject are to be found in
De Mens tussen mythe en machine (1974), but for the pur-
poses of this thesis we choose to examine a later, brief-
er essay, Mens en Gereedschap, which contains all the raw
material we need. There are two important parts to the
discussion: in the first, Kwee describes the differing
responses of animal and man in relation to culture, and
in the second, in relation to technology. We begin with
the first. Kwee writes:

Man is not alone is being able to construct an arti-
ficial environment. Animals too produce all kinds
of artefacts. They produce, collect and work diff-
erent types of material, through which they are
able to give an appropriate form and shape to their
direct environment. Coral, spiders, bees, termites
birds, beavers: all are capable of impressive constructions. There are, however, important differences between the building activities of animals and those of man (19).

The structures animals are able to build, notes Kwee, are directed by an innate program. Spiders, bees and birds have no conscious goals other than their webs, hives or nests. Yet, they are able to carry out, in proper order and coherence, faultlessly, purposefully and effectively, the various constitutive stages of their program.

Man, on the other hand, lacks this internal instinctive program. But it is precisely due to this lack that he possesses the potential for learning from and through experience. On dissecting this experience, he is able to develop a continuous insight into the possibilities of his artefacts. And combining these possibilities within reflection, he can propose objects or goals far removed from the given.

Since the behaviour pattern of animals is internally programmed, they encounter difficulty in being able to choose or change or vary their activity. The pattern and the resulting structure are characteristic for the species, not for the individual within the species. The nests of swallows and weaver-birds may vary among themselves, but within the species themselves, there is little variation. The building program, the blueprint, is already given: the implementation is instinctively regulated.

As we said earlier, because men do not possess a genetically determined building program, they are able to invent a building program themselves. The plan, further, can be pictured, discussed with others, modified and carried out, either by the individual or through a social consensus. Stonehenge, the pyramids, palaces, temples, caves, olympic stadiums, cathedrals and supermarkets, as examples, are only sensibly understood within the framework of the goals and ideals that lie underneath.
The goals may be described variously: they may be military, religious, political or economic. Even playful.

Thus far, the ideas of Kwee. There is another side to the coin, put forward by Clifford Geertz, in the volume that we have already mentioned. Geertz points out that man himself works out his life within certain limits, the limits set by his own culture's program. As he puts it, the fact that culture was ingredient in the early development of man, means that while we have been obliged to abandon the regularity and precision of detailed genetic control, we have also simultaneously in the direction of a more generalized system of control provided by cultural sources, the accumulated fund of symbols: this symbolic or cultural control over our conduct is not to be seen as any less than the earlier instinctive program:

To supply the additional information necessary to be able to act, we were forced, in turn, to rely more and more heavily on cultural sources - the accumulated fund of significant symbols. Such symbols are thus not mere expressions, instrumentalties, or correlates of our biological, psychological, and social existence; they are prerequisites of it. Without men, no culture (Kwee); but equally, and more significantly, without culture, no men (20).

As I said, Kwee and Geertz both examine the same coin, but from different sides: there is no contradiction in the two views. There is no doubt that man is often free to invent and implement his own programs. Here, Kwee's ideas find much greater elaboration in the writings of the Spanish philosopher, Ortega y Gasset, who noted that from the point of view of bare living, the animal is perfect and needs no technology. In words, practically paralleling those of Kwee, he added about man:

In the vacuum arising from the transcendence of his animal life man devotes himself to a series of non-biological occupations which are not imposed by nature but invented by himself.... Is human life in its most human dimension a work of fiction? Is man a sort of novelist of himself who conceives the fan-
ciful figure of a personage with its unreal occup- 

tion and then, for the sake of converting it into reality, does all the things he does—and be- 
comes an engineer? (21.

Yet, with Geertz, it is difficult to deny that the very structure of our thinking about goals, the framework of mind, is provided by culture. And because we have different cultures, we have in reality also different cultural paradigms, different programs. If technology is an element of a total cultural system, one culture's understanding of technology will differ from another's. Therefore, in a very real sense, it becomes possible to speak in terms of alternative technologies. There is a characteristic passage in Geertz that might have also been written by Kwee, if a turn of phrase be permitted:

Beavers build dams, birds build nests, bees locate food, baboons organize social groups, and mice mate on the basis of forms of learning that rest predo- minantly on the instructions encoded in their genes and evoked by appropriate patterns of external stimuli: physical keys inserted into organic locks. But men build dams or shelters, locate food, organ- ize their social groups, or find sexual patterns under the guidance of instructions encoded in flow charts and blueprints, hunting lore, moral systems and aesthetic judgments: conceptual structures molding formless talents (22.

Homo faber for Geertz is also homo fabricatus. The ideas, values, acts, even emotions of men, like their nervous system, are cultural products, manufactured out of the capacities, tendencies and dispositions with which they are born: men, like their cathedrals or their tem- ples, are cultural artefacts.

The second element of Kwee's homo faber model con- cerns technology, and as with the first, Kwee discusses this issue too by distinguishing animal technical capaci- ty from human technological possibility. He writes:

This important difference between the internal, ge- netically and instinctually programmed blueprint available to animals and the external, blueprint programmed by men through social communication and
consensus connects with another fundamental difference, namely, that between the organic, bodily specialization of animals and the organizational and technical instrumentality available to man (23).

In other words, both animals and men have reached a stage of bodily specialization (24), that is, the stage where their morphological development in evolutionary terms can be considered to be complete. In the case of the animal, however, the state of specialization determines their activity; and in the case of man, the state of specialization provides a flexibility that allows in turn the fulfilment of purposes other than activities or goals internally programmed.

Thus, spiders and caterpillars possess glands that produce material for their webs and cocoons. Colonies of bees and termites avail of a division of labour based on a bodily-determined, specialization of functions. On the other hand, the hands of man have, very early, provided him with an escape-hatch through which he has been able to avoid the limitations of a set, morphological structure. These hands enable him to work materials, to build, and to construct according to a program he himself constructs. Every culture has also a system of technology, and therefore, especially if it has survived for a long length of time, also a history of technology.

Even with this second element of the model, however, we find another perspective, another side of the coin. For, this technical possibility of man can work within prescribed limits: the limits of the natural environment. A culture's ecology is a subsystem of a larger natural ecology that contains it. Material culture constitutes the bridge between the two: *homo faber*, the bridge between culture and nature.

The earth, in other words, comes before *homo faber*: the natural environment existed before he did. If he moulds it with the unique flexibility of his hands, it in turn moulds him as much. The course of civilization wends its way not necessarily westward, but in the direc-
tion of resources and fields. As man starts from the Tropics, the path of empire is mostly north and south; and today, it may laugh at all formulas and turn backward to the east. But everywhere, the culture of the soil precedes and conditions the culture of the mind.

There is here, as before, no contradiction. If most species may only operate within the confines of their specific ecological niches, man's ability for culture enables him to create his own ecological niches or exploit different ones. Though in one sense he finds himself restricted in having to adapt to his environment, in another sense it is his very ability to do so that lays the basis for a varied history of technology.

Take an obvious example. In the very first volume of his studies in ancient technology, where he discusses the use of bitumen and petroleum in the old world, R J Forbes remarks on the fact that while bitumen was a common building material in the eastern half of the Fertile Crescent and an important element in the mummifications and lacquers of Egypt, yet, with the arrival of Hellenism, it decreased in importance. The Greeks and Romans instead preferred tar and pitch. Forbes found a simple explanation for this.

According to him, the frequent use of bitumen for all manner of purposes, presupposes the production of large quantities of the material, available of course as natural resources. This the people of the Fertile Crescent had in plenty. While they did know that the production of charcoal for metallurgical and heating purposes produces tar as a side effect, the quantity of wood available in the area had already been greatly diminished.

The Romans, on the other hand, found it difficult to exploit bitumen because it sat under enemy control. But the production of tar and pitch were greatly eased by the presence of the large forests of Calabria, Thessaly and the territories of north-western Europe. (25)

It is more instructive to examine the rise of tech-
nology in places where environmental pressures prescribe harsh and strict limits to production. In *Craftsmen of Necessity*, Christopher Williams provides a panoramic view of a number of indigenous communities today that must cope with difficult temperatures and limited materials, and whose technology is in fact a response to environmental pressures.

Thus, two hundred people live in homes under the ground, constructed by themselves, in southern Tunisia; a few miles deeper into the Matmatas range, where the environment can offer the inhabitants the luxury of a single material:

A village of Sahara Berbers has established a permanent home on a mountain of rubble stone. Stone houses them, holds their water, food, stairways and latrines, grinds their meal and cooks their bread (26).

In the Arctic circle, where only groves of stunted birch can grow, the Lapps use the wood for the skeletal structure of their homes, and for their hunting equipment. Williams goes on to describe the mud houses of the Bedouins in Syria, the mortarless stone walls of north-western Bulgaria, the manufacture of boats in Turkey, Egypt and in the boatyards of the Calabria section of Italy and the art of contemporary blacksmiths near Mount Etna in Sicily.

When a human society has been living in the same place for a long period of time and operating in the same manner without the need to change because of diminishing supplies, we can assume that that society is in balance with its environment. It consumes, but not enough to deplete; its wastes and excesses are somehow utilized (27).

Take present-day Egyptian technology: traditional and modern. Egypt's agricultural land is a little more than a green strip four hundred miles long; beyond that lies the memory and reality of the desert. So there is little waste.

Their environment is composed of four primary elements: the sand, the river, the waterborne mud carried by the ebb and flow of the Nile, the palm tree that is the most important thing that grows (28).
The banks of the Nile have been recruited to support a population for a period extending 3,000 years. "The river is a continuum from the past in culture and work." An ingenious, decentralized system of irrigation, consisting of ditches and troughs and heavy water-wheels with wooden gears, the Archimedean screw, has evolved and been continued for countless years and served its purpose.

The new, mammoth Aswan dam, constructed for electricity and irrigation in upper Egypt, has had severe effects on the system of the lower Nile valley, and disintegrated the latter's function:

Before the dam, there was an annual inundation of the delta fields, which came at a time when there were no crops down and so did little damage and kept the fields supplied with fertile soil. Today the soil is less able to produce because the fields no longer have this annual influx of mud. The fish at the delta mouth have become scarce and in some places have disappeared, because the river no longer maintains food supply. And an infection carried by snails, which attacks the human body, has reached epidemic proportions as the snails, which prefer still water, have proliferated (29).

The greater half of the world still lives with simple technology, simple but sophisticated. Its people have concepts of form and function that have been developed, through experience, out of the biology of their land. But the Aswan dam is a portent of future events. The Western technological apparatus rushes in like a bull in a china shop. It invades, it disintegrates, rarely does it build. We will see this later in England and India, when we examine the process of the Industrial Revolution.

Man, wrote Kwee, is morphologically disposed to technology and culture. He is, at it were, biologically prepared or outfitted for the use of tools and plans. Every culture brings forth architects and builders, craftsmen of necessity, poets and entertainers. A culture without a system of technology is a contradiction in terms. What are termed "poor" nations today are little more than masses of people whose potential for technology has been radically reduced by external impediments.
In other words, the human capacity to exploit, through culture, a wide range of ecological niches, has been whittled down, by a hostile environment, both political and natural, to a mere necessity to cope. Which means that poor societies are often the only societies that make optimal use of their resources, because they are forced to do so: they therefore waste the least. Every bit and piece of their resources, ability and wit is exploited to meet the needs of survival.

In a non-industrial society, the observer will therefore encounter, not complexity, but sophistication. The two should not be confused, as Robert Spier has pointed out. Complexity in the modes of production is more often a distinct response from a society where numbers have arrived at the threshold of importance.

At some point along the line of increasing complexity of operations the law of diminishing returns sets in: the effort to possess and utilize all of the paraphernalia of modern life becomes too great for the returns received (30).

The descriptions of Williams concern cases of technological sophistication rather than complexity. The principles of one do not cover the rationale of the other: they are results of differing existential situations. To categorize the former as belonging to a "lower" state of technological development and the latter as "advanced" is to betray a preference for technological development per se, a preference based itself on a belief that technological change can be studied independent of the needs that have brought it about. Such an extreme view, that practically parallels the orthogenetic view in evolutionary theory, is probably evidence that some scholars' minds tend to move in straight lines, not that technological change ever does.

Thus far, we have, with the aid of Williams, elaborated on Kwee's ideas. Perhaps, the other side of the coin is more significant: the scale of restriction. It has not often received the attention due to its role. For too long have we dwelt on what man, at least in indus-
trial society has created, without seriously examin-
ing the limitations built into the structure of that
creation. We are told in numerous volumes that indus-
trial man has invented a new technological environment
to move in, which has reduced his dependence on the re-
gular, yet unpredictable, movements of nature.

In 1972, however, the Club of Rome let loose **Limits
to Growth** on a complacent world. The document studied
five factors: population, food supplies, industry, re-
sources and pollution, to conclude that mankind was
headed for disaster unless it worked immediately in the
direction of zero population and economic growth. In
other words, the Club of Rome document pleaded for a re-
turn to global ecological equilibrium. The crucial fac-
tors the document listed can be reduced to two simpler
issues: population and resources, both of which are inex-
tricably connected with technological systems, for the
latter are the means by which human societies have ex-
ploited resources to meet their needs (31).

Almost all living species have a choice between de-
veloping methods of population limitation or facing con-
tinuous starvation as their numbers begin to meet the li-
mits of the available food supply. Natural selection
seems to have led a great many species to adopt the for-
mer strategy and human societies (there is considerable
evidence for this) have often limited their numbers
through social controls (32).

The relationship between a population and its re-
sources is a delicate one, and if ecological equilibrium
is upset for any reason, resource scarcity invites in-
creasing difficulties in coping. At first, such a scar-
city may be overcome by imports to cover the deficiency,
through trade flows in general, including specialized pro-
duction for export. At other times, a society may be for-
ced to change its entire resource base entirely, look for
new resources or develop more intensive methods of exploi-
ting current ones. These will inevitably imply more in-
volved, expensive and complex production and processing
systems. The substitution of coal for wood, for example, is not merely a matter of substituting a pick-axe for an axe: it means all the problems that come with mining and the processing of coal for industrial and domestic use.

Upto and including the first industrial revolution, technological change is better understood as being stimulated when societies find themselves in phases of ecological disequilibrium. To make this clearer: productive tools and equipment are designed to exploit a particular set of resources and to transform them into the articles we need. A period of ecological disequilibrium, involving resource scarcity, will necessitate a resource change if that is possible in the circumstance. Changes in the resource base will necessitate changes in the technological apparatus. As the leading edge of culture, this technological change may force the rest of the culture to reassemble round a new productive system.

The element of pressure is important, for as a rule, technical change gives rise to more problems than it solves. Mineral resources, for example, are less easily utilizable than landbased ones, like wood, and transport becomes increasingly a problem as local self-sufficiency breaks down. Transport adds only to the cost of goods, not to their value.

More significant are the costs of the new productive system that tend to get hidden during the transition period. For example, the total costs of mining coal and processing it for human use will, in absolute terms, be greater than those corresponding to a situation where wood is the resource base because it is still plentiful and cheap. Generally, as the new resource becomes the base of a new productive system, the prices of the earlier resource have already risen due to scarcity.

From 1501-1693, for example, the general price index in England rose from 95 to 525; the firewood price index, for the same period, rose from 100 to 1058. At that stage only the rich could continue to use firewood, while the rest of the population had begun to use coal, which
of the two is less valued as a desirable domestic fuel. In our contemporary world, societies are pressing forward their nuclear energy program on the ground that it is the only possible alternative they have in a world of ever increasing depletion of fossil fuels. Those who value nuclear technology in this light will tend to highlight man's continuous ability to meet challenges, each more difficult and obnoxious than its predecessor. Others might be more disposed to see the contemporary rush to nuclear technology, even after surveying the dangers and unsolved problems it offers, as the regrettable plight of societies with their backs to the ecological wall (33).

THE NEW MODEL AND ITS USE

In what follows, I shall try to explain the reason why I have felt it necessary to propose a new anthropological model, in relation to our understanding of technology and culture, and within the perspective of a generalized philosophical anthropology.

The major conclusion (merely one is enough at this stage) is, naturally, that we can only get an inadequate understanding of ideas and technics if we study them outside their original cultural contexts. These contexts, in turn, are to be seen as systems of meanings, and therefore, in the final analysis, incomparable with each other.

Yet, it is difficult to deny that in the period of dominance that came to obtain (and still does) between the Western nations and non-Western societies, which we shall examine at length in the thesis, Western technological power arrived in the company of a conviction of the corresponding superior vitality of Western culture itself. This technological power was explicitly and implicitly used to suppress the technical capacities of those cultures that had to face it. Technological weakness was itself accompanied by a thorough-going doubt about the quality of non-Western cultural systems (also to be later
studied in the thesis. During the last fifteen decades, particularly during the last three, the peoples of Asia, Africa and Latin America, have thus been taught, directly and indirectly not merely to compare their technological systems in terms of the Western productive system: they have been pressured into defining themselves and their cultural systems in relation to a very particularistic Western philosophical anthropology. Every aspect of the life of their societies has been compared, judged or assessed in terms of what obtains in the West. Thus, the Western technological system has been seen as "advanced", their own, traditional, preindustrial or primitive. Is it really possible to make such distinctions? Are they meaningful in any terms? Can an Archimedean screw in Arabia, a Persian wheel in India, and an electric pump in England, be compared: if each of them fulfils its purpose in its own contexts, does it make any sense to think of the last as "advanced", especially if we realize that the last may be rendered obsolete through fuel exhaustion, or is constantly dependent on disruptable sources of energy?

Nowhere is this attitude (there is less reason in such a phenomenon than is normally supposed), that the "advanced" system of technology is on its way to supplant "traditional" systems in the performance of necessary tasks, more easily studied than in the literature that has arisen around the history of technology itself. Historiography has its uses, but the study of historiography even more. And there is no better way to illustrate the general purport of our thesis than by analyzing the histories of technology that are already behind us.

We might begin with the Dutch historian of technology, R J Forbes, who first published his history of technology and engineering, Man the Maker in 1950. He used the term, homo faber in the narrow sense we have already criticized, but he made his position amply clear. Not far from Mumford, he observed that early man assumed "the role of both craftsman and engineer in addition to that of artist, philosopher and teacher." However, he would use the
expression, *homo faber*, he wrote, to denote "a sociological species distinct from *homo sapiens*"; as it finally turned out, this "sociological" description preserved itself for a few pages, then gradually fused into a total description, in the same manner as Ralf Dahrendorf's *homo sociologicus* had once crossed over from the model to the real world.

Now, Forbes was one of the first historians of technology to conclude that technology was the work of mankind as a whole, and that "no part of the world can claim to be more innately gifted than any other part." Here, he was providing a useful corrective to the opinion of historian Arnold Toynbee, who had written earlier, on the basis of what evidence we do not know:

However far it may or may not be possible to trace back our Western mechanical trend towards the origins of our Western history, there is no doubt that a mechanical penchant is as characteristic of the Western civilization as an aesthetic penchant was of the Hellenic, or a religious penchant was of the Indic and the Hindu (34).

Four years later, Forbes produced the rich and prodigiously detailed multivolumed, *Studies in Ancient Technology*, which set out a remarkable-for-the-times description of the different technologies of Asia, Africa, pre-columbian America and Europe. But, it was with *The Conquest of Nature* that Forbes gave in to the attitude I have criticised through this thesis: there he subsumed the numerous and varied technical acts of men in different cultures under a philosophical anthropology that was unmistakably a Western heritage: the domination of nature. Incredibly, the volume even ended on the promise of our redemption from the consequences of technology through the event of Easter.

Another influential work of the time was the German scholar, Friedrich Klemm's, *A History of Western Technology*, which provided a presentation of Western technology in which non-Western technologies had no hand at all. Klemm's volume appeared in the same year as the first volume of Joseph Needham's work on Chinese technology. The
English translation appeared, however, in 1959: in it, Needham's work is merely mentioned in the bibliography, for purposes of courtesy. This is obvious, because Klemm could only substantiate his interpretation of Western technological development by consciously denying the reality of non-Western technological histories. In fact, the only quote on Chinese technology in Klemm's work is from the Kwan-Yinn-Tzu, a work of a Taoist mystic of the eight century AD, and the quote is paraded to prove why, in China, the religiously coloured, oriental rejection of the world could not have provided a stimulus for science and technology in that country.

My final illustration concerning the inadequate attention paid to non-Western technologies is, of course, the once-standard, *A History of Technology*, edited by Charles Singer, E J Holmyard and A R Hall in a series of five volumes. Though the first volume appeared in the same year, again, as Needham's, and though the writers themselves acknowledge that up to the Middle Ages, Chinese technology was the most sophisticated in the world of that time, little of Chinese technics is documented. This is unintelligible: three of the Singer volumes dealt with pre-industrial technology, where China should logically have been given the major space: the Western technological development should have then been added on probably as an appendix. Matters have not changed since the volumes first appeared. Derry and Williams later condensed the five volumes into a single-volumed, *A Short History of Technology: From the Earliest Times to AD 1900*. They admitted knowledge of Needham's work, then proceeded to ignore it, after a summary admission of embarrassment.

Singer's volumes have by now been laid to rest by Western historians themselves on one issue alone: that they studied technology only within the framework of its own subject matter, as if it were insulated from the rest of society. Such a treatment, wrote Melvin Kranzberg, derives inevitably from the definition of technology as "how things are commonly done or made" and
"what things are done and made." But many other questions immediately come to mind: Why are things done and made as they are? What effects have these methods and things upon other areas of human activity? How have other elements in society and culture affected how, what, and why things are done or made? The five volumes of A History of Technology codify the present state of scholarship, but they do not answer these further questions (35).

In opposition to that, Melvin Kranzberg and others founded the Society for the History of Technology in the United States in 1958, which a year later, began to publish a new international quarterly, Technology and Culture. The purpose of the new Society was to study the history of technology in its relation to society and culture. Fair enough, admirable. Kranzberg further attempted to distinguish his new journal from others in the field, like the British Newcomen Society's Transactions and the French, Documents pour l'histoire des techniques, by declaring that it would be the first truly international journal of its kind, "serving the needs of scholars in America and throughout the world."

A careful study of the journal issues over the past fifteen years, however, shows no indication of Kranzberg's promised internationalism. The majority of the articles published are still devoted to Euro-American technological history and culture and the journal as a whole has not succeeded in avoiding the parochialism of Klemm.

There is naturally a very good reason for this continuing restricted approach to the study of technology. It is taken for granted that the technology that evolved in Western societies is the only important one there is. We are speaking here of an attitude, which could make little sense without a theory to back it. The theory is sometimes called the "internalist" model of technological development; R J Forbes terms it the theory of "self-generation", based on a presupposition that there exists an iron chain of causes and effects leading to the present Western milieu: he refuses to accept it; other historians would join him in theory, but their ac-
tual works betray their acceptance of it in practice. Ortega y Gasset understood and criticized the attitude in the clearest possible terms:

One of the purposes of the foregoing argument has been to warn against the spontaneous but injudicious tendency of our time to believe that basically no more than one technology exists, the present American-European technology, and that all others are but awkward stammerings, rudimentary attempts. I have opposed this tendency and embedded our present technology, as one among many others, in the vast and multiform panorama of human technology in its entirety, thereby relativizing its meaning and showing that every way and project of life has its corresponding specific form of technology (36).

But the internalist theory continues to be held and its consequences for scholarship are evident, as we saw, even in the latest histories of technology. The reason for the continuance is not hard to find: any internalist theory, implicit or explicit, has no logical answer to the real existence of other technologies with other rationales and purposes. There are two elements here: the internalist theory must first attempt to minimize the influence of other technologies on Western technological development. In the second place, if the internalist theory is to substantiate the proposition that there is some internal dynamism or active principle in Western culture itself that explains its present technological status (as Bronowski attempted to do), it would then be hard put to explain the readily proven fact of alternative technologies that grew in non-Western cultures and in the absence of Western culture itself and the elements in it that might have had something to do with technology. Let me elaborate, briefly, on both issues.

Joseph Needham has something important to say about both. In the first place, he has turned out to be the single most important critic of the view that it is possible for scholars "to work backward from modern science and technology, tracing the evolution of scientific thought to the experiences and achievements of Mediterranean antiqui-
ty. An abundant literature exists in which we may read of the foundations laid by Greek and Roman thinkers, mathematicians, engineers and observers of Nature." Another sinologist, A C Graham, pointed out that for two thousand years Greek rationality gave no technological advantage for those who had it over those who had not. But this is probably not the most important issue. What is important is the number of inventions from India and China, to take just these two nations, that once helped fill real gaps in the technological development of the West, and have now been sufficiently documented by Needham, Lynn White and others. (37. How important were the diffusions of these inventions to the West? A simple example, from the understanding of Bacon would suffice:

It is well to observe the force and virtue and consequences of discoveries. These are to be seen nowhere more conspicuously than in those three which were unknown to the ancients, and of which the origin, thought recent, is obscure and inglorious; namely, printing, gunpowder, and the magnet. For these three have changed the whole face and state of things throughout the world, the first in literature, the second in warfare, the third in navigation; whence have followed innumerable changes; insomuch that no empire, no sect, no star, seems to have exerted greater power and influence in human affairs than these mechanical discoveries (38).

All three "mechanical discoveries" were, of course, Chinese. Yet, Western scholars find it hard to acknowledge the Chinese origin. As Needham points out, even J B Bury, who in his Idea of Progress recognized the crucial role of these inventions, failed to point out, even in a footnote, that none of the three was of European origin.

I said earlier, and this concerns the second issue, that the internalist theory has tried very nearly to absolutize the technological question for a particular purpose: if it can be shown that Western man has a special penchant for technology, this must, of course, be due to some extraordinary quality of the Western cultural system
itself. The existence of other technologies then poses a real theoretical difficulty, for it proves in essence that the connection between Western culture and present Western technology is more apparent than real.

The existence and the documentation of the existence of non-Western technologies is one of the main issues of this thesis. As I said at the very beginning, I do not intend to do the documentation myself, but the problems involved in such a task fall well within the scope of this work. In the first place, the Western monolithic framework in which technology has been so far understood has had unfortunate theoretical and practical consequences in the way of the documentation and study of alternate technologies.

Theoretically, since entire generations in Asia, Africa and Latin America have practically been taught that they had no technical past or history to speak of. A piece of propaganda, which, if taken to its rigorous conclusion, would imply that for the hundreds of years that these societies have survived (before Western contact) they have existed purely on sunshine or some form of manna that fell regularly from heaven. And if Western historians of technology have leaned over backward to explain why the West has won technologically, their other colleagues in sociology, religion, psychology, anthropology and history have found it "intriguing" to focus their analytical tools on non-Western cultures, to enquire into the conditions why these cultures or civilizations have not germinated and nurtured the kind of technological development evident in Western history recently. Religion, philosophy, tradition have been pulled out of cultural contexts to be paraded as possible disincentives to technological progress in these societies. From here, it has been quite natural a step to look to the West for "transfers of technology" and for non-Western cultures to de-recognize their own capacity for indigenous technologies.
Practically, our preoccupation with Western technology has resulted in more attention being paid by the new nations to transplanting elements of the Western technological system instead of updating their own indigenous productive systems. In the minds of planners at least, indigenous technologies are, a priori on their way out: they will eventually be supplanted by "advanced" technology. A fruitless effort thus to pay any serious attention to them.

Once, however, these categories of "advanced" and "pre-industrial" are seen to be the false distinctions they are, our attitude to technology in the world changes. If a technology is to be understood as any productive system that meets at least man's primary needs, then it would be foolish to restrict our attention merely to the technology in use in the industrial nations, for large masses of people do not use that productive system. They use another, and it is adequate more or less for their present purposes. There is an adequate proof of this: the gradual rise of population using indigenous means of subsistence.

To use the terms introduced in this chapter, it is more than necessary that we begin to see that homo faber is not to be identified merely with Western homo faber: with the Western productive and cultural system. We can at least begin to think in terms of African homo faber or the Chinese or Indian edition of the model itself. Today, it is possible to see how the model has become identified with Western capacity for technology and culture. So that we think that any technical problem can only be solved in the Western way. What indeed did the new nations and their peoples do to solve their technical problems before first contact with the West in 1500?

They had their own indigenous systems, some of which are still in use. In part, then, our study of the present could also be simultaneously a study of the past.
In an article published in *Nature*, twenty-five years ago, Joseph Needham gently took a native scholar of Siam (P Rochanapurananda) to task for disclaiming that his own people had failed to make any contribution to science. Needham mentioned the work of Loubère in the late seventeenth century on Thai science, indicating that the European had found sufficient grounds to be interested in what the Siamese knew. Needham went on to enquire about Siamese technology, particular textile technology, in which experience through long traditions had made possible a unique level of sophistication. (39.)

Twenty five years ago, men of learning in Sri Lanka were probably as alienated from their own technical histories as their Siamese counterparts. Today, the situation has changed for the better. A thorough study of the vast and ancient structures of hydraulic engineering has become the basis for a massive governmental effort to reactivate them in order to solve Sri Lanka's irrigation problems (40).

A solid contribution has recently seen print in Korea: Sang-woon Jeon's *Science and Technology in Korea*. The MIT historian of technology, Nathan Sivin has put the work in a proper perspective (also the one of this thesis) in a splendid foreword which needs quoting in some detail:

Korea's science and technology are worth knowing and thinking about in connection with technology transfer for special reasons. Unlike China, Korea's styles in thinking systematically and objectively about nature and in developing instruments and techniques of material culture were always defined in the shadow of a large and sophisticated nearby civilization. The Korean experience differs from Japan's in that its influences from China flowed in more freely and directly, across a shared land border or a short stretch of sea. It was from Korea in fact that new sciences and arts were carried into Japan during the early centuries until regular contact between Japan and China became possible. As recent Korean and Japanese scholarship begins to cohere, it
is becoming plain that we have not yet adequately recognized what a great part immigrant Koreans played in the formative phases of Japanese civilization as men of learning, craftsmen, and indeed nobles. Korea thus presents for our reflection the case of a country seeking to maintain its identity against pressures too imminent to be shut out (41).

As I have tried to make clear since the prelude to this thesis, I am consistently interested in the issues surrounding technology in different societies rather than in the actual techniques themselves. This should not be difficult to understand. Anyone wishing to study Korean science and technology will read Jeon's volume and consult the extensive bibliography therein. Important for us is the fact that such a volume is needed to raise Korean confidence in the face of the Western technological system that haunts the borders. Sivin expresses the matter fairly well:

(Jeon Sang-woon) is a Korean, and his pride in certain inventions and techniques is perceptibly greater than if he were a foreigner writing about Korean science. He knows that he is addressing a worldwide readership most of whom did not dream before they picked up his book that Korea is entitled to exert any claim upon the universal history of science. He knows that many educated people in Europe and the United States are just recovering from the shock of learning Joseph Needham's lesson, that the Chinese tradition is as indispensable as that of the early West in determining the potentialities of science. This book opens up still another range of awareness by demonstrating that peripheral societies must be examined with equal seriousness if we are not to overlook real originality. The author also knows that this implication will be equally surprising to most of his fellow Koreans. In Korea today the power to exploit nature is seen as an importation, as foreign in its essence. Few people are aware that, say, Korea in 1400 may very well have had the most advanced astronomical observatories in the world. Is it possible that science is not fundamentally Caucasian and Judeo-Christian (and all sorts of other things Koreans are not) after all? (42).

Science and Technology in Korea has an excellent chapter on astronomy, ancient observatories, sundials, and the measurement of time in general. Another entire
chapter is devoted to meteorology; one more, to physics and physical technology, and includes descriptions of printing, firearms, shipbuilding, civil engineering and architecture. Two final chapters deals with chemistry, chemical technology and pharmaceutics, and cartography. Altogether, merely a preliminary investigation: the real history of science and technology in the service of the Korean civilizations is still to come.

The case for *homo faber* in Africa is not so easily described, not because it does not exist, but because too many people have thought it did not exist. Though the myth of Africa, raised from the ground by Europeans, is now being gradually dis-established, it will be many years before Africa gets its own Needham.

As late as 1952, a former Governor of Kenya, Lord Milverton, could claim (and be believed) that the African had stagnated in primitive savagery during the period in which most other civilizations had been busy accumulating histories. The myth of African primitiveness was so widespread that whole generations were brought up in the belief that Africa had had no past (43).

Today, this picture is changing. There are already eight good histories of African civilizations, based on new archaeological finds that have forced a more objective and rich image of the African continent: a Dutch geographer, Olfert Dapper, writing in 1668, for example, describing Benin, could only compare it with Amsterdam, seeing its broad wide streets, the quality of its architecture, and the fact of its cleanliness, for which the Dutch have a reputation (44).

Archaeology and contemporary accounts have unearthed the numerous civilizations of Nubia and Kush, Ethiopia and the Sudan, of the East Coast, the Bantus, of North Africa, the Sahara and the states of the West African forests, none of which could have arisen or flourished without an equally thriving technics, whether in agriculture or industry.
On the other hand, it is equally obvious that Africa did not have to build up a splendid technology as did the Chinese, for, with its vast reserves of gold and ivory (and like the OPEC nations today) it could acquire the commodities it needed through trade. The traditional trade of Africa would fill a volume, as did The Traditional Trade of Asia (45).

If, however, the technology of Africa is little documented, not so its languages. Africa, like India, is an oral civilization, and therefore, not to be compared to the civilizations of literacy: one cannot be looked on as superior to the other, for there are no independent criteria in relation to which both could be referred. A literate civilization may excel in certain regions of human expression, while, in an area like language, an oral culture has the more refined equipment. Benjamin Lee Whorf noted how the language of the Hopis today is better equipped for the subtleties of modern science than English.

In Africa today there are more than six hundred languages, each with its own host of dialects. Several languages are used outside their original area, as a result of migration or political domination or trade activity.

Although presenting a multitude of forms, all African languages have in common a rich vocabulary and a lively sense of the concrete. In the Ewe language for example, (a Negro-African language of the Kwa group) there are four verbs meaning "to eat", depending on what one is eating; forty words to describe the human act of walking. The tongues are the richer and more concrete in that the majority of African civilizations, lacking writing, are oral civilizations, giving a large role to speech (social life gives the greatest importance to palaver and oratory) (45).

As far as African technology is concerned, we will restrict ourselves to two main industries: metallurgy and textiles. The African iron-working processes have been detailed by Forbes (47, but put into a larger perspective by Basil Davidson (48).
The iron-industry probably first reached significant proportions after the rise of Meroe, "the Birmingham of ancient Africa", situated in North-east Africa, where by the middle of the first century B.C. smelting works on an extensive scale had already been initiated.

Sayce, who looked at Meroe some fifty years ago, could write that "mountains of iron slag enclose the city mounds on their norther and eastern sides, and excavation has brought to light the furnaces in which the iron was smelted and fashioned into tools and weapons." By the time of the building of Musawarat, in short, Meroe was the centre of the largest iron-smelting industry in Africa south of the Mediterranean coast. (49.

Davidson writes that a study of the African iron age is of key importance for an understanding of contemporary African origins, for,

Only with good iron tools would African peoples subdue the natural difficulties of living where they did, spread themselves across the land, flourish and multiply (50.

So crucial was iron's role, that the Portuguese at the end of the fifteenth century found the king of Congo himself to be a member of an exclusive "blacksmiths' guild". And in the middle of the nineteenth century, in the area south of the Sahara another foreigner would write,

the enhad (smith) is in much respect, and the confraternity is most numerous. An enhad is generally the prime minister of every little chief" (51.

From Kush the technique of iron-making went further south, where we encounter another startling phenomenon: iron trade with India. Our source here is Edrisi, an Arab historian who visited the coast of East Africa in 1154. The people of the East coast, the Zanj, he wrote, own and work mines, trade in wrought iron and make large profits

"Hither come the people of the islands of Zanedji to buy iron and transport it to the mainland and the islands of India, where they sell it for a good price; for it is the object of a big trade there, and is in big demand (52.
Edrisi went on to observe that the iron of Sofala (on the coast) was better than Indian iron, though he also added that "the Indians are masters in the arts of working it." We shall, later, encounter this "Indian iron", which was in fact a steel, produced and exported from India to Damascus for the manufacture of swords. Thus iron ore mined in south-eastern Africa, was forged in south-western India, fashioned in Persia and Arabia, to end up as the weapons and chain mail of the Saracens as they faced the Crusaders.

We know more about African textile-production, and African taste concerning the quality of textiles and their colours. Textiles form round a few basic elements: material and the art of dyeing and printing. The citizens of Meroe wore silk that was brought from China and cotton imported from India. Independent of these, they and most other peoples in the continent were proficient in the manufacture of bark fibre cloth (very similar, as far as manufacturing processes are concerned to the paper-making industry). Needles were not invented as this type of cloth could be watered, beaten and joined up wherever desired. The particular technique seems to have been perfected in Central Africa, in Uganda and Tanganyika, where craftsmen travelled from village to village catering to local needs. For resist, use was made of locally available materials, including mud and clay. The Yoruba people of the Niger region still practice adire elek dyeing, in which they use a paste of cassava starch. The Soninke people of Senegal, on the other hand, use rice paste for the same purpose.

The African is part of a culture that encourages the developing of very sophisticated tastes: he will not accept or wear what he considers inferior fabric, crude design or garish colours. Neither does he like dull colours. With the result that he has forced industries, that expect to serve his needs, to restructure their manufacturing processes to his cultural standards. Up to 1750 for example, textile goods from Manchester that were being
sent to Africa to displace Indian goods, were sent back to England with the order that the English industry would do better to improve their imitation techniques: till that time the Africans preferred to stick to buying Indian textiles. Even today, industries in Great Britain, Holland and Germany that cater to the African market, continue to submit to the demands of African cultural taste. Stuart Robinson writes that European products are still produced with an indigo-type dye (Africans love indigo) and with a slight looseness of top colour (genuine indigo goes rub off on the skin). African designs are simulated as faithfully as possible to produce the effects normally associated with hand-painted fabrics (53).

Africa today is at the cross-roads (54), seeking an identity that is able to take-up and continue, in refinement, the experience of its valuable past. Technology, African ability to use its own hands and brain, has played a significant role in the shaping of this past. New technology, where it is in keeping with the abilities of African homo faber, and in so far as African governments use it to re-establish indigenous techniques and processes in which people have technical confidence, can be increasingly Africanized, as has happened in the case of industries outside Africa being forced to adapt to African taste. For, the cultural re-awakening in Africa is the strongest among the new nations today. But it cannot of itself do much, unless it be accompanied by an acceptance of African man's technical ability, so long denied in opinion.

Our final foray is into the large continent of Latin America, including Mexico. Not much time, indeed, need be spent on the technologies of the Maya, the Aztecs and Incas: the documentation is still continuing and new archaeological discoveries are constantly being announced concerning newer sites of activity (55). There is an entire volume, for example, devoted to the textile processes of Peru (56). Everywhere the comment made is that the
the pre-Columbians accomplished such a wide variety of works using but a restricted set of tools.

Here, as before, it is the side issues that prove interesting. In trying to assess the worth of these civilizations, Fernand Braudel was not so certain that they could be placed among the higher civilizations of the time. He wrote:

Do the Aztec or Mexican civilizations and the Inca or Peruvian civilization - have full right to be placed at that level? The answer is yes as far as ability, brilliance, art and original turn of mind are concerned. It is equally so if we consider the ancient Mayas' wonderful science of calculation and the longevity of these civilizations: they survived the terrible impact of the Spanish Conquest. On the other hand, the answer is no when we note that they used only hoes and digging sticks; that they had no large domestic animals (except llamas, alpacas and vicunas); that they had no knowledge of the wheel, arch, cart or metallurgy in iron (57.

The assessment is unfair. In the first place, as Benjamin Whorf who studied the languages of these civilizations and peoples noted, the predilections of one culture are not necessarily those of another. In technology, it is imprecise to criticize the lack of metallurgy, when these civilizations had large deposits of obsidian which they had learnt to work into tools and weapons. Nobody criticizes the United States for using wood for 90 per cent of its energy needs upto 1850 and even later, and not going in for coal, particularly when the use of coal had already been well established by English technicians. And Lewis Mumford has exploited the fact of Maya and Inca city roads as independent proof "that broad streets and even highways are not a mere by-product of wheeled chariots or carriages. Religious processions and military parades both have need for them." (58.

The vandalism of the conquistadores who melted down the Indians' priceless and exquisitely fashioned gold and silver works of art to convert them into money, is repeated by scholars on the level of ideas, when the latter subject non-Western phenomena to the criteria of their own.
Thus the Latin American, as his counterpart in Asia or Africa has been showered a host of uncomplimentary adjectives: he has been called hostile, ignorant, superstitious, shifty and mean. Yet, when he enters the National Museum in Mexico, he can see immediately what he is capable of:

miracles of artistic creation expressed in the carvings, pottery, and textiles of contemporary and bygone ages, and a traditional lore which ranged from the sophisticated abstractions of the Mayan calendar to a wealth of legend and popular poetry (59).

Once, without the benefit of the European, he was expert in the art of terracing fields, paving roads, and constructing suspension bridges high up in the Andes.

Perhaps the social organization should be mentioned, in which the Incas, for example, showed such genius, so much so that it has even been described as "socialist" or "communist". And a young mestizo, José Carlos Mariátegui (1895-1930), once suggested that the traditional social groups of the Indians, the ayllu, should be maintained and strengthened in the face of aggrandisement by landowners. Mariátegui suggested that the Indians' strong instinct for communal action should be taken into account in working out the future transformation of his country, which he at any rate thought to be inevitable, and he was able to defend the ayllu "not on abstract principles of justice nor for sentimental traditional reasons, but on sound practical and economic grounds."

The stark individualism of the West is not the only manner of fulfilling human existence. Tanzania has recognized this too, in its scheme surrounding ujamaa villages. Chinese commune-development confirm the issue. And part of the land reform movement in Mexico depended a great deal on the re-establishment of ejidos, cooperative land-holdings similar in some respects to the Peruvian ayllu.

Stephen Clissold summed it all up:

"The Latin America of today is the China of Yesterday; the China of Today is the Latin America of To-
morrow" is a "poem" which has been given recent currency in Cuba. But most thinking Latin Americans have no wish to see their countries as another China, another Russia, another North America, or another Europe. What they wish to see is a Latin America which is truly itself, which has explored and harmonized its own diverse potentialities, rediscovered its past, and incorporated the still living structure into its personality, a Latin America which looks to others only in order to be genuinely itself. A Latin America which, has, in the fullest sense of the term, acquired a mind of its own (60).

This, I think, is how it always should be or always should have been. As Western cultural history is but one strand in a number that hold together a larger geography of mind, there is a certain violence perpetrated in attempting to examine the whole through structures associated so closely to the part. The plurality of cultures entails of itself a plurality of means, and since every culture, in the final analysis, is an attempt to solve the existential problem, it alone can provide its members with the relevant means.

This is not to deny that cultures are constantly changing, adapting, learning and incorporating elements from other meaning-systems. But any archaeology of a culture's mind will indicate the continuing replication of its core, a core more permanent and stable than is generally acknowledged to be the case. It was G B Sansom who demonstrated, for example, that in the most Westernized country in the East, Japan, the colour and substance of Japanese institutions had not submitted to Western precept in political, social or religious life.

The plurality of cultures raises a host of problems in a world which needs frames of reference for mediation between different societies for different purposes. Volumes have been written on the evolution of a new world culture, most of them unacceptable, for a world culture could only evolve on a basis of equal participation from all existing cultures. The present cultural domination of the West could otherwise lead to a world culture not
very much different from the Western particular and thus inevitably serving Western interests, ideals and goals. Joseph Needham has already pointed out, for example, that the philosophical bases of most international organizations are Western, and ultimately, have through the years, benefited the further extension of the power of the Western world (61).

Before we think in terms of applying one cultural pattern to the face of a global civilization, it would be more in the interests of a "democracy" of cultures if we first made available to ourselves all the answers (as Geertz put it) "that others, guarding other sheep in other valleys, have given." The same holds true for technology, unless we wish to extend the range and control of a gravely-faulted megamachine to every nook and corner of the world. It is not our intention here to repeat what others have written about Western technology and the problems for man, animal and nature built into its very structure. But with Nathan Sivin we think it possible, throughout this thesis, to argue convincingly that the model of technological and social development idealized out of the Industrial Revolution in England, the United States, and certain parts of Western Europe is no longer the sole means by which the traditional societies of Asia, Latin America and Africa can hope to survive.

SUMMING UP

A debate on human nature is no mere academic exercise. The planets will move as they always have whether we adopt a geocentric or a heliocentric view of the heavens. But the behaviour of men is not independent of the theories of the nature of man that men adopt. And in the four distinct parts of this chapter, I have tried to show how the presentation of a new anthropological model of man has far reaching consequences for our understanding of technology and culture in today's world.

In the first part, I set out to rescue the homo faber concept from the restricted understanding of it in the general and philosophical traditions of Western thought, and with an important modification, to propose
it is a valuable tool in the service of a universalized, transcultural philosophical anthropology. I began by sharpening my ideas negatively, on the straps of other men's conceptions, particularly, those of Jacob Bronowski, observing that a description of man purely in terms of his tool-making abilities, devoted too exclusive and unwarranted importance to the functionality of the human hand and thereby proved to be bad theory, as it ignored half the available evidence. In distinguishing human from animal solely on that basis, scholars and thinkers have laid the basis for a Bronowski or Toynbee to exploit similar propositions to demarcate Western from non-Western cultures.

With the critique behind, I proposed instead a new and more inclusive anthropological model, with the help of Kwee Swan'liat and Clifford Geertz. The nature of homo faber and his potentiality I rooted in the morphological structure of man; this structure made him essentially disposed to technology and culture. I argued thereby in the historically attested plurality of technical histories and cultures: the meaning of speaking in terms of African, Chinese or Western homo faber. I felt however that in the past number of decades we had been brought to believe that it would only be through a conscious imitation of Western homo faber or the Western paradigm of human activity that non-Western societies could hope to overcome their present difficulties, a belief this thesis would question in a number of respects.

I tried to show, in the third part, through an analysis of written histories of technology, how we had come to restrict our idea of technological possibilities to the Western line. I pointed out my dissatisfaction with these works in general, implying that the amount of material left out probably indicated the reason why so little material got in. I suggested it would no longer be possible to ignore the technical histories of other societies, not only regarding the past, but also the present.

In the final part, I presented a brief picture of Korean, African and pre-Columbian American technologies and cultures, as a kind of interlude to a more comprehensive illustration of my model in the three chapters to follow, where I would discuss the Indian, Chinese and English editions of homo faber operating in a specified period of time in history.

The homo faber model will be taken over and consequently enlarged in the final chapter of this thesis. Its uses will be further clarified and its inadequacies indicated. For the present, a basic structure of explanation should suffice.
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In which, very simply, we examine in brief, Indian science, technology and culture before the period of British conquest and domination. We begin with a brief prelude relativizing the position of Indian metaphysics. A survey then follows of Indian agriculture and industry. Within the scope of the latter, we discuss the question of Indian iron and steel and more particularly, Indian textiles; finally, Indian medicine. We end with a short description of the Indian mind. An introduction, thus, to the achievements of the Indian hand and the cultural patterns of the Indian mind.

The description of homo faber in India, as set out in this chapter, may at first sight seem to fall prey to the criticism presented in the first chapter, for here we will emphasize Indian technology at the cost of the other dimensions of Indian life. The reason for this, however, will become clear in what immediately follows, but briefly, so great a quantity of paper and print has been devoted to Indian philosophy and art, and so pervasive is the opinion abroad that these aspects of the Indian mind have remained saturated with "spirituality" and "world-denying" tendencies, that it has seemed but a natural conclusion to claim that technology or material culture could not have been attended to in any great measure.

The idea of India's other-worldliness was systematically emphasized by Max Müller, though he was not the
first (1. The modern West, in fact, first came to its acquaintance with the Indian mind through the translations published by the French scholar, Duperron, in 1802. It was through this translation that Schopenhauer came to call the Upanishads the solace of his life and death.

What turned out to be the solace for Schopenhauer, however, has proved to be a menace for those interested in interpreting the realities of India's economic and technological development. A number of works have over the years been devoted to the theme that sees India's underdevelopment as somehow related to this supposed predilection for other-worldliness (2. As late as 1972, one more Indian writer, Subhayu Dasgupta, set out to argue in his Hindu Ethos and the Challenge of Change, that the decisive obstacle to India's rapid economic development was the "stagnant Hindu mentality", fortified and maintained by the caste system (3.

An improved version, but parading a similar theme, is available with Alan Watts:

A king of ancient India, oppressed by the roughness of the earth upon soft human feet, proposed that his whole territory should be carpeted with skins. However, one of his wise men pointed out that the same result could be achieved far more simply by taking a single skin and cutting off small pieces to bind beneath the feet. These were the first sandals.

To a Hindu, the point of this story is not its obvious illustration of technical ingenuity. It is a parable of two different attitudes to the world, attitudes which correspond approximately to those of the progressive and traditional types of culture. Only in this case the more technically skilful solution represents the traditional culture, in which it is felt that it is easier for man to adapt himself to Nature than to adapt Nature to himself. This is why science and technology, as we know them, did not arise in Asia (4.

Or take Ortega y Gasset:

A nation where the existence of the bodhisattva is regarded as man's true being cannot develop the same technology as one in which people want to be gentlemen (5.

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There are elements in Watts and Gasset that we can appropriate for our purpose later on; right now, the real question remains: is the bodhisattva the function of the Indian cultural program, or is it merely one of them? Or is it that Watts and Gasset have been unduly influenced by a view of the Indian mind that arose during a specific period of historical writing? Pratap Chandra poses and partly answers these questions:

Our historical judgment has been coloured by this ardent desire to wish away all heterogeneity from ancient India. In the ideological sphere, it has resulted in the conjuring up of an intellectual monolith supposedly governing the Hindu ethos for centuries. The creators of this stereotype were frankly biased in favour of absolutism and spiritualism, and they made sure that Indian thought became predominantly, if not exclusively, a collection of idealistic and absolutistic views. Moreover, their preoccupation with Western thought and its categories and terminology easily persuaded them to view Indian thought analogously with it. Consequently, terms like "orthodox" and "heterodox", "established viewpoint" and "heresy" crept into all the accounts of Indian thought without anyone's asking whether these terms were relevant in the Indian context...Indian thought in this way became fixed in the popular mind as an instance of a unilinear, stream-like growth in which absolutism formed the "main current" and other views became either its imperfect expressions or deviances from it (6).

This myth of the absolutist nature of Indian philosophy was repeated so often that the average Westerner came to accept it as gospel truth: the average Hindu became a dreaming visionary while his philosophy, a world-and-life-negating dogma. Indians exhilarated for a long period in this world-wide appreciation of the greatness of Indian thought. Yet, when Max Weber's analysis appeared, and in the light of which it seemed to many that it was precisely Indian religion that might have impeded economic development, a new crisis of confidence had reasserted itself. Weber had set out to "inquire as to the manner in which Indian religion, as one factor among many, may have prevented capitalistic development (in the occidental sense)" (7).
Weber should have known better. He had in fact, refused to conclude that Hinduism was a religion in the Western sense of the term. He had noticed that without becoming a non-Hindu, a Hindu could accept highly important most characteristic doctrines which every denominational Christian would consider exclusively his own.... In Hinduism a teaching may be orthodox without being bindingly valid,.... indeed, the doctrinal fluidity of Hinduism is not incidental but, rather, the central issue of "religion" as we conceive it (7).

Yet, he continued to use the word "orthodox", which more aptly described the straitjacket that medieval Europe's religious culture in fact was: notice the inquisition and the crusades. In India, on the other hand, there is still no evidence that one line of thought was so dominant that it had become "orthodox"; there was no one established view that set itself up against and above a number of other supposed heresies. As Chandra writes:

It is necessary to see that ancient Indian society was so placed historically, and even geographically, that it had no option but to become radically pluralistic from the beginning. This can by no means be said of medieval Europe. Ideological divergence originating in a pluralistic society is qualitatively different from that in a singularistic society. No doubt the diversity obtaining in ancient India must be emphasized and highlighted, but only after noticing the peculiarly Indian connotation of this term. Both plurality and protest are examples of diversity; but plurality is not protest. If one may say so, ancient India was unaware of dissent, protest and reform for the very simple reason that it was also unaware of intellectual straitjackets, monolithic culture, ideological homogeneity or even a demand for any of them (8).

Before we proceed, then, it is necessary to lay down the fashionable cliche that India has through her history placed too much of her energy in the pursuit of metaphysical speculations. This erroneous, unrepresentative myth was sketched during a period of scholarly writing when Europe constituted the single most important criterion of human development: which has not gone unnoticed (9. But it will be sometime before the view that India was careless
about technology is finally overthrown. The easiest manner of aiding this process is, of course, to present historical evidence of Indian technology, and science. That we can now proceed to do.

INDIAN AGRICULTURE

Before industrialization revolutionized England and implicitly devalued agriculture, most of the civilizations of the world functioned as plant economies (10). Agriculture constituted the substratum of all other human activities. Indian agriculture, practised for about four thousand years, made possible a civilization so complex and so varied that some elements of it even today remain incomprehensible. Yet, the art of agriculture was exercised within the conscious limitations presented by the ecology of the land.

Dr Wallick, a Superintendent of the East India Company's Botanical Garden at Calcutta, was heard by the English Common's Committee on this issue, on the 13th of August, 1832. We might add, he was also the first to remark about technology being "inappropriate":

The husbandry of Bengal has in a great measure been misunderstood by the Europeans out of India. The Bengali husbandry, although in many respects extremely simple and primeval in its mode and form, yet is not quite so low as people generally suppose it to be, and I have often found that very sudden improvements in them have never led to any good results. I have known, for instance, European iron ploughs introduced into Bengal with a view of superseding the extremely tedious and superficial turning of the ground by a common Bengali plough. But what has been the result? That the soil which is extremely superficial, as I took the liberty of mentioning before, which was intended to be torn up, has generally received the admixture of the under soil, which has deteriorated it very much (11).

He was asked whether the techniques could be improved. He answered in the negative:

Certainly, but not to so great an extent as is generally imagined; for instance, the rice cultivation. I should think, if we were to live for
another thousand years, we should hardly see any improvement in that branch of cultivation (12).

Twelve years earlier (1820), Colonel Alexander Walker had prepared a more comprehensive report on the agriculture of Malabar and Gujerat. We quote extensively, since the document will not be widely available for quite some time. The entire report may be found in Dharampal's *Indian Science and Technology in the Eighteenth Century* (13, a volume that contains a fine collection of documents, by British visitors to India during the colonial period. Comparatively speaking, the book is as important for a study of Indian technology as is Sang-woon Jeon's volume for the Korean. Wrote Walker:

In Malabar the knowledge of Husbandry seems as ancient as their History. It is the favourite employment of the inhabitants. It is endeared to them by their mode of life, and the property which they possess in the soil. It is a theme for their writers; it is a subject on which they delight to converse, and with which all ranks profess to be acquainted (14).

Their sacred Bulls, and their superstitious regard for the cow, have their foundation in the great service they render to Husbandry. Under all these circumstances of favour and encouragement, we should expect that it would be the study of this people to improve the art of cultivating the ground, and that they would in such a length of time have discovered the most convenient and effectual instruments for the purpose. This however has been strenuously denied by those who wish to accommodate the ideas and habits of European Husbandry to that of Malabar. They reproach the Hindus for employing rude and imperfect instruments. This censure cannot apply equally to every part of India where various instruments are in use, and of different construction. The plough is the first and foremost important machine in agriculture. In Gujerat it is a light and neat instrument. It has no Coulter but has a sheathing of iron; the furrows of the Husbandman are as straight as a line, and of sufficient depth to produce the most abundant crops. This is the real and only useful test of good farming (15).

Walker observed that the Malabar plough was light enough to be carried on a man's back; more important, it was accommodated to the soil, which was light, unobstruc-
ted by stones and softened with water.

In a climate where the productive powers are so great, it is only necessary to put the seed a little way into the ground... It must be a strong proof that the Indian plough is not ill adapted for its purpose, when we see arising out of the furrows it cuts, the most abundant and luxurious crops. What can be desired more than this? The labour and expense beyond this point must be superfluous. The Indian peasant is commonly well enough informed as to his interest, and he is generally intelligent and reflecting. He is attached to his own modes, because they are easy and useful; but furnish him with instruction and means, and he will adopt them, provided they be for his profit. He will not be led away by speculation and theory, which he cannot afford to follow; but he will not refuse any more economical, and less laborious mode of cultivation (16).

Walker then goes on to recall an experiment done at Salcette, in Goa, where European ploughs and implements were delivered to natives to use in their fields. The experiment failed because the plough was too heavy, the oxen more easily fatigued, the implements more expensive, and more important, had failed to produce any results that were better than those earned with the traditional plough. As usual, Walker notes, the failure was imputed to the prejudice, sloth and obstinacy of the villagers. Walker then proceeded to make two conclusions that still remain valid today:

Before we charge them with ignorance and obstinacy for neglecting to adopt our recommendations, we should first be sure of two things; that the new system would give them more abundant harvests, at less expense and labour; and that we have taken all the means and care that were within our power, for their instruction in the art. It should also be well considered how far our agricultural process is suited to the cultivation of rice, the great crop of India, and of which we have no experience.

We ought also to remember that India has very little occasion for the introduction of new plants for food. There are more kinds of grain cultivated perhaps, than in any other part of the world.... I am at a loss to know what essential present we can make to India. She has all the grains that we have and many kinds more of her own (18).
Walker then describes the drill plough, the system of rice transplantation, the variety of agricultural implements, "some of which have only been introduced into England in the course of our recent improvements." He notes the different kinds of ploughs adapted to the different sorts of soils or seeds, the mallets, harrows, and rakes, the methods of hoeing and weeding. Presenting the care the Indian farmer devoted to the performance of his art, he writes:

The numerous ploughings of the Hindoo Husbandman have been urged as a proof of the imperfection of his instrument; but in reality they are a proof of the perfection of his art. It is not only to extirpate weeds that the Indian Husbandman re-ploughs and cross-ploughs; it is also to loosen the soil, apt to become hard and dry under a tropical sun; and hence it becomes necessary to open the earth for air, dew and rain. These advantages can only be obtained by exposing a new surface from time to time to the atmosphere. In India dews fall much more copiously than they do with us, and they are powerful agents in fertilizing the soil (19).

He has also something to say about ecological farming, the growing of different crops within the same field, each beneficial to the other; he mentions the culture of fodder for cattle. "It would require a volume to pursue all the details of Hindoo Husbandry." The fencing and enclosure of fields; the broad grassy margins for pasture. The whole world, he exclaims, "does not produce finer and more beautifully cultivated fields than those in Gujerat."

He acknowledges a debt to Col. Wilk's History, where he has seen a note, based on the result of observation and study on the spot. "It shows that the practice of the Indian farmer is founded on the most enlightened principles of modern farming." There are more details about the cultivation of fruit trees, the collection of manure, the rotation of crops.

In every part however that I have visited the application of manure for recruiting and restoring land is well understood. The people seem to have all the resources that we have in this respect (20).

He next produces an extract from a letter of a friend,
"whose intelligence and opportunities of observing the practice of Indian Husbandry, are not I believe exceeded by any man in that country."

In Gujerat, and indeed in the Deccan, but specially in Gujerat, careful and skilful agriculture, is probably, as much studied as in England. In many points an English farmer might condemn the practice at first sight; but in time he would learn that much of what he did not approve, under an idea that the same system in all respects that succeeds in England ought to be followed here, was of the first importance; was in fact what constituted the great means of success in this climate and that to depart from the existing practice would be folly (21.

The extract is another eulogy on the Indian practice of farming, and ends by noting that "the system of the natives is too well founded on experience to reject."

Walker's document contains too many details to summarize here: there is a more detailed account, for instance, of the agriculture of Malabar itself, the fifty kinds of rice grown, the knowledge of the kinds of soil, and how they should be treated. He is surprised that these experiments of the Malabar farmer correspond exactly to the theorizing of Lord Kairns concerning fertilizing soils, and the observations of H Davy.

Walker's document, finally, is not singular, but representative of the state of Indian agriculture in the early part of the nineteenth century. Dharampal's volume contains another article on the drill husbandry of South India. There are many more, not merely with Dharampal, but in the archives of the Jesuits in France, the Dutch in the Hague, the Portuguese in Lisbon and of Goa.

All this, of course, constitutes evidence for agriculture in the late colonial period. But there are numerous accounts of an earlier date, both by Indians and foreigners, that reinforce the later picture. Abul Fazl, for example, found agriculture flourishing "in high degree" in Bihar, where rice "which for its quality and quantity was rarely to be equalled" (22.

Perhaps, some idea of the variety of Indian agricul-
al produce might say more about the flourishing state of agriculture itself than a mere detailing of techniques. Thus, in writing about the indigenous plantations of south India, Buchanan noted the practice of having a separate piece of ground allotted for each kind of plant. "Thus one plot is entirely filled with rose-trees, another with pomegranates, and so forth." The coconut tree supplied a great deal of necessities: pith, liquor, fruit, "cloths", roofs, sails and ropes. In Bengal, notes one writer, "the plantations have no end." He mentions mangoes, oranges, citrons, lemons, pineapples, coconuts, palm-fruits and jack-fruits. Stavorinus adds bananas and guavas. Other fruits, grown in large-scale plantations, included melons, apples, peaches, figs and grapes. Ives refers to "the endless variety of vegetables" used by Indians in their curries and soups.

Bengal itself produced a surplus that was traded all over the country: grains, spices and pulses. "To mention all the particular species of goods that this rich country produces is far beyond my skill." Rice was grown in such plenty that, writes Orme, "it is often sold at the rate of two pounds for a farthing." According to Dow, much of the land in Bengal had turned into desert through oppressions and famines (1770-71). Even so, it continued to produce "for double the number", that is, about 30 million people. There are further reports about the agriculture of Bihar, Rohilkhand, Rajputana, Malwa Flat, Gujerat, Khandesh, the West coast as a whole.

In general, the valleys of all rivers consisted of "one sheet of the richest cultivation." Berar, with its black soil, produced cotton, wheat, barley and flax. Nagpur wheat matured in three months. In 1806, we can encounter "the undoubted prosperity" of this region, for, "under the fostering hand of a race of the Gond princes, a numerous people tilled a fertile country; and still preserved the neatness of their houses, in the number and magnificence of their temples, their ponds and other pub-
lic works, in the size of their towns, and in the fre-
quency of their plantations." The Northern Circars are
put down as "the granary of the Carnatic." The spices of
Malabar, including pepper, ginger, cardamom and cinnamon,
found their way into Europe (23).

Of irrigation technology too, there is much to be
said, though it might be added at once that the Indians
did not need the kind of massive hydraulic works with
which the Chinese engaged themselves (24). Yet, the opi-
nion that India's irrigation works were of little conse-
quence has been so influential that even Indian historians
have glibly accepted it. R C Majumdar, for example, is
quite certain of "the comparative absence of artificial
irrigation" in eighteenth century India (25). Contrast
this with Alexander Walker's comment that,

the practice of watering and irrigation is not
peculiar to the husbandry of India, but it has
probably been carried there to a greater extent
and more laborious ingenuity displayed in it
than in any other country (26).

In Bengal, thus, dykes were the usual response to
floods, and tanks and reservoirs stored water if rains
were scarce. Wells were a common feature; even today
every village has its own well. Where there were no
rivers, deep extensive tanks, measuring three to four
hundred feet at their sides, were constructed, with a
short temple for adornment. Ghulam Hussain writes about
Bengal:

Rivers, small and large, are plenty in this coun-
try and the practice of digging tanks is very com-
mon. People in this country seldom drink the wa-
ter of wells because everywhere the water of ri-
vers and tanks is found in abundance. And gener-
ally the water of the wells is salt, but with a
little digging of the soil water comes out (27).

Elphinstone reports that expensive embankments had
been constructed on the rivers of Khandesh for irrigation
purposes, and in Rohilkhand, the local chiefs had built
aqueducts "traversing corn-fields in all directions." In
the hilly regions, dams blocked streams. In the early part of the nineteenth century, Bishop Heber described Bharatput state as "one of the best cultivated and watered tracts which I have seen in India." Elphinstone found the people in the Maratha region to be generally happier under the Marathas than under the Company:

It has not happened to me ever to see countries better cultivated and more abounding in all the produce of the soil as well as in commercial wealth than the southern Mahratha districts.... there was as much cultivation in the Deccan as it was possible for an arid and unfruitful country to admit. I do not think either commercial or agricultural interests are likely to be improved by our rule (28.

Walker, in the document already quoted, writes:

The vast and numerous tanks, reservoirs, and artificial lakes as well as dams of solid masonry in rivers which they constructed for the purpose of fertilizing their fields, show the extreme solicitude which they had to secure this object.

Besides the great reservoirs for water, the country is covered with numerous wells which are employed for watering the fields. The water is raised by a wheel either by men or by bullocks, and it is afterwards conveyed by little canals which diverged on all sides, so as to convey a sufficient quantity of moisture to the roots of the most distant plants (29.

INDIAN INDUSTRY

With that summary description of Indian agriculture, we can now move on to Indian industry. We begin with textiles, for upto 1800 no country produced a greater abundance or variety than India did. China remained a close rival.

In 1700, itself, India was the largest exporter of textile goods in the world. Next to agriculture, cotton and cotton goods constituted the principal industry in the sub-continent, as did the woollen industry in England.

The technical skill of the Indian craftsman, today largely doubted, was greatly appreciated during the period (1500-1800), particularly by European travellers within
the country. The authors of *The European in India* were quite conscious that the Indian worker in cloth had in fact few rivals at that time. For a world today that cannot understand production except in terms of high energy inputs, complex machines and processes and massive organization, merely to imagine how fine manufactures could be effected in such large quantities, through the simplest tools, is indeed a difficult task.

Wrote Dubois:

> With such simple tools the patient Hindu, thanks to his industry, can produce specimens of work which are often not to be distinguished from those imported at great expense from foreign countries (30).

Another traveller, Stavorinus, wrote how Europeans were surprised "to behold the perfection of manufactures, which is exemplified here (Bengal) in almost every handicraft, effected with so few, and such imperfect tools."

Every district, noted Robert Orme, produced a different kind of cloth, and the "fabric has been transmitted, perhaps for centuries, from father to son", a custom which contributed in his opinion to the "perfection of the manufacture."

Particularly in the eighteenth century, the loom provided the basis of the Indian textile industry. It provided employment to "hundreds of thousands of inhabitants, comprising the weaver caste" and to "countless widows" and families, who engaged themselves in the subsidiary processes of cotton spinning. The weaving industry itself was extensive, stretching "from the banks of the Ganges to the Cape." "On the coast of Coromandel and in the province of Bengal, when at some distance from the high road or a principal town, it is difficult to find a village in which every man, woman or child is not employed in making a piece of cloth."

The fact is the textile industry was highly coordinated with agriculture. Indeed, it was usually during their "vacations from agriculture", that is, when the
crops were growing or had just been harvested, that one found a great number of villagers applying themselves to the loom, "so that more silk and cotton are manufactured in Bengal than in thrice the same extent of country throughout the empire and consequently at much cheaper rates."

In the north, the great Moghuls maintained kharkhanas (factories) for their specific needs. Elsewhere, native princes preserved their own arrangements. Wrote Foster:

The Native Princes, and chiefs of various description, the retainers of numerous dependents, afforded a constant employment to a vast number of indigenous manufactures, who supplied their masters with gold and silver stuffs, curiously flowered, plain muslins and diversity of beautiful silks and articles of Asiatic luxury (31.

And at least one Indian economist has noted how this constant source of employment declined and withered as the princes fell prey to the unscrupulous schemes of British power (32.

So stable had the textile industry been, that there had been no great change in the main areas of textile production in the country during the two thousand years since Roman times till the decline of the industry in the nineteenth century:

They are described in the Periplus of the first century A.D. in much the same terms as they were described by travellers of the seventeenth and eighteenth centuries. These main areas were three: Western India, with Gujerat, Sind and Rajputana as the focus; South India, comprising the Coromandel Coast as it used to be known, stretching from the Kistna Delta to Point Calimere, and North-east India, including Bengal, Orissa and the Ganges valley (33.

Each of these areas specialized in specific classes of fabrics and even employed techniques indigenous to the region itself and different designs, motifs and symbols. We will discuss each briefly in turn.

From Abbe de Guyon, in the middle of the 18th cen-
tury, we have the following account of Ahmedabad in western India:

People of all nations, and all kinds of mercantile goods throughout Asia are to be found at Ahmedabad. Brocades of gold and silver, carpets with flowers of gold, though not so good as the Persian velvets, satins, and taffatas of all colours, stuffs of silk, linen and cotton and calicoes, are all manufactured here (34).

Surat, "an emporium of foreign commerce", manufactured the "finest Indian brocades, the richest silk stuffs of all kinds, calicoes and muslins."

Painted and printed calicoes constituted the most important class of Indian fabric exported from Surat in the seventeenth century. They covered a wide range of quality, the best and the more expensive being painted rather than printed...In the former case, dyes and mordants were applied to the cloth, not with a wood-block, but free-hand with brush. Thus, each painted design had the character of individual drawing with the human and sensuous touch, instead of being limited to the repeat-pattern imposed by the print-block. Sometimes painting and printing techniques were combined, but the finest decorative calicoes from both Western India and the Coromandel Coast were of the painted kind (35).

There has been among textile historians a controversy about whether Indian craftsmen printed their chintz with mordants: the original assumption being that this technique (like the drill plough in agriculture) had first been discovered in Europe. In 1966, however, the controversy was effectively settled in India's favour, when the Roques manuscript was discovered in the archives of the Bibliothèque Nationale in Paris: the manuscript contained a detailed account of the textile industry and manufacturing processes, including textile printing, observed by the writer in western India (36).

The chief centres of cotton painting in western India were Sironj in Rajputana and Burhanpur in Khandesh. Cheap printed cottons came from Ahmedabad, though these were also produced in the regions devoted to painting.
Gujerat also produced embroideries on quilts and coverlets, but this industry had declined by 1690, when the centres of European trade had shifted to Sind and the Punjab. The century also saw the development of the carpet industry, almost certainly due to the emperor Akbar (1556-1605) who is known to have encouraged the immigration of Persian craftsmen for the purpose. The industry was located principally at Agra and Lahore.

The woollen industry was located in Kashmir, which produced the extraordinary Kashmiri shawls, whose beauty was considerably "enhanced by the introduction of flower work." The wool was imported from Tibet, after which it was bleached and manufactured. As for silks, in western India, fabrics from them were often mixed with cotton. True silks were worked as _patolas_ in Patan, Gujarat. Printed silk, _culgar_ is still produced in the same places today, in the form of saris of artificial, printed silk, or _kalgers_. One species of cotton and silk fabrics were the _alachas_, striped fabrics, and later consciously imitated in England. The _cuttanee_ was a satin weave; the cheapest of the mixed fabrics were called _tapseils_, produced for the West African trade. And for the Portuguese demand were silk and wool fabrics, called _camboolees_, produced in Sind.

The _calicoes_ themselves ranged from the finest and most expensive muslins to the cheapest and coarsest sackcloth. There were three varieties of these.

Plain white calicoes, either muslins or seribaffs, wanted in the Islamic countries. The English exported a great deal to the Levant Company for re-export to North Africa and Turkey. Some of these pieces had their heads brocaded or embroidered sometimes with gold and silver threads, and most of these fine muslins came from the Burhanpur region, the main muslin-weaving area of Western India.

Ordinary white cloths, _baftas_, were woven at Broach and Nosari, Surat and Nuncereee. This industry was hit
by the great Gujerat famine of 1630, but it later recovered, though by this time imitation factories had sprung up all over India. Semianas came from Samana in Patiala and Akbarpur in Lucknow.

Coarse cloth, dungarees and gunny, came too from the Rajapur area, north of Goa. Dholka produced rough cloth; seryas were woven at Broach and Ahmedabad. Unfigured dyed cloth came from Lucknow and Ahmedabad; the cloth was actually transported from Lucknow to Ahmedabad for dyeing.

Calicoes were patterned on the loom, that is woven from different coloured threads; this distinguished them from calicoes dyed after weaving. These later went to the slave populations of the West and East Indies, and came to be known as guinea cloths. The colours remained bright after washing and this was their great attraction.

We have presented this varied picture of the textile industry and mentioned a great many vernacular names not because we wished to add local colour to our thesis, but merely to indicate the width and breadth of the Indian influence in the period. Irwin and Schwartz give a very interesting list of the Company's orders in the West coast for a single year (1695-6) as a sample:

20,000 Pallampores large
10,000 Pallampores midling
10,000 Pallampores small
2,000 Quilts large, new patterns, 3 1/4 X 3 yds.
2,000 Quilts midling
5,000 Quilts small
10,000 Chints Culme2
20,000 Chints Caddy3, as much variety of works and stripes as may be.
10,000 Chints broad, 9 X 1 yd. of variety of new patterns
20,000 Chints narrow
10,000 Serunge (Sironj) Chints, the best and newest works and paintings on good strong cloth, 1/4 stripes, 1/4 flowers
20,000 Chints Paunch Runge4
5,000 Chints Surat (37).

The south Indian textile industry was concentrated on the Coromandel coast and was specifically directed to
the spice trade in the Malay Archipelago. The economies of the spice islands had no need for bullion or any other foreign commodities: Indian cloth formed the only acceptable means of exchange. The trade was tri-cornered. Arabs carried bullion to the Coromandel coast, exchanged these for textiles, exchanged the latter in the islands for spices, to return with these to the Middle East.

When the Portuguese arrived at the end of the fifteenth century they found this profitable barter trade as it had been for centuries, mainly in Arab hands. In the following century they succeeded in usurping it for themselves, diverting its entrepots from the Middle East to Western Europe. In the seventeenth century it was once again usurped, this time by the Dutch and by the English. But all the time the essential workings of the trade and its dependence on barter remained the same (38).

Like the Africans, the Malays were quite particular about their choice of cut, colour and design, and were quite capable of refusing goods brought by foreigners, particularly the Europeans, if these did not suit their taste. Today, powerless, they have lost these options, but in those centuries this concern for personal satisfaction led to a high degree of specialization and accumulated experience in manufacture in the coast of Coromandel itself.

Whereas in the areas of Gujerat and Sind, weavers mostly gathered in the market towns or nearby, in the south, they were dispersed among inland villages. The conditions not entirely happy, they were encouraged by the Europeans to leave their villages and later work in company trade settlements. Write Irwin and Schwartz:

The Gujerat famine of 1630-32, which interrupted the already established flow of cotton goods from that part of India to Europe, caused the English and Dutch Companies to consider seriously the suitability of Coromandel piece-goods for the Western market. However, the Coromandel suffered her own equally severe, famine in 1646 which interfered with these plans, and it was not until the 1660s that Coromandel piece-goods were sent to Europe on any substantial scale. Henceforth demand increased rapidly, reaching a peak in the last quarter of the century, when Indian cotton-paintings revolutionised European fashions. This
development coincided with the political and eco-
nomic disintegration of Golconda, consequent upon
wars and bad administration. As a result foreign
traders encouraged the gradual transfer of a large
part of the weaving and cotton-painting industry
from Golconda to the coastal belt of Madras pro-
per (39).

Finally, Bengal, where we must be all too brief,
precisely because of the profusion of material. About
1772, Pattullo wrote that "the demands for Bengal manu-
factures can never lessen, in regard that their quality
is so peculiar to that country that no nation on the
globe can either equal or rival them." "Cloths of all
kinds, most beautiful muslins, silk - raw or worked", came out in streams from the towns of Baranagar, Kasim-
bazar, Chittagong, Rajmahal, Radhanagar, Nadia, Murshi-
dabad and Santipur. Unqualified praise went to Dacca for
its muslins. "Muslins are sometimes wove so fine that a
piece of twenty yards in length, and longer can be en-
closed in a common pocket tobacco box," wrote Stavorinus.
He even provided the dimensions of such a box: eight in-
ches long, one inch deep and four inches broad.

The various exports of Bengal boggle the mind: they
included ordinary silk, mixed silk and cotton goods, cali-
coes, linens, mulmuls, tanjebs, chintzes, gingham, pure
silk and woollen fabrics, turbans and shawls. Unwrought
silk from Kasimbazar itself totalled 300,000 to 400,000
pounds weight, and went to form the base for manufactures
in Europe. Of the country around Kasimbazar, Grose was
able to claim that the workers there "generally furnish
22,000 bales of silk a year, each bale weighing a hundred
pounds." This constituted a boom, which it was, and to-
wards the end of the seventeenth century, most Europeans
found these silks cheaper than the French and Italian
silks they had till then patronized.

Within another fifty years, this entire picture
would be totally reversed through a variety of factors
which we shall later describe. In 1817, James Mill would
then get himself a job in the East India Company by writ-
ing his History of British India, in which, without any
personal experience or knowledge, he spoke of "the hideous state of (Indian) society," much inferior in acquirements to Europe even in its darkest feudal age. Other administrators and historians, including Lord Elphinstone, now found it useful to speak of the "unchanging village communities of ancient India," as they wished simultaneously to propose that the entire existing social and economic framework should be altered through legislation. And Karl Marx would construct "the Asiatic mode of production" basically on this picture of a self-sufficient village economy.

In England, on the other hand, the textile industry was being revolutionized by the study and imitation of the work of Asian craftsmen, and something similar was happening too on the Continent. And later, these improvements, harnessed to the machine, would finally change the tide.

INDIA TEACHES EUROPE

The second volume of the Singer History of Technology concludes with a curious and startling opinion:

(But) this volume has also seen to its end a relationship between east and west that we shall not encounter again. When the Middle Ages closed, the east had almost ceased to give techniques and ideas to the west and ever since has been receiving them (40.

Singer, a medical scholar did not know, of course, that British surgeons learnt the art of plastic surgery from Indian practitioners: we shall see this later. But it is the history of the development of textile industry in the West after the Middle Ages that absolutely refutes his claim. There is no doubt that particularly after 1500, India's influence was crucial to the European textile industry. Country by country tells the same tale.

We are not talking here of trade, which normally supplied the genuine and costly Oriental fabrics that were coveted by the European nobility. We mean the vast imitation industry that sprang up to cater to the common-
ers, who unable to afford the expensive originals, had to be content with copies, and this not only in England, but also in France, Germany, the Netherlands, Spain, Switzerland and America.

Thus P R Schwartz and R de Micheauix, in their book, A Century of French Fabrics 1850-1950, state that in France "the term indiennes (chintz) is found in Marseilles inventories since at least 1580, and on 22 June, 1648, a card-maker and engraver of this two was associated with the dyeing of cloth to make indiennes (41. The imitation printing of these chints was banned in due course, but the indiennes continued to grow in popularity, "despite the heavier fines imposed, the ripping off by the police of the offending print dresses from the backs of women walking in the streets and the destroying of stocks of garments." (42. Once the ban was lifted in 1759, the designers began to introduce designs at first based upon Oriental patterns.

The same can be said of Germany, where in order to protect the home industry Frederick William I banned the wearing, importing or selling of any kind of printed or painted calicoes. Again, these laws were flouted and in 1743, print works were established in various parts; imitation printing being officially permitted in 1752.

Textile workers in Italy, from the late seventeenth century to about 1855 had their earlier patterns based on indiennes. More obvious is the case of the Netherlands:

The Dutch merchants and explorers were some of the first to bring back the painted and printed Coromandel cloths from the East during the early seventeenth century... and Dutch textile printers attempted to imitate the brilliantly coloured Indian cottons which were not only fast to water but became more beautiful and brilliant when washed. Their first attempts with the oil or water colours long used in Europe, that either smelt badly or would not wash, bore no comparison with the Eastern cloths printed or painted with mordant dyes and indigo.

The first European print works was founded in Amersfoot in Holland in 1678 and attempted to use Indian methods (43.
Success came only after nearly seventy years, when Dutch printers succeeded in copying the sheer Indian cottons by using copper plates.

The first Spanish calico print works started by the Esteban Canals in Barcelona in 1738, copied indiennes and used the imported Eastern textiles as a source of pattern. Switzerland repeats the story, and in the United States, the earliest evidence of textile printing shows Eastern influences in the patterns.

It has not been any different with the circulation of ideas in Europe. Literature wise, three large documents found in European libraries are representative, being written with the express purpose of informing Europeans about Indian processes and techniques. The letters of the Jesuit, Coeurdoux, for example, were sent out in 1742 and 1747. The earlier letter begins typically:

I have not forgotten that in several of your letters you have urged me to acquaint you with the discoveries I might make in this part of India, since you are persuaded that knowledge is to be acquired here which, if transmitted to Europe, would possibly contribute to the progress of science or to the perfection of art. I should have followed your advice sooner, had not almost continuous occupation taken up all my time. Recently, with a little leisure, I have used it to find out the way in which Indians make these beautiful cloths, which form part of the trade of those Companies established to extend commerce, and which, crossing the widest seas, come from the ends of Europe into these distant climes to search for such things (44.

The second letter begins in a similar vein, though it is actually an introduction to a letter written to Coeurdoux by a certain M Lepoivre, on Indian processes, to which Coeurdoux has added a lengthy comment (45. It is the sequel to these letters, however, that is significant:

Father Coeurdoux's actual descriptions contain many further processes in the printing and the dye preparation and these were studied and commented upon by Edward Bancroft (1744-1821), the distinguished English chemist, in his book, Experimental researches concerning the philosophy of permanent colours, London 1794 and 1813. It was also used in G P Baker's outstanding work, Calico painting and printing.
in the East Indies in the 17th and 18th centuries, London 1921, and in a number of Continental books and journals of the seventeenth and eighteenth centuries (46.

The second manuscript, called the Beaulieu Manuscript, discovered also quite recently, dates about 1734. It was quoted in the treatise on cotton painting by the Basle manufacturer, Jean Ryhiner (1728-90) which was first written in 1766, though not published till 1865. It was also discussed in the book of the Chevalier de Querelles, Traité sur les toiles peintes, Paris, 1760. It still exists, together with eleven actual samples of painted cloth brought back by de Beaulieu, as well as full details of the processes discovered.

The third manuscript, also recently come to light, is the Roques manuscript, of 333 pages, and in which, as we noted earlier, the priority of wood-block printing in India is firmly established (47. These documents are representative; there are many more, like the anonymous article to be found in the Journal oeconomic, Paris, July 1752. It begins thus:

There can be no doubt but that it would be most harmful to the State were we to neglect our own production of light silken and woollen materials in favour of Persian or Indian cottons. It can, however, only be a good thing to know how these peoples set about applying colours to their cotton cloths, which not only did not run or fade when washed but emerge more beautiful than before. Everyone can see for himself how useful this would be when he envisages what the possibilities could be for our cotton, linen and hemp cloth (48.

The writer then goes on to describe two Indian methods of the dyeing process.

All this knowledge, of course, crossed the seas free of charge. Father Coeurdoux milked the neophytes he had recently baptised for his information. And the painter, Pieter Coeck Van Aelst (father-in-law of Pieter Brueghel the Elder) transported back to Holland the techniques of indigo resist painting after his travels in the East in the early sixteenth century. Yet, once this knowledge and
expertise entered the European countries, it soon made its way into the patent system. As early as 1676, in England, William Sherwin, an engraver of West Ham, took out a patent for:

A grant for fourteen years of the invention of a new and speedy way for producing broad calico, which being the only true way of the East India printing and stayning such kind of goods (49).

The history of iron and steel in India has not thus far seen consistent review, neither will we attempt one here, for it might take us into a volume. We shall rest content with a few illustrations at best, and note the influence of Indian steel on the industrial revolution in England.

One of the earliest wonders of India is a feat in iron, produced as a memorial to a king round 400 AD, and commonly known as the Iron Pillar (50). The Pillar is 23 feet high, is a single piece of iron, and of a size and weight which, it is generally accepted, could not have been produced by the best of European iron-founders up to a hundred years ago. It must have demanded considerable metallurgical skill, particularly in the preparation and heating, the more so, since the Pillar has withstood more than 1,500 monsoons and not yet seen rust (51).

As Dharampal notes, there are a number of accounts concerning the production of iron and steel in India during the Vasco da Gama epoch; in fact, one of the earliest ones, numbering about seven pages, is to be found in the book of D Havart, a Dutchman, entitled, The Rise and Decline of Coromandel, originally issued in Utrecht in 1692. Dharampal's volume itself contains three reports dated, 1795, 1829 and 1842. Here, we will say something about steel, about whose development in India there is all too little in the public imagination. Then, everyone called it not steel, but "wootz".

The Celtic smiths of Noricum, a Roman province, (today, Lower Austria) made good steel as early as 500 BC.
and traded it to Italy. There were other centres during the Iron Age where steel was produced by holding wrought iron in the charcoal of the forge until it reached white heat and then quenching it, but the resulting product did not reach Celtic standards. The latter itself, however, was not as good as the so-called Damascus steel, the only true spring steel known before the Age of Gunpowder. And this steel was made in India, as early as the 5th or 6th centuries BC in the Hyderabad district by smiths through a process of fusion known as wootz:

One takes black magnetite ore, bamboo charcoal and the leaves of certain plants and seals them in a clay crucible. A forced draught melts this combination, which turns into a button of metal. Such buttons, alternately melted and cooled four or five times, are fused together into cakes five inches in diameter, a half-inch thick, and weighing about two pounds. In Roman times these cakes were exported to Adulis, a seaport on the Eritrean coast of Africa, where the merchants who supplied Rome obtained them, in ignorance of their origin. When the Arabs conquered India, they carried these cakes to Damascus, where a lively industry in converting the unique material into weapons and armour arose. They also took it to Toledo, in Spain, for the same purpose.

Unlike the Romans, the Arabs visited the Indian smelters and saw how wootz steel was made. They carried this knowledge as far west as Toledo, whence it eventually spread northward... the hand production of spring steel made possible improvements in cutting weapons and armour, and the invention of the cross-bow, which rendered most armour useless. Steel in small quantities was used in making needles for compasses, which have to be of steel because iron quickly loses its magnetism, and in or about 1500, Heinlein of Nuremberg made the first spring-driven watch. Probably, the greatest immediate utility of fine steel, however, was in tool-making, the key to all metallurgical advances (52.

In the 1790s, a sample of wootz landed in England, where it roused considerable scientific and technical interest. It was examined by several experts, found in general to match the best steel then available in England, and, as one observer put it, "promises to be of importance to the manufactures of" Britain. He also found it "excell-
ently adapted for the purpose of fine cutlery, and par-
ticularly for all edge instruments used for surgical pur-
poses." (53. Demand increased, so that 18 years later,
one frequent user could write:

I have at this time a liberal supply of wootz, and I intend to use it for many purposes. If a better steel is offered to me, I will gladly attend to it; but the steel of India is decidedly the best I have yet met with (54.

The man who felt Indian steel as being of some impor-
tance to the manufactures of Britain was none other than Stodart, the person who later assisted Faraday in preparing and investigating a large number of steel all-
loys. According to Heyne, Stodart was "an eminent instru-
ment-maker," and according to another, a man named Pear-
son who was assisted by Stodart in conducting the experi-
ments on wootz in 1794-95, the latter was "an ingenious artist." (55.

Nineteenth century England produced very little of its steel from its own iron. In one year alone (1823) it imported more than 12,000 tons of iron, mostly from Swe-
den, to work into steel. The quality of iron ore in the country was decidedly low for the purpose, and so was the fuel. The English, on examining Indian wootz, applied their own experience to conclude "that it is made directly from the ore; and consequently that it has never been in the state of wrought iron." Dharampal writes:

Its qualities were thus ascribed to the quality of the ore from which it came and these qualities were considered to have little to do with the techniques and processes employed by the Indian manufacturers. In fact it was felt that the va-
rious cakes of wootz were of uneven texture and the cause of such imperfection and defects was thought to lie in the crudeness of the techniques employed.

It was only some three decades later that this view was revised. An earlier revision in fact, even when confronted with contrary evidence as was made available by other observers of the Indian techni-
ques and processes, was an intellectual impossibili-
ty. "That iron could be converted into cast steel by fusing it in a closed vessel in contact with car-

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bon" was yet to be discovered, and it was only in 1825 that a British manufacturer "took out a pa-
tent for converting iron into steel by exposing it
to the action of carburetted hydrogen gas in a
closed vessel, at a very high temperature, by which
means the process of conversion is completed in a
few hours, while by the old method, it was the work
of from 14 to 20 days" (56.

The founder of the Indian Iron and Steel Company,
later also connected with Sheffield, J M Heath, soon dis-
covered that the wootz process combined both the British
discoveries mentioned above:

Now it appears to me that the Indian process combi-
ines the principles of both the above described
methods. On elevating the temperature of the cru-
cible containing pure iron, and dry wood, and green
leaves, an abundant evolution of carburetted hydro-
gen gas would take place from the vegetable matter,
and as its escape would be prevented by the luting
at the mouth of the crucible, it would be retained
in contact with the iron, which, at a high tempera-
ture, appears from (the above mentioned patented
processes) to have a much greater affinity for gas-
eous than for concrete carbon; this would greatly
shorten the operation, and probably at a much lower
temperature than were the iron in contact with char-
coal powder (57.

Heath went on to add that while the Indian method
lasted two hours and a half, the processes at Sheffield
required four, "to melt blistered steel in wind furnaces
of the best construction, although the crucibles in which
the steel is melted, are at a white heat when the metal is
put into them, and in the Indian process, the crucibles
are put into the furnace quite cold."

He concluded, of course, by denying that the Indian
producer had any theory of his operations, since the pro-
cess was discovered by scientific induction, for the theo-
ry of it can only be explained in the light of modern che-
metry (58. Such a conclusion is strange, but it was easy
during the ethnocentric atmosphere of the times to propose
it. Even the British Royal Society betrayed the spirit of
the times: a letter describing wootz as having "a harder
temper than anything we are acquainted with" was altered
to "anything known in that part of India." (59.
The literature on Indian medicine is enormous, rich and various and we do not intent to paraphrase it all here. In what follows, we shall merely describe two of the more important medical arts of India, practised particularly through the time or period under study: plastic surgery and innoculations against small-pox disease. Both were indigenously evolved and the accounts we have of them come to us from Westerners sent out to study them. In the case of plastic surgery, the world's debt to India is easily acknowledged in every volume on the subject. The second might come as a surprise, though not to those conversant with similar discoveries about Chinese medicine.

For general competence in surgery, Colonel Kyd, an Englishman, wrote:

(In) chirurgery (in which they are considered by us the least advanced) they often succeed, in removing ulcers and cutaneous irruptions of the worst kind, which have baffled the skill of our surgeons, by the process of inducing inflammation and by means directly opposite to ours, and which they have probably long been in possession of.

Dr H Scott, wrote the following letter on January 12, 1792, again on the subject of Indian surgery:

In medicine I shall not be able to praise their science very much. It is one of those arts which is too delicate in its nature to bear war and oppression and the revolutions of governments. The effects of surgical operation are more obvious, more easily acquired and lost by no means so readily. Here I should have much to praise. They practise with great success the operation of depressing the chrystalline lens when become opake and from time immemorial they have cut for the stone at the same place which they now do in Europe. These are curious facts and I believe unknown before to us.

One of these curious facts was the innoculation against small-pox disease, practised in both North and South India, till it was banned or disrupted by the English authorities in 1802-3. The ban was pronounced on "humanitarian" grounds by the Superintendent General of Vaccine (following Dr Jenner's discovery in 1798). There are two detailed accounts of the Indian methods in Dharampal's volume.
Small-pox has a long history in India: it is discussed in the Hindu scriptures and even has a goddess devoted exclusively to its cause. It seems therefore almost natural to expect an Indian medical response to the disease. The inoculation treatment against it was carried out by a particular tribe of Brahmins from the different medical colleges in the area. These Brahmins circulated in the villages in groups of three or four to perform their task.

The person to be inoculated was obliged to follow a certain regime, particularly in having to abstain from fish, milk and ghee (a form of butter), which, it was held, aggravated the fever that resulted after the treatment. The method the Brahmins followed is similar to the one followed in our time in certain respects. They punctured the space between the elbow and the wrist with a sharp instrument and then proceeded to introduce into the abrasion "variolous matter", prepared from inoculated pustules of the preceding year. The purpose was to induce the disease itself, albeit in a mild form: after it left the body, the latter was rendered immune to small-pox for life.

The Brahmins had a theory about their operations. They believed the atmosphere abounded with imperceptible animalculae (refined to bacteria, within a larger context today). They distinguished two types of these: those harmful and those not (63. According to Dr J Z Holwell FRS, who addressed the President and members of the College of Physicians in London concerning this:

That these animalculae touch and adhere to everything, in greater or lesser proportions, according to the nature of the surfaces which they encounter; that they pass and repass in and out of the bodies of all animals in the act of respiration, without injury to themselves, or the bodies they pass through; that such is not the case with those that are taken in with the food, which, by mastication, and the digestive faculties of the stomach and intestines, are crushed and assimilated with the chyle, and conveyed into the blood, where, in a certain time, their malignant juices excite a fermentation...which ends in an eruption on the skin.
They lay it down as a principle, that the immediate (or instant) cause of the small-pox exists in the mortal part of every human and animal form; that the mediate (or second) acting cause, which stirs up the first, and throws it into a state of fermentation, is multitudes of imperceptible animalculae floating in the atmosphere; that these are the cause of all epidemical diseases, but more particularly of the small pox.

The Brahmins therefore believed that their treatment in innoculating the person expelled the immediate cause of the disease:

That when once this peculiar ferment, which produces the small-pox, is raised in the blood (through inoculation), the immediate (instant) cause of the disease is totally expelled in the eruptions, or by other channels; and hence it is, that the blood is not susceptible of a second fermentation of the same kind. That the great and obvious benefit accruing from (inoculation), consists in this, that the fermentation being excited by the action of a small portion of matter (similar to the immediate cause) which had already passed through a state of fermentation, the effects must be moderate and benign; whereas the fermentation raised by the malignant juices of the animalculae received into the blood with the aliment, gives necessarily additional force and strength to the first efficient cause of the disease.

How effective was the innoculation in achieving its goals. According to Holwell:

When the before recited treatment of the innoculated is strictly followed, it is next to a miracle to hear, that one in a million fails of receiving the infection, or of one that miscarries under it.

A later estimate by the Superintendent General of Vaccine in 1804, noted that fatalities among the innoculated counted one in 200 among the Indian population and one in 60 or 70 among the Europeans. There is a natural explanation for this divergence. Most of the Europeans objected to the innoculation on theological grounds; more importantly, the social context of innoculation had changed.

We have said that the innoculation of the Brahmins incuded the disease, although in a milder form. The risk
inherent in such a treatment becomes obvious: the disease might spread by contagion from those inoculated with it to those not so treated. Certainly, this was not the problem when the operation was universally practised and everyone underwent it. This universality ceased to obtain with the arrival of the British. Like many specialists in India, including teachers, the Brahmin doctors had been maintained through public revenues. With British rule, this fiscal system was disrupted and the inoculators were left to themselves. This should be connected to the other changed situation: new poverty in Bengal as a result of Company rule. Indeed, Bengal became the first region to taste poverty in a total, ecological sense (67).

In such a deteriorating situation even Vaccine inoculation could find little acceptance. In 1870, another Superintendent General of Vaccine wrote that the people were still reluctant to get vaccinated because of the general opinion that the indigenous inoculation possessed "more protective power than is possessed by vaccination in a more damp climate." Thus, the indigenous method still continued to win allegiance. For the areas round Calcutta in 1870, it was estimated that only ten per cent of the population had not been so inoculated; for Bengal, the figure was 36 per cent. The result: India soon fell prey to a wave of small-pox epidemics (68).

The experience of plastic surgery, happily, followed more fruitful routes (69). The art of plastic surgery or rhinoplasty rose again as a perfect response to a peculiar Indian custom: the cutting off or amputation of the nose in punishment for crime or plain humiliation. The resulting disfigurement drove the sufferer to a class of surgeons who soon founded a thriving business in the reconstruction of noses. In 1794, Dr H Scott would refer to the "putting on noses on those who lost them" and send to London a quantity of cautex, the cement used for "uniting animal parts."

The earliest of these rhinoplasties were performed in India in 600 BC and there are still families that prac-
tise the same method today. The operation is described in the Sushruta Samhita, a book written in 600 B.C. by the well-known Indian surgeon Sushruta: a flap from the cheek was cut out to reconstruct the nose. Later, a better method used flaps from the forehead. A later Indian surgeon named Vagbhat, provided a more detailed description in his book, the Ashtanga Hridayam, in the fourth century A.D. Twice did this art spread from India to the rest of the world. Writes S C Almast:

In the centuries which followed the golden age of Ayurveda, the knowledge of rhinoplastic procedures was probably transferred to Western civilization by the free interchange of thought and experience between Hindu, Arab, Persian, Greek, Nestorian and Jewish scholars. Celsus the Roman who lived 25 B.C. to 50 A.D. was probably the earliest Western European to describe plastic operations on the nose. The Sushruta Samhita was mentioned as Kitabe Sushrud by Ibn Abi "Usaybia" (1203-1269 A.D.), the first historian of Arabian medicine, in his book. It was also stated that during the reign of Al-Mansur (died 775 A.D.) an Indian medical work by Sushrud was rendered into Arabic by Manke, the Hindu court physician by the suggestion of Wazir Yahyaibn-Khalid.

The practical secret of rhinoplastic operations spread from India through Arabia and Persia to Egypt and from there it leaked to Italy. In the 15th century in Sicily, Branca used cheek flaps to reconstruct the proud noses of hot-blooded swordsmen. His son Antonio tried flaps from the arm and by the late 16th century Tagliacozzi had published his work on the Italian method of arm flap rhinoplasty. (70.)

It was, however, only two centuries later, in the nineteenth century, that German, French and English surgeons could study the entire method afresh, through the translation of the Sanskrit literature and personal observation through travels in India:

In Kumar near Poona a Mahratta surgeon was seen by two medical officers of the East India Company, James Findlay and Thomas Cruso, performing a rhinoplasty by the median forehead flap. This case was reported as a "singular operation" in the Madras Gazette of 1793. The patient was Cowasjee, a Mahratta bullock driver with the British army in the war of 1792. He was taken prisoner by Tipu Sultan who cut off his nose and one of his hands.
He went back and rejoined the Bombay army of the East India Company and after one year had his nose reconstructed in Kumar near Poona. A description of this case also appeared in the Gentleman's Magazine of London in a letter from India in 1794 (71. The description of the "singular operation" was responsible for the later spread of this technique to European countries and to the United States of America. The first successful case of forehead flap rhinoplasty performed in England was published in 1814 about twenty years after the Cowasjee case. Carpue's book: An Account of Two Successful Operations for Restoring A Lost Nose from Integument of the Forehead was published in the year 1816 and helped to create a considerable interest in this subject. In Germany Carl Ferdinand Von Graefe performed the first total reconstruction of the nose in 1816 and coined the term "plastic surgery" in his text on this subject published two years later. Jonathan Mason Warren from America undertook rhinoplasty by the Indian method in the year 1834. Captain Smith published his Notes on surgical cases - Rhinoplasty in the British Medical Journal in 1897 and suggested improvements. Keegan (1900) wrote a review of rhinoplastic operations describing recent improvements in the Indian method (72.

If plastic surgery began in India with the reconstruction of noses, the Europeans took over the principles of the method: not living in a culture that insisted on visiting punishments with the lopping off of noses, they could readily see a possible application to other areas of bodily defect. A similar case of development of techniques after diffusion concerns the noria, another peculiar Indian invention, originally thought to have originated in Egypt, but now generally acknowledged as Indian (73.

In fact, if there is one invention that seems to have resulted directly from a philosophical attitude, it was probably the noria, or, the Persian wheel. The noria, as a wheel, was provided with buckets for irrigating fields. The wheel in Indian culture is also a common symbol for cyclical time or continuous change. Lynn White is of the opinion that in India, "the idea of perpetual motion was entirely consistent with, and was perhaps rooted in, the Hindu concept of the cyclical and self-perpetuating nature of all things." (74. Joseph Needham has made a similar observation:

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It may very well not be fanciful to seek the ultimate origin or predisposition of the Indian conviction in the profoundly Hindu world view of endless cyclical change, kalpas and mahakalpas succeeding one another in self-sufficient and unwearing round. For Hindus as well as Taoists, the universe itself was a perpetual-motion machine (75).

The first mention of a perpetual-motion machine is to be found in the *Aryabhatiya* of the great Indian mathematician Aryabhata (A.D. 499):

One should cause a sphere of light wood, equally rounded and of weight on all sides, to move in regular time by means of quicksilver, oil, and water (76).

Another reference can be found in the *Siddhanta Siromani*, a book by another brilliant Indian mathematician, Bhaskara (A.D. 1150), who was the first Indian scientist to prove that zero was infinity. Bhaskara, in the book, describes in some detail how one might construct a perpetual-motion machine by secretly filling the edge or rim of a wheel with quicksilver. Writes Richard Lannoy:

> It is evident that Bhaskara's quicksilver wheel was meant as a device for displaying the magical power of the scientist working in harmonious unity with the energies of nature, and to provide a graphic demonstration of life as a process of continuous change (77).

As it now known, however, the *Siddhanta Siromani* was translated into Arabic a few decades later and found its way into Europe by 1200 A.D. with the quicksilver wheel appearing soon after, in almost identical terms in the sketchbook of Villard de Honnecourt, setting in train a spate of research into perpetual motion which, according to Needham, "deeply influenced modern scientific thought at one of its most crucial early stages."

It is now easy to understand the opinion of Robert Orme, the traveller, who though often critical, was forced to admit that "the arts which furnish the conveniences of life have been carried by the Indians to a pitch far beyond which is necessary to supply the wants of a climate which knows so few." He went on to remark paradoxically
that though the knowledge of the Indians in "mechanical
matters is very limited", Europeans were "left to admire,
without being able to account for" the manner in which,
for example, the people built their bridges and construc-
ted their huge temples.

Or ships, for that matter. In the middle of the
eighteenth century, John Grose noted that at Surat, the
Indian ship-building industry was very well established,
indeed. "They built incomparably the best ships in the
world for duration" and of all sizes with a capacity of
over a thousand tons. Their design appeared to him to be
"a bit clumsy" but their durability soundly impressed him.
They lasted "for a century". Lord Grenville mentions, in
this connection, a ship built at Surat which continued to
navigate up to the Red Sea from 1702 when it is first men-
tioned in Dutch letters as "the old ship" up to the year
1770.

Grenville also notes that ships of war and merchan-
dise "not exceeding 500 tons" were being built "with faci-
licity, convenience and cheapness" at the ports of Coringa
and Narsapore. The Parsees in Bombay were known as great
builders of ships - highly skilled as "naval architects". In
Les Hindous, Solvyns, after introducing about 40 sket-
ches of boats and river vessels used in the Indian north
in the 1790s, observed that "the English, attentive to
everything which relates to naval architecture, have bor-
rowed from the Hindoos many improvements which they have
adapted with success to their own shipping (78. Needham
too sees the multiple masts of India and Indonesia in this
light.

Dr H Scott sent samples of dammer to London, as this
vegetable substance was used by the Indians to line the
bottom of their ships: he thought it would be a good sub-
stitute "in this country for the materials which are
brought from the northern nations for our navy... There
can be no doubt that you would find dammer in this way an
excellent substitute for pitch and tar and for many pur-
poses much superior to them."
which are brought from the northern nations for our navy... There can be no doubt that you would find dammer in this way an excellent substitute for pitch and tar and for many purposes much superior to them."

We have left out of this representative review of Indian technology a number of other technical processes used by Indians before and during the colonial period, including the making of paper, ice, armaments, the breeding of animals, horticultural techniques and so on. What we have tried to do here is to re-state mildly the originally Marxist contribution that it is rarely profitable to see a superstructure (particularly, an element of it, such as Indian metaphysics) as determinative or impediment of material culture. And we shall see later, that though a superstructure may always hold only a secondary importance, it may be exploited for reinforcing exploitative relationships already holding in a stage of material culture.

A few words on Indian science or systematic thought. Wrote Needham in 1963:

We cannot forejudge what the future developments of the history of science will bring forth, but if India was probably less original than China in the engineering and physico-chemical sciences, Indian culture in all probability excelled in systematic thought about Nature (as for example in the Samkhya atomic theories of kshana, bhutadi, paramanu, etc.), including also biological speculations....When the balance comes to be made up, it will be found I believe, that Indian scientific history holds as many brilliant surprises as those which have emerged from the recent study of China - whether in mathematics, chemistry, or biology, and especially the theories which were framed about them (79).

Our first task in formulating the history of science in India is abound to be purely negative: the rejection of myths, held by both Indians and Westerners on the subject. Since there are too many of them, we can afford to be selective and brief. Already in 1947, the French indologist, Filliozat, provided an introduction to and summary of such a program of "de-mythologization", in his preface to his splendid monograph on the theories of classical Indian medicine:
Some may doubt the legitimacy of placing Indian and Greek science on the same level, preferring to compare the former rather with that of Islam. The common opinion that Indian science lacked originality presupposes that it was derived from Greek science, and is therefore sister to the science of the Arabs.

This problem has been far too much prejudged. Indian scholars, moved by national pride, are prone to maintain that their sciences in high antiquity surpassed even those of today. In the West, on the other hand, many maintain that the spirit of scientific research could only have been born in Europe, and that what science the Indians had they borrowed. In either case the only proofs presented are a few examples claimed as characteristic and used as the basis for generalizations, hypotheses taking the place of facts which are still undiscovered...

The greatest historians of science have not always escaped from the inconvenience of knowing only one side of the matter. Paul Tannery, so famous for his studies on ancient mathematics, is an example. We know that the trigonometric sine is not mentioned by Greek mathematicians and astronomers, that it was used in India from the Gupta period onwards (200 AD), that the Surya Siddhanta (300 or 400 AD) gives a table of sines, that the Arab astronomers knew them from their Indian contacts and passed them on to Europe in the twelfth century, when the work of al-Battani was translated into Latin. The only conclusion possible is that the use of sines was an Indian development and not a Greek one. But Tannery, persuaded that the Indians could not have made any mathematical inventions, preferred to assume that the sine was a Greek idea not adopted by Hipparchus, who gave only a table of chords. For Tannery, the fact that the Indians knew of sines was sufficient proof that they must have heard about them from the Greeks.

If this is the way we are to argue, there was never any science other than Greek science, and the question whether science has any origins other than the Greek "miracle" is solved in advance. Only a profound study of Indian scientific developments in parallel with those which took place elsewhere about the same time, can reveal the degree of originality of that science, and hence enable us to understand the role which India played in the history of the growth of man's knowledge of Nature (80).

Tannery, as Filliozat remarked, was one such case. There are many others. Take the excellent dissertation of H T Colebrooke on Hindu Algebra: this work included a brilliant review of all the studies done till its time on
the subject and in it Colebrooke also attempted a comparison between developments in Europe and India. He found it hard to grant India an independent development. Though he was ready to admit that the Algebra of the Greeks was not up to standard, and did not compare with its Indian counterpart, he insisted that the subject "was made known to the Hindus by their Grecian instructors in improved astronomy." As a sort of consolation, he explained away the perfection of Hindu Algebra by inferring that

by the ingenuity of the Hindu scholars, the hint was rendered fruitful and the algebraic method was soon ripened from that slender beginning to the advanced state of a well arranged science (81.

Colebrooke was strongly rebuked for this, but the rebuke did not see wide publicity. A reviewer of Colebrooke's *Algebra, with Arithmetic and Mensuration*, his dissertation, stated bluntly in the *Edinburgh Review* that Indian Algebra "could not have been derived from Greece." And he went on to observe:

> Mr Colebrooke, after demonstrating the excellence of this algebra, and comparing its more perfect algorithm and its superior advancement with the Greek algebra, as explained in the work of Diophantus, seems nevertheless willing to admit, that some communication about the time of the last mentioned author may have come from Greece to India, on the subject of the Algebraic Analysis. Of this we are inclined to doubt; for this simple reason, that the Greeks had nothing to give on that subject which it was worth the while of the Indians to receive. Mr Colebrooke seems inclined to this concession, by the strength of a philological argument, of the force of which we are perhaps not sufficiently sensible. It seems however certain, that the facts in the history of Algebraic Analysis, taken by themselves, give no countenance to the supposition (82.

Another interesting case concerns the Binomial Theorem, on which Reuben Burrow published a paper in 1790, entitled, *A Proof that the Hindus had the Binomial Theorem*. Till that paper, and even after it, in standard reference works like the Encyclopaedia Britannica upto the twentieth century, the discovery of the theorem had been
attributed to Newton. Later it was discovered that Briggs had already been teaching the theorem in 1600. Thirty years after Reuben's paper appeared, came another, and this one was entitled, Essay on the Binomial Theorem; as known to the Arabs. The article concluded:

It plainly appears, that whatever may have been the case in Europe, yet long before the time of Briggs the Arabians were acquainted with the theorem (83.

The most unusual case in Indian science history, of course, has to do with astronomical tables. John Playfair, a professor of mathematics and natural philosophy at the university of Edinburgh, set out to examine the astronomy of the Hindus in certain of its respects. In the course of his study, he came across the astronomical tables of south India. He found the period of these tables coincided with the Kaliyuga, the last phase of the Hindu cosmological time-scale, which began in 3102 BC.

There was one possibility of fraud: that the planetary positions were merely calculated backwards from more recent times to coincide with a mythical Kaliyuga. The actual fact would be that these planetary positions were observed about 3102 BC itself.

Playfair had to discount the fraud alternative, observing that it would have been impossible for astronomy, even in its most perfect state, to work back 46 centuries and ascertain the situation or loci of the heavenly bodies at so remote a period, except with the help of the recently developed integral Calculus and the theory of gravitation. Yet, his calculations on the tables had led him to the conclusion that the tables appeared to be exact by every conceivable test. He also wrote that the construction of these tables implied a good knowledge of geometry and arithmetic and the possession of a calculus equal to trigonometry.

He had two possible conclusions: either the Indians reached their results through complex astronomical calculations or through direct observation in 3102 BC. He
settled for the latter, since the former would have implied that

there had arisen a Newton among the Brahmins, to discover that universal principle which connects, not only the most distant regions of space, but the most remote periods of duration, and a De La Grange, to trace, through the immensity of both its most subtle and complicated operations (84).

It is also obvious from a paper in Dharampal's volume that the Indians knew about the four satellites of Jupiter and the seven moons of Saturn, much before these were discovered in the West. To achieve this, the Indians must have had excellent instruments, probably differing from modern ones, but fully as powerful. This is evident when it is known that the seventh satellite of Saturn was not discovered by Herschel until he had completed his large telescope which contained a focal length of 40 feet. The author of Colonel Pearse's memoirs (it was Pearse's paper on the Indian knowledge of the satellites that was sent to the Royal Society) thinks it probable that Herschel might have come across this important paper and worked on it to achieve his results. The question is, however, how long will historians of astronomy hold on to the fiction that it was Herschel who first discovered these satellites? (85).

There is also the controversy surrounding the differential calculus, whether this was invented by Newton or the Indian mathematician Bhaskara, who lived nearly six centuries before. Mr Spottiswoode, who joined the debate concluded by stating that mathematicians in Europe would be surprised to learn of the existence of such a process in the age of Bhaskara (circa 1150 AD, born 1114 AD), that the formula Bhaskara established and the method of establishing it bore a close resemblance to the corresponding process in modern mathematical astronomy in the determination of the differential of a planet's longitude (86).

All this is the tip of the iceberg of Indian science: we have not even mentioned the Observatory of Benaras, which the Encyclopaedia Britannica in its editions upto
1823 rated as one of the five "celebrated observatories" of the world. A more inclusive picture will only be available after all the relevant documents in Sanskrit, Tamil, Arabic and Persian have been translated and interpreted, and we might add, after Western historians of science have found the courage to be slightly more objective then they have been till now.

THE INDIAN MIND

Our brief illustrations of Indian science and technology should not be construed as constituting our total interpretation of the Indian homo faber paradigm. For the technology of India can be related to other aspects of an Indian philosophical anthropology, or, an Indian mind. Take textiles.

The colours used by the Indian craftsmen for their textiles, writes Robinson, were not only brilliant and of great variety, they were also often exceedingly subtle and particularly so in their tonal qualities:

Their colours seem to contain hidden qualities and effects that only appear in differing lights. The pagris or headwear produced in Rajasthan (originally Rajputana), Kotah and Alwar contained two slightly differing shades which produced a constantly changing colour pattern as the fabric rippled (87).

It may surprise the reader, but a similar "moving" principle underlies the painted frescoes of the Ajanta caves. In describing these frescoes and their techniques, Richard Lannoy, the most scintillating interpreter of Indian culture to date, writes:

At first sight it is the genial "Buddhist humanism" which strikes the visitor (to the fresco caves). Yet these reassuringly human scenes are not quite what they seem to be. For one thing, even the best preserved are exceedingly elusive to "read"; one must make an appreciable effort to slow down one's reading of their visual language in order to perceive the spatial and tactile relations established between the figures. There is no recession - all advance towards the eye, looming from a strange undifferentiated source to wrap around the viewer.

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This is not an optical illusion of cave-light; on close examination it will be found to result from a controlled use of almost equal tones in the variation of local colour. A patch of green, say, juxtaposed to a patch of red, is of very nearly the same tonality when photographed in monochrome. Because of this tonal equality one is constantly discovering new figures which were unseen through the deliberately unaccented or "suppressed" tonality of detail, and the tempo of this slow discovery is very precisely calculated. Every figure has a counter-figure, every body an anti-body. Each figure is inseparable from its environment. The optical basis of this technique is very simple and is frequently used by Bonnard, Vuillard, and Matisse to obtain a hallucinating, visionary effect; the later, psychedelic poster artists made a trick of it. One can assume that the Ajanta painters discovered the effect under similar lighting conditions. There is one vital difference, however: at Ajanta there is no source of light in the caves, a fact which says much about the metaphysic of the cave sanctuaries. Objects are their own light when experienced by all the senses in harmony, and such harmony was the goal of the cave ritual.

When viewed by flickering light, as was intended, only fragmentary glimpses of the colours and lines of the objects depicted can be obtained. A body undulates towards the eye from an indistinguishable blur; moments (perhaps minutes) later, a second body wells out of the blur and is seen to be intertwined with the first. The viewer is so involved in this optical assimilation that his relation to the other figure only proceeds gradually from the tactile to the emotional recognition of its significance. It cannot be reduced to verbal interpretation, as it is pure tactile sensation (88).

Lannoy himself admits that his interpretation of these frescoes came to him in the company of C V Raman, who also won the Nobel Prize for Physics. He also acknowledges that the experience made him change his mind that there is any sort of antithesis between the unified aesthetic sensibility nurtured by Indian culture through ages, and the demands of the scientific spirit.

He then goes on to make a sharp distinction between the "single, fixed viewpoint to which we (in the West) are conditioned by the artifice of optical perspective" and the "multiple-perspective, shifting viewpoint employed in the portrayal of figures, animals and objects at Ajanta."
Here, we might deviate a little to indicate one more example of the imperialism of categories that has resulted in a grossly distorted view on the abilities of the Indian artistic personality. In most art history volumes, the appearance of perspective has often been seen as a form of "development" in the regular refinement of techniques in art: this criterion has then been universalized, without the recognition that another culture may refuse the technique, not out of ignorance, but out of choice: this is confirmed by the insistent indifference of the Indian artist to the single pyramidal tableau contained within a border, which is the commonest structure for the Western-type image. In The Speaking Tree, Lannoy not only distinguishes Indian art from Western, he also emphasizes its distinctness from Chinese art, a point well made after the general confusions spread abroad by Northrop (89).

The entire metaphysic of the Ajanta frescoes is too complex to get across here, cramped as we are for space. More fruitful would be a minor discussion about Indian architecture, which can again be sharply distinguished from its counter-part in Western experience.

Lannoy has pointed out that the caves of India are the most singular fact about Indian art, and he is right, for they serve to distinguish it from that of other civilizations. A prodigious amount of labour, spread over a period of about 1,300 years, was expended in this "art of mass", the excavations of rock sanctuaries and monasteries. These caves were hewn out of solid rock, in other words, they were "constructed" through the excavation of space.

These sanctuaries were cut from nearly perpendicular cliffs to a depth of a hundred feet: in all cases, this excavation was carried out by means of a chisel 3/4 inches wide; the same chisel was also used to carve out elaborately decorated columns, galleries and shrines. The two largest structures of the kind are staggering in their dimensions:
The Kailash temple at Ellora, a complete sunken Brahmanical temple carved out in the late seventh and eight centuries AD is over 100 feet high, the largest structure in India to survive from ancient times, larger than the Parthenon. This representation of Shiva's mountain home, Mount Kailash in the Himalaya, took more than a century to carve, and three million cubic feet of stone were removed before it was completed. An inscription records the exclamation of the last architect on looking at his work: "Wonderful! O how could I ever have done it?" (90).

In Europe's middle age, the great cathedrals, including the one of Chartres, rose from the ground upwards to the sky, supported not so much by stone as by the powerful religious symbolism that drove the Christian church. In India, the craftsmen did not build, but removed the earth and stone to discover space in the service of a different religious symbolism, not one identified with any religious monolith, but instead, one to which different religious groups owed allegiance. Lannoy is more precise (and Arnold Pacey would agree):

A hollowed-out space in living rock is a totally different environment from a building constructed of quarried stone. The human organism responds in each case with a different kind of empathy. Buildings are fashioned in sequence by a series of uniformly repeatable elements, segment by segment, from a foundation upwards to the conjunction of walls and roof; the occupant empathizes with a visible tension between gravity and soaring tensile strength. Entering a great building is to experience an almost imperceptible tensing in the skeletal muscles in response to constructional tension.

Caves, on the other hand, are scooped out by a downward plunge of the chisel from ceiling to floor in the direction of gravity; the occupant empathizes with an invisible but sensed resistance, an unrelenting pressure in the rock enveloping him; sculpted images and glowing pigments on the skin of the rock well forth from the deeps. To enter an Indian cave sanctuary is to experience a relaxation of physical tension in response to the implacable weight and density of the solid rock (91).

Such an analysis of the distinctness of the Indian mind could be reinforced by further investigations into Indian literature-forms, music-structures and language.
The similarities between the worlds of Sanskrit drama and the Ajanta caves, and the structural disaffinities between Kalidasa's *Shakuntala* and Shakespeare's *King Lear* will not hold us here, but something might be said about Indian music, for this art is one of the few living and thriving expressions of Indian cultural life today.

The Indian system of *tālas*, the rhythmical timescale of Indian classical music, has been shown, (by contemporary analytical methods) to possess an extreme mathematical complexity. It is, in a sense, fortunate, that the results of these analyses were not available in the time of Max Weber, especially when he set out to write his essay on "rationalized" character of Western music (92). For, in conception the basis of the system is not conventional arithmetic but *pattern recognition*. To quote Lannoy again:

In the hands of a virtuoso the *tālas* are played at a speed so fast that the audience cannot possibly have time to count the intervals; due to the speed at which they are played, the *tālas* are registered in the brain as a cluster configuration, a complex Gestalt involving all the senses at once. While the structure of the *tālas* can be laboriously reduced to a mathematical sequence, the effect is subjective and emotional... The audience at a recital of Indian classical music becomes physically engrossed by the agile patterns and counter-patterns, responding with unfailing and instinctive kinaesthetic accuracy to the terminal beat in each *tāla* (93).

This ability with instruments is repeated with the voice. The extraordinary degree of control of the human voice has been described by the musicologist, Alain Daniélou, who has stated that Indian musicians can produce and differentiate between minute intervals (exact to a hundredth of a comma, according to identical measurements recorded by Daniélou at monthly recording sessions). This sensitivity to microtones is, from a purely musicological point of view of little importance, like the mathematical complexity of the *tālas*. Nevertheless, as Lannoy puts it:

It is an indication of the care with which the "culture of sound" is developed, for Hindus still be-
lieve that such precision in the repetition of exact intervals, over and over again, permits sounds to act upon the internal personality, transform sensibility, way of thinking, state of soul, and even moral character (94

SUMMING UP

This chapter has continued elaborating the theme of the first and should therefore not be seen as standing independent of it. It is merely one more exemplar of the universal homo faber model: the Indian paradigm.

I have emphasized certain dimensions of Indian life to the detriment of others. Indian culture, for example, is well known, Indian philosophy, even better. What does not exist in the public mind is any idea of Indian technology, some elements of which this chapter has set out to present.

I began by relativizing or devaluating Indian metaphysics, pointing out that it makes little sense in the light of past historical experience, to speak in terms of any orthodox metaphysic directing the Indian mind. The tendency to deny Indian interest or achievement in technology through a kind of deduction from a world-disinterested philosophy stands questioned.

More useful in this regard, however, is to provide some concrete details of Indian involvement in material life. For this, I began with a description of agriculture and irrigation technology, then moved on to that part of Indian life not connected with agriculture, though complementary to it: industry.

Since the textile industry was the largest industry in the period, the space I devoted to it should not, I hope, appear unreasonable, particularly when we consider its concrete influence on the development of the Western textile industry itself. I followed this up with a briefer picture of Indian iron and steel, after that, Indian medicine, and finally, the noria, placing all these in a relationship with Western development of technology.

A discussion then followed of Indian science or systematic thought; also brief, indicating principally how scholars have treated the issue in the past.

My final issue was circulated around a brief overview of Indian culture and possibly, its relation to Indian technology. In short, I was interested in arguing the existence of a distinct Indian mind, an Indian manner of experiencing the world, through an analysis of Indian music, painting, and architecture. I saw no contradiction between this sensibility and the demands of a scientific method, but I questioned the possibility of attempting to understand Indian culture through catego-
ries evolved in another, particularly Western, context.

My objectivity may be tested in this chapter, since at the cultural level, we are all petty chauvinists. But if the reader recall my continuous insistence against terming cultures superior or inferior, he will be ready then to grant me some indulgence.

REFERENCES: NOTES: LITERATURE

The literature spread out among the notes below is a small sample. While a great deal of the Sanskrit, Persian, Arabic and Tamil sources have been translated, still more remains to be done. Accounts of foreign travellers in India and Asia during the period 1500-1800, necessary for re-constructing the history of the period, are listed comprehensively in the volumes of Donald Lach's Asia in the Making of Europe (1965) Lach and Flaumenhaft have also edited a volume, Asia on the Eve of Europe's Expansion, which contains some useful details (1965)

O P Jaggi's History of Science and Technology in India, in five volumes, is a great disappointment: the title, to put it mildly, exaggerates his intentions. Three of the volumes are on Indian medicine and the other two are restricted to science and technology in the earliest periods of Indian history.

A Rahman's Trimurti: Science, Technology and Society (1972) might have been written by some of the writers we have criticized in the introduction to this chapter: the foreword by Needham is brief and unextraordinary, written for personal reasons: both writers are Marxists.

The best source up to date on the subject is Dharampal's Indian Science and Technology in the Eighteenth Century (1971), without which this chapter might have proved extraordinarily difficult to construct. As Dharampal notes, the selections in his volume are merely a small part of the material available. In the space of just two days, I was able to collect a random list of more than thirty volumes written on the subject of Indian medicine alone. The textile industry has been well researched, the results are available with the Calico Museum of Textiles in Ahmedabad, India, which also publishes a first-rate journal on these matters. The CIBA Review published since 1936 from Switzerland has done distinctive work in the field: two issues are exclusively devoted to Indian textiles.

Of course, Needham's monumental Science and Civilization in China carries numerous references to Indian science and technology.

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The last person to suffer from variola major, the severe form of small-pox was a girl in Chittagong on the 15th of September, 1975. The disease no longer exists according to WHO.

The following discussion is indebted to the excellent paper of:

Also, note 37, chapter one.
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Chapter Three

Chinese Technology and Culture: 1368–1842

In which we present the Chinese homo faber paradigm, but not before a critical discussion of how not to go about such a task. Past, primarily Western attempts to write about China are disabused by the imperialism of categories in its sharpest form; that is, the attempt to fit Chinese history into frameworks and categories evolved in the contexts of Western experience. As an example, we examine the presuppositions of the very famous question, Why did China not have a scientific revolution? and conclude by de-valuing the worth of such questions, for they betray an unreasonable refusal to examine the past in terms of the past, to see China through Chinese eyes. All this, as important prelude to the presentation of the Chinese paradigm itself of culture and technology, its divergence from the Western counterpart. And finally, a large section on how Chinese man met, even in the face of increasing difficulties, the problems his environment presented him in the pursuit of his material and cultural needs.

Early in this century, A H Smith put forth the opinion that Chinese history "is remote, monotonous, obscure and worst of all, there is too much of it." Though the earlier parts of Smith's opinion have by now been sufficiently dis-established, his conclusions still hold. How much of this history, reconstructed in the main by Western scholars, is useful for our purposes here, is a moot question. That it has not been wholly useful for the Chinese themselves is evident from the pages of China Reconstructs,
a journal that has busied itself with a re-interpretation of the pattern of the Chinese past that is more in keeping with the new consciousness of the Chinese Revolution, or, as W F Wertheim put it, with the Chinese belief in an a-religious promised land: a better earth.

Interpretation is a central characteristic of all historical writing: since the historian necessarily faces a past he can never experience at first-hand, he is forced to work out an archaeology of mind, reinterpret words and things, documents and objects in the light of a credible and comprehensive theory. However, with Herbert Muller, historians have often recognized that the past has its uses; the Chinese today are no exception. More than twenty years ago, that brilliant Dutch historian, Peter Geyl, in an essay on Isaiah Berlin, expressed a similar opinion:

The truth is rather that history is an active force in the struggles of every generation and that the historian by his interpretation of the past, consciously or half-consciously or even unconsciously, takes his part in them, for good or for evil (1).

The Chinese insistence on the reconstruction of their own past indicates the existence of a credibility issue in a larger context: do we accept the work of Western historians or do we incline towards the interpretations of the newer historians of China and Asia in general? To take a not unrelated example, the early European expansion in Asian waters has been subjected to three different interpretations, depending of course on the nationality of the historian involved. The English historian, R H Tawney, presented it as a puppet show managed by the merchants of Antwerp (2. Sir G B Sansom saw it as "a civilization on the march" (3. The Asian historian, Sardar K M Panikkar, established it as

an attempt to get round the overwhelming land power of Islam in the Middle East, supplemented by an urge to break through the "prison of the Mediterranean" to which European energies were confined (4.

An interpretation or a theory, if it is to appropriate at least some of the qualities of Karl Popper's ob-
jective knowledge, must also be a matter for public agreement. And any account of Chinese history that ignores the opinion of some 800 million Chinese might just turn out to be beside the point. Wertheim had already indicated this conclusion, with great foresight, way back in 1958:

The failure of many intellectuals in the West to understand fully the implications of the revolution in China may be symptomatic of a certain rigidity occurring in Western culture which may damage its adaptability to new developments in the world (5).

What Wertheim (and Jan Romein too) was trying to express at that early date was a premonition that the countries of Latin America, Africa and Asia were moving gradually into a position from which they would feel compelled, in their own interests, to see and write history on their own terms. The importance of China for us here lies not in any use it might have for the Chinese (they can defend themselves and stand on their own feet), but in that it gives us a very clear instance of independence from the West, from the Western interpretation of Chinese history.

For, what the Chinese feel about their past, particularly about their technology and culture would be difficult to identify with what Westerners have felt about the same Chinese past. As Bodo Wiethoff puts it, in his recent volume, An Introduction to Chinese History, "European conceptions of China have rarely reflected Chinese reality, but have first and foremost been the response to European needs."

The twists and turns that the Chinese image underwent in the West have all been well-documented in the numerous representative histories of the period (6, and need not concern us here: the point has been made. From the wide-eyed wonder of Marco Polo and the other medieval travellers, to the Jesuit acknowledgement of the sophistication of the culture they faced, to Herder's impression of an "embalmed mummy, painted with hieroglyphs and swaddled in silk", Engel's "decaying semi-culture at the end of the earth" and Karl Marx's scorn concerning the "heredity stupidity" of the Chinese, is indeed a long jour-
ney, but it sketches indeed the face and personality of Europe more faithfully than it ever did the authentic details of the Chinese cultural creation.

Even Chinese scholars, educated in Western universities, have not been able to refrain from manipulating Chinese history to reinforce conclusions reached earlier by means frankly ideological, though at least their activities are intelligible in the light of the almost total devaluation of the role of the intellectual in the life of modern China. Mao Tse-tung always believed that the vast majority of intellectuals, both within and outside the Party were basically bourgeois.

Thus, the late Lin Yutang, born and raised in China, but with his spirit moulded in the United States, was ready to confess (in 1937) a complete lack of confidence in the recuperative powers of his own people:

Today China is undeniably the most incoherent and chaotic nation on earth, the most dramatically weak and impotent, the most incapable of rising up and marching ahead.... With the best will in the world, not even the League of Nations could help it bring order out of its chaos, put an end to its civil wars, free itself from its students, from its militarists and revolutionaries, from its political cliques.

That father and son team, Ch'u Chai and Winberg Chai, writing for an American audience, found it worthwhile to extol the Chinese past in The Changing Society of China, so that they could find it justifiable to discuss the Mao regime with a great deal of dismay and an unmistakable touch of hate.

In this thesis, we are not concerned with all of the Chinese past, but a very restricted period, specifically, the period that began with the dynasty of the MING (1368/1644), followed later by the CH'ING (1644/1911), the dynasty of the foreign Manchus. Even with the latter, we restrict our description to 1842, the date of the Unequal Treaties, and the beginning of Western political dominance.

It is precisely the interpretations of this specific period of Chinese history that have caused the greatest con-
troversy. The greatest of these have to do with the scientific and technological development of China, and the celebrated question asks why China did not produce either modern science or an industrial revolution on the English pattern, especially since Chinese technology at least had reach a level of sophistication not yet attained by any other part of the world, as late as the fifteenth century.

I am aware that the discussion which will follow now might more suitably have been taken up in the earlier chapter on Indian science and technology. However, the fact that most of the debate round this all-important issue has been taking place in the Chinese context, and even around and with the active involvement of Joseph Needham himself, has dictated its being considered here. The reader, however, is advised to retain the qualification that the conclusions arrived at here would be equally applicable to other contexts, like those of Indian and Islamic science history. With that said, we can now proceed to set out first a few important distinctions.

Not merely Needham, but a number of other writers have made a critical distinction between traditional science and modern science that began with Galileo. In fact, all civilizations have attempted science, if by the word is understood systematic abstract thought about nature. Nathan Sivin puts it the following way:

"Abstract" may have the sense not only of defining concepts on a more general plane than that of concrete sensual experience, but also that of seeking objective driving forces of change within nature itself rather than, like religion and magic, looking for explanations in terms of conscious will or emotion (8).

This is the reason we felt it worthwhile to talk about Indian science in an earlier chapter, though few would wish to believe that it exploited the Galilean method. More recently, in fact this year, the Islamic scholar, Seyyed Hossein Nasr, has made a similar point in his splendid volume on Islamic science (9). As he points out in the preface to his work:
Islamic science, which is taken in this work to include disciplines concerned with the study of the cosmos, embraces a wide spectrum of intellectual activity, from the study of plants to algebra, carried out over more than a millennium by many races and peoples spread over the middle belt of the earth from Spain and Morocco to eastern Asia. Because of its traditional character, this science is not limited in scope or meaning as is the modern discipline with the same name (emphasis added). The Islamic sciences, even in the more limited sense considered here, which excludes the religious and many branches of the philosophical sciences, are concerned at once with the world of nature, of the psyche and of mathematics. Because of their symbolic quality, they are also intimately related to metaphysics, gnosis and art, and because of their practical import they touch upon the social and economic life of the community and the Divine Law which governs Islamic society (10).

In a review of the fourth volume of Needham's work on China, Lynn White remarked that Chinese science is of interest in the interpretation of East Asian cultures, though Chinese technology, on the other hand, has global significance. Nathan Sivin, thinking along similar lines, has asked whether the label "anthropological" might not express what we have in mind:

If we use the first definition of science as systematic abstract thought - which might be called "anthropological", since it lets the Chinese theoretical encounter with nature define its own boundaries - the structure of knowledge looks very different indeed from that of modern science. It becomes as individual, in fact, as the map of scientific thought in ancient Greece or medieval Europe (11).

Sivin goes on to observe, in line with the basis themes of our theses, that each culture breaks up its experience of much the same physical world into manageable segments in very distinct ways. In each culture, in fact, certain basic concepts are consolidated in use due to their general usefulness in making nature comprehensible:

In Europe after Aristotle's time among the most important of these notions were the Four Elements of Empedocles and the qualitative idea of a proper that was part of the definition of each thing. In ancient China the most common tools of abstract thought were the yin-yang and Five Phases concepts, implying as
they did a dynamic harmony compounded out of the cyclical alternation of complementary energies. Today scientists use a wider range of well-defined concepts, embracing space, time, mass, energy, and information.

Thus the fields of science in a given culture are determined by the application of these general concepts, suitably refined, re-interpreted if necessary, and supplemented by more special concepts, to various fields of experience, demarked as the culture chooses for intrinsic and extrinsic reasons to demark them (12).

In the light of the new basic concepts available to modern science, traditional or "anthropological" Islamic, Indian, European or Chinese science could be labelled "proto-science", since the ideas or concepts characterizing them have come to be modified beyond recognition or supplanted entirely (a process that seems to affect even the content of modern science itself). The point to remember is that without these "proto-sciences", the foundations of modern science might never have been available in the first place, as no one can see the latter as having had some form of spontaneous generation (13).

It is at this point that we enter controversy: scholars in the history of science have tended to re-examine the past of other cultures to try to discover why they did not make the breakthrough to modern science. The issue is then reduced to a rather misleading debate concerning the peculiar social or philosophical factors that could or might have inhibited the rise of, say Chinese science. The hidden assumption in the discussion is that within the Western traditional itself there were conditions sufficient enough for the rise of Galilean science. As Graham has noted, this has become increasingly hard to prove. Nathan Sivin puts it the following way:

The basic concepts that (the Chinese) used to explore physical phenomena are precisely yin-yang, the Five Phases (wu hsing), the trigram and hexagram systems...., and others that used to be invoked (even by twentieth-century Chinese thinkers) as chiefly responsible for the failure of Chinese to learn how to think scientifically.
But to place the responsibility there is to commit one of the most elementary fallacies of historical explanation, namely to present a description of what the world was like before X as though it were an explanation of why X happened so late or failed to happen at all. Since the concepts I have mentioned were the vocabulary of early scientific thought, it is as misguided to call them an impediment to modern science as to consider walking an impediment to the invention of the automobile (14).

In the same preface from which this quote comes, Sivin attempts to excuse Needham from the error of thinking in the same direction as the one he has just criticized. In a sense he can do that, since he is criticizing the internalist theory, and Needham has never sympathized with that theory. The question, yet, is whether Needham has not concentrated on the same issue, albeit approaching it from the angle of socio-economic conditions, in other words, an externalist approach. A brief discussion of Needham's work will make this obvious.

The Sinologist, Arthur Wright, has dug up two teleological assumptions that pervade Needham's work:

- the development of science as a universal progress toward a single goal (the assumption that every ancient scientist in every country was working toward the fruition of science in the modern Western sense), and that this goal is Marxist in character (the assumption that progressive people everywhere have always aimed, whether conscious of it or not, at an ultimate, collectivist utopia (15).

We are concerned here with the first issue obviously; and to anyone conversant with Needham's work as a whole, there will appear a great deal of truth in the observation that Needham has often tried to take "anticipations of isolated ideas or techniques of modern science as the sole measure of orientation toward the future." In his restrained critique of Needham's work, Shigeru Nakayama makes the following pertinent remark:

Those who work amid a humanistic tradition tend to think of science as only a minute part of the whole culture. Even today, despite the overwhelming claims of science, even well-educated people seldom have an elementary grasp of its fundamentals.
They are not prepared to comprehend the part it plays in their lives. In classical Greece, in Islamic culture, in the Middle Ages, and even in the age of the seventeenth century Scientific Revolution, very few people were interested in and engaged in exact science. Until the establishment of its legitimate position in the nineteenth century, science was only an insignificant constituent in the ocean of general culture; its theoretical basis was an integral part of philosophy. There was no clear-cut scientific culture in the contemporary sense (16).

If this observation seems reasonable enough and is accepted, it then becomes obvious why Needham has found himself continually forced to modify his views on the development of science and technology in China. Already in 1944, On Science and Social Change provides his first answer to the question about why modern science did not arise in China, an answer that is Marxist in character and influenced by the early Wittfogel:

As we have already seen above, the rise of the merchant class to power, with their slogan of democracy, was the indispensable accompaniment and sine qua non of the rise of modern science in the West. But in China the scholar-gentry and their bureaucratic feudal system always effectively prevented the rise to power or seizure of the State by the merchant class, as happened elsewhere (17).

It is interesting to note that Needham has turned out to be one of the sharpest critics of Wittfogel and his theory of Oriental despotism in recent years. More relevant to our discussion is the question why the social organisation of China should and could have been similar to the one that obtained in Europe, precisely when Needham has been the first person to emphasis, in great detail, the originality and distinctiveness of Chinese social and economic organisation, law and philosophy, and of course technology. As this is naturally to be seen as a consequence of the fact that the Chinese have inherited a different range of problems, considering that they have been active in an environment very different from the Western counterpart.

Twenty years later, in 1964, in Science and Society
in East and West, Needham still felt confident enough to propose the same sociological explanation. In Time and Eastern Man, however, he found himself crossing the border line between "internalist" and "externalist" theories, by expressing sympathy for the view that the concept of linear time might have had a positive effect on the development of Galilean science. And in Human Law and the Laws of Nature, he added the concept of a Divine Legislator as a further plus. In The Grand Titration, however, he was ready to realize that the problem was indeed tremendously complex:

Whatever the individual prepossessions of Western historians of science all are necessitated to admit that from the fifteenth century A.D. onwards a complex of changes occurred; the Renaissance cannot be thought of without the Reformation, the Reformation cannot be thought of without the rise of modern science, and none of them can be thought of without the rise of capitalism, capitalist society and the decline and disappearance of feudalism (18).

Yet, as Graham has noted, the question still remains whether such an analysis would still be able to explain why modern science did not arise in China:

We are shown that one of the interlocking factors in sixteenth-century Europe was missing in China, a kind of explanation which is liable to reduce itself to the vacuous observation that conditions in sixteenth-century Europe differed from those of any other place or time (19).

Graham concludes, finally, that we can always think of alternative routes to the scientific revolution, for it is not at all possible to demonstrate conclusively that modern science could only have begun in the field of astronomy and that it could not have made its takeoff with "laws statable in terms of traditional Chinese mathematics, only afterwards refining its geometry to deal with astronomy..." (20. The Dutch historian of science, R. Hooykaas, would agree, with a qualification absolutely proper:

The question may be raised whether this result could not have been brought about in a different way. Of
course, logically speaking, when now a non-chris-
tian world manipulates "science in the modern
sense", this same situation might have been possi-
ble in the seventeenth century and other epochs,
and also in other places than western Europe. His-
torically speaking, however, it makes little sense
to reconstruct a course of history different from
that which actually took place (21.

It is not that we think it necessary to reject the
sociological argument, and while we are at it, we might
add that the researches of Professor Hooykaas, eminently
sociological, provide a better picture of the influence
of social conditions on the development of modern science
in Europe than any simplistic Marxist analysis. But the
indiscriminate shift of the argument to a different so-
cial situation, to explain a negative occurrence, is not
going to prove very enlightening. One of the sharpest
critics of Needham in recent years has not been Graham,
but Mark Elvin, who in his recent work, The Pattern of
the Chinese Past, presents a different picture of the
Chinese merchant community than one available through
Needham's researches. To an extent, this is intelligi-
ble, as Elvin has used Japanese sources that escaped
Needham. Elvin, however, himself proves unable to escape
the concerns of Needham, and finally sets out to provide
his own argument about why Chinese science disintegrated.

He begins by studying the new orientation of Chi-
nese philosophy during the 14th century, through the 16th
when Wang Yang-ming developed his theory of moral intu-
tionism, which in effect was a marked shift towards in-
trospection and subjectivity, whereas Chu Hsi, the great
synthesizer of Sung dynasty Neo-Confucianism, had urged
earlier "seeking for principle in everything." Elvin sees
Wang Yang-mings idealism as a hindrance to the growth of
a mechanistic and quantitative approach to phenomena. Fi-
nally, he closely examines the labours of Fang I-chih,
(1611-71) one of the ablest thinkers in the science of the
seventeenth century, and his son Fang Chung-t'ung, to ask
why both of them did not make any real contribution to
the development of science. He is able to conclude that

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the sophisticated metaphysics of the Fang duo proved inappropriate for good scientific thinking: Fang's conviction of the universality of Mind enabled him to solve any puzzle in Nature through an internal shuffle of mind:

Given this attitude, it was unlikely that any anomaly would irritate enough for an old framework of reference to be discarded in favour of a better one. Here then was the reason why China failed to create a modern science of her own accord, and the deepest source of resistance to the assimilation of the spirit of Western science both in the seventeenth century and later (22).

The trouble with this sort of analysis is that it hardly illuminates; for the point could equally be made that what distinguished Galileo from his predecessors was precisely this fact, that they preferred to think in modes that Fang himself would have found quite comfortable. The fact is, however, that Galileo did in reality move further, which means that earlier forms of proto-science do not carry any inherent obstacle to the rise of a person or mind that might think differently.

The researches of R Hooykaas are relevant here. His boldness in proposing his positive thesis concerning the role of a religiously oriented culture in the encouragement of the scientific enterprise has now paid off dividends. Recent studies have confirmed the work he published some four years ago.

Metaphorically speaking, wrote Hooykaas, the bodily ingredients of science may have been Greek, but the vitamins and hormones were decidedly biblical. The activities of the Puritans played a crucial contributory role; more important, was the influence of Francis Bacon.

It was the Italian scholar, Paulo Rossi, who first drew attention to the millenarian aspect of Bacon's philosophy quite early in 1957 (in English, Francis Bacon: From Magic to Science, 1968). What Rossi did was to show by quotation, that Bacon thought of his "Great Instauration" of learning as an attempt to return to the pure state of Adam before the Fall, when, in close contact with God
and nature, he had insight into all truth and power over the created world. This insight and this power were lost by man at the Fall, when sin clouded his perceptions.

Professor Hooykaas uses the word Utopian, which is not exactly similar to millenarian. But he makes a similar point:

Francis Bacon, though no Puritan himself, had been educated in the spirit of Elizabethan Puritanism, as his religious creed showed, and this spirit was, as Spedding remarked, incorporated in his theory of the world. The whole scheme of Christian theology - creation, fall, mediation and redemption - underlay his philosophical works; there was hardly any kind of argument into which it did not at one time or another introduce itself (23).

Bacon's projected reform of the sciences had thus a strong religious tinge. The primary object of the Great Instauration was "to redeem man from original sin and to reinstate him in his prelapsarian power over created things." The millennium could thus only be brought about through this salvation through science; Bacon himself seems to have believed that the time was short and the End itself not so far off.

In a recent, weighty volume, The Great Instauration: Science, Medicine, and Reform, 1626-1660, Professor Charles Webster makes Puritanism and its eschatology the ideological framework of the science of the period. As Frances Yates has noted in a review:

The Puritans laid great stress on reform and spread of education, following the Baconian program as expanded by Hartlib and Comenius (see Hooykaas). The vital force behind this effort, according to Webster, was the Puritan insistence on the ruin of human abilities at the Fall, a ruin which needed to be restored in preparation for the millennium. With this interpretation of the spiritual motive force behind the intensive cult of education by the Puritans, Webster couples his detailed analysis of Puritan education (24).

Webster also related the program of medicine in the Puritan outlook to the effort to restore man's physical perfection, lost again at the Fall.
What Webster demonstrates is the fact that the Puritans made a great and determined effort to give practical form to the Baconian program. As Yates notes, in connection with the technology of the period:

The Puritan attitudes to technology, and particularly to agriculture, developed in the context of the Garden of Eden, to which man would be restored when he had regained control over nature by the new science and technology. Research and practical efforts were directed toward increasing productivity, through which food and wealth would be available to all. This was very obviously to be interpreted as a move toward the millennium, or (as Blake might say) toward the building of Jerusalem in England's green and pleasant land (25).

This clears up A C Graham's puzzlement, when in discounting the role of time in the development of science, he wrote:

I must confess to a personal inability to understand why the Hindu is supposed to be paralyzed by the knowledge that no human achievement can outlast a kalpa of 4,000,000,000 years, while the Christian, cramped inside a time scheme of a few thousand years from Creation to Judgment, works hopefully at sciences that have nothing to do with his salvation in the knowledge that the Last Day may already have dawned (26).

After Webster's work, it is easy to see that it was actually the Puritan eschatology that was the religious spur driving the Puritans to the cultivation of science:

One would think that people who believed that the End was near would fold their hands and make no further effort. For the Puritans, the millennium had to be worked for with hard social effort, with intense application toward regaining for man the lofty position which he had lost at the Fall. The Puritan doctrine of work was applied to working for the restoration of all things - man and the world would be prepared, through increased knowledge and scientific advance, for a millenial restitution of the state of Adam before the Fall (27).

As Yates concludes, the millennium did not indeed arrive, but something else did, and that was the Royal Society, symbol of the arrival of science, "through which man would indeed enlarge his knowledge and his powers,
though it has not yet restored him to the Garden of Eden."

With an atmosphere as parochial as this surrounding the early cultivation of modern science, we begin immediately to discover how very misplaced are those learned disputations of historians of science, whether sociological or philosophical, concerning the question of why China did not produce similar science. A C Graham's "fire argument" may be presented here to clinch the point. He wrote:

In the absence of grounds for expectation I explain why a house did catch fire (because someone left a cigarette burning), do not go through all the other houses in turn explaining why they did not catch fire (no one was smoking, the wiring was sound, there were no bombs, no lighting). The difference follows from the fact that like effects may have unlike causes; if the even does happen we can select from the possible causes, if it does not we may not be able to enumerate all the unrealized possibilities (28).

THE CHINESE PARADIGM

Much of the discussion above would not have appeared in print had historians accepted the obvious fact that as the Chinese had cultivated their civilization in so great an isolation from the rest of the human world, the program dictated by their culture would prove to be too distinctive to analyze through Western categories. And what we can proceed to do right now is to establish what in effect was the Chinese culture-program: it was certainly not salvation through science, but it was equally positive and real.

It would be necessary to begin by distinguishing sharply, the consciousness of Chinese society from its European counterpart. And almost the first reality that we encounter here is that China, first and last, has rarely seen itself under the pervasive influence of a monolithic religion: this probably resulted in China escaping the sway of millenarian tendencies. There
were no concepts of salvation or an after-life. In other words, the Chinese have always been oriented towards an immanent, rather than a transcendent, order and it was in the propagation and cultivation of the Great Harmony, an ideal that came through even in the speeches of Mao Tse-tung, that a great deal of intellectual and ethical activity was subordinated. As Professor Kwee explained:

"Life" is defined as sing-ming. The Chinese see life as placed between the poles of the given and the task, potency and realization, origin and destination. Both are considered in the context of the here-and-now, on this earth. Thus, life is not oriented towards a hereafter, as in the neo-Platonian-Augustinian tradition, but rooted in what we understand as Nature (29).

The fact that this cultural tendency was deeply rooted in the Chinese mind becomes evident when we view the repeated attempts, ultimately in vain, to transplant, first Christian, then Western culture, into Chinese civilization. The Jesuits, for example, provide prime material for the proof of the resistance of cultures to one another.

The Jesuits entered China to proselytize. At a very early date, realizing the sophistication of the Chinese literati, they decided to avoid, unlike their experiences elsewhere, a frontal assault on the Chinese intellectual tradition, and tried instead to undermine it by showing the Chinese that the Europeans had advanced beyond them in certain branches of learning. But as Needham points out, about 1640 Peking was already discussing whether the science the Jesuits had brought with them was primarily "Western" or primarily "New". As Christianity was Western to Chinese eyes, the Jesuits had an obvious advantage in commending it if they tied the prestige of the science they brought to it. The Chinese, however, objected and in 1669, the Kang-Hsi emperor finally insisted that "Western" should henceforth be dropped in favour of "New" (30).

As Needham wrote, a great many scholars still re-
gard the civilization of Christendom as formally inseparable from the modern scientific view of the world, "the necessary concomitant of the latter." And they tend to get unduly distressed when they realize that European religious values have been decisively rejected by all Asian and African movements of national independence. And not for no good reason. The preaching of new crusades to impose fuller forms of European religion and culture on the rest of the world may be set forth under banners which carry the figure of the cross, but the banners themselves have been carried by "capitalism and imperialism." (31.

A comprehensive summary of Chinese natural philosophy is available in Kwee Swan-Liat's essay, Man and Nature in Chinese Thought, and we shall use it now as an entry into the issue. As in the West, wrote Kwee, so too in China, man and nature form the two poles of thought. That is, in both Western and Chinese cultural philosophy, and in the pre-modern scientific theories and the social and cultural praxis based on them, one can distinguish a humanistic orientation from a naturalistic one. However, while in the West, attention was principally diverted to nature, and the natural sciences were earlier and further developed than the human sciences, in China, man formed the focus of both theory and practice. If in the West, man saw himself as able to dominate nature, the Chinese refused that attitude, placing man instead not merely as central, but simultaneously, as an integral part of nature.

Kwee went on to agree with Needham that perhaps the later development of Chinese technology (1500 AD) was inhibited when Confucianism, with its strong preference for humanism, prevailed over Taoism, the latter strongly preoccupied with nature. Thus, though both Confucianism and Taoism viewed man as a part of nature, the former devoted its principal concerns to the regulation of human affairs.
In China, the technology of "natural objects" has not been strong enough to overtake another technology concerning human society itself, a form of "human engineering" that even in recent times, during the Great Proletarian Cultural Revolution, played an important role (32).

Here, indeed, we are at the core of what might constitute a Chinese philosophical anthropology. In China, an individual's identity was defined in terms of his harmonious integration in the family structure and in the order of Nature. In other words, the basic focus of awareness was not the individual self-conscious "I" in its individuality as in the West, but rather the whole structured relationship formed in accord with li and the Tao, between the souls of the departed and those of the living members of the family. The basic self-identity was located not in the ego, but in the family ethos. The ideal of harmony means the focus of concentration, not upon the discrete entities themselves, seen in relationship to one another, but rather on the relationship per se: the Tao is simply the inherently right connectedness of things. Marcel Granet has even argued that the notion of a soul as a purely spiritual essence is alien to Chinese thought.

This is the Chinese cultural pattern: to criticize it from the point of view of a Western philosophical anthropology is to make some profoundly irrelevant statements. Westerners do not seem to realize that Chinese culture might find no meaning in the type of identity demanded by the West for its own members. Criticisms of totalitarianism in China today suffer, in my opinion, a similar irrelevancy; since when has the West appropriated to itself the proper manner in which a culture might clothe its members?

Kwee concludes his essay by indicating the close connection that exists in Chinese metaphysics between knowledge (of nature) and norm (in society). Nature speaks a language that we can make sense of: this language contains not mere information, but normative structures. Understanding is therefore bound to human transformation (33).

The object of the Baconian program was the resti-
tution of society in a millennium that would approximate a condition similar to that before the Fall. The Chinese differed, not so much in the fact that they rejected a millennium: they might conceivably be seen as working towards the restoration of the age of the sage-kings. Rather, and more crucially, they differed as to the means or manner in which the Great Harmony might be regained: the normative regulation of human affairs.

In the light of this cultural tendency, the proper representative of the period is not, as Elvin took him to be, Fang I-chih, who did make a careful distinction between normative and natural laws, only to subordinate the former to the latter; rather is it more contextual to focus on a thinker like Huang Tsung-hsi (1610-95). We are not at all being bold in suggesting that Bacon's The Advancement of Learning played as crucial a role in the Europe of the seventeenth century as Huang's Ming-i Tai-fang Lu (freely rendered by Bary as A Plan for the Prince) was intended to play in a similar Chinese period.

The context in which Huang wrote his treatise is not just significant, it is startling. On the surface, this Chinese scholar proposed "in bold terms a new order inspired by traditional ideals" (34). The immediate cause for the work was almost certainly a problem that weighed heavily on his mind, and on the minds of those Ming loyalists despondent after the defeat of the Ming Dynasty at the hands of the foreign Manchus: how had this defeat come about, especially as the Chinese had considered the Manchus numerically and culturally inferior to themselves? Certainly, this was not the first time this had happened in Chinese history. Huang accordingly decided on a thorough re-appraisal of Chinese institutions from ancient times to attempt to discover where precisely the fault lay.

The fourteenth century writer, Hu Han had noticed that the period of decline had set in after the time of Confucius and had never been halted or reversed ever since. Huang cited this opinion in his own work:
Since the death of Confucius and throughout the dynasties succeeding the Chou - the Ch'in, Han, Chin, Sui, T'ang, Sung, and so on down for two thousand years - the time has not come for a change (35).

If there was ever the western equivalent of the doctrine of the Fall in Chinese culture, of a decline from an earlier state of thriving institutions, enunciated by sages, this was probably the one. More interesting is the fact that Hu Han predicted a change after the two thousand years, which coincided with Huang's own period. Huang's work seems to have been inspired by his belief in this announcement of a new Chinese resurgence. A Plan for the Prince was to be seen as the blueprint for the re-establishment of earlier harmonies.

There is a parallel to the situation in which Huang found himself in the seventeenth century. During the last reign of the Shang dynasty (1200-1122?), the legendary classical figure Chi-tzu found himself thrown into prison for criticising the decadent ways of his king. He was released however by King Wu, after the latter had deposed the Shang. Chi-tzu, however, refused to serve Wu, as the latter was an usurper. Yet, he found himself unable to refuse, when king Wu visited him for advice in the running of the country, and communicated to him the political principles that Wu would preserve and practise.

Huang lived in a similar period: except that in his time the Manchus did not come to him for advice (though they tried to patronize him, without success, in later years). There is evidence, on the contrary, in Huang's work, that the new order he envisaged was not to come under Manchu auspices; evidently, he was expecting the rise of a new Chinese power in the near future.

In the Plan, Huang first set out a radical examination of the entire range of Chinese institutions:

Unless we take a long range view and look deep into the heart of the matter, changing every-
thing completely until the ancient order is restored with its land systems, then, even though minor changes are made, there will never be an end to the misery of the common man (37).

Of course, Huang recognized that many of the proposals made in classical times were inapplicable to the situation in his own day. He is not asking that the past be duplicated, but for a new system of government based on classical principles, which is quite a different thing. Those principles, Huang understood in the light of his Confucian past; they exemplified, one might call it, the Chinese habit of managing affairs through the primacy of the political mean.

For him, as for any true Confucianist, the most fundamental principles are involved in the conception of rulership, since Confucianism asserts that the key to any and all forms of social improvement as well as to all social evils, is the personal example and influence of the king (38).

Yet the Plan remained an eloquent and critical summary of the Confucian political ideal. In it, Huang proposed that the law be made into an instrument more basic than a mere dynastic tool: unlike his predecessors in the Confucian past, he refused to acknowledge that dynastic law was inviolate, though it should be made clear that he conceived of the few basic laws that he proposed more in the nature of a constitution or system of government than a legal code.

True law was enacted for the benefit of the people by the sage-kings and is embodied in the system of government laid down in the classics. It consists not in multitudinous statutes, prescribing in detail what men should do and attaching a severe penalty to each infraction, but rather in a very simple and general set of institutions which are basic to proper functioning of government and to promotion of the general welfare (39).

His institutional reforms included the raising of the status of ministers, restoring the prime ministership (abolished by the Ming), both of which if accepted would prove an excellent check to the despotism of the
Emperor. He also proposed that the power of the eunuchs be curbed: this could only happen if the Emperor restricted himself in the size of his harem. He also suggested that education and schools be open for all, and provided examples by means of which the civil service examinations might be improved. He asked for a revision of land reforms and land taxation, and for a reform of the lower levels of bureaucracy.

That Huang's proposals did not see the light of day does not deny the originality of his recommendations, so early in the day. More importantly, the prime condition for the carrying out of those proposals, the rise of a Chinese dynasty, was never fulfilled: the Manchus carried on till 1911, and in the process assimilated what was necessary of Chinese culture for their administration.

Both Bacon and Huang proposed blueprints for a new order; both had the past etched as a model in their minds. Bacon proposed that the restoration be brought about through science or knowledge about nature; Huang, in the line of his tradition, believed his kind of order would be most effectively created through the active involvement of an enlightened prince. Is it a surprise to observe that the Chinese today still retain the primacy of political action before all else? As Needham himself wrote recently, probably the greatest risk that China may be exposed to, and one that the Chinese leaders are determined to eliminate, is the creation of a generation of technocrats, the very thought of which makes Chinese hair stand on end.

Our interpretation of the Chinese and their mind during that period, however, is supported by a couple of Sinologists who have been familiar with Needham's work about the Chinese past, which they feel has a number of contradictory attitudes. They note, for example, how Needham, an acknowledged sinophile has often praised a great deal of the Chinese past: yet, he has all too often been forced to criticise this past and some of its
elements in the light of his theories of science and its development. Typical of his approach is the following:

In some ways, however, Confucianism was all too humanistic; though humanist, it was anti-scientific. It simply had no interest in the world outside human society. It discouraged such interest.

Nakayama has noted that Needham had already developed his basic scientific viewpoint before he devoted himself to Chinese science. More significant is the opinion of the sinologist, Arthur Wright, who has remarked that Needham’s approach, which makes Taoism the forerunner of modernity, and sees Confucianism and Buddhism as inhibitory factors in the same direction, misses the point of Chinese culture. And according to another sinologist, Arthur Hummel, who is generally friendly to Needham, it was the problems of the worlds of man and society rather than the natural world that occupied the attention of the Chinese mind, and very little is gained by dismissing them out of hand. This opinion is similar to the one of Kwee Swan-Liat, already quoted above.

All this probably explains why one of the foremost Chinese historians of philosophy, Fung Yu-lan, already in 1922, wrote an article entitled, now no longer strange, Why China has no science: an interpretation of the history and consequences of Chinese philosophy. Fung understood science as Galilean science: this should be kept in mind when reading what he wrote:

China produced her philosophy at the same time with, or a little before, the height of Athenian culture. Why did she not produce science at the same time with, or even before, the beginning of modern Europe? This paper is an attempt to answer this question in terms of China herself.... I shall venture to draw the conclusion that China has no science, because according to her own standard of value she does not need any.

Fung then went on to summarize the tendencies of the different, historical schools of Chinese thought,
to conclude with an examination of the consciousness of Sung Neo-Confucianism:

This period of the history of Chinese philosophy was almost perfectly analogous to that of the development of modern science in European history, in that its productions became more and more technical, and had an empirical basis and an applied side. The only, but important, difference was that in Europe the technique developed was for knowing and controlling matter, while in China, that developed was for knowing and controlling the mind (45).

Now, this long and extensive discussion of the role of science in culture might turn out, to some, of purely theoretical and academic interest. After the discovery of how to discover, the characteristic of modern science, the value of earlier science seems to be automatically in need of disparagement. Is it? The historian of science, Nathan Sivin, is probably one of the few to realize the paucity of that attitude. One of the fertile questions we can ask, he writes, in view of our contemporary crisis, "is exactly how science and other aspects of culture co-existed in unity earlier", for they do not do so now.(46)

Sivin has the West in mind in writing that sentence, but it should also be obvious that at least two other civilizations have similar problems, from the other side, so to speak: Islam and India. No Islamic scholar has expressed the dilemma better than Seyyed Hossein Nasr. Almost the cardinal thesis of Nasr's book on Islamic science argued that no serious study of the Islamic sciences could be carried out without some reference, no matter how brief, to the principles of Islam and the conditions created in time and space by Islam for the cultivation of the sciences. Not surprisingly, Nasr viewed a possible solution of the conflict raised by the assault of modern science on Islamic culture only in the light of the manner in which the problem had been engaged with in past Islamic history. Wrote Nasr:
The Muslims became faced once again in the 13th/19th century with the onslaught of Western science, which has since threatened both the Islamic hierarchy of knowledge and the harmony of its educational system, wreaking havoc with them to an extent that is unprecedented in Islamic history. Al-Fārābī became known as the "Second Teacher" (al-mu'allim al-thānī) because he gave order to the sciences and classified them. To a lesser extent Mīr Dāmād performed the same function in Safavid Persia and gained the title of the "Third Teacher". Today Islam is truly in need of a "Fourth Teacher" to re-establish the hierarchy of knowledge so essential to the Islamic perspective and to classify the sciences once again in such a way as to prevent the sacred from being inundated by the profane and the ultimate goal of all knowledge from being forgotten amidst the glitter of quickly changing forms of science which move ever so rapidly without approaching any closer to the centre of the circle of universal existence.

Joseph Needham is quite fond of constantly repeating his claim that, broadly speaking, "Chinese science and technology were very much more advanced than those of Europe between the third century BC and the fifteenth century AD, but that after that, Renaissance Europe began to take the lead" (48). Perhaps, it is statements like these that have led most people to leap to the erroneous conclusion that after the fifteenth century, technology in China began to stagnate, deteriorate and decline. Which has in turn, I think, incited Needham, in a recent essay, to qualify his earlier statements:

Perhaps there has hardly ever been so cybernetic and homoiostatic a culture as that of China, but to say that is by no means to speak of "stagnation" as so many Westerners have done; the rate of advance simply continued at its characteristic rate, while after the scientific revolution in Europe change entered an exponential phase (49).

A better word for the Chinese situation after 1500 is probably "stabilized": it will be evident that by the end of that period, most of the basic technical problems in agriculture and industry had actually been solved. It is also inappropriate to term Chinese technology before 1500 as "more advanced", as though we are speaking here of
a kind of race between Europe and China, or, as though the Chinese in that period were swayed by the symbols of invention that appeared later in Europe during the age of Progress. In fact, the Chinese probably saw as their principal problem the weakening of their institutions, that had led in turn, as Hu Han realized, to an increasing susceptibility as far as foreign invasions were concerned. This is also the reason, perhaps, why the Chinese treated the mechanical inventions brought in by Europeans at first as novelties and playthings.

But that the Chinese were mechanically-minded is evidenced by the fact that much before a Polydore Vergil rose in Europe, they had compiled detailed records of inventions and discoveries. The custom, however, rose in Chou times, with the practice of sacrificing to the spirits of the first inventors, who were regarded in fact as "technic deities" (50. Elvin concurs in observing how shrines were dedicated to the memory of inventors. The important point to remember is that these inventors were prized precisely because of the services they rendered to Chinese society in its early encounter with the environment.

Further, and not unrelated, is the fact that even until the nineteenth century, the Chinese really did not want anything from Europe. Both G B Sansom and K M Panikkar have made this obvious, but it bears repeating. Sansom even goes on to note that not only did India and China not feel any great need for foreign merchandise, "they have been under no great inner compulsion to seek wisdom or knowledge outside their own borders."(51,52.

As Needham himself notes, as late as 1675, the Russian Tsar asked for the services of a group of Chinese bridge engineers; the material influence of China too, during this period, on the West, akin to the influence of Indian textile methods in Europe, but concerning other technical processes has been documented by both Needham and Panikkar and will not delay us here, except to note
with Needham, that the Europeans were sending missions of investigators till the middle of the nineteenth century to search out the secrets of traditional Chinese industries, particularly ceramics, textiles, lacquer, tea and so forth.

Since most of the basic inventions and discoveries had already been in use before the fifteenth century, their description naturally falls outside the scope of this chapter. This in itself is a good thing, since we are then not seriously compelled to cover again the tremendous documentation of Chinese technics that Needham has produced in the five published volumes of *Science and Civilization in China*. A summary also is not necessary, since Needham has accomplished even that in a small booklet, called *Hand and Brain in China* (53).

The technological revolution itself in the Sung period has been well treated by Mark Elvin, in his recent volume on *The Pattern of the Chinese Past*. It is in fact humanly impossible to keep up with the books and monographs that appear every year. A stray example is the recent monograph by Klaus Flessel, in German, called, *Der Huang-Ho und die Historische Hydrotechnik in China*, which has an English summary; we mention it because it confirms our thesis.

Flessel shows how, during the period of the Sung dynasty, the earlier problems surrounding administration, not technology, concerning the Huang-Ho, were eased when they were assumed under the wider, centralised administration of the Sung. Till the arrival of this dynasty, the technical aspects of hydraulic engineering involving the river had been emphasized, studied and implemented, specially under the dynasty of the T'ang. It was only the problem of the centralised coordination of these works, an administrative one, that remained: that problem was taken care of in 1058 with the institution of the board of control, (tu-shui-chien).

Professional "technology officials" of this administrative body made regular inspection tours and had agencies outside the capital, wai-chien (outer
board of water control). This was in contradis-
tinction to pre-Sung periods when the responsible
officials executed their tasks from the remote
metropolis. For the duration of larger enter-
prises special supervisory officials, tu-ta t'i-chü
kuan, were appointed who kept in close contact with
the emperor. The discussions show that all impor-
tant public works for flood prevention and the re-
pair of water damages were under the control of the
central government, not of the local administration(54).

The hydraulic works served their purposes so well
that they provided the cornerstone for hydrotechnical
practice up to modern times. "There were no further fun-
damental innovations in hydraulic structures until the
introduction of Western technology and the use of con-
crete as a building material."

Arnold Pacey, in his essay on the role of ideas and
idealism in the technology of China writes that after the
middle of the fifteenth century, the tendency in China to
feel that the practical arts needed little further develop-
ment was slowly gaining ground. He tries to explain this
by emphasizing that Chinese intellectual life was becoming
less sympathetic to some forms of technical development
and that in some fields, the practical arts were already
entering a period of stagnation (55).

At this stage, we feel it would be worthwhile to
examine closely this notion of "stagnation" which we have
already criticized above. And there is no better way to
bolster our criticism than by a summary review of two of
the largest industries in China during the period of the
Ch'ing: cotton and silk. We might anticipate our conclu-
sion to observe that they did not show any great signs of
"stagnation."

Just as two people can describe the same glass of
beer as half full or half empty, scholars have va-
riously characterized traditional economic organi-
zation in China. Taking a twentieth-century pers-
pective, some scholars compare traditional China
with modern societies and emphasize its short co-
mings. Ch'ing China, as they never tire of point-
ing out, did not possess, nor was it rapidly de-
veloping, machine technology or natural science.
But if focusing on the empty space in the glass is
valid, so is examining its actual contents (56.)
That quote comes from the beginning of Craig Dietrich's comprehensive essay on Cotton Culture and Manufacture in Early Ch'ing China. He goes on to suggest, after a summary outline of the history of the cotton industry in the Ch'ing period, that there was in China a capacity for change that is at odds with the stereotype of timeless China. By the time of the Ch'ing, change had slowed, and no revolutionary mechanical or organizational developments appeared during that period. Indeed part of the industry could be described as simple and changeless. But another part reveals itself to be differentiated and adaptive. The industry possessed, for example, a range of techniques and organizational forms that permitted cloth to be made both by self-sufficient families and by a system of market-oriented specialists (57.

Though cotton was known in China since early times, it had never been considered more than a kind of exotic commodity. And it actually reached its position as the single most important fibre in the Chinese economy only during the two or three centuries that corresponded with the late Sung, the Yuan (the Mongols) and the early Ming.

The reason for its new popularity seems to be, as happened in England a little later, the pressure of population on land resources. Though we are to deal with this issue at leisure below, it seems proper to mention already at this stage that by 1050 A.D., the pressure of population had already resulted in the de-forestation of large portions of North China. This in itself may not seem so extraordinary, till we discover that plant yields for cotton per acre are ten times those of other fibres, including hemp, which cotton soon replaced, and which together with silk, till that time, constituted the basic material for clothing. The introduction of cotton in such a context would immediately find favour, in that it would supply two important functions: release land for food production, and at the same time, meet the needs of a larger population and even trade. Mark Elvin notes that the cotton gin's arrival in the thirteenth century was a reasonable response to the sudd-
en glut of raw cotton, and quotes Wang Chen's *Treatise of Agriculture* that appeared in 1313:

In times past rollers were employed (to remove the seeds from raw cotton). Nowadays, the gin is used... It is several times more advantageous than the use of rollers. Even if there is a large quantity of cotton, the use of this method permits one to get rid of the seeds immediately, and to avoid a backlog piling up (58).

An interesting fact of history in this context is the activity of the Taoist nun, Huang, who is said to have brought more efficient techniques for ginning and spinning cotton from the Hainan Island into the lower Yangtze area; so grateful were the people of the village of Wu-ni Ching, near Shanghai, where she settled, that in the typical Chinese tradition, they erected a shrine to her.

By 1760, the use of cotton had spread all over China: the perennial variety of cotton tree grew in the more suitable wet climate of the remote Southern areas, while the annual shrub variety took deep root in the heartland of China itself and the Yangtze region: the latter forming the basis of the newly developed Chinese cotton industry. As Li Pa, a prefect in Fukien province wrote in that year:

If we search for (the fiber) that is most widely used, that is most reasonably priced and labour-saving, that is suited both to cheap and to expensive textiles, that benefits rich and poor alike, (we will find that) only cotton has all these exceptional qualities.... In all the places that my feet have left their traces there was no man who did not wear cotton and no soil that was not suited to its production (59).

Dietrich concludes on the basis of his own studies that between three-fifths and four-fifths of all hsien (county), both in the late Ming and in the early Ch'ing periods, manufactured some cotton cloth. In contrast, however, to the period of dynamic growth and change earlier when cotton was introduced on a wide scale, the industry seems to have stabilized, even with regard to its geographical distribution and specialization. The
technology developed had apparently reached a plateau: the limits to any possible improvement in techniques had already been reached by the end of the Ming period.

What China was experiencing in this period was the introduction and switch to a new resource base in its textile industry: the crucial point is that China adapted to it, not only with new techniques of production, but novel methods of social organization. We shall say something briefly about both issues.

As early as the Sung, the Chinese had discovered the utility of a small iron roller with which to accomplish the process of ginning: the removal of seeds from the cotton fibre. The double-roller soon after made its appearance, from India. Early in the fourteenth century, two cranks were used to move the rollers. Still later, a treadle was attached to one of the cranks. Sometime before the eighteenth century, a flywheel was added to the treadle-powered roller to sustain its rotation.

For loosening the cotton fibres, since they normally got matted through transport or package, the Chinese exploited a device, also used earlier in India (and still used in the latter country today) similar in construction to an archer's bow, and with a hard, tough and taut string. When struck, the string vibrated and reduced the matted cotton to a fluffy state, free even from impurities. Later, these bows got larger and had to be vibrated through the rhythmical strokes of a mallet.

The spinning of this fleecy fibre was accomplished on a series of different devices. The simplest one in Ch'ing China was the suspended spindle, still unexcelled for producing fine and even yarns. But it was not long before the spinning wheel, originally developed in India again in the thirteenth century, arrived to supplant the suspended spindle which lacked its ease and speed. The single-spindle wheel remained the norm all over Ch'ing China, except in the densely populated lower Yangtze area, where the greater demand for yarn, soon
stimulated the invention of the compound wheel, which exploited three spindles. Actually, the Chinese experimented with two-, four-, and five-spindle machines, finally settling for the three-spindle apparatus as it proved to be the best compromise between quality and quantity.

As with the operations of spinning, so with the processes connected with weaving, a new range of instruments was soon made available, depending, of course, on the relative size of the operation. Different kinds of spools, reels, frames and cranking devices were used to combine "several yarns into long, multiple-ply thread suitable for warp." And to prevent warp threads from the friction of the weaving process, various methods of sizing were evolved for the purpose.

By the time of the Ch'ing, there were three main kinds of loom: the horizontal, the "waist" and the draw. While the first was in general use, the last was generally operated to produce luxury textiles, which involved the weaving of elaborate patterns and designs.

The Chinese dyeing and printing processes are described in Stuart Robinson's two volumes on the subject and will not delay us here. The arts of dyeing and printing were jealously guarded secrets, evidently of great economic value in a thriving cotton industry, and they were only passed down from father to son or trusted apprentices. The Chinese craftsman was also proficient in the art of resist-dyeing and printing with woodblocks. And when it came to giving the final textile a glossy finish, the arts of calendering were certainly not in any sense behind the others.

Craig Dietrich concludes:

Thus in two or three centuries the Chinese had adapted and improved the gin, the bow, and the spinning wheel, all imported from South Asia, and combined them with appropriate Chinese devices such as reels, looms, and calendering stones. The result was a technology suitable for a range of productive organizations, from the single family to highly differentiated, market-oriented entrepreneurs (60.
An adapting technology made possible an equally flourishing trade, which in turn forced the industry to be increasingly commercialized. "Thus, even if there is a bad harvest in our counties, our people are not in distress so long as the other counties have a crop of cotton" (61).

Those peasants that were drawn within the commercial network, normally fulfilled varying functions. Some merely grew cotton and then sold it all to the brokers. In other areas, as in Wu-hsi Hsien, the people worked on cotton brought from elsewhere. This might be partly explained by the fact that in some areas at least cotton refused to grow; a good example is the frustrated attempts of the villagers of Jui-chin Hsien in the Kiangsi area. Significant in this context, is the beginning of cotton manufactures in north China in the seventeenth century, so far impeded by the tendency of the threads to snap in the dry atmosphere: now the problem had been overcome by spinning the yarn in moist underground cellars and the local supplies that were normally sent to the Yangtze region for processing, were now kept back for the new industry, so that the people of the Yangtze had to look for new supplies of raw cotton from Manchuria.

The commercialization of the cotton industry led to increasing specialization and differentiation of functions. In some areas, brokers who bought large amounts of cotton, found it profitable to begin an independent ginning industry, since the removal of seeds lessened the weight of the cotton bags and made for cheaper transport costs. In other areas, ginning and bowing processes were combined under one roof, and the end product then sold to spinners. There were still others who began to specialize in the bowing industry itself.

Spinning for commercial purposes could also only be done in specialized units. One late Ming gazetteer suggests a strong economic reason for this, when he noted that "the poor people lack funds and cannot weave cloth. Daily they sell several ounces of yarn to make a living." As for specialization in weaving processes, this could on-
ly be possible if a certain amount of yarn was only produced specially for the market. "A late-nineteenth-century source for a hsien in Kiangsu notes that the northern and eastern villages had established themselves as producers of high-quality yarn." This was sold to villagers in other areas, who wove it into good-quality cloth, again for the market.

The finishing processes, of their own nature, called for a specialized social organization: they required materials like dyes and sophisticated equipment. As for calendering itself, the Su-chou area in the lower Yangtze region employed many thousands of workers to process large quantities of cloth. The following is a description by Li Wei, governor-general of Chekiang, in 1730:

In the prefectural capital of Su-chou....the green and blue cotton cloth from the various provinces is bought and sold. After it has been dyed it has to be given lustre by being calendered with large stone foot-rollers. There is a class of persons called "contractors" who make ready large stones shaped like water chestnuts, wooden rollers, tools and rooms. They gather together calenderers to live there, and advance them firewood, rice, silver and copper cash. They receive cloth from the merchant houses to be calendered. The charge per length is 0.0113 of an ounce of silver, all of which goes to the aforesaid workers. Each of them, however, gives to the contractors each month 0.36 of an ounce of silver as representing the rent for the workspace and the tools...Formerly there were only seven or eight thousand men in the various workshops...Now a careful investigation of the area outside the Ch'ang Gate of Su-chou has shown that there are altogether over 340 persons acting as contractors, and that they have set up more than 450 calendering establishments, in each of which several tens of men are employed. There are over 10,900 calendering stones, and the number of workers must equal this (62).

Altogether, a picture of tremendous activity; a thriving market, great inter-regional flows of goods, a complex social organization. No wonder Mark Elvin has described this period as one of economic development without technological change, of quantitative growth and qualitative standstill, if the latter is
seen, of course, as referring to technique.

A similar case could equally be made out concerning the texture of the silk textile industry in the period of the Ch'ing, but here we can be more brief.

Silk has, of course, been always connected with China since the earliest times; and, as E-tu Zen Sun puts it, the Ch'ing dynasty merely fell heir to an agrarian economy (of Ming times) in which "sericulture was well-established both as a source of primary goods and as an item of fiscal reckoning of the empire." In fact, since some silks, because of their superior quality, were indispensable for the Great Sacrifices (ta chi) at the Imperial Court, the regions engaged in producing these fabrics, like Lu-chou in Shansi, were commanded to pay their taxes in kind: this as late as 1884.

As Sun points out, silk has never actually been considered a luxury item in Chinese society; rather, should it be seen has having been a kind of "prestige" commodity. The uses of silk at different levels of society are too many to mention, even in brief: significant is the fact that even in the nineteenth century, some fifty-five per cent of the raw silk produced in China went into the domestic market, in spite of a progressive increase in the amount of silk exported.

Before the Taiping wars (1850-65) resulted in the widespread destruction of the silk regions in eastern China, one English traveller in the region of Hangchow, a central silk-producing area, was able to note its widespread usage:

The people of Hang-chow dress gaily, and are remarkable among the Chinese for their dandyism. All except the lowest labourers and coolies strutted about in dresses composed of silk, satin, and crepe...The natives of Hang-chow, both rich and poor, were never contented unless gaily dressed in silks and satins (63).

The silk industry was therefore a leading factor of the Chinese economy: sericulture supplemented the incomes of the peasantry (as in cotton), and the Ch'ing élite was
certainly not lacking in its perception of the significance of this activity to the maintenance of a stable agrarian economy. The silk industry and its concerns were included as a matter of course in any important administrative discussion or memorial. As when the time arrived to integrate Yunan more closely into the nation in the eighteenth century: sericulture was seen to contribute thereby an important role.

For those who may still wish to speak of "stagnation" during that period, it will come as a surprise to discover that it was precisely in the dynasty of the Ch'ing that the mulberry spread to larger areas:

From Kwangtung and Fukien on the coast to Hupeh and Szechwan along the middle and upper Yangtze, from Shensi in the north to Kweichow and Kwangsi in the south-west, many localities began to practice sericulture for the first time, or substantially improved their techniques. Some of these new areas soon began to produce very high-quality silk. The silk fabrics produced at Changchow, Fukien, for instance, were considered in the eighteenth century nearly to rival the products of Su-chou, which had served as the model. Sericulture and its related handicraft industries constituted one of the main forms of diversification in the agrarian economy of traditional China, and as such provided the system with a necessary degree of resilience, thereby contributing to the prolonged institutional "stability" of the economy (64).

It is worthwhile to describe here the significant role of the Ch'ing governments and their local officials in the encouragement of more silk production in this period. In the early Ch'ien-lung period, (1736-1796), for example, the government itself promulgated an agricultural handbook, entitled Shou shih t'ung k'ao, one of the eight sections of which dealt specifically with instructions on the cultivation of mulberry trees and the raising of silkworms. And local authorities took it upon themselves to urge people, particularly those that formed part of the farming population, to take up silk production on an individual household basis.

In 1737-42, a prefect introduced the making of Shan-
tung tussore silk and silk fabrics into Tsun-i, in Kweichow: the industry once started continued to flourish well into the late nineteenth century. In 1840, Governor Ho Ch'ang-ling memorialised the successful planting of mulberry trees in Kweichow province, of which 140,000 were already near the stage of maturity. In 1751, the governor of Shensi initiated the setting up of silk-production knowledge centres in the provincial capital: these centres raised silk-worms, disseminated the knowledge of weaving among those who wished to learn it, and even bought mulberry leaves and cocoons to set them on their way.

In 1740, at government expense, Chekiang experts in sericulture were imported into certain areas in Fukien to introduce silk culture where it was not yet begun. Fifteen years later, a government textile workshop was founded in Hunan that employed artisans brought in from Kiangsu and Chekiang. As E-tu Zen Sun observes, this kind of traditional governmental patronage continued as late as the 1890s. From 1890 to 1893 for example, 10,000,000 mulberry saplings were distributed for a Hupeh project for transplantation and further growth: these were given to the people free of charge and, characteristically, together with a booklet on sericulture.

A great deal of this activity took place, indeed, during the century from 1699 to 1799, which also coincided with the high-Ch'ing period of domestic peace and steady economic growth.

Most of the technical problems, except one, connected with the production of silk and silk fabrics had already been solved very early in China's long silk tradition. A machine for reeling silk appeared in the period of the Northern Sung (960-1126). It was worked by a treadle and drew a number of filaments simultaneously from a tub of boiling water in which the silkworm cocoons were immersed. The unsolved problem that was finally resolved only in the late nineteenth century involved the preserva-
tion of the cocoons: the unwinding of the cocoons and the rewinding of the silk into hanks had to begin at a critical period and completed before the moth hatched. With large organizations, the work-pace could reach frantic heights. The puzzle is, methods of preserving cocoons were described already in Yuan and Ming books on agriculture. No record however has turned up of the use of these methods, there were three, during the Ch'ing period. Perhaps, the increased population in the Ch'ing had something to do with it: the large labour force would have refused labour-saving devices. The late nineteenth century method of killing the chrysalis through heat probably got accepted in the context of the extraordinarily large output of the industry in those times.

Otherwise, the silk-work industry required more skill than technology. Silk-production till today remains a very laborious process: the planting and cultivation of mulberry trees, the raising and nurture of silk-worms, the care of these through the cocoon stage, the reeling of silk fibres. The experience was rarely lacking, and sericulture itself presupposes that the best leaf-producing trees are only available with grafted stock.

More important perhaps, is the organisation of the industry itself, brought about through the pressures of increasing commercialization. Mark Elvin notes that the growing of mulberry leaves had become in itself a profitable undertaking and that there were even special markets for mulberry saplings. The practice of selling the leaves in the open market began to be particularly widespread from the eighteenth century onward, when internal peace and markets, and foreign demands stimulated greater coordinated output. Robert Fortune, quoted earlier, described the situation in Hang-chow:

During the space of two days - and in that time I must have travelled upwards of a hundred miles - I saw little else than mulberry trees. They were evidently very carefully cultivated, and in the highest state of health, producing fine, large and glossy leaves. When it is remembered that I
was going in a straight direction through the country, some idea may be formed of the extent of this enormous silk district, which probably occupies a circle of at least a hundred miles in diameter. And this, it must be remembered, is only one of the silk districts of China, but it is the principal and the best one (65).

By the 1840s, large-scale productions of this kind of crop had already appeared. One writer describes a "silk farm" as a large establishment of many buildings, and conveniently situated on a tributary to the Grand Canal. E-tu Zen Sun details six types of firms involved in the silk-business, the last of these the Nanking firms (Ching chuang) who bought silk for the Imperial Silkworks at Nanking.

We stop here, although we have merely begun. There is yet no comprehensive account of the sericulture industry in China, not merely of this period of the Ch'ing, but of China's span of life as a whole. Till that time arrives, however, E-Tu Zen Sun's comprehensive article on Sericulture and Silk Textile Production in Ch'ing China, should suffice.

Right now, we can conclude with Mark Elvin that, the last three centuries of pre-modern Chinese history saw the creation of much larger units of private economic organization than ever before, and that the change here was qualitative as well as quantitative. In particular, rural industries were co-ordinated through a network of rapidly increasing density, and urban industry, supplied with materials and customers through this network, developed new structures to handle larger numbers of employees (66).

Instead of diffusing our attention, we have tried to provide brief sketches of the industrial activity concerning two of the principal commodities of the Ch'ing period. The fact is similar descriptions might be made available for others. Mark Elvin provides two excellent pre-modern descriptions by contemporary writers of the large activity in the porcelain and iron industries. Most of the material on this subject has been brought together in a recent bibliography of science and technology.
in China, to which the reader is here referred.

Arnold Pacey, with many others, including Needham, have come to feel that "the classical Confucian motif of scholarly austerity" as practised by Chinese administrators and scholar-landlords was perhaps responsible for a withdrawal of Chinese interest, not merely from, for example, the marine adventures of the period around 1400, but also from other areas of practical concern. Yet, the picture we have delineated above of the two major industries of cotton and silk textiles in pre-modern China do present a dissimilar conclusion. Any reader new to these two different views of China would immediately notice the chasm that appears between this "theory" and "practice": the perception would indeed be sound.

However, in the light of the forty-odd pages of debate, criticism, argument and proposal with which this chapter has had its fill, the disharmony of views might seem more apparent than real. We have in fact suggested that there are two ways of studying the central role of the Confucianists in the life of Chinese society. In the first, we might discuss them from the point of view of modern science: in that case, we would feel it necessary to be dismayed with them, and to befriend the Taoists. We have disagreed with this view and approach, since such historiography leads to a distortion of the Chinese cultural program of those times. With Michel Foucault as our unconscious model, we have emphasized instead, with Hummel, Wright and Gittings, that Chinese society should be seen in its own terms.

This coincides with the second way in which one might examine the Confucianists; they might have refused the preoccupations of the Taoists, yet this would hardly suggest that they had begun to grow increasingly introspective. On the contrary, against the Taoists, the Confucianists re-emphasized the primary element of their long tradition: the concern and regulation of human
affairs. It is therefore in this light that we proposed the crucial importance of Huang Tsung-hsi's *A Plan for the Prince*, for if there is anything for which Huang is known today, it does not concern his being an original thinker or the founder of a new school, both of which he was not; it is because he was able to combine the broad scholarship of the Chu Hsi school with the active interest in contemporary affairs that characterised the best of the Wang Yang-ming school.

In our current age, enthused as most of us are over the phenomenon of a scientific culture, it is indeed difficult for us to imagine that some future historian of human affairs might assume a criterion of judgment that would give precedence to those societies that concerned themselves more with man and action (Arendt), than to those that attained a state of unusual dominance through the exercise of a method that, by postulate, ignored the human. As Fitzgerald expressed it in *The Birth of Communist China*, such a historian may suggest, perhaps,

that technical skills are not good criteria of true civilization, that harmony and balance in a human society are better than restless change and the chimerical search for progress to some undefined goal (67).

In the final part of this chapter, we examine the role of the final element of our *homo faber* model: the factors outside Chinese societal and imperial control that gradually, but inexorably, questioned the stability that that society had succeeded in preserving right up to the early decades of the nineteenth century. We are not interested in the usual question concerning why Chinese society did not produce an industrial revolution: in fact, when we have finished, it might seem all the more obvious that the question does not make significant sense.

Our analysis here concerns the socio-economic causes
that led to the fall of the Ch'ing dynasty in 1911. No historian worth his salt, however, would and should accept the absolute value of such "impersonal" interpretations of events. Yet, that they are often influential is not very easily denied. On the other hand, there are few historians able to combine in practice, much less in theory, the peculiar combination of personal (Carlyle's great-men thesis, for example) and impersonal (socio-economic, ecological) elements that produce the vast drama of human life.

If the great K'ang-hsi, for example, had succumbed to small-pox as a child, the course of Ch'ing history might have been radically different: he survived, and did more than anyone else to consolidate the empire and dynasty of the Ch'ing. And if Hung Hsiu-ch'üan had not had a dream which proved to him that he was indeed the younger brother of Jesus Christ and thus inspired him to found the Heavenly Kingdom of Great Peace, then millions of people might not have died, and the Ch'ing achievement of K'ang-hsi might not have received the irreparable blow it did.

So we must be cautious; perhaps, if we look again to the two pairs of elements that constitute the paradigm of our first chapter, we might discover a clue: the shift, continuous through history, between the poles of being able to control and being controlled.

What Chinese society was not able to control was the growth of its population. We shall examine the close relation between population growth and the pressures it exerts in the direction of agricultural and technological development only in the chapter that follows; we shall also discuss in brief the theories of Service and Sahlins, Wertheim, Romein and Veblen. For now, we shall assume the hypothesis. And to prevent it sounding very arbitrary, we can present the literature that deals with the issue in China.

In a recent article, co-authored with Ray Huang, Joseph Needham wrote that "it is easy to over-stress the
influence of philosophers and to minimise the effect of concrete environmental and economic factors. ... The importance of ideology, however great, can never obscure the basic fact that underneath lie the material forces of climate, geography and social integration" (68).

Needham and Huang note that the high degree of centralisation that developed very early in China was not an invention of political thinkers, but rather, inspired by circumstances, geography being the overriding factor. (In fact, one of the most startling sketches of geographical influence on the nature of Chinese society is the map by Chi Chhao-Ting, concerning the principal economic areas, and attached to the first volume of Needham's SCC, volume one).

Both writers continue:

During subsequent centuries this centralised system had to be continually refined and sustained until China's political and ethical maturity ran far ahead of the development of other institutions, such as a diversified economy, codified civil contractual law, and a system of jurisprudence protective for the individual (69).

In their following discussion on the influence of the Huang-Ho, both writers stress the fact that the emergence of a unified China in 221 B.C. was favoured by the need for hydraulic works, not only in flood protection, but also for irrigation and later, for bulk transport. Since the rest of the article is a polemic against the views of particularly Mark Elvin, we shall ignore it here: but we have a starting point here already. Though it should not be over-emphasized, the role of the river and the Chinese necessity to control it played an important part in the political organization of China for many centuries.

Chinese population pressure and the response of the Chinese people and society to it, might be understood in much the same terms: again, what surely emerges is the ingenious Chinese response to the gradually increasing weight of numbers. But, as economists will inform us,
there is always a point of diminishing returns.

The classic work on the population of China, based on Chinese records, and yet to be updated, is the book of Ho Ping-Ti, *Studies on the Population of China*, 1368-1953 (70). An equally important volume is *Agricultural Development in China*, 1368-1968 (71), which specifically investigates the manner in which Chinese agriculture evolved to meet the increasing needs of a growing, steadily growing, population. A recent work by Mark Elvin present the thesis of a high-level, equilibrium trap in Chinese production techniques, which inhibited the rise of further invention (72). We shall briefly present merely the skeletal structure of this entire issue, first in its general features, and later, in the case of a specific industry, that of cotton. This will facilitate our re-assumption of this issue in the following chapter, where we shall also devote some attention to the same industry in England.

The first signs of a disequilibrium in the relation of a population to its environment are, as Braudel summarized them, the occupation of new territory, emigration, clearing of new land, agricultural improvements and urbanisation (73). We have already noted the deforestation of China in the north about 1050 A.D.: the claiming of new land. Yet, already in the fourth and fifth centuries, Chinese settlers had begun to migrate in large numbers towards the south, in the direction of the Yangtze river valley.

We follow Esther Boserup here in her classic analysis of the stimulation of agricultural development (74). The methods of cultivation, at first, in the Yangtze region were crude: the land was cleared by fire, then flooded and eventually abandoned (75). The increase of the population, however, reduced this earlier system of fallow cultivation, usually only available in loosely populated areas. The population became more settled, and wet-field rice cultivation, as opposed to the dry farming of the north, soon turned out to be the most fa-
voured method of cultivation. As Perkins writes:

Accompanying the expansion of rice cultivation were the development of new tools, new crop rotations, and hundreds of new seeds. Wet rice, transplanted into flooded fields, required a radically different technology from that used to grow millet and wheat on the parched land of the north (76).

Thus, we agree with Mark Elvin's observation that Chinese agriculture saw itself transformed between the eighth and twelfth centuries. It is useful, at this stage, to notice the difference in the trends of agricultural development in Europe and China. Population pressure gradually shifted the economic centre of gravity away from the Mediterranean in Europe: the movement was towards the north, and the symbols of advance were the axe, the heavy plough and the efficient horse harness. Lynn White has also shown how the introduction of the new, heavy plough to work the heavier soils of the north, necessitated a change in the very shape of the fields (77). The Chinese advance, as noted, was towards the south, to a river valley with few forests, but with problems of equal significance, in this case, concerning irrigation. The corresponding symbols of advance included the dam, the sluice-gate, the noria and the treadle water-pump. Both advances could only be made through the expenditure of a great deal of labour, a situation accepted only under conditions of great population pressure (78).

By the time of the Northern Sung (960-1126), the Chinese population was already over a hundred million. The population of England at the beginning of the industrial revolution was about 6 million (1740). The difference in the scale of magnitudes would normally wreck any attempt at meaningful comparisons; yet these comparisons have repeatedly been made.

Mark Elvin probably comes close to the truth when he sets out to describe the changes this large population brought about, as a series of revolutions in farming,
water transport, money and credit, market structure, urbanisation, science and technology. Much as we would like to present some view of the medieval economic revolution as he calls it, since it falls outside the scope of this chapter, we can only refer the reader to the book itself. More relevant for us, are the conclusions of Perkins, to which we can now briefly turn.

Fernand Braudel may be allowed to summarize the situation first:

The extraordinary demographic increase in China did not begin until 1680, or more accurately until the reoccupation of Formosa in 1683. China was protected by wide continental expansion that later took her people to Siberia, Mongolia, Turkestan and Tibet. At that time China was engaged in extremely intensive colonisation with its own boundaries. All the low-lying lands and hills that could be irrigated were developed, followed by the mountainous areas where forest-clearing pioneers multiplied...This colonisation met no great obstacle until about 1740. After that the portion of land reserved to each individual gradually diminished as the population indubitably increased more rapidly than cultivable space (79).

Perkins' studies qualify the descriptions of Braudel. His analysis of the six centuries he studied allowed him to conclude that even though China's population increased five- or six-fold in the period, Chinese farmers were able to raise grain output, and that they did so in more or less equal measure by expanding acreage and by raising the yield per acre.

The Mongol invasions had greatly reduced the earlier increases in population, but by 1400, the population had begun to increase again. With a temporary lapse at the fall of the Ming later, and the Taiping rebellion in the middle of the nineteenth century, it continued gradually to increase from around 80 million in 1400 to about 583 million in 1953. Yet the expansion in grain output continued to more or less match the increase in the number of people. How had this been possible?

First by migration into uncultivated land: even till
after the fourteenth century, the southernmost regions of Kwangtung, Kweichow and Yunnan were able to receive large numbers of migrants. In the early part of the Ming, this migration continued towards areas like Kwangtung, but also now into the sparsely populated areas of central China: Hunan and Hupei. Later, migrants found a further opportunity to move onto the North China Plain and the northwest: these trends continued through the eighteenth century. In the Ch'ing period itself, the major recipients of migrants were the provinces to the west, particularly the southwest. In the twentieth century there was still some land left, poorer land, but that too was filled up. Most of this land was in the north-east, the homeland of the Manchus and in some regions in the northwest.

But Chinese farmers were also able to increase grain-yields on existing land, through a variety of means: technologically, however, the elements of rice production had been developed and spread to the populated areas long before the fourteenth century. The improvements came with other means, including the planting of a large number of new seeds, the organization of the system of manure, in which hogs played a great role. As Perkins notes, "the rise in the number of hogs and draft animals made it possible to more or less double the application of fertilizer per mou between the fourteenth and twentieth centuries." All in all, through sheer ingenuity in increasing the efficiency of existing means, changing cropping patterns (which was possible through extra labour), and the occupation of new land, the Chinese agricultural system was able to prevent a decline in food intake: per capita grain consumption remained stable through the six centuries.

The moment there was no more land to open up, diminishing returns began to set in, brought about by factors related to the land. With pre-modern techniques, Chinese wheat yields even in the 1920s were substantially above those available in most of Europe on the eve of the
industrial revolution: fourteen bushels of wheat per acre to the 9.5 bushels in France at the end of the eighteenth century. Rice yields for the Chinese in the 1920s were in the region of 56 bushels. Investigations in the 1930s in the regions of Shantung and Hopei suggest that the land in these places could have profited from larger quantities of manure. The shortage of manure in turn was caused by the shortage of grazing land, which in itself reflected the need of a dense population to turn pasture into arable. Thus a civilization that in the third century and even up to the Sung had used livestock as an important element in the farm economy, was by the late traditional period and the twentieth century forced to adopt vegetarian ways. Even the hogs were incapable of improving matters: their increase depended on an increase of grain. Prof. Wertheim, after his visit to China in the fifties, could write:

The civilization of China is essentially based on vegetables. Clothes, utensils, houses, all of them are made principally of vegetable materials. About 98 per cent of the calories in the Chinese diet are of vegetable origin (80).

This picture, of a steady movement of the Chinese population towards a kind of ecological wall has a corresponding equivalent in Chinese traditional industry. Few people are willing to accept the fact that in such a vastly populated country, the traditional textile industries of cotton and silk, and the encouragement of traditional means of production in them, were not merely a necessity, but a positive boon, enabling as they did the average Chinese agrarian household to achieve a better means of subsistence. Mechanization in such a context could only have been seen as a crime: Elvin provides instances of "Ludditism" in China in this context. The issue is better examined perhaps through a description of the Chinese cotton industry's fortunes.

We have noted that cotton replaced hemp in the thirteenth century, and the sudden glut of cotton that
arrived, stimulated the invention and use of the cotton gin; later, the ready supply of labour would disfavour further invention on a radical scale. The Jesuits in 1777 had already seen the problem:

The question of the utility of machines and working animals is not so easy to decide, at least for a country where the land is barely sufficient to feed its inhabitants. What use would machines and working animals be there? - to turn part of the inhabitants into philosophers, that is to say into men doing absolutely nothing for society and making it bear the burden of their needs, their well-being, and what is even worse their comical and ridiculous ideas. When our country folk (the argument is expounded by Chinese Jesuits) find themselves either supernumerary or unemployed in a few cantons, they decide to go away and work in great Tartary, in the newly conquered countries where our agriculture is making progress....(81.

By the 17th and 18th centuries, most of the poor in China (as in England with the woollen industry) were to be found employed in the spinning and weaving of raw cotton. They made daily trips to the market to get this raw material. We have already noticed that a great deal of this industry was based on subsidiary labour: income from spinning and weaving constituted only a portion of the total income of a peasant household. Thus, for a part of the year, when agriculture demanded all attention, even the simple equipment lay unused. If demand rose, then the enormous capacity in hundreds of thousands of peasant households was brought into play by diverting labour from agriculture. If demand fell, the damage was not so serious, as it affected only a portion of the total composite income of each peasant household; even this might be alleviated by re-directing labour into farming. Thus, in times of boom there were no great prospective rewards for inventors, even no need for them. In times of slump there were few penalties severe enough to drive the inefficient permanently out of business.

Even such a situation, beneficial in the absence of anything better, could last as long as population did not
continue to rise; yet it did. By the sixteenth century, for example, there was already an acute shortage of cotton in the lowe Yangtze valley, the most densely populated area in China and also the main centre of the cotton industry. Inter-regional flows of cotton began on a massive scale, signally a breakdown of local self-sufficiency. Land that had been reserved for cotton was now needed to grow grain; and by the sixteenth and seventeenth centuries, there was little land available in China for any crop except food-grains. Any expansion in the supply of raw cotton beyond bare parity with population growth depended on raising higher a per-acre agricultural productivity that was already the highest in the world, or, alternatively, on increased imports of either cotton or food. Thus, between 1785 and 1833, the single province of Kwangtung imported on average from India, each year, six times as much raw cotton as all Britain used annually at the time of Arkwright's first water-frame invention.

Now, we might look back with the wisdom of hindsight, as it were, and wonder if mechanization of the cotton industry might have helped. Mark Elvin does this, when he observes that the persistent difficulty of obtaining raw materials (unlike England's case) cannot have made the creation of labour-saving machinery seem an urgent necessity. He adds that the Chinese in fact possessed the knowledge necessary to mechanize textile spinning if they so wished.

Elvin names this concatenation of events a "high-level equilibrium trap". In his own words:

With falling surplus in agriculture, and so falling per capita demand, with cheapening labour but increasingly expensive resources and capital, with farming and transport technology so good that no simple improvements could be made, rational strategy for peasant and merchant alike tended in the direction not so much of labour-saving machinery as of economizing on resources and fixed capital. When temporary shortages arose, mercantile versatility, based on cheap transport, was a surer and faster remedy than the contrivance of machines. This situation may be described as a "high-level equilibrium trap" (82.

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We shall return later again to Mark Elvin's explanation concerning why China did not have an industrial revolution as England did. Right now, we shall merely summarize this chapter and proceed with the next.

SUMMING UP

We have been concerned in this chapter with the presentation of one more concrete instance of the model proposed in the first chapter, the Chinese edition of homo faber. Our task, here, has been easier, since the Chinese, unlike the Indians, have always been conscious of a national cultural tradition. Further, their science and technology has seen ample documentation at the hands of Joseph Needham and a host of other sinologists.

The perspective of this chapter, however, is Chinese: an attempt, in other words, to examine China through Chinese eyes and to analyze the cultural dictates endorsed and nurtured by the Chinese mind in the ordering of Chinese society. We begin therefore by cautioning the reader about the differing qualities of the numerous sources and interpretations available.

Thus, we proposed it a major misinterpretation to try to examine China through categories evolved in another context. A famous question here, why China did not have a scientific revolution, we devalued after a deeper examination of science in history. We observed that historical objectivity concerning China may only be possible by attempting to see China as the Chinese at that time understood it, within the bounds of their cultural institutions and symbols, Geertz's point. And we dared criticize Needham and Mark Elvin for spending too much time on these questions about why China did not....

We proceeded next to examine some of the elements of the Chinese cultural paradigm. We observed how Chinese culture proved strong enough to withstand alien attempts to Christianize it, wondering in the end whether such attempts are ever fruitful. With Kwee Swan-Liat, we examined the peculiar Chinese attitude to social engineering. Finally, we discussed a representative institution, the culturally sanctioned attempt to e-order Chinese society through political means, a pattern repeated with the Chinese manner of acting today.

As for Chinese technology, we questioned the interpretation that it had stagnated or was in decline, whatever that may mean, adding that Chinese man had met and solved a number of important technical problems much earlier, and thus what remained was merely a continuous refinement of earlier means. (Later, we shall see how Chinese society continued to fulfill its primary functions even till after the 1930s). We wondered whether scholars who talked in
terms of "decline" and "stagnation" were not once again attempting to see a Chinese vain attempt to move in the direction of technological advance for the same of technological advance, especially when such an issue did not exist in Chinese society at the time. There is no doubt we admitted, that the Chinese were facing problems, particularly as the population advanced in numbers. The last section of this chapter suggests how the Chinese met these problems and would have continued to meet them even till the 1950s, if we are to believe the investigations of Perkins into the relevant trends.

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Chapter Four

English Technology and Culture: 1500 – 1830

In which we examine the activities of homo faber in England, both before and during the industrial revolution. We begin with a re-interpretation of the nature of technological revolutions and the role of population pressure or growth in the stimulation or inducement of technological activity. After a description of English agriculture in those terms, we move to an understanding of the real significance and meaning of the industrial revolution itself: homo faber facing and resolving a new range of problems presented by resource shortages. Finally, we argue that the revolutionary aspect of the revolution appeared in the sphere of culture rather than technology: homo ludens suffered a temporary eclipse and culture, though remaining culture, was gradually technologized, as the preference for consumption over leisure indicates.

Our essay on the Western homo faber paradigm, on technology and culture in the West in the period 1500–1830, is restricted in its scope to Britain. Why Britain in particular, and not Europe in general, needs we hope, no large explanation. What is generally termed the "industrial revolution" took place in the Britain of the eighteenth century. And, it was only a hundred years after those phenomenal beginnings on the island, that the countries on the Continent found themselves capable of catching up with the lone industrial pioneer (aided, of course, by the fact of their relative backwardness,
and the ready availability of a model they had merely to imitate). Yet, till 1860 or thereabouts, Britain remained the "workshop of the world", and nothing revealed this truth more startlingly than the great Crystal Palace Exhibition of 1851.

The literature focused on this remarkable period (1 is overwhelmingly large, and certainly this chapter is not going to add one more account to the numerous histories of the new machines. Instead, merely two complex issues will occupy us here, and in the following chapter. We will first present these issues in brief, before taking them up in turn and in depth.

The first issue has to do with the internal dynamic of the industrial revolution itself and is perhaps a crucial one in the deeper understanding of the homo faber model in general. If man is everywhere disposed to technology, how is it possible that in the Britain of this period an attitude to technology appeared that was out of keeping with earlier attitudes and which was responsible for the erection of the mammoth structure of the industrial revolution? The absence of such an attitude seems to be conspicuous not merely within the civilizations of China, India and Islam, but even among the nations of Europe. Europe, contrary to all that has been written on the subject, did not produce the industrial revolution, Britain alone did: any attempt to found the revolution on European culture as such must flounder on the fact of this obvious divergence.

The answer to that question will itself throw a great deal of light on the relationship between technology and culture in that age, which we see as radically altered. Before the industrial revolution, technology had always preserved as an element in the firmer sea of culture. After the revolution, the demands of culture came gradually to be fulfilled through an extension of the productive system over non-economic areas of life. In this sense, British society proved to be not merely the workshop of the world, but also a laboratory in
which far reaching results first appeared.

It is precisely this radical change in the relationship between technology and culture that has convinced us to continue using the terms "industrial revolution", even though we remain quite aware that a number of historians have cautioned against the appropriateness of the term "revolution" for the changes taking place. It is not that we do not agree with them. We do. However, the fact is that the not-so-revolutionary argument has never been directed at the technology-culture issue which we consider equally important. Rather has it been directed, quite rightly in our opinion, against the unwarranted assumption of the emergence of industrial, economic and technological processes during the period as sudden and somehow spontaneous. Thus, T S Ashton, who concentrated on the economic aspects of the industrial revolution, emphasized their phenomenality with a great deal of caution and qualification:

The word "revolution" implies a suddenness of change that is not, in fact, characteristic of economic processes. The system of human relationships that is sometimes called capitalism had its origins long before 1760, and attained its full development long after 1830: there is a danger of overlooking the essential fact of continuity. But the phrase "Industrial Revolution" has been used by a long line of historians and has become so firmly embedded in common speech that it would be pedantic to offer a substitute (2.

Of the other historians who have spent some time on the subject, R J Forbes comes closest to our own views. In The Conquest of Nature, he wrote:

The Industrial Revolution... was by no means as sudden as is often claimed, nor as revolutionary as some have believed. It had its roots in the important technological changes of the 16th century, although it did not gain momentum until about 1800. From a social point of view, however, the changes during the period from 1730 to 1880, dramatic in their strange medley of good and evil, often tragic in their combination of material progress and social suffering, might indeed by described as revolutionary (3.
John Nef, a specialist in sixteenth century English history, like Forbes, has argued too in favour of technological gradualism and has produced weighty evidence to slay the chronological conventions first established by the elder Arnold Toynbee in his lectures on the subject, first published, posthumously, in 1884. Nef holds that the British economy had already assumed industrial proportions in the period 1570-1640, when production found itself oriented to the needs of the general population, and not merely to those of a select few, as earlier:

The growth in the importance of mining and manufacturing in the national economy was, it seems, scarcely less rapid between the middle of the sixteenth century and the Civil War than between the middle of the eighteenth century and the first Reform Act (4).

Such a sense of gradualism and continuity is indeed missing in the recent, now standard, but rather academic treatment of the industrial revolution, David Landes' *The Unbound Prometheus*. We prefer to see with W F Wertenheim, a fundamental difficulty with those interpretations that imply that a cataclysmic change can occur in the bounds of a stable and equilibrium dominated society (5).

Our second issue, to be taken up in the following chapter, but closely connected with this, concerns the relationship between mechanization and colonialism. Historians, as a rule, rarely dwell on this point. Yet, it is no longer a matter of debate that the greatest wealth of this period was made possible not purely through the ingenuity of the English in devising new arts and skills or from an advanced technology, but from the extensive phase in European history that provided the raw materials and the markets for modern industry. Any discussion of the self-sufficiency or self-reliance of the countries of Asia, Latin America or Africa must return to this point in history.

We will propose then that the industrialization of England went hand-in-hand with the de-industrialization
THE NATURE OF TECHNOLOGICAL REVOLUTIONS

As we begin with Britain in 1500, we are confronted first with an agricultural civilization, supplemented no doubt with a large manufacturing capacity, and therefore in nature transitional. So much has been written about what happened after the transition: little about what occurred before. Every work on the industrial revolution compulsorily carries a brief account of an agricultural "revolution" that preceded, or ran simultaneously with it. A thorough scrutiny of the agricultural scene at this early date will lead to the conclusion that the word "revolution" exaggerates the nature of the changes involved, particularly when seen from the angle of technological development.

It is necessary at this stage to entertain a detour and to sketch out the skeletal features of a framework within which a stricter description of English agriculture would stand in a more intelligible light. In dwelling for a while on the nature of what constitutes an "agricultural revolution", we will also exorcise a few notable, even influential fallacies. The ensuing discussion will also aid in the understanding of non-western attitudes to work, efficiency and the proliferation of goods; and will also explain the despair felt by development experts, driven by the western experience of agricultural work and economic activity, when faced with peasants, farmers and tribals in the no longer self-sufficient areas of the world.

At first (and last) glance, it seems those historians that have spoken of "agricultural revolutions" have rarely been conscious of the costs, tabulated in terms of human labour inputs, these "revolutions" have incurred. This observation will be seen to be valid.
when seen in the context of the relationship that obtains between agricultural technology and the volume of population it is designed to serve. One strong and influential view, held by such notables as Carlo Cipolla and Lynn White Jr., sees progressive changes in agricultural activity as the result of autonomous technical revolution: the resulting surplus is seen to lead in turn to an increase in population, often concentrated in the cities (6). Those who follow this line of thinking have normally set forth to discover numerous types of agricultural "revolutions", each one enabling a greater surplus. These "revolutions" are all to be distinguished from the first Agricultural Revolution that made it possible for hunters and food-collectors to settle down to a steadier life based on the domestication of plants and animals.

Historically, and even in recent times, actual events have not reinforced such a perspective. Few observers, for example, would like to suggest that the tremendous growths in population rates witnessed throughout the underdeveloped world in the two post-war decades could be explained as a result of changes in the conditions of food production. As we have tried to show with China, the rule is normally for a population to be pressured by the increasing size of its numbers to the exploitation of more intensive or newer techniques for the increase of output. Throughout history, manufacturing activity on a commercial scale has arisen when too many people in agriculture has made supplementary activity for supplementary income necessary for subsistence. The Danish economist, Esther Boserup made a detailed study of this issue and it is her hypothesis that we set out now to propose (7).

One of the major contentions of Boserup is that the growth of population is a major determinant of technological change in agriculture, so that one can normally expect some similarity to exist between the rates at which population was growing and the rates at which technological change was occurring. Conversely, one should be able
to observe technological regress or stagnation after the reduction of population or the entry of settlers into areas sparsely populated.

Boserup notes that primitive forms of agriculture use land unintensively, yet provide the population with adequate subsistence and with little hard work. The earliest form of agriculture, slash-and-burn, involves little more than clearing an area in a forest through fire and ring-barking the trees to kill them. Seeds are then cast into the ashes or digging sticks used if tubers are to be planted. Burning destroys the seeds of potential weeds. All fertilizing is unnecessary due to the system of fallow: the land, after use, is let alone to regain its fertility, usually for a period ranging from twenty to twenty-five years, before being used again. Such a system is only possible if there is plenty of forest land and the population quite sparse. Carl Sauer's observation is significant in this context:

Primitive agriculture is located in the woodlands... The larger the trees, the easier the task... It is curious that scholars, because they carried into their thinking the tidy fields of the European plowman and the felling of trees by ax, have so often thought that forest repelled agriculture and that open lands invited it (8).

Figures for the average number of hours put into such a system of work, when calculated, fall between 500 and 650 hours in the year. Compare this with the 2000 hours of work that people in industrial societies must expend, with a 40-hour week and a 50-week year.

These figures naturally force important comments on the nature of primitive societies. And indeed, one of the great surprises of recent anthropological research and interpretations of primitive economic life no longer support the long-held view of these societies being permanently on the brink of starvation. The anthropologist, Marshall Sahlins, even went so far as to label Palaeolithic hunters (before they were even required to adopt slash-and-burn) as the original affluent society (9.)
Further, anthropologists have come to recognize that early societies, contemporary primitive cultures, and pre-industrial economies not yet required to radical change under population pressure, are often characterised by what one calls a "leisure-preference." In other words, once a society of this nature and number has taken care of its subsistence needs, it turns its attention to non-economic activities. There are ample studies of this attitude; here, one should suffice.

The study concerns the Siane of New Guinea and was produced by R F Salisbury, who observed the replacement of stone axes by steel in the community: the change had the effect of reducing the amount of time men had to spend on subsistence activities to less than two-thirds of what it had been. Instead, however, of using their new-found spare time in further subsistence or economic activities, the Siane spent it on additional ceremonial activities, fighting and leisure. They were keen to take advantage of any possible way of increasing their efficiency, but since the land was plentiful and subsistence adequate, increases in efficiency had very little connection with economic development (10).

The term "efficiency" needs a small comment: as an attitude and motive it only makes sense in certain economic contexts. Before industrial society made efficiency necessary and profitable, it normally appeared only in societies that had begun to face subsistence problems, that is, after ecological disequilibrium had set in: ecological equilibrium here is understood as the balanced relationship between a population and the resources it needs to exploit for its subsistence problems (11). The moment a population outgrows the carrying capacity of the land it lives on, subsistence problems arise, as more people must be fed on existing methods of exploitation: this in itself will demand the intensification of existing land use, or, stimulate new techniques. In the former system, efficiency has an important, even overriding

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economic value. In cases like the Siane it will be accepted only because it reduces labour. Today's advanced technological societies, faced with the threat of the exhaustion of resources, have once more turned more efficient, less wasteful than they were twenty years ago with the promise of unlimited resource supplies.

To return to Boserup, as population density increases in a particular area, and more people lay claim to land, the extensive use of the land, including the permissibility of long fallow periods, has to be necessarily curtailed. In the case of slash-and-burn agriculture, the peasant can make do with an ordinary digging stick; in the following phase, he is forced to invent and use a hoe. The hoe is not an advance in technics: it is a new tool for a new technical problem. Since fallow time is shortened, the forest no longer has sufficient time to regain its original state. Bushes now become the norm. Now, bushes do not prevent sunlight, as do trees, from reaching the grasses at floor level: weeds grow. Weeding is a nuisance arriving only in a new circle of events: in some cases, the labour of weeding might equal the labour spent in clearing new forest land. The total amount of labour in bushfallow is therefore doubled. More, under bush and shrub vegetation the soil itself tends to become more compacted: original forest soil, under the cover of dead leaves does not. Neither the digging stick nor the plough here can do the work exclusively restricted to the hoe. It has also been noted that productivity per unit of land falls under bush-fallow; this is probably the reason why primitives will refuse to exploit bush-fallow if the easier system of forest-fallow is still possible. The Peru Incas had evidently reached this stage of cultivation in the mountainous Andes: to criticize them for not having invented the plough is therefore wrong, for the plough would have been useless in their circumstances.

For ploughing becomes a necessity only after popula-
tion density has further reduced fallow time till only grasses can grow. Grassland cannot be prepared for cultivation by burning: the turf will survive the fire. It must be turned. The plough is again no advance on the earlier system of bush-fallow, for it involves harder labour and more technical problems: draught animals become a necessity, and any draught animal requires a larger area for grazing than it can plough. The ingenuity of homo faber is evident in the balance he has been able to obtain between the amount of land set aside for grazing, the number of animals needed for ploughing and eating and the supply of manure produced for the fertility of the arable land.

But further population growth may even break this equilibrium. Notice the situation today in large parts of India and North Africa where population increase in this century has contributed to a sharp shortage of pasture, with the result of animals overcrowded on less land and the corresponding decrease in their condition. The European agricultural revolution in the middle ages faced and solved this very problem: it was a response in fact to a grazing shortage. The "revolution" consisted in changing from a system of short-fallow cultivation to one of annual cropping, with fodder plants as part of the new system.

Some of these fodder plants were leguminous crops: crops that fix nitrogen into the soil directly from the atmosphere, increase the fertility of the soil and also simultaneously produce fodder. Viewed as a technical feat, it seems to be a revolution in the way in which it solved problems of increased food output; in the process, even raising a surplus. Yet, few historians of technics have taken account of the labour costs that this revolution involved, which were nearly double those of the earlier system. Fodder crops are support crops, but require as much labour as the annual crops, like wheat. In other words, the farm labourer had now to work twice as much as he did before. Whereas earlier he had merely to
work some months in a year, now he had to work the year around.

It is precisely this large increase in labour hours that farmers refused to accept as long as population pressures did not require it: all the general features of the revolution had already been known long before. The methods introduced in this period, including the significant innovations of crop-rotation without fallow and the use of leguminous plants as fodder were used in the ancient world in the Mediterranean as well as other regions, all densely populated. Writes Boserup:

Their reappearance began in the densely peopled and highly urbanized valley of the Po, and from there they moved to England and northern France via densely peopled and urbanized Flanders where the turnip for instance, was used already in the thirteenth century. These few facts suggest that the transition in Europe from short fallow to annual cropping was not the result of contemporary inventions; it could more plausibly be described as the spread of various methods of intensive cultivation most of which, although known since antiquity, was little used in Europe until the increase of urban population raised the demand for food and the increase in rural population provided the additional labour needed for a more intensive cultivation of the land in the most densely populated regions of the continent (12.

POPULATION AND ENGLISH AGRICULTURE

If we now return to England, we observe three broad population movements in her history of the past ten centuries. The first rise occurs during the middle ages and continue till the mid-fourteenth century. This rise is countered and reduced sharply by Malthusian checks and the Black Death. The population begins to rise again after the middle of the fifteenth century till about 1640, when it stabilizes at roughly five and a half million. The third rise begins about 1740. Since figures like these are tentative, it is best to tally them with other indices, as land-reclamation. In each period, the relation
between technological development and population increase is obvious. That the increase comes before renewed technological activity is evident from the question of wages: wages tend to fall during a period of population increase and rise in periods of decrease or stability. At least the causal role of population growth behind the sixteenth century price inflation has been proved beyond doubt by F J Fischer of the London School of Economics (13). Also, this period of growth immediately fits in with Nef's description of an increase in the volume of manufactures and their scale, particularly if we keep in mind the fact that before the industrial revolution manufactures provided supplementary incomes for surplus agricultural labour.

A comparison with China in the same period is instructive. The Chinese population, we have noted, provided for increased technological activity during the 11th and 12th centuries, even stimulating the construction of polders. The number of people was radically decreased during the Mongol invasions. It began to rise again in 1400 and continued at a progressive rate, with a few setbacks caused by the fall of the Ming, epidemics and the Taiping Rebellion. The areas of greatest technological activity, more intensive systems, including multiple cropping, were also those of the densest population. But notice the lack of technological proficiency in the same period in the province of Hupei, observed by visitors from the more highly populated areas:

For the most part, the fields in Hupei are different from those in Chiang, Che and Min (the east and south-east). The land is so sparsely peopled that they do not have to bestow any great effort on their farming. They sow without planting out or weeding. If perchance they have weeded they do not apply manure, so seeds and other sprouts grow up together. They cultivate vast areas, but have poor harvests (14)

In England, the population growth of the twelfth and thirteenth centuries brought about the colonisation
of new lands; wooded areas were cleared and marshes and fens drained and reclaimed. Once this colonisation was no longer possible, the farmer turned to a more intensive utilization of existing fields. In this stage, the law of diminishing returns began increasingly to set in. The average fertility of land and the yields from seed began to decline during the thirteenth century: pasture could no longer be increased to provide greater services to arable land. Fallow periods were considerably shortened, poorer land used, increased yields attempted by liming, ploughing in straw ash: but the improvements did not, as in China, keep pace with population growth. This is evident in at least two periods, 1160-79 and 1300-19, when wheat prices more than tripled. The result approximated more closely to the situation in the non-self-sufficient areas of the world today: poverty. The real need for supplementary sources of income stimulated manufacturing activity and produced, what one economist in a flight of enthusiasm, has termed, "an industrial revolution in the thirteenth century." Most of this activity was centred around the staple industry of England: wool, which was expanded, so that by 1310, English exports of wool had increased by about 40 per cent. The shift of the wool industry from the older urban areas to the countryside confirms the increase of rural involvement, and this in turn, made the development of fulling machines, which required running streams, extraordinarily favourable.

The regress of population after the Black Death led to a corresponding regress in agricultural activity, and a lack of rural labour. Throughout the land, the progress in material wealth which had been so marked a feature of Edward I (1272-1307) had not only been arrested; civilization and refinement had gone back and England at the accession of Henry VII (1485-1509) was far behind the England of the thirteenth century.
However, by the middle of the sixteenth century, population had begun to increase again and to provide the conditions of agricultural growth. One of the effects was a rise in the price of food and in the value of land, which meant greater wealth for the landowners and those able to buy land, and absolute destitution for others. In 1538 already, a German chronicler could write that "landed property and rents for dwellings be become so very dear that they can hardly go higher." And a generation later, an Englishman repeated the complaint:

The people are increased and ground for ploughs doth want, corn and all other victual is scant. People would labour if they knew whereon; the husbandman would be glad to have ground to set his plough to work - if he knew where (15).

These uprooted landless labourers soon aggravated the condition of the labouring classes in the urban areas: surplus labour had its effect on wages. By 1571, in the building trades, wages could buy only two-thirds as much as the wages of a century before, and this fall in the standard of living would carry on for another forty years.

No issue reveals the state of affairs more ideally than the problem of enclosures: the increased value of land led to its fencing, principally by powerful landowners. Enclosures had begun as early as the thirteenth century, chiefly due to the profitable trade in wool, which necessitated protected pastures. The descriptions concerning the issue make this obvious; Thomas More's Utopia contains references:

sheep...these placid creatures, which used to require so little food, have now apparently developed a raging appetite, and turned into man-eaters... noblemen and gentlemen, yea, and certain Abbottes... leave no grounds for tillage; they enclose all in pastures; they throw down houses; they pluck down towns; and leave nothing standing but only the church, to make of it a sheep house (16).

A mid-century Protestant preacher complained that
"whole towns are become desolate, and like unto a wilder-
ness, no man dwelling there, except it be the shepherd
and his dog." And an anonymous writer set out to demon-
strate the decay of England through an argument which
maintained that, everytime a plough was put out of use
by the increase of sheep, 6 persons lost their employ-
ment and 7½ persons their potential supply of bread."
A John Hales wrote in 1549:

....where XL persons had their lyvings, now one
man and his shepherd hath all...Yes, those shepe
is the cause of all theise meschiefes, for they
have driven husbandrie out of the countries, by
the which was encreased before all kynde of vic-
tuall, and now altogether shepe, shepe (17.

As Robert Heilbroner notes, the process would not
stop until the mid-nineteenth century. He notes that
in 1820, the Duchess of Sutherland dispossessed 15,000
tenants from 794,000 acres of land, replaced them with
131,000 sheep, and by way of compensation rented her
evicted families an average of two acres of submarginal
land each.

"Depopulating enclosure" was exposed, condemned,
and combated by a long series of proclamations, royal
commissions and statute laws, yet it carried on because
few dared interfere with the liberties of the powerful
and dominant landowning class. Poverty now came to be
seen as a social problem: a large population on the
move could only be identified as a potential menace.
For wage-earners who had no other source of income - a
class ich must have included a high proportion of all
those who left the land at this time, hoping to better
themselves in the towns - the evidence all goes to show
that it was more difficult to live than at almost any
other period in English history. Unlicensed beggars
and vagabonds, seen by the upper classes as a direct
threat to society, were believed to be about 10,000 in
early Elizabethan times.

Enclosures increased during the industrial revolu-
tion: the motive this time was no longer wool, but a more basic commodity, food. About 17 years after the third spurt in population, that is, in 1757, England, from a food-exporting country, became the reverse. Demand exceed supply and could only be fed through imports. The period also saw the quadrupling of the price of wheat. As prices rose, the profits of landowners moved in the same direction. It had indeed become profitable to improve agriculture and output.

It is at this point that historians, well aware of the disadvantages of enclosures, have felt duty bound to appreciate their role in the coming of the industrial revolution. Ashton represents this view:

Some writers who have dwelt at length on the fate of those who were forced to leave the land have tended to overlook the constructive activities that were being carried on inside the fences. The essential fact about enclosure is that it brought about an increase in the productivity of the soil. Many of those who were divorced from the soil were free to devote themselves to other activities: it was precisely because enclosure released (or drove) men from the land that it is to be counted among the processes that led to the industrial revolution, with the higher standards of consumption this brought with it (18)

This is evading the issue, which is, that technological change to improve the productivity of the soil was brought about at the expense of the lower income groups; that the motivation for it was not to produce more to feed the supplantled, but profit, in a situation where food had become profitable. And that the displaced were not "free to devote themselves to other activities", but forced to wander in villages asking for alms, or enter the cities and towns to become unwilling pawns in a factory system where labour endured longer hours each day and year than had ever been allowed even in agriculture.

This is not to deny that in some enclosures, landowners, using more intensive techniques, required more labour than before, as Landes has pointed out (19. But this
opportunity was actually a compensation for the misappropriation of common and small-holder land. Besides, not all those who had enclosed land actually set out to improve it, and it is this fact that eventually turned the mind of one of the most ardent supporters of the enclosure system: Arthur Young. A tour he made of East Anglia in 1800 shocked him, and convinced him that the entire system was rigged by the landowners for their own benefit. There was waste land - or simply unused land - available, which if cultivated would have produced enough food to keep the poor from starvation, or from the workhouse. But so little did the landowners care that often the poor did not even know who the land belonged to: certainly it did not any more belong to them:

These poor people know not by what tenure they hold their lands; they say they once belonged to the duke, but that the duke has swopped them away to Lord Ossory. How little do the great know what they swop, and what they receive....what a field is here! How very trifling the repairs to render those poor families warm and comfortable! Above their gardens on one side there is a waste fern tract now enclosed, from which small additions might be given them, yet would enable them to live from their ground at least much better than at present. What have not great and rich people to answer, for not examining into the situation of their poor neighbours? (20.

Young concluded that the labourers should be given back some land, for experience had shown that where labourers were provided with land, the results were strikingly beneficial.

The writing of agricultural history has never been achieved by those who were actually required to make it possible: the large majority of the poor before and during the industrial revolution. Lynn White noticed this attitude, before falling prey to it himself:

...nowhere are the urban roots of the word "civilization" more evident than in the neglect which historians have lavished upon the rustic and his works and days...Not only histories but documents in general were produced by social groups which took the peasant and his labours largely for granted (21.

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In case the reader wishes here to appreciate this perception, he should pause to read what White writes in the very next paragraph:

To be sure, we have heard that in the late seventeenth and eighteenth centuries "Turnip" Townshend and a few other adventurous agronomists in Britain and on the continent developed root and fodder crops, reformed agriculture, and thus provided the surplus food which permitted labour to leave the fields and to man the factories of the so-called Industrial Revolution (22 (emphasis added)).

Finally, it comes as no surprise to note that one of the most influential treatises of the late eighteenth century concerned itself with population. In 1798, Thomas Malthus published An Essay on the Principle of Population as It Affects the Future Improvement of Society, in which he set out his by now famous law concerning population:

The power of population is infinitely greater than the power of the earth to produce subsistence for man. Population, when unchecked, increases in a geometrical ratio. Subsistence increases only in an arithmetical ratio. A slight acquaintance with numbers will show the immensity of the first power in comparison with the second. By that law of our nature which makes food necessary for the life of man, the effects of these two unequal powers must be kept equal. This implies a strong and constantly operating check on population from the difficulty of subsistence (23).

The Essay seen outside the context in which it was written is a pessimistic document; within its context, it becomes an apologia for the landed class, though it should be emphasized that Malthus was himself not a member of that class. That he believed in its constructive role in the production of the general wealth is however obvious in the light of the argument he had with Ricardo on the question of rent. What was actually the context?

In 1601, Elizabeth I passed an Act in which it became compulsory for the well-off, principally the landowners, to pay rates for the maintenance of the poor. Much earlier, in fact, the Church had normally concerned itself
with the poor problem, through funds collected on religious grounds from the rich. Provided a rich man would put aside a tenth of his income for distribution among the poor, that should be a sufficient passport to paradise, so long as he had committed no other grievous sins. Thus, in medieval England a kind of unwritten pact existed between Church, landlords and serfs, designed to mitigate the hardships arising from what was then the commonest form of involuntary poverty, when death or disablement removed the family breadwinner.

The Black Death broke the stability of this system: the resulting labour shortage enabled the serf to leave the manors and seek more profitable employment elsewhere. In the process he lost the measure of security he had previously enjoyed. By the sixteenth century, with enclosures, he joined the increasing ranks of evicted, landless labourers. Work not being always available, he often wandered into vagrancy and begging. Henry VIII's dissolution of the monasteries removed one important source of alms. By the end of the century, the poor had become a thorny social problem. Attempts to revive the medieval system of support were infructuous, and the well-off were found in the main to be evading their responsibilities. Elizabeth's Act made compulsory contribution for poor relief a legal fact, liable for penalty if not carried out. The switch from almsgiving to rate-paying soon led to a change of attitude on the part of donors: if by their contribution they were no longer laying up for themselves treasure in heaven, there was nothing to be gained by generosity. Inevitably, they began to look at the poor through the eyes not of Christians, but of taxpayers.

By the time of Malthus, this rate-paying or poor relief had come to a state where it was seen as nothing more than a millstone round the neck of Progress. Evidently, poor relief could not be justified on economic grounds. If it should be demonstrated that a larger population was not in the national interest, in other words, the final justi-
fication for the poor law would be removed. And in 1798, Malthus set about removing it, in his Essay.

Malthus claimed that ordinarily a check operated on any population growth. As food shortages would result, the price of food would rise; but as the supply of labour would be increased, wages would fall. Inevitably, many of the poor would suffer severe distress, and their numbers soon reduced. The poor law merely perpetuated the problem: it was a futile exercise calculated to perpetuate the misery. The poor, Malthus even argued, had no right to relief; a man born into an already full world,

if he cannot get subsistence from his parents, on whom he has a just demand, and if society does not want his labour, has no claim of right to the smallest portion of food and, in fact, has no business to be where he is. At nature's mighty feast there is no vacant cover for him. She tells him to be gone, and will quickly execute her own orders, if he do not work upon the compassion of some of her guests.

The debate on Malthus and his population law is so enormous it would be difficult to summarize here. What we can do is assess his principal ideas in the light of the discussion we have set out above, if only to sharpen our own thesis on the straps of his own theory.

Whether we are talking about Malthus or the neo- Malthusians the central belief among them has been that the supply of food for the human race is inherently inelastic, and that this lack of elasticity is the main factor governing the rate of population growth. Thus, population growth is seen as the dependent variable, determined by preceding changes in agricultural productivity which, in their turn, are explained as the result of extraneous factors, such as the fortuitous factor of technical invention and imitation. Those who see the relationship between agriculture and population in this essentially Malthusian perspective agree that there is at any given time in any given community a warranted rate of population growth with which the actual growth of population
tends to conform. It is easy to see that historians like Lynn White and Carlo Cipolla or Gordon Childe for that matter, have a similar opinion on the role of technology in society: they merely differ in arguing that surplus populations are made possible by technological innovation, and because they ignore the context of technical change, often tend to see such a pattern of development as something to be idealized.

Malthus, on the other hand, was more realistic; the fact that his general theory is disputed should not distract us from the other equally important observation that the conditions during his time tallied at least with his empiricism: high food prices, surplus labour and intense poverty. The lack of elasticity involving the supply of food is evidenced by the fact that England during the period was forced to import food, indicating the breakdown of rural self-sufficiency. Existing means of agricultural production had reached a point of diminishing returns: witness Ricardo's theory of rent in this context.

Richard Wilkinson, however, has shown how the Malthusian theory itself does not fit the facts of general economic history in England. If Malthusian constraints were operative all the time before the nineteenth century, we would expect that whenever there was a temporary improvement in wages, population would immediately expand until wages returned to their original level, and that a fall in the population would signal a fall in real wages. The evidence is contrary; suggesting, that before the nineteenth century the tendency was for real wages and population to move in opposite directions. From the late fifteenth century to the early seventeenth century the population increased and real wages fell; the same is also true of the second half of the eighteenth century. From the Black Death until the mid-fifteenth century population fell and real wages rose, and during the second half of the seventeenth and first half of the eighteenth century population was stable while real wages rose (25).
Malthus, however, cannot be blamed for not being able to observe this pattern; neither could he realize the structure that pattern revealed: that economic development arises from poverty. A shortage of food or a surplus of labour will drive a society to agricultural innovation, or, supplementary manufacturing activity. In both cases, the bulk of society would suffer, because more labour would be demanded of it for its subsistence needs. The stronger, more secure, wealthier portions of the same society would discover the situation to be extremely profitable to exploit.

An economist looking for the roots of the situation that leads to increased economic growth would find it in the breakdown of self-sufficiency, the increase of trade, the increase of manufactures and innovations in agriculture. He will then proceed to universalize this experience, until he realizes that there have always been societies (and primitive cultures today probably provide the sole examples) that, being in a state of ecological equilibrium, their populations controlled through social and cultural restraints (as Malthus realized), are not forced to start out on the road to economic development in the first place. To put this idea in economic jargon, innovation, economies of scale, education, capital accumulation are not causes of growth; they are growth. The causes of growth would include, at least up to and including the industrial revolution, the dynamic role of population pressures.

As Wilkinson observes, if there are some societies that do not wish to sacrifice existing levels of efficiency for increased production, others may be equally unwilling to sacrifice possible increases in leisure. It is possible that some societies will thus use improvements in techniques to reduce the time needed to produce subsistence, in order to increase their leisure. Economists (and a large number of "developmental" economists, who have attached a higher priority to increasing the output of goods, would have preferred the extra time being used for increased production (26.

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Which brings us to the industrial revolution and the role of population growth within it. A perusal of the literature might bring the reader, not aware of the larger context, to the conclusion that here at last *homo faber* entered a new phase of security, in which machine power not merely took over functions reserved for man, but multiplied the results many times over, to enable not merely a few, but the larger mass of society to attain a standard of living rarely before achieved in human history. The "official" dates demarcating the period of the revolution are 1760 and 1830. However, the most important innovations concerned resource changes, and these came much before 1760; and no industrial revolution would have been possible without them.

We are interested in the social history of the period and the crucial position of technology in it. So we might as well begin by parading out assumptions. We are convinced and reiterate that the process of technical change is not inherently developmental; every technical change that is necessitated by the circumstances of the age raises a host of problems, most of which are dumped on the backs of the weakest members of the particular social group. Histories of inventions, taken by themselves, mean very little, for they tend to present the unwholesome view that technology is one of the few branches of civilization in which the line of development is always on the upgrade, that mechanization itself undergoes constant evolution, and that technical change always follows the principle of efficiency and moves always forward. "While faiths veer and fashions oscillate, techniques advance", is all to common a wisdom. In such a context, efficiency becomes the sole criterion of progress and those preoccupied with it will proceed, conceptually and methodologically, to detach the process of technical change from its historical, geographical and human context.
It is not that we see no merit, contrary to some writers, in the phenomenon of the industrial revolution. We can only marvel that man was able to encounter and solve problems on a scale and using methods for which there is very little historical precedent. This in itself indicates that the industrial revolution was a response to a wide range of problems, which we discover as having appeared in a society gradually facing a state of ecological dis-equilibrium and unsolvable through traditional means.

In adapting to these problems, English society was coerced into making corresponding fundamental changes in its pattern of life. Perhaps, this statement should be qualified: it was the majority of English people, unsupported by privilege, those that constituted the lower rungs, that were forced to accept, for the sake of subsistence, a cultural deprivation and a disruption of symbols that till today has not seen integrated repair. The minority rich were rarely called upon to face this, so we shall not concern ourselves with them.

Richard Wilkinson summed up the context of the industrial revolution in ecological terms: the initial stimulus to change came directly from resource shortages and other factors connected with that, and their effects on an economic system expanding to meet the needs of a population growing within a limited area. The emphasis is important to be able to distinguish the English response from the responses of other countries on the Continent, which were also undergoing population increases. Traditional resources having reached scarcity levels, it became necessary to substitute new ones in their place, new technology to process them, and longer working hours:

The ecological background to the industrial revolution was an acute land shortage. In the centuries before industrialization the English population was dependent on the land for almost all its materials. The supply of food and drink depended on agricultural land, clothing came from the wool of sheep on English pasture, and large areas of land were needed for extensive forests: almost all domestic and industrial fuel was firewood, and tim-
ber was one of the most important construction materials for houses, ships, mills, farm implements etc. In addition, the transport system depended on horses and thus required large areas of land to be devoted to grazing and the production of feed. Even lighting used tallow candles which depended ultimately on the land supply. Land was bound to become in increasingly short supply as population increased (27)

We have already discussed the land-question, and will bypass it here to tackle the fuel and energy problem represented by the most important landbased resource after land itself: wood. Living in a gas-supported society, we tend to forget that wood constituted the source of everyday power before the industrial revolution. As Braudel ably describes the situation:

Calculations of power today leave out work by animals and to some extent manual work by men; and often they ignore wood and its derivatives as well. But wood, the first material to be in general use, was an important source of power before the eighteenth century. Civilizations before the eighteenth century were civilizations of wood and charcoal, as those of the nineteenth century were civilizations of coal (28)

The shortage of wood was first felt sharply during the population increase of 1540-1640. The fact is easily illustrated if we point out that it was during this period that the price of firewood rose nearly three times as fast as the general rise of prices. A part of the shortage might have been due to the increased production of iron (charcoal) and the shipbuilding industry; a larger part was however due to the increased number of people needing wood for domestic purposes. The "timber famine" was therefore in large part due to ecological forces: the conversion of woodland into arable, and the necessity for larger quantities of domestic fuel. The import of wood did not help matters. In 1631 Edmund Howes wrote down his experience of the times:

within man's memory, it was held impossible to have any want of wood in England. But...such hath been the great expence of timber for navigation, with infinite increase of building houses, with great

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expence of wood to make household furniture, casks, and other vessels not to be numbered, and of carts, wagons and coaches, besides the extreme waste of wood in making iron, burning of bricks and tiles, that at this present, through the great consuming of wood as aforesaid, and the neglect of planting of woods, there is so great a scarcity of wood throughout the whole kingdom that not only the City of London, all haven-towns and in very many parts within the land, the inhabitants in general are constrained to make their fires of sea-coal or pit-coal, even in the chambers of honourable personages, and through necessity which is the mother of all arts, they have late years devised the making of iron, the making of all sorts of glass and burning of bricks with sea-coal or pitcoal (29)

Eric Hobsbawm emphasizes the use of coal in the domestic scene:

Coal grew almost entirely with the number of urban - and especially metropolitan - fire-places; iron - to a much small extent - reflected the demand for domestic pots, pans, nails, stoves and the like. Since the quantities of coal burned in British homes were very much greater than their needs for iron (thanks in part to the unusual inefficiency of the British fire-place compared to the continental stove), the pre-industrial base of the coal industry was much sounder than that of the iron industry (30)

Thus it was in the pre-industrial period, due to the paramount timber shortage, a landbased resource, that many industries that used large amounts of fuel in heating processes, including glassmaking, salt-boiling, brewing and brickmaking, switched to coal, a mineral resource. The shortage of wood, however, would affect a large number of tools, instruments and containers made usually from it, leading thus to a greater demand for iron. In the following passage, the term "iron" would easily be substituted for "wood" after a century a half:

It is the technology of wood that inspires building, even in stone; it is from wood that means of over-land and maritime transport, utensils and tools are manufactured. The carpenter's tools are made of wood, except for the cutting edge which is made as thin as possible; it is from wood that looms and spinning wheels, wine-presses and pumps are made; most ploughing implements are wooden; the swing
plough is made entirely of wood, the plough most frequently has a wooden ploughshare fitted with a thin iron blade (31.

The problem, however, is more complex than that: for the making of iron itself depended on wood. Iron and glass making factories often had to shift their locations from forest to forest. A blast furnace built in Wales in 1717 was not fired until four years later, when "enough charcoal had been accumulated for thirty-six and a half weeks' work". The blast furnaces that had replaced the "bloome-ry" technique associated with small forges could, because of the perennial lack of wood supplies, operate once in two or three years, or even one year in five, seven or ten. Calculations show that an average iron-works where the furnace worked two years on and two years off needed the resources of 2000 hectares of forest before the eighteenth century. It is not surprising to find increasing legislation during this period to preserve forests, for the navy needed timber.

The serious lack of self-sufficiency that developed could only be offset by imports of iron from Sweden, where forests were in plenty and the cost of the smelted metal quite low. And this dependence on Swedish imports would continue for a round sixty years after the Restoration: the English production of iron remained static and low. And it was this concern that finally drove men to attempt to harness coal to iron production. One man, Dud Dudley, made the point so obvious:

I have held it my duty to endeavour...the making of iron...with pit coal, sea coal, peat and turf, for the preservation of wood and timber so much exhausted by iron works of late (32.

It was only in 1709 that Abraham Darby thought of borrowing the solution to the maltsters' and brewers' problems and used coke for iron-smelting, but a generation was to pass before this method was refined through knowledge and experience to make it more acceptable for general use, and still another generation before coke-blast iron could be di-
rectly converted into wrought-iron (33).

The dilemma faced by historians who see the substitution of wood by coal as a conscious choice exercised in the all-round striving for progress is to explain why coal was not used earlier on a larger scale, when it was already known; unless, the answer is that most people saw coal as an inferior fuel compared to wood: the shift itself from one resource to the other, required, as we emphasized, through ecological shortages, raised a host of problems and demanded different adaptations. Further, where wood was plentiful, it continued to be used. In areas not so well favoured, the change to coal was inevitable.

In industries, for example, where substances were kept separate from the fuel in vats or containers, it was quite easy to substitute coal for wood. But in processes like metal-smelting, where the fuel came into contact with the raw material, or in drying processes where things were hung in the fumes above the fire, coal could bring about undesirable chemical changes in the product. Precisely as the heavy plough once forced a new shape on fields, coal forced bakers to change the design of their ovens to avoid contaminating their bread with coal fumes, and brick-makers had to experiment long and hard till they found the less gaseous coals that did not fuse the bricks together, glass-makers had to use covered pots and maltsters had to develop further the use of coke to avoid the smoky gasses and tars given off by raw coal.

Coal is also disadvantageous as a domestic fuel due to the harmful constituents it contains; and its widespread use for domestic purposes during the late sixteenth and early seventeenth centuries was paralleled by the spread of chimneys as the smoke forced people again to abandon the traditional custom of having fires in the centre of the room with a hole in the roof (34. Finally, the rich were able to prevent and delay coal use much longer than were the poor: paralleling the situation in the textile industry, where the rich could continue to wear wool while the poor had already been reduced to cotton.

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It is more appropriate then to see the use of wood instead of coal in the preceding centuries as a rational choice in a situation where wood was plentiful, and therefore cheap. The switch came about when timber scarcity raised the price of wood till it was more expensive than coal; in most countries today, particularly for the poor of Asia, Africa and Latin America, wood is still more inexpensive than coal. The use of coal means paying high transport costs. And in places where open-cast mining is no longer possible, deep mines raise costs as production turns more difficult than the felling of trees. Such costs in England at the time of her resource change became hidden costs: on the market both coal and wood were presented at what seemed superficially a similar price, the former even cheaper. Only a traveller from a wood-economy entering what had turned into a coal-economy would have noticed the difference.

Seen any other way, the issue will generate contradictions in any standard history of technology and resources. David Landes provides a good example. At one place he is required to admit that coal, unlike wood, was not the best of all possible fuels. He writes:

From the sixteenth century on, as we have noted, the need for new sources of thermal energy in a country almost denuded of its forests led Britons to substitute mineral for vegetable fuel in a wide variety of heat-absorbing industrial operations. At the same time, the consumption of coal for domestic purposes rose steadily: there was perhaps a time, in the sixteenth century, when the Englishman recoiled at the acrid, sulphurous fumes of burning coal; but by the modern period, such scruples were laid by familiarity and necessity (35).

His commitment to progress in industry for its own sake is patent in his discussion of the comparative disadvantages that prevented coal usage on an English scale, and in turn, hindered industrial growth on the Continent:

On the supply side, the contrast between Britain and the Continent was less sharp. Yet the resources of
the mainland countries were in fact less favourable to industrial expansion than those of Britain even before the change in raw material requirements consequent on the Industrial Revolution. The cloth industries of France, the Low Countries, and Germany, for example, had to import the bulk of their fine wool from abroad. And the lack of concentrated, easily accessible known deposits of coal led to a neglect of the possibilities of mineral fuel; here, indeed, even nature's bounty hurt, for the relative abundance of timber seems to have encouraged retention of the traditional technique (36).

So we should not be surprised that Arthur Young was surprised to discover that "the wheels of these (French) waggons are all shod with wood instead of iron". In spite of this, Landes goes on to produce a bundle of contradictions, in writing:

Whatever the sources of this ferruginous temper, it is the more impressive for having developed in the face of the growing scarcity of fuel; until well into the eighteenth century, Britain used iron because she wanted to, not because it was abundant or cheap. (To be sure, the most likely substitute, wood, was perhaps even dearer). Even so, one can but wonder what would have happened, had she had to go on depending on costly and inelastic foreign sources for much, if not most, of the principal structural material of modern technology (37).

If we are to believe Landes, what might we indeed say about the intelligence of his own countrymen when we realize that coal did not overtake wood in the American economy until 1887!

Finally, it is when we examine the history of the steam engine that we can fully understand the strength of the view concerning the stimulus provided by resource shortages, ecological disequilibrium and population pressure. It is well known that the steam engine was the invention of Hero of Alexandria: the library at Alexandria contained a perfectly working model of it. Greek society might have ignored it, because there were enough slaves. The West however slept over the design for well nigh two thousand years. When it was resuscitated, it was not for the purpose of exploiting sources of power on a large scale,
as it is expressed in text-books, but to raise water from mines that had reached below the water table. This problem arose since the demand for coal had so increased, that open-cast deposits being exhausted, the mines had to be sunk deeper and deeper. Mines on hillsides might be drained by digging a special drainage shaft that led out of the hill to a point below the level the mine had reached. But once below the water table, the problem of drainage became acute. Mines close to streams could exploit a waterpowered pump; otherwise, a horse-whim might accomplish the purpose. But the use of these methods was restricted to shallow depths. By the end of the seventeenth century, however, depths up to 200 feet were common in most mines, and some had even reached 400 feet. At such depths, horse-whims, bucket pumps and rag-and-chain pumps began to suffer the law of diminishing returns: more energy was spent in moving the machinery itself, little left over for lifting the water (38).

Attempts to raise water through means of "fire" had been tried out since 1631. Steam power seemed to be a worthwhile proposition not because it was initially more powerful than horse or stream power, but because the power itself could be delivered in a more appropriate form: one had either to reduce the pressure above the water to be raised or increase the pressure below it. In either case, coal to fuel the steam engine was available in plenty, at the pit-head itself. Horses displaced meant that less fodder need to be grown in a period of land shortage. Further, not all mines could be located, or found themselves located by streams.

Thomas Savery's "Miner's Friend", patented in 1698, unfortunately blew up too often. Newcomen's "fire-engine" was available only in 1712. Even so, only one was in operation in England thirty years later, in 1742. In the following thirty years, a further sixty were in use in the tin mines of Cornwall. Thus, for nearly a century, the use of the steam-engine remained confined to a reciprocating pumping motion. And only in the late eighteenth
century, when the new cotton mills began to demand rotary power did Boulton and Watt succeed in manufacturing the first steam engine harnessed to produce a rotary motion. The reason for this delay was perhaps due to the continued existence of a number of sites where water wheels provided the easiest and most economical means of obtaining a rotary motion for mill production. The increasing acceptance of the steam version later must also be put down to the fact that not only was it a dependable source of power, but also not fixed in its operations to a place, like a stream. Till that time, however, the rotary steam-engine did not displace traditional methods in the performance of traditional tasks.

Richard Wilkinson has surveyed the evidence to confirm the fact that a similar situation did lead to innovations and resource substitutions in other important and basic areas of the English economy. Briefly, then, the central features of these analogous changes, before going on to explore the value of this argument in the industry that practically launched the industrial revolution itself: textiles.

The development of transport during the period of the industrial revolution was stimulated by the breakdown of self-sufficiency in two vital areas: deficient areas had now to import fuel and grain, sometimes metal, and people who had formerly produced commodities themselves were now forced to enter into increasingly complex trading relationships. Here, as elsewhere, costs were rising. Modern economies celebrate high-speed, large-scale transport systems, while at the same time, are keen to forget that transport, as we noted early, adds to the cost of goods, not to their value. Secondly, the shortage of agricultural land made horse-transport increasingly prohibitive, for pasture entailed the sacrifice of arable land, which was already in short supply. The growth of wheeled transport led to better roads, an invention in itself, not required earlier, and the rise of turn-pike trusts was able to finance their development.
The "mania" for canal construction arose directly in response to the horse problem: the high costs of hay and corn increased the costs of goods. This is more easily accepted if we know that the feeding of each horse required the hay grown on between four to eight acres of land. Traders were aware of these problems at the time. As Wilkinson notes:

An engineer writing in about 1800 on the proposed Grand Surrey Canal Navigation calculated that "as one horse on an average consumes the produce of four acres of land, and there are 1,350,000 in this island that pay the horse-tax, of course there must be 5,400,000 acres of land occupied in providing provender for them. How desirable any improvement that will lessen the keep of horses..." The Earl of Hardwick writing in favour of the Cambridge and London Junction Canal used a similar argument: "If the canal should be the means of releasing 1000 horses from...employment,...8000 acres of land...might be applied to more useful purposes, which would help to keep the labouring poor from suffering from want of bread" (39).

Arguments to counter the high initial costs of the steam railways were expressed in similar terms. Witness the following report to the House of Commons on "steam carriages" in 1833 and its calculations:

It has been said that in Great Britain there are above a million of horses engaged in various ways in the transport of passengers and goods, and that to support each horse requires as much land as would upon average support eight men. If this quantity of animal power were displaced by steam-engines, and the means of transport drawn from the bowels of the earth, instead of being raised upon its surface, then, supposing the above calculation correct, as much land would become available for the support of human beings as would suffice for an additional population of eight millions...The land which now supports horses for transport on turnpike roads would then support men, or produce corn for food, and the horses return to agricultural pursuits (40).
duction without any increase in unit costs. After the Great Fire of London in 1666, legislation to secure the rebuilding of houses in brick was made correspondingly easier.

Resource changes had important consequences in the early chemical industry. Alkalis were important for a wide variety of products including glass, soap, alum and saltpetre. When the different processes used wood, potash was readily available as a byproduct. The switch to coal, necessitated by wood shortages, made potash supplies scarce; they had even to be imported. This led to the processing of large quantities of sea-weed. The chemistry historian, N L Clow has summarized the industry's earlier development "as a subsidiary facet of the search for an alternative to wood" in its search for natural alkali. Thus, the new industry aided in the general growth of the economy: prices had to be paid for a commodity that earlier was available free in the form of wood-ash. Hidden costs again.

Ecological shortages also lay at the back of the transition from tallow candles to gas lighting. Tallow candles were obviously dependent on land supply. Prices rose in the industry sufficiently high enough, till large quantities had to be imported. In 1838, Britain still imported over £1 million worth of vegetable and whale oil to satisfy home needs. Yet, gas lighting was known already at the end of the eighteenth century. Why did the change not come about?

Simply because people were being asked to use an inferior product: the fumes from the impure gas were so unpleasant that most people preferred to go on using the older oils. When gas use became inevitable due to high costs, people went so far as to mount the lights outside the windows so as to avoid the fumes.

It is the textile industry, however, that carries a few important lessons in the actual development of the
industrial revolution and links the latter with the technological experience of the colonial areas. Central to the issue is the reason why cotton, not wool, was the first to undergo mechanization, especially when we note that wool constituted the principal staple industry of the English economy up to the eighteenth century. Historians who set out to describe the "conscious and progressive" nature of the industrial revolution seldom get beyond this great dilemma. David Landes has tried to explain it away by pointing out that wool-mechanization was more difficult than that of cotton, but his arguments probe rather than convince (41).

In the period before the industrial revolution, the woollen industry was indeed the foundation of English manufactures. We have tried to explain the increase of activity in wool-working on the same basis as we did for the Chinese industry. As one description has it:

*Wheresoever any man doth travel, ye shall find at the hall door...the wife, their children, and their servants at the turn spinning or at their cards carding, by which commodities the common people live... The weaver buyeth the yarn of the spinster, the clothier sendeth his cloths to the tucker or fuller, and then the merchant or clothier doth dye them in colours, or send them to London or elsewhere to his best advantage* (42).

Technical innovations had been tried out in the industry before: the stocking frame was delayed by the hostility of the hand-knitters and so was the "Dutch loom". In 1733 John Kay invented the "fly-shuttle", which did not so much save labour as it did labourers; it was opposed, and according to some writers, because of the "conservatism" of the workers themselves.

As in China, however, the methods and scale of the woollen industry had reached a stage where a precarious balance existed between social, ecological and economic constraints. The spinners and weavers were often among the poorest in the community and took up their trade when their land holdings proved insufficient. One study has
in fact shown that the woollen industry tended to concentrate in areas where inheritance customs led to the successive division of land in periods of population growth: villages that practised partible inheritance tended to be more densely populated than others; land holdings were smaller and people had to earn part of their income from weaving and other domestic work.

The price and quantity of wool supplies (unlike those of cotton) were largely fixed by the land situation; markets were limited, and given the technology, comparatively competitive. In such a context, the inefficient machinery in use (inefficient, of course, in the light of further refinements), was maintained as a way of ensuring a sufficiently wide distribution of the small rewards available. Both the early inventions that transformed the cotton industry, Kay's fly-shuttle and Wyatt and Paul's spinning frame were invented for wool, not for cotton. In the context, hostility to them in the wollen trade was not merely understandable but necessary.

Legal action often supported workers in the trade, but it would soon prove helpless in preventing radical changes brought about by the ecological disequilibrium we have seen affecting other industries. More people on the land meant simply less pasture for sheep, especially when this was complicated further by the new profitability of food itself. As prices rose and real wages fell, a new resource became necessary for clothing material. Cotton was known earlier, and would have been used more extensively if people had but desired it, but in a cold climate it must be considered quite inferior to wool. Scarcity made up for the difference. As opposed to the seasonal demand called up by fashions, cotton first came to be used by the poorest customers for general purposes all the year around, and being cheaper its widespread use would soon be favoured in the context of the high wool prices created through scarcity. In the middle of the nineteenth century, Engels made the point rather obvious, in
describing the clothing of the working classes:

Linen and wool have practically disappeared from the wardrobes of both men and women, and have been replaced by cotton. Men's shirts are made of bleached or coloured cotton cloth. Women generally wear printed cottons; woollen petticoats are seldom seen on the washline. Men's trousers are generally made either of fustian or some other heavy cotton cloth. Overcoats and jackets are made from the same material..... Gentlemen, on the other hand, wear suits made from woollen cloth. The working classes... very seldom wear woollen clothing of any kind. Their heavy cotton clothes, though thicker, stiffer and heavier than woollen cloth, do not keep out the cold and wet to anything like the same extent as woollens (43.

More significant for the cotton industry, however, is the fact that its supplies did not have to be grown on British soil and thus, to compromise an already aggravated land shortage. Raw cotton could be imported en masse, first from the Indies, later and after Eli Whitney, from America. During the American Civil War, India was made to step in as substitute. Arnold Pacey's figures for cotton imports into England speak for themselves. From 1760, that is, twenty years after the third population rise, to 1775, cotton imports increased from two to seven million pounds. Within the next fifteen years, they increased from seven to thirty-four million pounds. As in China with its gin, in England too, the crucial inventions appeared much after the demand for cotton had raised imports to large proportions. Hargreaves' jenny appeared in 1765, Arkwright's water frame in 1769, Crompton's mule in 1779. Thus, in no case did the invention precede the increase in demand (44.

We have said that periods of transition and resource changes brought about by population pressure on limited land are more than usual periods of intense discomfort for the majority of the population; not only have the lower classes to make do with inferior products, they are also forced to work more and keep longer hours. This fact was no doubt noticed by some contemporaries.
The historian, Rowland Prothero, after a study of documented enquiries, speeches, pamphlets and speeches on the subject of the agricultural labourer's distress during the period 1800 and 1834 (he was writing fifty years later), concluded that their standard of living had indeed sunk to the lowest possible scale; in the south and west wages paid by employers fell to 3s.-4s. a week, augmented by parochial relief from the pockets of those who had no need of labour; and insufficient food left its mark in the physical degeneracy of the peasantry. Herded together in cottages which, by their imperfect arrangements, violated every sanitary law, generated all kinds of disease, and rendered modesty an unimaginable thing...compelled by insufficient wages to expose their wives to the degradation of field labour, and to send their children to work as soon as they could crawl, the labourers would have been more than human had they not risen in an insurrection which could only be quelled by force. They had already carried patience beyond the limit where it ceases to be a virtue (45).

The poet Shelley, like Cobbett whom we have quoted on the contents-and-contexts page, emphasized the difference between the past of the poor and their present; and he noticed the longer hours:

Not that the poor have rigidly worked twenty hours, but that the worth of the labour of twenty hours, now, in food and clothing, is equivalent to the worth of ten hours then. And because twenty hours cannot, from the nature of the human frame, be exacted from those who performed ten, the aged and the sickly are compelled either to work or starve. Children who were exempted from labour are put in requisition, and the vigorous promise of the coming generation blighted by premature exertion. For fourteen hours' labour, which they do perforce, they receive - no matter in what nominal amount - the price of seven. They eat less bread, wear worse clothes, are more ignorant, immoral, miserable and desperate (46).

Prothero and Shelley were describing the situation among the farm workers, who were still in the period the largest segment of the labouring population. Though this has not gone unnoticed, it has often been ignored in the belief that the essential test for betterment, seeing into
the future, was the industrial worker. What about his condition? For one category - the largest, in fact - the situation did not get better, but unmistakably worsened. By the 1830s the handloom weavers had been reduced to a wage of less than a penny an hour: they were able to keep alive only when their children or wives found work in the factories. The application of steam power to looms gradually undermined their independence and their number. They did not give up easily, but they had to in the end, provoking Ashton to term the period one of the most depressing chapters in the economic history of the time.

The factory system needs less comment: when factories first appeared the owners found it difficult and often impossible to persuade men and women to work in them. Later, even if many adult workers found themselves in better-paid jobs than they could have hoped for if the factories had not been built, the tens of thousands of children working in a way recorded history has never known before, is a fact civilized men will never be able to exorcise from their minds.

To get back to the factory's bleak appeal, Inglis's sketch of the period puts its briefly and well:

When Owen first went to New Lanark, for example, his predecessor there explained that he had been compelled against his will to use pauper apprentices because such was the dislike of factory work that, with few exceptions, "only persons destitute of friends, employment and character were found willing to try." If convicts had been compelled to work a twelve-hour day as part of their punishment, in jails, it would have provoked a humanitarian outcry. Yet the twelve hour working day in factories had been established on commercial grounds - and not just as the norm; as the minimum. It was this, rather than the cruelty involved which was the ugliest aspect of the factory system: that it imprisoned men, women and children, for so much of their lives (47).

The mill-owners did not deny the cruelty, they merely found the discussion about it irrelevant. In their opinion, the factory worker was better off. He was enjoying a standard of living higher than he otherwise could have
hoped for, especially if his lot were compared to a cen-
tury earlier when there had been no factories. If it
were not for the efficiency and economies of factory
production, leading to better trade, there would be no
job for him to do and he would be faced with the alterna-
tive of the workhouse or starvation. The mill-owners
were in a sense right, and the young Macaulay, who would
later, significantly, turn out to be one of England's
most influential imperialist historians, felt justified
in arguing that English labourers were no worse off than
their counterparts on the Continent: the point however,
is whether they ought not to have been better off.

Therefore, when Karl Marx began to talk of surplus
value, everybody understood what he meant: while influen-
tial theoreticians have reacted sharply to his theory on
the fall of capitalism, no writer worth his salt has felt
it necessary to dispute his understanding of surplus value
itself, for it was based on fact, bare fact. In 1834,
Jean de Sismondi, accepting the fact that machinery had
vastly increased England's productive potential, and had
made fortunes for many employers and enabled England to
become the foremost trading nation of the world, still
made it known that all of it had been built up only at the
workers' expense:

The proletarii are cut off from all the benefits of
civilization; their food, their dwellings, their
clothes are insalubrious; no relaxation, no pleas-
ures except occasional excesses, interrupt their
monotonous labours; the introduction of the wonders
of mechanics into the arts, far from abridging their
hours of labour, has prolonged them; no time is left
them for their own instruction or for the education
of their children; no enjoyment is secure to them
in those family ties which reflect their sufferings;
it is almost wise for them to degrade and brutalize
themselves to escape from the feeling of their mise-
ry; and that social order which threatens them with
a worse condition for the future, is regarded by them
as an enemy to combat and destroy. And this is not
all: whilst their own distress is increasing, they
see society overcome, as it were, by the weight of
its material opulence; they are in want of every-
thing; and on all sides their eyes are struck with
what is everywhere superabounding (48).
The tragic sequel to this almost dismal chain of events, however, arrived precisely when the economic situation of the English working class improved after 1840 and in a gradual movement till 1875. The improvement came about through various factors, one of which was the forcible opening of new markets in the colonial areas of the world, particularly in India, where indigenous modes of production and commerce were systematically suppressed and discouraged. In a very real, though indirect sense, the English worker's betterment was founded to some extent on the increased pauperization of the peoples in Asia, Africa and other territories. But this is an issue for the following chapter: now it suffices merely to draw the connections.

The ecological argument, finally, is also useful to our understanding of Japanese and American developments in technology in their formative phases. Geertz has applied it to Java, where the Dutch presence provided an artificial dis-equilibrium that eventually led Javanese society to "involute" (49. In fact, Geertz distinguishes the Japanese and Javanese reactions to population pressure in terms not dis-similar to our own:

The existence of colonial government was decisive because it meant that the growth potential inherent in the traditional Javanese economy - "the excess labour on the land and the reserves of productivity in the land" - was harnessed not to Javanese (or Indonesian) - development but to Dutch (50.

The reason we applied the ecological argument to Britain need no explanation in a thesis of this kind. Western scholars have normally used it to describe other societies but their very own. Thus Arnold Pacey, for all his discussion of the role of ideas and idealism in the technology of cultures, readily use Ho Ping-ti's studies on the Chinese population to note that "the pressure of population (by 1840) on resources was becoming critical". Yet, such an analysis does not figure in his study of
England itself: that is explained only through some new dynamic that affected the quality of the English mind, which had its corresponding effect on its overwhelming technological development.

It should also be apparent by now that evolutionary hypotheses do not move us the way they do a great number of writers, whose thinking still seems to be controlled by a more sophisticated version of the concept of organic evolution or developmentalism proposed in the eighteenth century. What then is the nature of the argument we have proposed in the course of this chapter?

To put it all briefly, we might begin with the evident, that English society, for example, obviously differs from primitive society, but can it appropriately be called an advance on the latter? What we have tried to suggest is that such a question in itself is misleading. English society, instead of doing the same productive tasks as primitive societies more efficiently than they, is concerned with a completely different range of tasks and activities. A primitive or pre-industrial culture, for example, may have the means at its disposal for working with wood and thus may be able to exploit this material to its maximum potential to bear on subsistence or agricultural tasks. There is however no reason why such a society should always contain within it the means to produce a more advanced technology to achieve the same tasks. As Wilkinson sums it all up:

One of the most striking features of longterm economic development is how little overall increase in efficiency there has been in producing subsistence and maintaining the necessary life-support systems. Ecological pressures change the optimum choice of materials and techniques. They make it beneficial to exploit new materials and techniques. Priorities change and new productive problems are substituted for old. The needs and choice spectrum which formed the context of the established technology is suddenly altered (51).

Within any evolutionary theory, moreover, hides the
more insidious assumption of progress. We call it an assumption because no philosopher has yet been able to describe in any credible terms a goal or even a direction which, having assimilated, man might see himself having at the same time, progressed. Except perhaps W F Wertheim.

Wertheim, however, has not picked his "emancipation-theory" out of the air. If he was able to propose a more inclusive and novel account of human evolution, he was able to do so only by distinguishing his own ideas from those from whom he had in fact learnt. Leslie White was an important source. White attempted to develop a theory in which he saw cultural development as the product of the harnessing of increasing quantities of power, or energy. If man originally was restricted in his possibilities due to the limitations of his own labour power, progress would come only after he had been able to exploit fire, animal power, wind and water, and finally, in the Fuel Age, coal oil and gas, when cultures were finally able to grow and blossom "in all the arts - industrial, esthetic and intellectual" (52).

In 1960 four anthropologists got together to present Evolution and Culture (53, with White providing an introduction, in which they distinguished specific evolution, or, the adaptation of a culture to its natural environment, from a more general evolutionary theory:

The more specialized and adapted a form in a given evolutionary stage, the smaller is its potential for passing to the next stage...specific evolutionary progress is inversely related to general evolutionary potential (54).

Wertheim has shown the similarities between this theory and the ideas of Jan Romein condensed in the latter's "dialectics of progress". Moreover, his critique of all these theories concerning their precision sees them has "hardly greater than that of the biblical saying: And the last shall be the first" (55).

Dissatisfied, Wertheim has seen fit to provide his
own version of the human story, under the rubric of the "rising waves of emancipation", but we can immediately note inadequacies. Wertheim writes:

It appears to me that the basic principle underlying the concept of evolution could be understood as a general trend towards emancipation. At the same time, this general trend cannot be separated from an increasing human capacity to cooperate...

The general trend of human evolution, therefore, amounts to an increasing emancipation from the forces of nature......

Emancipation from human domination, therefore, goes hand in hand with emancipation from the forces of nature......(56.

While the second trend is extraordinarily worthy, it is not at all certain whether it can in any sense be achieved without the first. Wertheim formulated his ideas before the Club of Rome's report, the oil crisis, and the threat of a permanent exhaustion of the raw materials on which the industrial nations have built their economies. One of the leading apologists of capitalism, Robert Heilbroner, surveying the scene, came up with some hard pronouncements:

In place of the long-established encouragement of industrial production must come its careful restriction and long-term diminution within society... Rationalize as we will, stretch the figures as favorably as honesty will permit, we cannot reconcile the requirements for a lengthy continuation of the present rate of industrialization of the globe with the capacity of existing resources or the fragile biosphere to permit or to tolerate the effects of that industrialization (57.

Heilbroner went on to hold the threat of a more totalitarian governmental system that he saw inevitable for the most democratic country in the world:

In bluntest terms, the question is whether the Hobbesian struggle that is likely to arise in such a strait-jacketed economic society would not impose intolerable strains on the representative democratic political apparatus that has been historically associated with capitalist societies. (58

Let me try to answer the problem by stressing an as-
pect of it which we have hitherto ignored - the extent of the institutional changes needed to attain a condition of ecological equilibrium. Central among these changes will assuredly be the extension of public control far beyond anything yet experienced in the West, Socialist or capitalist. To bring environmental stability, the authority of government must necessarily be expanded to include family size, consumption habits, and of course the volume and composition of industrial and agricultural output (59).

Finally, Wertheim is also more than inadequate regarding the relations between the industrial world and the countries of Asia, Africa and Latin America. The core of the issue is that the emancipation of the peoples of the industrial world is based on a technological system that presupposes the dependence, and thus, the continuous suppression of any attempts at realistic emancipatory processes in former colonial areas.

THE RISE OF A TECHNOLOGIZED CULTURE

Our final point: the new face of culture in a radically altered productive system.

The sort of pressures we have described in the larger part of this chapter, brought about an awesome, lasting and pervasive change in the structure of English society itself. For the first time, the majority of its members found themselves facing a situation in which the total adaptation of their lives to the rigours of a new production system became a virtual necessity. By the time further technological changes arrived, a new generation had grown up, as David Landes observed, "inured to the discipline and precision of the mill." No wonder the workers were reluctant to enter the factory. A Committee report of 1834 reported that "all persons working on the power looms are working there by force." Charles Fourier had labelled it a "mitigated form of convict prison."

We are still not at the core of the problem. Eric Hobsbawm came close to it when he wrote that material poverty went hand-in-hand with social pauperization: the
destruction of old ways of life without the substitution of anything the labouring poor could regard as a satisfactory equivalent (60). The upper classes did not face this problem, and Hobsbawm has further noted, that if there was indeed a relation between the industrial revolution as a provider of comforts and as a social transformer, then, those "classes whose lives were least transformed were also, normally, those which benefited most obviously in material terms..."(61).

Thus, if we have the majority poor in mind, then, on balance it seems likely that English society had to pay for increased production of basic subsistence items by undergoing a worsening of cultural, social and environmental conditions during at least a part of the nineteenth century. We have observed that the people only accepted the rigours of industrial life in the hope of improving their subsistence; in the bargain they came close to suffering severe cultural, social and environmental deprivation: they came near to living on bread alone.

Poverty in one sphere was exchanged for poverty in others that seemed less vital: entertainment, education and social activity. And it is the lack of these forms of experience that have created the urgency of the consumer society. New needs sprang up because of the changed life-styles: the old methods of satisfying many human needs were destroyed or rendered obsolete. As Hobsbawm has put it:

Pre-industrial traditions could not keep their heads above the inevitably rising level of industrial society. In Lancashire we can observe the ancient ways of spending holidays - the rush bearing, wrestling matches, cockfighting and bull baiting - dying out after 1840; and the forties also mark the end of the era when folksong remained the major musical idiom of industrial workers (62).

Secondly, new needs have also sprung from the new pattern of living itself. Society has relied heavily on the economic system to right this situation. Man has had to be encapsulated increasingly in his own creations to make
his urban industrial lifestyle workable. Mass culture has been perhaps the logical result (63). This is to be distinguished from what is today a new phenomenon, founded no doubt on the earlier, the huge eruption of interest in, or curiosity about, (high) culture itself, on a scale unprecedented in human history, significantly more impressive in America than in Europe. The economic system has of course been able to discover even the lucrative possibilities offered by this new urge, but how much this interest in culture has been deflected into an interest in what is provided under the name of culture will never be known.

There were undoubtedly many aspects of the pre-industrial way of life which were especially satisfactory, and it was only after the disruption of this way of life that people experienced some particularly pressing needs outside the sphere of traditional subsistence. Without the enormous increases in incomes and consumption which continued industrial development has produced, members of industrial societies would surely have been worse off than their agricultural predecessors. In human terms the real standard of living in the early and mid-nineteenth century was abysmal. Incomes had to increase sufficiently to offset the losses before real progress was possible.

To take one prime example, the breakdown of local community - of the "neighbourhood" as a social reality - created a need both for new forms of entertainment to replace the disappearing social activities and traditions, and for transport and communication systems to allow contact between geographically separated friends and relatives. Homo ludens of rural festival life, of leisurely companionship, suffered an eclipse during the industrial revolution, but music halls, competitive factory brass bands, football clubs, tried to raise him back into the light of human experience: in the twentieth century, the cinema, radio, popular music, record players and above all, television would fulfil a similar function. It has even been proved statistically that people in more neighbourly
areas turn on their television sets less often than those in more unfriendly areas: the latter is the commoner situation today. In the USA, fifty per cent of the population moved house during the five years 1955-60.

Both modern entertainment and the mass media indicate in their content and styles that they have grown up to fill a specifically social vacuum. A great deal of programs attempt to create the direct illusion of a close personal relationship with their audiences. Or take the press. In a community where there is a high level of interaction between the members, the community itself provides behavioural norms for its members - social approval, disapproval, rewards and sanctions are generated from within. Today, the press plays increasingly this important role, and sometimes steps in to provide the reference point from which people might develop their individual attitudes and behaviour. Is it any more unusual that we can even identify a person's norms by the kind of newspapers he reads?

The question is not whether primitive or pre-industrial societies would not enjoy some of the goods of modern life; rather one should ask whether people in pre-industrial populations would be prepared to work for these goods and services. Articles of consumption do not fulfil needs, personal, social needs, in cultures that have other, traditional means of fulfilling them. It should come as no surprise to discover that it was already in the mid-eighteenth century, as the industrial revolution began its inexorable course, that attitudes to leisure changed, and labourers began to use any rise in earnings to increase their consumption rather than their leisure time.

Writes Wilkinson:

It appears that industrialization requires a more extravagant lifestyle than the modes of production that preceded it. The problems it creates and the needs it sets up make increased consumption a necessity if people are to lead reasonably satisfactory lives. The continuous expansion of gross national product which this requires should perhaps be
regarded more as a reflection of the rising real cost of living than an indication of increasing welfare (64.

From what has been said, it does appear that rich societies are less rich and poor societies less poor than has been hitherto imagined. It is not to be concluded, however, that we are harking back to a nostalgic past. We agree wholeheartedly with Wertheim and Braudel that there is never any progress unless it be accompanied with an enhancement of human life, that when man has a certain cost price as a source of power, for example, then it is necessary to think about aiding him or, better still, replacing him: the too many, highly efficient coolies of China have gone - good riddance.

Yet, we will refrain here from drawing certain conclusions about what kind of technology may be appropriate for societies now undergoing (or even not yet) the problems England faced during the industrial revolution. That is an issue that will occupy us only in the final chapter. At the present, we might end with a significant statement of Max Weber's made way back in 1919:

The peasants of the past died "old and satiated with life" because they stood in the organic cycle of life, because their life had brought to their declining days all the meaning it could offer, and because there were no more puzzles they would have liked to solve. Thus they could consider themselves "satisfied" with life. Civilized man, on the contrary, situated in the midst of a civilization constantly being enriched with ideas, knowledge and problems, may become "weary" of life, not "satiated" with it. In fact, he can never grasp any more than a minute part of what the life of the spirit produces that is new. He can only grasp something provisional, never the definitive. That is why death is for him a meaningless occurrence (65.

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SUMMING UP

This chapter describes our final paradigm exemplifying our universal model, if we may be permitted to continue talking in Plato's terms. In a sense, it is also a bridge or transition point to the chapters that follow, for we shall see later that the technology and culture of England, in fact, the industrialization of England, was more deeply connected with countries outside English borders than has been hitherto supposed. Yet, a separate chapter for the industrialization of England is plausible and necessary since the meeting of major technological challenges in the English economy was accompanied by revolutionary changes on the social and cultural level in English life.

We use our dis-satisfaction with the terms "industrial revolution" to launch, first, a more comprehensive view of the causes and consequences of the periodic Revolutions that men see as having affected human history at different periods. Gradualism is our general theme, rather than suddenness, for the time-scales of history appear smaller than in actual fact should we restrict ourselves solely to written histories. This attitude or theme corresponds with our general conclusion that the pressure of population on the English economy brought about or made inevitable resource changes that in turn stimulated a new generation of appropriate machines. Seen in this light, it becomes possible to re-value the state of the English economy before 1760, and to indicate the nature of the changes taking place in a number of different but basic industries, which changes later proved a preparation for the industrialization of England itself.

If we do accept a revolutionary dimension to the changes taking place, this has to do with the human aspect of society during the period. In other words, the changes in industry or the organization necessitated by the new productive system, had radical effects on the content of human life. The new social context diminished older cultural ways of fulfilling human needs, and also created new needs in turn. It is no accident that the consumption society, or a society in which individuals define identity by consumption, first came to life during the mid-eighteenth century. The preference for consumption over leisure was aided by the available opportunities to exercise the former rather than the latter. Though culture, as a sociologist might see it, remained culture, it had indeed become technologized. In the context of such a description, the high standards of industrial societies might be a cloak hiding the fact that the consumption of more might just as well belong to the "real cost" of living in the new productive system.
See the following important, key works:


Landes D S, *The Unbound Prometheus: Technological Change and Industrial Development in Western Europe from 1750 to the Present* (1969)

Chambers J D, *Workshop of the World*


Inglis B, *Poverty and the Industrial Revolution* (1971)

Hodgen M T, *Change and History* (1952)


White L, Jr., *Medieval Technology and Social Change,* (1962)


Sahlins M, *Stone-Age Economics* (1974) chapter one. See also,


Salisbury R F, *From Stone to Steel* (1962)


For a sharp critique, see,


Boserup E, *Ibid: p 38*


16 More T, Utopia (Turner trans.) p 46
18 Ashton T S, Ibid: pp 20-21
19 Landes D, Ibid: p 115
20 Inglis B, Ibid: p 88
21 White L Jr., Ibid: p 39
22 White L Jr., Ibid: p 40
23 See, Inglis B, Ibid: p 66
24 See, Inglis B, Ibid: p 69
25 Wilkinson R, Ibid: p 70
28 Braudel F, Capitalism and Material Life: p 266
29 Armytage W H G, A Social History of Engineering (1961)
30 Hobsbawm E J, Ibid: pp 46-47
31 Braudel F, Ibid: p 266
32 Derry and Blakeway, Ibid: p 233
33 See Landes D, Ibid: for a brief, but excellent survey of the technical aspects of this issue. pp 88f.
34 See Inglis B, Ibid: for a comprehensive account of the condition of chimney-sweeps and other forms of child labour.
35 Landes D, Ibid: p 96
36 Landes D, Ibid: p 126
37 Landes D, Ibid: p 95
38 For some excellent material and pictures of intricate, but increasingly cumbersome machinery in the Limburg mines in the Netherlands, see, Raedts C E P M, De Opkomst de Ontwikkeling en de Neergang van de Steenkolenmijnbouw in Limburg (1974)
42 Derry & Blakeway, Ibid: p 95
45 See, Inglis B, Ibid: p 367
See also, Hobsbawm E J, Labouring Men: Studies in the History of Labour (1964/1968)
46 See Inglis B, Ibid: pp 369-70
47 Inglis B, Ibid: p 369
48 See Inglis B, Ibid: p 371
49 Geertz C, Agricultural Involution: The Process of Ecological Change in Indonesia (1963)
50 Geertz C, Ibid: p 139
51 Wilkinson R, Ibid: p 140
52 White L, The Science of Culture (1949)
53 Harding, Kaplan, Sahlins, Service, Evolution and Culture (1960/1968)
54 Sahlins, Service, Ibid: p 97
54 See also:
Veblen Thorstein, Imperial Germany and the Industrial Revolution (1915/1966)

55 Wertheim W F, Ibid: p 78
58 Heilbroner R L, Ibid: p 89
60 Hobsbawm E J, Industry and Empire: p 94
61 Hobsbawm E J, Ibid: p 80
62 Hobsbawm E J, Ibid: p 91
63 See:
Rosenberg B & White D M, Mass Culture (1957)
Y Gasset O, The Revolt of the Masses (1930/1972)
64 Wilkinson R, Ibid: p 185
65 Quoted in,
In which we argue that the industrialization of England went hand-in-hand with the de-industrialization of India. De-industrialization presupposes industry, at least on a wide commercial scale and should not be taken to mean the disruption of village production. We have in earlier chapters examined the nature and extent of the non-mechanized, but commercialized industry. Even so, we open this chapter with a general picture of the self-sufficient economies of India and China before the period of Western dominance. This self-sufficiency should not be taken to mean the absence of poverty: poverty existed here as in other civilizations of the time. Our point is that it was in the period of British dominance that the roots of a more intractable poverty were laid. We follow these statements and views with a documentation of the de-industrialization of Indian commercialized industry in the interests of Empire. We also observe disruptions in Indian agriculture. A word of caution: since India was a total colony of the British, it occupies most space in this chapter. China on the other hand could with difficulty be de-industrialized, for it remained a semi-colony till the end, and its independent political status enabled it to ward off the damage that was suffered by its Indian counterpart.

Man, we observed, as homo faber, is morphologically predisposed to technology and culture. Through providing concrete examples in our investigations of technology and culture in India, China and Britain, we were able to conclude that in each instance man evolved a technology that enabled him to meet his subsistence or survival problems. Yet, it seems more than obvious today that there exist societies that appear unable to exploit their technical capacities and thus
remain rooted in poverty. Further, it has often been claimed that these societies have cultural systems that inhibit the health encouragement of such capacities.

That these capacities were not, in fact, impeded by their cultural systems is easily evident when we examine their technological histories, whether we have here in mind countries as diverse as China, India, Africa or Latin America. The cause of the technological wilderness in large areas of some of these lands must be sought elsewhere. We prefer to identify some of these causes as the results of the unequal power relationship that first appeared in the colonial age. In other words, we are interested in this chapter in the relationship between politics and technology within the framework of the colonial period.

In 1498, Vasco da Gama opened the sea-route to India, and simultaneously, a new chapter in Asian history that would end a long four hundred and fifty years later after, with the withdrawal of British forces from India in 1947 and of the European navies from China in 1949. It is important to note here that before 1498, the civilizations of Europe, India and China had been virtually, and in a greatly limited sense, geographically isolated from one another: the fact of "technological osmosis" between these civilizations is the reason for our qualification. Yet, even after 1498, in fact, till the year 1800 (as a mean), the relations between East and West still continued to be conducted within a framework and on terms established by the Asian nations. Except for those who lived in a few colonial footholds, the Europeans were all there on sufferance (1.

Support for this view of Donald Lach, also comes from G B Sansom, who wrote already in 1949:

A survey of the enterprises of Europeans in Asia after the great voyages of discovery shows that during the sixteenth, seventeenth and eighteenth centuries neither their colonizing and trading activities nor their missionary work brought about any significant change in the life of the peoples with whom they came into contact. The presence in Asiatic countries of small groups of European officials and traders made little impression upon indigenous cultures

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outside a very narrow circle.... Indeed, far from Europe affecting Asia, it was Asiatic goods that changed and enriched European life, and Asiatic ideas that attracted some European minds (2).

And from Panikkar, who has some amusing evidence:

Essentially, till the nineteenth century,...there was no large demand for European goods in any Asian country. The Empires of Asia...had, generally speaking, self-sufficient economies. Though the trade of India was large at all times, the economy of the country was not based on trade. This was true of China also, and the imperial government seems at all times to have discouraged the import of foreign goods into its territory. Also, Europe at the time had but little to offer to Asian economy. The story of the Amsterdam Company which exported to Siam a collection of thousands of engravings, of madonnas and biblical scenes, "prints recording the stories of Livy and, finally, prints with a more general human appeal, a collection of nudes and less decent illustrations" is not by any means strange or unique. Richard Cocke's letter from Japan complaining of the lack of interest in biblical paintings may also be quoted here, "They esteem a painted sheet of paper with a horse, ship or a bird more than they do such a rich picture. ...either will any give six pence for that fair picture of the conversion of St Paul" (3).

That this state of affairs was recognized, and where not, soon made obvious, is evident in the opinions of men in China, India and Britain during the entire period. The edict of Ch'ien-lung, who in the 18th century (1793) received an embassy from King George III of England, is worth quoting even in part:

The various articles presented by you, O King, this time are accepted by my special order to the office in charge of such functions in consideration of the offerings having come from a long distance with sincere good wishes. As a matter of fact, the virtue and prestige of the Celestial Dynasty having spread far and wide, the kings of the myriad nations come by land and sea with all sorts of precious things. Consequently there is nothing we lack, as your principal envoy and others have themselves observed. We have never set much store on strange or ingenious objects, nor do we need any of your country's manufactures (4).

Ssu-Yü Teng and John Fairbank described the framework within which this edict rests (the Chinese theory
of tributary relations) as "traditional and outmoded" and thereby provided a subtle apologia for the newly assumed right of the western nations to trade. For, behind this attitude of these two influential sinologists lies the western understanding of international law and right, which Joseph Needham has admirably exposed (5. The problem first seems to have become serious and immediately resolved by the Portuguese in the sixteenth century when during the course of their voyages of discovery they also introduced the policy of terrorism and piracy in Indian waters. As one of them put it:

It is true that there does exist a common right to all to navigate the seas and in Europe we recognize the rights which others hold against us; but the right does not extend beyond Europe and therefore the Portuguese as Lords of the Sea are justified in confiscating the goods of all those who navigate the seas without their permission (6.

Panikkar has observed how this strange claim was soon to be firmly held by every European nation upto the end of Western supremacy in Asia. As he so admirably puts it:

...the principle that the doctrines of international law did not apply outside Europe, that what would be barbarism in London or Paris is civilized conduct in Peking (e.g. the burning of the Summer Palace) and that European nations had no moral obligations in dealing with Asian peoples (as for example when Britain insisted on the opium trade against the laws of China, though opium smoking was prohibited by law in England itself) was part of the accepted creed of Europe's relations with Asia. So late as 1870 the President of the Hong Kong Chamber of Commerce declared: "China can in no sense be considered a country entitled to all the same rights and privileges as civilized nations which are bound by international law." (7.

As far as India is concerned, it is worthwhile to remember that though the British began their policy of conquest in Bengal in 1757 (Plassey), they were only able to complete their task, due to the impediments placed in their path by Indian militaries, in 1848. In fact, for the two hundred and thirty years after Albuquerque's disastrous attempt to challenge the power of the Zamorin of
Calicut (1506) - he had to be carried unconscious to his ship - no European nation attempted any military conquest or tried to bring any ruler under control. In 1739, for example, the Netherlands who came up against the Raja of Travancore had to surrender. A year earlier, the British naval authorities on the West coast reported:

Our strength is not sufficient to withstanding him (Sambhaji Angria) for I assure Your Honour that he is a stronger enemy than you and a great many others think (8).

We should also remember that a Company settlement was made possible in Madras in 1708 only after a grant of five villages was made by the Government in Delhi. That the viceroy of Bengal continued to be addressed in the most cringing terms. In addressing the Emperor one of the English Presidents described himself as

the smallest particle of sand, John Russel, President of the East India Company with his forehand at command rubbed on the ground (9).

More significant, perhaps, is the attempt of the English to sell textile goods in the East. We have already noted, in an earlier chapter, that in the sixteenth century, the staple industry in England was the weaving and dyeing of woollen cloth. As production was always in excess of home consumption, the export of woollen cloth was vital to the national economy. However, two wars on the Continent - the Spanish War and the French Civil War - soon put this market into jeopardy. A serious crisis of overproduction in the 1550's stressed the need for new outlets and the most hopeful prospect then seemed to be that of establishing trade with the Far East: both China and Japan it will be noted have cold climates. The voyages of 1554 (Willoughby and Chancellor), 1575 (Frobisher), 1578-83 (Drake), 1585 (Davis), 1596 (Wood) and finally, the founding of the East India Company in 1600, all these were inspired, directly or indirectly, by England's pressing need to sell her own textiles in the Far East. Sansom confirms this when he writes that "the history of English
commercial enterprise in the Far East shows a continuous but abortive effort to find a 'vent' for English woollens" (10).

Of course, there was another objective, which was, to compete with the Portuguese and the Dutch for the pepper and spices of the Malay Archipelago, but the principal aim remained the selling of English textiles in Asia. History books perhaps generally ignore this, because it proved to be so total and embarrassing a failure.

The Company's attempts to establish trade with China were unsuccessful. So it next tried to dispose its English woollen cloth on the spice-islanders. Here it discovered that the only commodity acceptable was Indian textiles and this prompted it to seek a market for its woollen goods in India, with the idea of buying in return the Indian cottons and silks wanted by the spice-islands. With this end in view, English ships reached Surat (Gujerat, India) in 1608. Here again the Englishmen tasted failure. And three years after, the Company's factors wrote to the London Directors:

Concerning cloth, which is the main staple commodity of our land...it is so little regarded by the people of this country that they use it but seldom (11).

A decade later the Company had finally abandoned hope of a big Asian market for English broadcloth. Yet, some other commodity had to be bartered if the Company wished to get its hands on the spices and pepper of Malay. Other alternatives were tried, including consignments of looking-glasses, sword-blades, oil-paintings, drinking glasses, quicksilver, coral and lead. To stimulate the demand for English lead in India, it was decided to send out "plumbers to teach them the use of pumps for their gardens and spowtes on their houses." This was followed by a scheme to persuade Jahangir (the Moghul Emperor) to pay for the erection of waterworks for the supply of Agra, knowing that it would require plenty of lead piping. There is another story of how the London Directors, hearing that Indians "are very superstitious and washe their hands whenever they goe to their worship", immediately ordered the despatch of a consignment of wash-basins for trial sale.
But to no avail. In the end, the factors were forced to conclude that "no commodity brought out is staple enough to provide (in return) cargo for one ship."

Earlier, the Portuguese had faced a similarly disheartening situation. The presents offered by da Gama to the King of Calicut, included some striped cloth, hats, strings of coral beads, wash-basins, and jars of oil and honey. As Sansom observes, these were curious gifts to bring to the classical land of treasure, and the King's officers readily found them laughable. In fact, when he received da Gama, the King had in his hand a golden spittoon and by him a golden basin for his betel. He was wearing a crown set with pearls, and golden anklets set with rubies (12).

To come back to the English Company, it was forced to fall back on the export of bullion (in the form of gold and silver) for the purchase of goods in India. This raised a storm in England from people who feared that the country was being drained of its wealth. The directors were able to counter this by the re-export of Indian goods to the European continent and the Levant, thus recovering the return of the original wealth, plus a trade profit. Later, they were able to pay for Chinese goods with Indian opium.

Self-sufficiency in basic goods in the countries of Asia, before the appearance of Europeans, had in fact stimulated a flourishing trade between them in the form of semi-luxury and luxury goods. C G F Simkin has amply documented and detailed the various trade routes that had been long established between Japan, Korea, China, East Turkestan, Tibet, North and South India, Ceylon, Thailand, Laos, Cambodia, Vietnam, Sumatra, Afghanistan, Iran, Java, Malaya, Burma, the Philippines and Taiwan. And the history of European expansion in Asian waters is nothing more than the usurpation (through means more foul than fair) of this trade.

Merely the example of Malacca in the fifteenth century will suffice to present some idea of the extensive
nature of the traditional trade of Asia. Four groups of harbour masters (shahbandars) were responsible for the four different points of trade: one looked after ships from Java and the other parts of Indonesia; a second met ships from China, Champa, Burma and Thailand; a third, ships from Bengal, Malabar and North Sumatra; and a fourth, principally ships from Gujerat. Such was the diverse nature of merchants that gathered there that a special Malay lingua franca soon evolved to meet the confusion of eighty different languages or dialects.

The trade between Malacca and Gujerat was described by Tomé Pires, a Portuguese official who visited the former trade center between 1512-1515. He wrote:

Four ships come every year from Gujerat to Malacca. The merchandise of each ship is worth fifteen, twenty or thirty thousand cruzados, nothing less than fifteen thousand. And from the city of Cambay one ship comes every year; this is worth seventy or eighty thousand cruzados, without any doubt. The merchandise they bring is cloth of thirty kinds, which are of value in these parts; they also bring pachak, which is a root like rampion, and catechu, which looks like earth; they bring rosewater and opium; from Cambay and Aden they bring seeds, grains, tapestries and much incense; they bring forty kinds of merchandise....

The principal merchandise brought back is cloves, mace, nutmeg, sandalwood, seed pearls, some porcelain, a little musk; they carry enormous quantities of apothecary's lignaloes, and finally some benzoin; for they load up with these spices, and of the rest they take a moderate amount. And besides they take gold, enormous quantities of white silk, tin, much white damask - they take great pains to get this - coloured silks, birds from Banda for plumes.... These have the main Malacca trade. They pay in dues six per cent.... they pay the Bemdara, Lasamane, Tumumguo and Kabamdar one cloth per hundred, and each according to who he is, which the merchants regard as a great oppression (12.

Or take the trade of Bengal with Malacca, also considerable on its own terms:

A junk goes from Bengal to Malacca once a year, and sometimes twice. Each of these carries from eighty to ninety thousand cruzados worth. They bring fine
white cloths.... They bring steel, very rich bed canopies, with cut-cloth work in all colours and very beautiful; wall hangings like tapestry; and also sugar preserves of various kinds in great plenty.... They bring an abundance of strongly scented vases in dark clay, which are highly esteemed in these parts and very cheap....

The chief merchandize they take to Bengal is Borneo camphor and pepper - an abundance of these two - cloves, mace, nutmeg, sandalwood, silk, seed pearls, a large quantity, white porcelain in plenty, copper, tin, lead, quicksilver, large green porcelainware from the Liu Kiu, opium from Aden and some little from Bengal, white and green damasks, enroladas from China, caps of scarlet-in-grain and carpets; krises and swords from Java are also appreciated (13).

This detail about Malaccan trade is but part of a total description that has been sketched out by Simkin in his excellent study. More important, as we noted earlier, the Portuguese were able ultimately to build their sea-borne empire largely from this trade within Asia. Sansom has noted that it was the profits earned by the Portuguese as carriers and brokers that sustained, for example, their commerce with China, rather than the sale of the few European products for which they could find a market (14. John Harrison has summed up the matter as follows:

The Portuguese used their naval power to draw Asian shipping to their ports and customs-houses - and to plunder those who did not give either submission or a timely bribe. Officials and settlers themselves engaged, alone or in partnership with Asian merchants in the various trade systems of the Indies. This "country trade" was far greater than that with Europe. One complex system interchanged the goods of East Africa, the Red Sea and Persian Gulf and India, this was linked by Indian cottons and opium to the nutmegs and cloves, tin, copper and gold, porcelains and silks assembled at Malacca, which drew in turn upon the trade between Siam, China, Japan and the Spice Islands. The Portuguese helped to link all three together, and in the process earned the means to defend Malacca or to embellish golden Goa (15).

The strength of this largely autonomous (in relation to Europe) Asian trade was bound to have its consequences on the economies of Europe once these entered the stream. "One is apt to think of European intrusion" wrote Sansom,
"as producing disturbances in Asiatic life and to forget that from their adventures European countries experienced effects which were not all beneficial."

The import of Indian textiles into England threatened to upset the woollen trade there. As early as 1695, in fact, Parliament was urged to prohibit the use of Indian fabrics, as the visible depression and unemployment in the English woollen trade was no longer possible to ignore. The demonstrations raised by the woollen and silk weavers alarmed government, and in 1700 there followed the bill prohibiting the home consumption of silks or printed calicoes of Asiatic origin. To quote Sansom again:

The Asiatic trade not only changed our mode of dress and introduced new aesthetic principles, but also altered in the long run the constitution of English commerce and even the trend of English economic thought. It was the controversy over calicoes that presented in an acute form to people and Parliament the choice between protection and free trade and ultimately – after a protectionist phase – led to the adoption of those doctrines of free enterprise and laissez-faire which dominated English theory and practice for many generations (16).

Also of equal significance was the nature of the encounter of Europe, India and China on the level of their cultural systems. Sardar Panikkar has a comprehensive chapter on the attempts to Christianize the East and their ultimate failure and the reader is referred to his work. The only point we would wish to emphasize here is that the Jesuit influence in China has in fact been vastly overrated. The fact is the Chinese authorities never did fail in keeping the Jesuits and their mission under control. Further, the scientific contributions of the Jesuits when placed in their proper perspective are truly ambiguous. We must remember that the work of the astrological bureau (euphemistically termed astronomical by the priests) and to which Jesuit Adam Schall von Bell was appointed, was not strictly speaking a scientific one. Its principal business included the preparation of an official calendar, containing auspicious dates for almost every event of domestic or na-
tional importance. This compromise to which Ricci and Schall were forced was noticed by fellow Jesuits who reacted to it in the strongest terms. And as Panikkar has noted, Schall was being plainly dishonest and unscrupulous when he did not hesitate to interpret the sun spots on one occasion as representing the hostile influence of the Buddhist priests near the Emperor. "Schall and his friends were supposed to be promoting the truth of their religion by this kind of deceit."

The favourite strategy of the Jesuits, from Ricci onwards had involved a continual critique of Buddhism in order to raise themselves in the eyes of the Confucian literati. The permanent patronizing attitude of the Chinese to the entire Christian mission is obvious. Later, during a particularly weak phase, the re-entry of the Church hand-in-hand with imperialism (the Bible in one hand, and opium in the other) would prepare the way for the massacres of the Boxer uprising.

Today, the West has replaced Christianity as the new ideology inextricably connected with imperialism. Ultimately, it might have to suffer the same pattern of events that Christianity had to undergo in India and China. The re-establishment of Asian trade, the renewal of Asian cultural systems, the re-assumption of political autonomy for the determination of their own technological futures might conceivably lead to a situation that existed before the European impact and which we have briefly outlined above. The relativization of the Western paradigm is not inevitable. But it is desirable and necessary in the light of the attempts by the nations of Asia, Africa and Latin America to emancipate themselves. The eventual success of these attempts would make the relativization inevitable.

This larger perspective established, it is now time to tackle the specific themes of this chapter. There are in fact three of them: the third will be taken up only in the course of the next chapter. As before, however, we might introduce the themes briefly, and then move on to a
more detailed examination of them.

First, we need to discuss "the other side of the medal", particularly as far as India is concerned. In the second chapter we presented, it is true, an interpretative sample of science, technology and culture in India. But, we said next to nothing about the economic and social levels of the mass of the population in the period. An adequate description of China too must include negative aspects of Chinese society in the past, which present Chinese are keen to forget.

Second, we need to examine one of the cardinal issues of this thesis: that the industrialization of England was closely connected with the de-industrialization of India and China, that it profited from this de-industrialization and contributed to it in great measure. The destruction of technics in colonial territories was accompanied by a weakening of their cultural systems, which left their peoples open to the unwarranted opinion that Western culture might in fact be superior to their own.

Third, we need to inspect the renewal of culture and technology in India and China: the reaction to the impact of a more powerful technology from the West. To put it in other words, it is necessary to sketch the beginnings in China and India of the kind of emulation that enabled the Continental nations earlier to catch up with England itself. For methodological reasons, we will discuss this issue in the following chapter, when we write the prelude to the Chinese and Indian response to technology and culture after their independence in 1949 and 1947 respectively.

INDIAN POVERTY IN PRE-BRITISH TIMES

There are conflicting opinions about the state of the average Indian in the period before British rule, during Moghul times. On the one hand, Indian nationalist historians have tended to portray the pre-colonial period as
one of general prosperity. Others, on the other hand, see the same period as not much dissimilar to that available in general over the world, before the advent of modern economies. In England, India and China the technological system enabled a few to live off the surplus made available through the exploitation of the majority who laboured.

Percival Spear concludes the issue as follows:

There seems to be good ground for thinking that the average peasant (in India) had more to eat than his European counterpart and suffered no more oppression from the lords. It is possible that the strength of custom and the intricacies of the caste system gave him greater protection. On the other hand he was more liable to the disaster of flood and famine, when his rulers could not help him much even if they would. .... Taking it all in all Mughal India, with an estimated hundred million inhabitants, had for about a century and a half a standard of life roughly comparable with that of contemporary Europe, though arranged on a different social and economic pattern.... Most European travellers commented on the dire poverty of the countryside but we must remember that before the agricultural revolution there was also dire poverty in the European countryside (17).

Angus Maddison, in his brief, strict and objective appraisal of a slightly later situation, implicitly testified to the general truth that all in inequality-ridden societies, poverty must come to be seen as a social product:

India had a ruling class whose extravagant life-style surpassed that of the European aristocracy. It had an industrial sector producing luxury goods which Europe could not match, but this was achieved by subjecting the population to a high degree of exploitation. Living standards of ordinary people were lower than those of European peasants and their life expectation was shorter. The high degree of exploitation was possible because of the passivity of village society. The social mechanism which kept the villages passive also lowered productivity, and provided little incentive to technical progress or productive investment (18).

A large part of the exploitation of the rural population came in the form of the land tax, which successive rulers, both Indian and foreign, have continuously levied on the Indian peasant as a matter of right. During the Mughal period, a third or more of the gross crop production had

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to be handed over as revenue. These taxes were used not only for state purposes, but also for the consumption expenditure of the élite.

Contrary to the English situation, the Indian aristocracy did not consist of hereditary landlords who derived their income by using serfs to cultivate their private demesne. In fact, the Indian aristocrats did not own any land; instead, they were allocated the revenue of a group of villages (that is, they were given a jagir). Part of this revenue was used for their own sustenance, and the rest was paid over to the state treasury in the form of cash or troop support.

The system was not of itself hereditary; nobles could be transformed from one jagir to another, and their estates could normally be confiscated by the royal authority on their death. There was therefore very little incentive for the improvement of landed property. Maddison sums up the entire issue brilliantly in the space of a paragraph:

The jagirdar had an incentive to squeeze village society close to subsistence, to spend as much as possible on consumption and to die in debt to the state... Towards the end of the Moghul period, as central power declined, many jagirs became hereditary in practice. But the ruling class always obtained its income by levying tribute on villages, it did not enter into the process of production (19).

Thus it is evident that very little of the revenue expropriated from the peasantry went into productive uses: Maddison's computations seem to indicate that not more than five per cent of the land benefitted from irrigation projects, which shows that Karl Marx and later, Wittfogel were wide off the mark with their theory of an "oriental despotism" functionally justified in the development and protection of irrigation. The Moghul state apparatus was therefore parasitic in the truest sense of the word. It was more a regime of warlord predators than an agrarian bureaucracy. Let the seventeenth century traveller, Bernier describe the real effects of the system:

As the ground is seldom tilled otherwise than by com-
pulsion, and as no person is found willing and able to repair the ditches and canals for the conveyance of water, it happens that the whole country is badly cultivated, and a great part rendered unproductive from the want of irrigation. The houses, too, are left in a dilapidated condition, there being few people who will either build new ones, or repair those which are tumbling down. The peasant cannot avoid asking himself this question: "Why should I toil for a tyrant who may come tomorrow and lay his rapacious hands upon all I possess and value, without leaving me, if such should be his humour, the means to drag on my miserable existence." The timariots, governors, and farmers, on their part reason in this manner: "Why should the neglected state of this land create uneasiness in our minds? and why should we expend our own money and time to render it fruitful? we may be deprived of it in a single moment, and our exertions would benefit neither ourselves nor our children. Let us draw from the soil all the money we can, though the peasant should starve or abscond, and we should leave it, when commanded to quit, a dreary wilderness."(20).

There are many more accounts of this kind, including a "remonstrantie" of life in Agra, written in 1626 by F Pelsart, for the information of his superiors in the Dutch East India Company. The most comprehensive and critical study of Indian economic history during the Mughal period is still W Moreland's From Akbar to Aurangzeb (21), who concludes that at the opening of the seventeenth century,

the population of India consisted of a small but extremely wealthy and extravagant upper class, a small but frugal middle class, and a very numerous lower class, living generally on the same plane of poverty as now (1923), but on the whole substantially worse of (22).

Such an assessment has not gone unchallenged and Moreland might have had reason to present pre-colonial India economically worse off than during British rule. One of India's most distinguished historians, Sir Jadunath Sar- kar, was convinced that the Moghuls did indeed deal quite severely with oppressors:

Several instances are recorded in the reigns of Shah Jahan and Aurangzeb in which harsh and exacting revenue collectors and even provincial viceroys were dis-
missed on the complaints of their subjects reaching the Emperor's ears (23).

Another historian, Stanley Lane-Poole, implicitly supported Sarkar when he observed:

Care was taken to provide an easy means of complaint when undue collections were exacted and to punish severely the guilty exactors... Collectors were to make yearly reports on the conduct of their subordinates(24).

William Bolts, in his Considerations on Indian Affairs, was more explicit. It was written in 1772:

The laws of Hindostan were widely instituted as barriers against oppression, and continued in force until the invasion of Nader Shah; till then there was scarce a better administered government in the world. The manufactures, commerce, and agriculture flourished exceedingly; and none felt the hand of oppression, but those who were dangerous by their wealth and power. For, till within these very years, merchants were nowhere better protected, nor more at their ease, than under this government: nor is there a part of the world where arts and agriculture have been more cultivated, of which vast plenty and variety of manufactures, and the rich merchants were proofs sufficient(25).

Our own personal opinion is to qualify all generalizations with a great deal of caution: the diversity of regimes in different parts of India, large and small, would have been responsible for healthy economies interspersed with others that were deteriorating. This is true for example if we consider the local incidence of famines: due to a lack of a quick and national system of communications, it was possible that some areas starved, while their neighbours enjoyed an indisputable surplus.

At any rate, the Moghul élite made possible a system of manufactures on a scale larger than Europe. In order to cater to its needs, a number of handicraft industries were called into existence to produce high quality cotton textiles, silks, jewellery, decorative swords and weapons. Yet again, these industries were located in the urban areas, and were normally worked by Muslims:

The courts had been great consumers of the various articles produced by Muslim craftsmen. All the finer
qualities of textiles like Dacca muslin and Kashmir shawls were woven by Muslim master weavers. The manufacture of rich carpets was a Muslim monopoly. The rich brocades which had been in fashion both among men and women of means were made by Muslims. The manufacture of the more delicately finished jewellery, inlay work in silver and gold, and the creation of many articles of beauty so highly prized by the wealthy classes were almost entirely in Muslim hands (26).

Another important phenomenon, not sufficiently recognized, is that the early phase of European expansion and participation in Asian trade did raise the productivity of the Indian economy. The entry of the Dutch, British, French, Danish and Swedish merchants expanded Asian and European markets. In an article on European commercial activity and the organization of India's commerce and industrial production between 1500 and 1750, Professor T Raychaudhuri arrived at the following conclusion:

To sum up, the impact of European commerce with India on a competitive basis was in many ways beneficial. New markets were opened for Indian exports and the existing ones further deepened. For the limited areas supplying the staples of export, this meant an increase in production and probably also in productivity, partly through the extension of the putting out system as well as the localization of industries. Thus, in certain parts of the country at least, the possibility of further significant changes in the volume, technique and organization of production had been opened. But the initiative in innovation remained throughout in the hands of certain foreign companies of monopolistic merchant capital whose interest in reorganizing production was necessarily limited.... Certain new techniques in dyeing and silk-winding were introduced by European experts working for the companies. In short, within the limits already defined, new elements of efficiency were introduced in production, probably resulting in an increased productivity (27).

It might be advisable here to attach now a few conclusions. In the first place, a description of material culture in India during the period should go a long way towards clearing up much of the debate surrounding Indian poverty in Mughal times. We have already done this in chapter two - technologically speaking, Indian society proved more often than not capable of responding to the
basic issues concerning its survival. Agricultural systems were developed through centuries of experience to fit close ecological constraints. That exploitation prevented large scale economic growth is a criticism acceptable only if the economist who makes it identifies economic growth as his own version of a sacred cow. Instead, we have tried to show in chapter four, following Wilkinson, that economic growth is a value only in a specific context, that even the concept of economic efficiency is not context-free, and it is a historical fallacy to undertake an investigation of the non-appearance of these values in societies not undergoing similar pressures.

The question, in brief, why a particular society did not produce an overwhelming desire for economic growth is as misleading and wrong as the question why a society did not make the transition from traditional science to modern science. The historical fallacy is committed when the historian or theoretician subsumes the experiences of alien cultures under a theory that he has constructed out of the experience of his own society while it was responding to new problems.

Thus, Moredland took great pains to show, for example, that all the evidence he had pointed to the conclusion that Indian peasants did their best to follow the market:

If we compare the close of our period with its commencement, we find no important changes either in products or in methods, and the records tell us only of efforts to meet the demand expressed by buyers, of the degree of success achieved, and of the hindrances arising from various forms of official activity (28).

A little earlier, however, he is already comparing the situation with England:

Producers were, as a rule, anxious to meet the market, but were not in a position to seek new markets for themselves; we look in vain for any traces of productive energy familiar in Western countries at the present day (29).

Angus Maddison has felt it relevant to isolate the Indian caste system and other elements of the "superstruc-
ture" as hindering the possibility of economic growth:

The theology of Hinduism did not encourage the growth of rational thought, and the social system hindered technical innovation. In spite of extensive contact with foreigners, India did not copy foreign technology either in shipping or navigation, or in artillery and military organization, and this is one of the reasons it was conquered by Europeans (30).

He also notes in another place that the degree of exploitation was possible because of the passivity induced by the caste structure of village society. Agricultural productivity was lowered by religious tabus which inhibited animal husbandry, and by a social system which provided little incentive to agricultural investment (31).

The poverty of the agricultural population (extreme even for Asia), and the thinness of the upper class stratum were a major handicap to growth in demand for industrial products. Nevertheless, industry developed further than in other Asian countries except Japan...(32.

That last sentence is unintelligible if we are to accept what Laddison has noted about the obstacles provided by the superstructure to technological innovation; nor is it understandable how peasants so affected could have been shrewd enough to follow the demands of the market, as Laddison himself has admitted "that the institutions of eighteenth-century Europe (did not) permit optimal use of production possibilities." And we have tried to show in the previous chapter that the industrial revolution in England did not take place in a setting that could have been by any terms, described as idyllic. This is not to deny or excuse exploitation, one of mankind's most treasured anachronisms; it is that in spite of this exploitation having been noticed, the economic acumen of people in poor agricultural communities has been generally maligned.
The Moghul Empire declined in the first half of the eighteenth century: more precisely, effective central control over the empire's territories was loosened and lost after the death of Bahadur Shah I in 1712 (33). However, an all-important point needs immediate stressing here: the absence of central political domination did not discourage, neither did it disintegrate material culture, a phenomenon not at all unique in Indian history.

In fact, such a trend has been operative in Indian history ever since the Mauryan emperors Chandragupta and Ashoka virtually unified the entire sub-continent under a single political authority in the third century B.C. It was during the course of this early empire that the idea of the virtually self-sufficient, non-commodity-producing village was first realized, which in turn bore the brunt of the top-heavy bureaucracy. However, such a structure of administration contained the seeds of its eventual demise - and would repeat itself even in Moghul times. As Richard Lannoy has pointed out:

The same error was repeated more than once: successful empires enjoyed no more than brief periods of prosperity before the closed economy of the village settlements they invariably patronised halted all further growth. It could not be otherwise, since commodity production (expropriated by the state to support an indispensable army and bureaucracy) always declined in inverse ratio to the increase in population in the village settlements (34).

That the decline of central Moghul political power did not mean much to the economy is evident from a quick look at the trade of the economy after Moghul decline. In 1708, Britain imported goods from India worth £493,257, and exported in return goods worth £168,357. By 1730, while the imports to England rose to £1,059,759, the exports fell to £135,484. In 1748, imports into Britain were still £1,098,712 and the exports had declined further to £127,224. The balance was paid by Britain in bullion; in

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fact, between 1710 and 1745, India received £17,047,173 in bullion (35).

The beginnings of British domination in India are important in the light of later events and we shall but briefly introduce them. After the Moghul decline, a number of Moghul warlords had established themselves in different provinces: the rich and fertile province of Bengal came under the hands of a capable viceroy, Aliverdhy Khan in 1750. Six years later, he was dead.

His succession became a matter of family intrigue, and his grandson, Siraj-ud-Doula succeeded in claiming the viceroyalty. He was challenged in this, of course, by another member of the family, Ghasiti Begum and her son Shaukat Jung: the East India Company threw itself behind the latter claimant. The group was supported by a powerful clan of Indian merchant, Hindu capitalists, equal in influence to the merchants of Antwerp in another area. These merchants entered into negotiations with the East India Company to create a palace revolution that unseated Siraj-ud-Doula.

Plassey, which was the result, was a transaction, not a battle. Two groups benefited from this reversal of events. One, the Hindu merchants who were keen on their association with foreign merchants, since they controlled the trade and thus could reap large profits. Two, the East India Company, which received the right to the revenue of the twenty-four pargannahs: a district. In 1764, the Moghul emperor attempted an engagement against the Company, which failed; he then awarded to the Company the diwani, that is, the right of revenue administration, over the rich territories of Bengal, Bihar and Orissa.

The Company's early administration in Bengal is too sordid to be repeated here in detail (36. Richard Becher, a servant of the Company wrote to his London masters on May 24, 1769, as follows:

It must give pain to an Englishman to have reason to think that since the accession of the Company to the diwani the condition of the people of this country
has been worse than it was before.... This fine country, which flourished under the most despotic and arbitrary government, is verging towards ruin (37).

The Company exploited its monopology position to impose taxes of numerous kinds on different products including salt, betel nut and tobacco. We shall merely describe the effects of Company rule on the textile industry.

The Indian textile industry declined before the industrial revolution in Britain. The displacement of the Muslim aristocracy simultaneously displaced domestic demand. A famine in 1770 may have reduced the population of Bengal by a third. Equally deleterious was the conduct of the Company towards the weaver.

Total political power allowed the men of the Company to ensure that the entire produce of the area was sold to them. As a document of the time noted:

They trade...in all kinds of grain, linen and whatever other commodities are provided in the country. In order to purchase these articles, they force their money on the ryots and having by these oppressive methods bought the goods at a low rate, they oblige the inhabitants and the shopkeepers to take them at a high price, exceeding what is paid in the markets. There is now scarce anything left in the country (38).

When a Company representative found that an order he had issued prohibiting manufacturers from receiving advances from outside merchants, had been disobeyed, "he sent out peons to destroy the thread in the looms of the weavers who had received such advances."

The prices paid to the weavers were "in all places at least fifteen per cent and in some even forty per cent less than the goods so manufactured would sell for in the public bazar, or market, upon a free sale." Weavers began to desert their profession. Writes Bolt:

With every species of monopoly, every kind of oppression to manufacturers, of all denominations throughout the whole country, has daily increased; insomuch that weavers, for daring to sell their goods, and Vallals and Pykars, for having contributed to or connived at such sales, have, by the Company's agents, been frequently seized and imprisoned, confined in irons,

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fined considerable sums of money, and flogged... The winders of raw silk, called Nagaads, have been treated also with such injustice, that instances have been known of their cutting off their thumbs, to prevent their being forced to wind silk. (39)

After the Company took over the administration of Bengal, the favourable balance of trade was reversed. Already in 1773, a report made to Parliament calculated revenue collections as amounting to £13,066,761 for the six years of possession, expenditure amounting to £9,027,609, and the balance with the Company as £4,037,152. In other words, the Company now had a revenue surplus bigger than the Indian surplus on commodity trade with the United Kingdom. The Company surplus was used to purchase Indian products for export into England: thus did the colonial "drain" begin (40).

Haddison notes the intricacies involved in repatriating the balance:

In order to effect the transfer of these additional resources, some Indian bullion and diamonds were shipped to the U.K. and Bengal silver was exported to China to finance British purchases of Chinese tea. In addition, Company servants sold their rupee profits to foreign trading companies against European bills of exchange, which supplanted other countries' exports of bullion to India. Bengal had a surplus on trade with other parts of India and these revenues were used by the East India Company to finance military campaigns in Madras and Bombay. Bengal revenues and profits were also used to finance the local costs of a larger contingent of Company servants and private traders. The annual net real transfer of resources to the U.K. amounted to about £1.8 million a year in the 1780s. This was also the size of India's exports (41).

Indian cotton manufactures continued to be exported into Britain. In fact, they reached their peak in 1798, and even in 1813 they still amounted to £2 million. The industrial revolution in Britain had already revolutionized the making of textiles: between 1779 and 1812, in fact, the cost of making cotton yarn dropped nine tenths. Why did the Indian goods still carry a demand?

Because even thirty years after the industrial revolution began in textile-production, Indian goods still con-
continued to be cheaper than machine made goods: this can probably be explained by the fact that the weaving processes in England had still not been extensively mechanized.

About the relative cheapness of Indian goods, witness the following extracts. The first is from the historian, H H Wilson, who wrote:

It was stated in evidence (in 1813) that the cotton and silk goods of India up to the period could be sold for a profit in the British market at a price from 50 to 60 per cent lower than those fabricated in England. It consequently became necessary to protect the latter by duties of 70 and 80 per cent on their value, or by positive prohibition. Had this not been the case, had not such prohibitory duties and decrees existed, the mills of Paisley and Manchester would have been stopped in their outset, and could scarcely have been again set in motion even by the power of steam. They were created by the sacrifice of Indian manufactures. Had India been independent, she would have retaliated, would have imposed prohibitive duties upon British goods, and would thus have preserved her own productive industry from annihilation. This act of self-defence was not permitted her, she was at the mercy of the stranger. British goods were forced upon her without paying any duty, and the foreign manufacturer employed the arm of political injustice to keep down and ultimately strangle a competitor with whom he could not have contended on equal terms (42.

Another independent source is the German economist, Friedrich List, who wrote the following in his volume, entitled, The National System of Political Economy in 1844:

Had they sanctioned the free importation of Indian cotton and silk goods into England, the English cotton and silk manufactories must, of necessity, soon come to a stand. India had not only the advantage of cheaper labour and raw material, but also the experience, the skill, and the practice of centuries. The effect of these advantages could not fail to tell under a system of free competition....

Accordingly, England prohibited the import of the goods dealt in by her own factories, the Indian cotton and silk fabrics. The prohibition was complete and peremptory. Not so much as a thread of them would England permit to be used. She would have none of these beautiful and cheap fabrics, but preferred to consume her own inferior and more costly stuffs. She was, however, quite willing to supply the Continental nations with the far finer fabrics of India at lower

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prices, and willingly yielded to them all the benefit of that cheapness; she herself would have none of it (43).

The high tariffs were exclusively raised to make Indian textile goods more expensive than the products of the machine. Historian Wilson was referring to this passage: the evidence of John Ranking, a merchant, examined by the Commons Committee in 1815:

Can you state what is the ad valorem duty on (Indian) piece goods sold at the East India House?

The duty on the class called calicoes is £3.6s.8d per cent upon importation, and if they are used for home consumption, there is a further duty of £68.6s.3d per cent.

There is another class called muslins, on which the duty on importation is 10 per cent and, if they are used for home consumption, there is a further duty of £27.6s.8d per cent.

There is a third class, coloured goods, which are prohibited being used in this country, upon which there is a duty upon importation of £3.6s.8d per cent; they are only for exportation.

This session of Parliament there has been a new duty of 20 per cent on the consolidated duties, which will make the duties on calicoes... Used for home consumption, £78.6s.8d per cent, upon the muslins for home consumption, £31.6s.8d per cent (44).

It is important to realize that this tariff system was primarily intended to protect England's infant factory system even in the first two decades of the nineteenth century. We have already indicated that the weakness of the English industry probably lay in the fact that the weaving industry had not yet been extensively mechanized. Though the power loom was invented by Cartwright in 1787, its adoption, as David Landes writes, "was slow during the first two decades of the century." The glut of machine-produced yarn made the situation, in fact, "a golden age of the hand-weaver, whose unprecedented prosperity was a shock to all, a scandal to some" (45. On the other hand, E P Thompson has even argued that the very cheapness and superfluity of hand-loom weaving retarded mechanical invention and the application of capital in weaving (46.
In sum, machine-produced yarn might have been vastly cheap (47, but the cloth made from it, hand-woven, still proved more expensive than Indian hand-woven textiles in England: it therefore became necessary for political power to support the machine. At this stage, on the Continent, a new circumstance appeared to further change the sequence of events.

What had happened with the woollen trade (p 217) now took place in relation to the newly mechanized English textile industry. The Napoleonic wars excluded British manufactures from the Continental ports and English merchants and manufacturers began to feel the need for fresh areas to "vent" their cotton goods. Upto 1813, the East India Company had been allowed the monopoly of trade with India, and this trade for primarily devoted to the export of Indian manufactures. In 1815, however, the House of Commons held hearings on the Company's right, which resulted in the abrogation of that right and the trade passed into the hands of private merchants financed by East India Agency Houses. That the large-scale entry of British goods was now almost certain is evident from the inquiries of the investigating committee:

Question to Warren Hastings, of the E.I.C:

From your knowledge of the Indian character and habits, are you able to speak to the probability of a demand for European commodities by the population of India, for their own use?

Hastings' reply:
The supplies of trade are for the wants and luxuries of a people: the poor in India may be said to have no wants. Their wants are confined to their dwellings, to their food, and to a scanty portion of clothing, all of which they can have from the soil that they tread upon.

Sir John Malcolm's reply:

They are not likely to become consumers of European articles because they do not possess the means to purchase them, even if, from their simple habits of life and attire, they required them.

Sir Thomas Munro replied in a similar vein, noting that the average wage of an agricultural labourer was bet-
ween 4s and 6s a month, that the cost of subsistence was between 18s and 27s per capita per year; that there was no probability of extending the sale of British goods because the people used coarse woollen of their own manufacture, that the manufactures were excellent. Asked if the civilization of the Hindus could not be improved by the establishment of open trade, he noted:

I do not understand what is meant by the civilization of the Hindus; in the higher branches of science, in the knowledge of the theory and practice of good government, and in education which, by banishing prejudice and superstition, opens the mind to receive instruction of every kind from every quarter, they are much inferior to Europeans. But if a good system of agriculture, unrivalled manufacturing skill, a capacity to produce whatever can contribute to convenience or luxury; schools established in every village for teaching reading, writing and arithmetic; the general practice of hospitality and charity amongst each other; and above all, a treatment of the female sex full of confidence, respect and delicacy, are among the signs which denote a civilized people, then the Hindus are not inferior to the nations of Europe; and if civilization is to become an article of trade between the two countries, I am convinced that this country (that is, England) will gain by the import cargo (49).

Neither Munro or his colleagues could stem the tide of events. Political domination had made economic imperialism possible, and the first to be affected by the rise of imported English cotton goods were Indian female spinners. In 1828, for example, cotton yarn and twist imported into India through Calcutta already totalled 1.2 million lbs; this volume was further increased to 3.2 lbs in 1835 and 17.5 million lbs in 1847. That there was very little chance of competing with machine-imported yarn is indicated by the following computations of 1840:
Prices of 1½ hanks:

<table>
<thead>
<tr>
<th>Count of yarn</th>
<th>English Rs.As.gds</th>
<th>Indian Rs.As.gds</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>0 3 0</td>
<td>0 13 0</td>
</tr>
<tr>
<td>190</td>
<td>0 2 15</td>
<td>0 10 0</td>
</tr>
<tr>
<td>180</td>
<td>0 2 15</td>
<td>0 6 0</td>
</tr>
<tr>
<td>170</td>
<td>0 2 10</td>
<td>0 5 10</td>
</tr>
<tr>
<td>160</td>
<td>0 2 10</td>
<td>0 4 0</td>
</tr>
<tr>
<td>150</td>
<td>0 2 10</td>
<td>0 3 10</td>
</tr>
</tbody>
</table>

(Source: Arno Pearse: The Cotton Industry of India) (1930)

If the Indian spinner fell by the wayside, the Indian weaver benefitted from the new availability of cheap yarn. Henry Gouger, an English merchant who had set up a factory near Calcutta, with a hundred looms powered by steam, discontinued the working of the looms, and switched the steam-power to the making of yarn: he found the latter more profitable. He himself thus produced, on his own testimony, about 700,000 lbs of yarn for the Indian market.

Spinning, as it was earlier in Britain and also in China, was a source of supplementary income and mostly women were engaged in it. That it was extensively practised is more than clear from a detailed economic survey made by Dr Francis Buchanan, who had been commissioned to make it in 1807. He toured a number of districts in Bengal and North India, and later, the South, and his figures for the number of women engaged in spinning speak for themselves.

In Patna city and the Behar district, the number of women engaged in spinning yarn was 330,426; in Shahabad, the number was 159,500; in Bhagalpur, 160,000; in Gorakhpur, 175,000. The number was roughly similar for Dinajpur and Purniya, which he also visited. Imported yarn might have been cheap, but it reduced the incomes of these female workers drastically, and made the average Indian peasant economically weaker, for his only source of income now remained agriculture.

Weaving, however, was a full-time occupation, and the cloth produced was consumed by, including others, the Mo-
ghul aristocracy, and the middle class, markets in Asia and Europe, and generally in India itself. In 1807, Dr Buchanan's journey of investigation brought to light important figures. In the Patna and Behar districts, there were 750 looms for the weaving of table-cloths alone; looms manufacturing coarse cloth brought in Rs2,438,621 every year. In Shahabad, there were as many as 7,025 weavers' houses, working 7,950 looms. In Bhagalpur, mixed silk-cotton fabrics were produced on 3,275 looms, and cotton weaving itself was done on 7,279 looms. In Gorakhpur district, there were 5,434 weaver families employing 6,114 looms. The 500 weaver houses in Vindajpur made Rs 120,000 a year. Puraniya district had, besides silk looms, nearly 10,000 looms for the manufacture of coarse cloth; the value of the cloth produced was Rs 1,069,500 and the individual workers earned 65s.

In Britain, on the other hand, the power loom was being used on a wider scale after 1815. David Landes notes that there were already 2,400 of them in 1813, and that the number had risen to 14,150 in 1820, to 55,000 in 1829, to 100,000 in 1833 and by mid-century, the number had crossed 250,000. In 1814, the quantity of cotton goods exported to India from Britain had been a mere 318,200 yards; in 1835, the figure had risen to 51,777,277 yards (50).

Two crucial circumstances brought about the ruin of the Indian weaver, and both had nothing to do with the cheapness of these imported fabrics produced in power-looms. One was the changed circumstance of demand in India itself for Indian cloth. As Addison sums it up:

Between 1757 and 1857 the British wiped out the No-ghul court, and eliminated three-quarters of the war-lord aristocracy (all except those in princely states). They also eliminated more than half of the local chieftainry (zamindars) and in their place they established a bureaucracy with European tastes. The new rulers wore European clothes and shoes, drank imported beer, wines and spirits, and used European weapons. Their tastes were copied by the male members of the new Indian "middle class" which arose to act as their clerks and intermediaries. As a result
of these political and social changes, about three quarters of the domestic demand for luxury handicrafts was destroyed (51).

The second circumstance was the unequal cotton duties. Mr. Montgomery Martin testified as follows to the Select Committee of the House of Commons in 1840:

I have examined at considerable length and for a series of years, the trade of India. I have taken the utmost pains to arrive at correct conclusions by examining various documents... And I have been impressed with the conviction that India has suffered most unjustly in her trade, not merely with England but with all other countries, by reason of the outcry for free trade on the part of England without permitting to India a free trade herself....

We have, during the period of a quarter of a century, compelled the Indian territories to receive our manufacturers; our woollens, duty-free, our cottons at 2½ per cent and other articles in proportion; while we have continued during that period to levy almost prohibitory duties, or duties varying from 10 to 20, 30, 50, 100, 500 and 1,000 per cent on articles, the produce of our territories. Therefore, the cry that has taken place for free trade with India, has been a free trade from this country, not a free trade between India and this country.... The decay and destruction of Surat, of Jaica, of Hurschedabad, and other places where native manufactures have been carried on, is too painful a fact to dwell upon. I do not consider that it has been in the fair course of trade; I think it has been the power of the stronger exercised over the weaker (52).

It would be senseless to criticize the British here for what happened in that period. But it is in important to emphasize that the furtherance of technology depended on power, on economic imperialism, rather than economic rationality. G G de Larpent, the chairman of the East India and China Association could not have made the point clearer:

This supersession of the native for British manufactures is often quoted as a splendid instance of the triumph of British skill. It is a much stronger instance of English tyranny and how India has been impoverished by the most vexatious system of customs and duties imposed for the avowed object of favouring the mother country (52).

But by 1840, it was beginning to be accepted that India was better off as an agricultural country, supplying
the raw materials for British industry: The following contention between Mr Brocklehurst, a representative of British industry, and Mr Montgomery Martin contains all the elements of the issue:

Mr Brocklehurst:
When the transfer of India to the Government of this country took place in 1833, the destruction of weaving in India had already taken place, and therefore, it is not a question of destruction, for that is past; and we have it in evidence that India is an agricultural rather than a manufacturing country, and that the parties formerly employed in manufactures are now absorbed in agriculture. Does it occur to you that there is an opening in this country, if manufactures are displaced, for the people to turn to agriculture?

Mr Martin:
I do not agree that India is an agricultural country; India is as much a manufacturing country as an agricultural one; and he who would seek to reduce her to the position of an agricultural country seeks to lower her in the scale of civilization. I do not suppose that India is to become the agricultural farm of England; she is a manufacturing country, her manufactures of various descriptions have existed for ages, and have never been able to be competed with by any nation wherever fair-play has been given to them (53).

Duties were finally repealed only in 1846, when Britain legally accepted the laissez-faire ideology. By then, of course, the British factory production system's foundations had been firmly cemented. There still remained the silk-problem: fine silk fabrics could not be woven by power and here the industrial was of little help. Yet, a large deal of raw silk had been continuously imported into Britain in the 1820s, where it was worked and later exported to European markets. The French brought in a new element into the picture.

Till the thirties, British silk goods had done well in France, where Indian goods were officially prohibited. Once the prohibition was removed, the entire British trade collapsed in favour of Indian silk fabrics. The export of raw silk began to decline: in 1829, India had exported raw silk worth £920,000. By 1831, this had come down to £540,000: more raw silk was being used in India for manufactures.
for export. In 1832, British silk exports to France had been valued in the region of £50,600 and India's at £29,000. By 1839, the British contribution had shrunk to £5,500 and India's stood at £168,500.

The duty on Indian silk goods to Britain was fixed at 20 per cent, while British silk goods to India paid a nominal duty of about 3½ per cent. A proposal to equalize the duties was rejected by the Select committee, to protect British labourers; evidently, the Indian weaver could be left to look after himself:

Mr Brocklehurst:

What would be the effect upon this branch of your trade if the present duty on East Indian silk goods were reduced from 20 to 3½ per cent?

Mr Cope, a silk weaver in Britain:

In my opinion, it would have the effect of destroying this branch of trade; and if so, it would rob of their employment, and consequently of the means of living honestly by their labour, all those parties which I have named, and would make them destitute and reckless, and cause them to become a burden to the rest of society, whose burdens are already too heavy. It would throw out of employment a large amount of capital, and would give into the hands of foreigners that employment by which we ought to be supported.

Mr Elliott:

Do you think that a labourer in this country who is able to obtain better food...has a right to say, we will keep the labourer in the East Indies in that position in which he shall be able to get nothing for his food but rice?

Mr Cope:

I certainly pity the East Indian labourer, but at the same time I have a greater feeling for my own family than for the East Indian labourer's family; I think it is wrong to sacrifice the comforts of my family for the sake of the East Indian labourer because his condition happens to be worse than mine; and I think it is not good legislation to take away our labour and to give it to the East Indian because his condition is worse than ours (54.

Thus throughout the period from 1814 to 1859, British exports were allowed to enter the country at low rates; these rates were not to protect Indian manufactures, but
were imposed purely as a source of revenue, the Indian finances being in a bad state. Efforts to raise the Indian national income were limited instead to further raising the tax on land, with heavier burdens for the Indian peasant. The increase in the cotton duties on British imports were ruled out by British manufacturing interests.

There is a clear pattern in the attempts by British manufacturers to convert India after 1813 into a complementary satellite economy providing raw materials and food for Britain and ever widening markets for its manufactures. All this could be accomplished through the means of a practical economic imperialism, in which the arts of political manipulation gave aid to the craft of enterprise and British technology and in which the dominion employed by the superior power came to be associated with wilful and effective subordination.

Contrary to the views of Lenin and Hobson, imperialism was not a late-nineteenth century phenomenon, that rose with the decline of free-trade beliefs. It was required earlier to support the rise and strengthening of the machine. Twenty years after the enshrining of the free trade legacy, Richard Cobden, one of the chief pillars of the Manchester school suggested that the principles of Adam Smith did not govern relations between Great Britain and India (55. A year before that, in 1962, Thomas Hazley, the president of the Manchester Chamber of Commerce had already decided that "the great interest of India was to be agricultural rather than manufacturing and mechanical"

The free-traders and their laissez-faire attitudes were irked beyond reason by those duties the Indian colonial government levied on English imports into India, As Harnetty notes:

The full development of India as a source of agricultural raw materials (and this meant, of course, cotton) was inhibited by the Indian cotton duties which, by protecting native manufactures, caused the consumption in India of large quantities of raw cotton that otherwise, i.e., under "free competition", would be exported to Great Britain. It followed that the duties must be abolished, thereby
enhancing the supply of cotton for British industry and enlarging the market in India for British manufactured goods. Such a policy could be justified on theoretical grounds by the doctrines of free trade. But to encourage India as a producer of raw materials required more than economic freedom. It also involved a contradictory policy of governmental paternalism. Lancashire demanded that the Government of India inspire the development of private enterprise in the Indian empire by financing some of this development. In line with this demand, the authorities in India guaranteed railway construction and undertook numerous public works. They also undertook the experimental cultivation of cotton and, in this connection, made the first attempt at state interference in India in the fields of production, marketing and trade (56).

In 1860, the East India and China Association was still protesting that a new increase in the cotton duties in India (to meet a deficit) would give a "false and impolitic stimulus to yarn spun in India, thereby serving to keep alive the ultimately unsuccessful contest of manual power against steam machinery." Another petition from the Manchester Chamber of Commerce in 1860 could continue to claim that any new tariff on British imports into India would harm not only the manufacturers of Great Britain but also the population of India "by diverting their industry from agricultural pursuits into much less productive channels under the stimulus of a false system of protection."

In the same year, the Board of Trade was supporting the case of English bleachers against the new tariff and noted that "in providing for a temporary emergency, a permanent injury be not inflicted on an important branch of the manufactures of these countries." Sir Charles Trevelyan, Finance Minister in India in the 1860s, was anxious to see the disappearance of the Indian weaver as a class, a development, which he thought would be good for both Britain and India; India would benefit because the weaver, faced with competition from machine-goods, would be forced to give up his craft and turn to agriculture; the increased labour supply would then raise output and England would benefit since makers of cloth would be converted into consumers of Lancashire goods (57).
It comes as no surprise to note that when the cotton duties were totally abolished in 1882, the Viceroy of India then, Lord Ripon was privately willing to admit that it was political pressure rather than fiscal arguments which had led to their general repeal, and that India had been sacrificed on the altar of Manchester (58).

Peter Harnetty's excellent study, which we have used for the information mentioned above, is valuable in that it sets out, with documented evidence, the almost yearly pressures and influence exercised by Lancashire interests to distort and cripple the Indian economy. This one-sided influence did not go unchallenged: there were British authorities in India who tried to fight the stream, albeit unsuccessfully. One characteristic personality was J P Grant, brave to make clear his dissent and to make evident what others had refused to acknowledge:

We think it our duty to submit our earnest protest against the principle that the taxation of India is to be regulated under pressure from powerful classes in England, whose private interest may not be the interest of India, and with regard to the principle established in England and for England, and without ascertaining by communication with the responsible Government in India the policy or financial bearing of the measure or the views and sentiments of our Indian subjects (59).

Harnetty also proves conclusively that the irrigation works, road building, railway construction and improvement of inland waterways were undertaken at the instigation of Lancashire cotton interests, to ensure a dependable secondary source of cotton, especially in the first half of the sixties when the American civil war disrupted nearly all supplies. The colonial government of India fell in with the schemes because it realized that any fall in the manufacturing capacity of Britain due to lack of raw cotton supplies would have been calamitous. Thus, the Governor of Bombay justified the exorbitant and wasteful financing of a nearly impossible feeder road between Bharwar and Karwar on the Indian west coast in 1862 in the following obvious words:
The money value to India is very great, but its value to England cannot be told in money, and every additional thousand bales which we can get down to the sea coast before the season closes in June 1863 may not only save a score of weavers from starvation or crime but may play an important part in ensuring peace and prosperity to the manufacturing districts of more than one country in Europe (60).

Likewise a Chief Commissioner of the Central Provinces argued that construction of a railway would not only secure the more rapid export of raw cotton but would also lower the cost of imported Lancashire piece goods. This in turn would divert, he went on to observe, labour from spinning and weaving to agriculture and so lead to an extension of the area under cultivation.

Thus far we have restricted ourselves to textiles, but the privileged entry conditions that allowed a variety of other imports like iron, paper and glass soon disemployed Indian craftsmen involved for centuries in their fabrication. The iron industry might be taken as a clear example: "Gharampal has estimated that there might have been around 10,000 small furnaces in use in India in the early 1700s. J M Heath testified to the Select Committee in 1840 that he imported iron from India into Britain to make steel and then went on to suggest that it would be a good idea to import this iron on a larger scale into Britain, since the latter was totally dependent on Swedish and Russian supplies for iron for steel-making purposes. Vera Anstey has noted, further, that the decline in the industry set in during the nineteenth century, as iron imports from Britain totally destroyed the indigenous industry. The following tables taken from Arnold Pacey speak for themselves:

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Iron and Steel Production in India

<table>
<thead>
<tr>
<th>Year</th>
<th>Production (tons of pig iron per year)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>before 1800</td>
<td>200,000*</td>
<td>very approximate estimate</td>
</tr>
<tr>
<td>1849</td>
<td>less than 10,000</td>
<td>estimate; competition from imports now severe; value of imported metal goods was £221,061</td>
</tr>
<tr>
<td>1857</td>
<td>negligible*</td>
<td>value of imported metal goods was £802,762</td>
</tr>
<tr>
<td>1866</td>
<td>negligible*</td>
<td>value of imported metal goods was £1,233,387</td>
</tr>
</tbody>
</table>

Iron production in India.


THE DISRUPTION OF AGRICULTURE

And finally, agriculture. Whatever may have been the condition of the average peasant or labourer in India during the period, there was little done by the British to improve it. The colonial government (it could not have been otherwise) was interested exclusively with arrangements that would guarantee their revenues from the land year after year, famine or no famine. Little therefore was done to promote better or new agricultural technology, either in the form of new seeds, fertilizer, livestock or...
agricultural training in general. Probably, this was due in part to the original excellence of the agricultural systems themselves. As late as 1889, a consulting chemist to the Royal Agricultural Society of England, Dr Voelcker, was sent to India to make inquiries and suggest improvements if necessary for Indian agriculture. The following are extracts from his report:

One one point there can be no question, viz., that the ideas generally entertained in England, and often given expression to even in India, that Indian agriculture is, as a whole, primitive and backward, and that little has been done to try and remedy it, are altogether erroneous... At his best, the Indian Ryot, or cultivator is quite as good as, and in some respects the superior of, the average British farmer: whilst at his worst, it can only be said that this state is brought about largely by an absence of facilities for improvement which is probably unequalled in any other country and that the Ryot will struggle on patiently and uncomplainingly in the face of difficulties in a way that no one else would.

Nor need our British farmers be surprised at what I say, for it must be remembered that the natives of India were cultivators of wheat centuries before farmers in England were. It is not likely, therefore, that their practice should be capable of much improvement. What does however prevent them from growing larger crops is the limited facilities to which they have access, such as the supply of water and manure. But to take ordinary acts of husbandry, nowhere would one find better instances of keeping land scrupulously clean from weeds, of ingenuity in device of water-raising appliances, of knowledge of soils and their capabilities, as well as the exact time to sow and to reap, as one would in Indian agriculture, and this not at its best alone, but at its ordinary level. It is wonderful, too, how much is known of rotation, the system of mixed crops and of fallowing. Certain it is that I, at least, have never seen a more perfect picture of careful cultivation, combined with hard labour, perseverance, and fertility of resource, than I have seen in any of the halting-places in my tour (61.

Caste or no caste, the Indian labourer or peasant was a resourceful personality, considering the fact that the government of the land was more interested in the payment of his revenue than his general welfare. And the British on their hand took great pride in their ability to collect this revenue, even in the most difficult times. As an exam-
ple: a serious famine hit Bengal in 1770, decreased the population by a third and returned a corresponding third of the land to waste. A year later, Governor-General Warren Hastings could still write to the Court of Directors thus:

Notwithstanding the loss of at least one-third of the inhabitants of the province, and the consequent decrease of the cultivation, the nett collections of the year 1771 exceeded even those of 1768.... It was naturally to be expected that the diminution of the revenue should have kept an equal pace with the other consequences of so great a calamity. That it did not was owing to its being violently kept up to its former standard (62.

More important, the colonial government set about making institutional changes in agriculture by transforming traditionally restricted property rights into something more closely resembling the unencumbered private property characteristic of western agricultural systems. William Woodruff sees in this one of the principal ideas that signalled the application of the western idea of progress in the non-western world. He even seems to regret that "over most parts of Africa, despite the intrusion of western nations, the indigenous customs and laws which govern the division, ownership, and use of land and natural resources remain" and "provide a bar to modern enterprise"(63 The trouble with such theorizing is it ignores the original purpose of these institutional changes: they were not introduced because of any overwhelming idea of progress, but because they were found to yield once again, year after year, a guaranteed income or revenue for the British economy.

Further, it was precisely this institution of property rights that ultimately turned out to be the principal "bar to modern enterprise". For the consequences of this half-Westernized land policy, this change from custom to contract, were that it led directly to the creation of one of the greatest curses ever to settle on the structure of the Indian rural economy: the rise of the power of the money-lender. With the emergence of clear titles, it now became possible to mortgage land.
Before the arrival of the colonizer, for centuries in fact, the moneylender had been nothing more than a servile adjunct to the cultivator, socially despised as much for his trade as for his religion. He was forbidden to wear a turban, permitted to ride only on a donkey, and often, as M L Darling observed the object of "unmentionable indignities". It was British rule that freed him from restraint and armed with the power of law, till he became as oppressive as he had hitherto been submissive (64).

The institution of property rights was specifically intended for the easier collection of the land tax: it established a direct legal relation between the colonial government and the peasant or landowner. This in itself led to the beginning of inheritance and thus, to the problem of the subdivision of land. About the tax, though the amount was fairly heavy in the early years, the important issue was its rigidity. Whatever the nature of the harvest, whether it was affected by drought or rain, a specific payment had to be made twice a year. As Namdani writes:

Given the fragmentation of land, one small drought was enough to drive an average peasant into debt. Not only that, but the tax had to be paid in cash. To obtain money for his crops, the peasant was obliged to sell them to the grain dealer - who was also the moneylender.(65

In the Punjab, as an example, the famines of 1860-61 and 1869, and the heavy mortality among cattle, the rule of the moneylender was firmly established. Moneylending became for the first time in Indian history the most profitable occupation in the area. See the figures. The 1868 Punjab census listed 53,263 bankers and moneylenders in the province. By 1911, there were 193,890, that is, a ratio of 1:100.

For agricultural development this turned out to be disastrous, for the moneylender was little more than a parasite (as the colonial government above him). He had no desire to own land, for proprietary rights yielded little profit. If he purchased the land, he got merely the land, but as a mortgagee he got the land and a hard-working, sub-
missive owner-tenant as well. In 1875-76, 44 per cent of the cultivated land in the Punjab, for example, was held by farmers who had become tenants; and by 1919, the figure had risen to over 51 per cent. (66.

Namdani writes:

It should be no surprise that under these circumstances the peasants - and particularly the owner-tenants who formed the majority of the cultivators - had little motivation for improving their agricultural methods and raising the productivity of the land. As agricultural prices increased, the increasing power of the moneylender was reflected in the gradual change from cash rents to rents in kind. If the peasant were to improve his farming methods and increase his productivity, the moneylender would simply demand a larger share of the produce. (66.

H Calvert, a registrar of the Cooperative Societies in Punjab in 1920 made this all the more obvious:

These tenants generally take less care in preparing the land for crops, plough it less often, manure it less and use fewer implements upon it than owners. They grow less valuable crops, especially avoiding those requiring the sinking of capital in the land; they make little or no effort at improving their fields; they keep a lower type of cattle; they avoid perennials and bestow no care on trees (67.

Observe now how these situations have been distorted in the pontifications spread abroad by a representative western thinker like William Woodruff:

The idea of using money to improve the economy was largely alien to the Indian mind. In comparison with traditional investments in property, money-lending, trade, and jewellery, money spent in improving agriculture and industry bore a lower yield. Even where they bore a higher yield, ignorance and apathy had to be overcome (68.

Similar platitudes have been broached by Angus Maddison: he is convinced that the passivity of village life and the caste system had inhibiting influences on agricultural productivity. And David McClelland went as far as to suggest that training courses should be introduced in traditional societies to breed an entrepreneurial class. What these theoreticians did not realize is that the behaviour of these peasants was most rational; that regard-
less of how beneficial any form of technology was in the abstract, they realized that the benefits went to the money-lender, not to them.

To outsiders the whole system did indeed seem irrational, that is, inimical to the interests of the majority of the people in the village. Dutch economist, J H Boeke, founded his pessimism on this inability to understand: while contrary to the men of his time, he could suggest that the persistence of traditional methods was not an indication of ignorance, he still felt that primitive tribes and villagers were unresponsive to economic incentives and preferred to behave in the traditional manner, also when it was against their economic interest (69).

Furnivall's critique of Boeke provided a larger framework for understanding the real issue:

Yet the Dutch picture of a native world, in which economic values are disregarded, seems, so far as it is based on facts, to be drawn from Java, where for some two hundred years employers secured labour through compulsion rather than by appealing to the desire of gain. In Africa likewise...a popular belief in the native disregard of economic values has been held to justify compulsion as a means of securing labour (70).

To return to India, the British did not merely change the structure of land-ownership relative to the rural economy, they set about to interfere directly in the kind of commodity they farmer might produce. Nowhere is this clearer than in the production of opium for the Chinese market. The East India Company began to ship the narcotic to Canton first in 1773. After the Chinese imperial ban in 1796, the Company denied that it was involved in the trade, but private traders plying the India-China route were licensed by the Company on condition that they carry only Company opium.

It was Warren Hastings who first introduced a monopoly on the production and trade of the drug in India. All sorts of means, such as withdrawing tenancies or manipulating tenants into debt, were found to compel Bengali pea-
sants to grow poppy and nothing else, not even vegetables for their own use (71. The profits (2,000 per cent) were excellent and the direct importance of the trade to the British economy has not been denied. In 1801, for example Britain spent £3.6 million on Chinese tea and since China did not need English goods, nine-tenths of the tea-price was paid by the British in bullion. Opium reversed the entire trend.

Between 1821 and 1830, expanded production in India led to a jump in imports at Canton from 580,000 lbs to 2,913,000 lbs; the entire enterprise was supported by the strange notion that it would aid Christianity: the German missionary Karl Gutzlaff noted that the "traffic would tend ultimately to the introduction of the gospel". And another missionary, this time an American, spoke of opium and naval forces as the instruments of "The Divine Will".

Back in India, even famine was no excuse: the shortage of food may have been terrible, yet several of the poorer farmers were compelled to plough up the fields they had sown with gram, in order to plant them with poppies. Contracts were forced on peasants for stipulated supplies, and a fine of 500 rupees for every chest short. The demand in India was first encouraged and consumption spread, until the Company realized that the addiction to opium considerably reduced the efficiency of native labour. Accordingly the price was raised to discourage consumption, except for medicinal purposes and the surplus exported to China where the degeneration of native labour would be no loss to the Company itself. By 1870 half of China's imports consisted of opium and in India, next to land revenue, opium was soon the most productive source of colonial income. The burden fell naturally on the peasant:

Great persecution is employed by the swarms of the peons to compel the ryot to take advances, and to devote a portion of his land to opium... I have possessed extensive properties in the opium-cultivating districts; and I have seen ryots through tyranny, and to save themselves from persecution, compelled to sow opium in land belonging to me, even in
the very compound of my house, which I have given them for other purposes (72)

Worse, whereas in the case of ordinary grain production, the land tax was one fifth of the gross, in the case of opium, the farmer had to surrender four-fifths. And when the ryot failed to produce, he was sued for the return of the advance at an interest of 12 per cent. The same interference in agricultural production would also apply to jute and indigo.

We rest here with this parade of distortions, though there still remains a lot to be said about other basic goods and services and their ultimate grafting onto the productive system of the English economy: we have not discussed the sugar, indigo, seed-oil, and shipbuilding industries; the disruption of traditional medicinal systems and education schemes. Nor have we set out to examine how food continued to be exported to Britain even during years when famine struck the Indian countryside. We can end with salt.

Before East India Company rule, production of salt was free, for trade or private use; it was also necessary: Forbes has noted how the nature of a vegetarian civilization is always reflected in its profuse use of this almost basic commodity. The Company first placed a tax on the salt trade; later, it made salt a monopoly and increased the price. The corresponding revenue was enormous—already in 1789, it totalled 7 million rupees. In that year, production of it in secret was blessed with penalties. In 1791, informers of clandestine manufacture were awarded one-fourth of the proceeds recovered. In 1812, the total proceeds had reached 11½ million rupees. By 1844, the cost of producing salt was one anna per maund, but the tax on it was two rupees. In 1883, W S Blunt wrote in his diary:

The police are empowered to enter houses night or day and, on their accusation of there being a measure of earth salt in it, the owner of the house may be fined fifteen rupees, or imprisoned for a month. If the villagers send their cattle to graze anywhere where there is a natural salt on the ground, the ow-
ner is fined or imprisoned, and the salt is thrown in heaps and burned. The cattle are dying for want of it, and the people are suffering seriously... In the Deccan, its pressure is more galling, because natural salt lies on the ground, and the people are starved of it as if it were in sight of plenty. In several villages which I passed the ryots told me that they had been reduced to driving their cattle by night to the places where salt is found, that they may lick it by stealth (73).

Blunt notes that a kind of leprosy had already begun to prevail along the coast, and that the police continued to collect and burn all salt found in its natural state above the ground. In 1883, the salt revenue netted six million sterling. In 1930, the salt revenue netted the government £25 million out of the £800 million pounds they still took out of the country.

In 1930, too, when Mahatma Gandhi wished to begin a new campaign of national civil disobedience, he began with salt: all he had to do was to trek down 200 miles to the Arabian Sea, there stoop and pick up a few grains of salt from India's ocean and the entire nation ignited. Later, after a jail term, as he sat for negotiations with the Viceroy, Lord Irwin, he was handed a cup of tea: from a small bag hidden under his shawl, he removed a bit of salt (tax-free) and put it into the cup; "to remind us," he remarked smilingly, "of the famous Boston Tea Party" (74).

THE CHINESE ECONOMY IN THE PERIOD

The Chinese have been a great deal more generous in admitting the exploitative nature of their past than the Indians have been. Mao Tse-tung speaks repeatedly of the contemporary emancipation of Chinese society from its semi-feudal and semi-colonial past, acknowledging thus both internal and external disruption. Perhaps, the more important difference in the recent past of these two large civilizations lies in the fact that China was never a full-scale colony, was never drawn into world commerce to the same extent as India.
Semi-colonialism tried out two different phases of exploitation: one was the attempt to find a market for Western, particularly British goods, which failed. The other, following on the first, was the accumulation of profit through investment, particularly in railways. Ultimately, this failed too, when in 1949, China liquidated all her debts, and refused compensation for investment within her borders by foreign companies (75).

In the first quarter of the nineteenth century, the position of the European nations in China was roughly what it had been in India before 1748. However, the industrial revolution in Britain had given this country at least a pre-eminent position in the East, between 1815 and 1848. If change appeared, it did so mainly in 1834, as the East India Company's monopoly of trade was abrogated by Parliament and the field left open to private merchants.

That these merchants were ready to demand "private and untrammelled enterprise" need not astonish us, for the opium trade was still labouring under the restrictions of illegality; on the other side, England's industries were already crying out: "Obtain us but a sale for our goods and we will supply any quantity." If the clash was inevitable, the excuse was shocking: opium. After the Opium War (1840-42) and the Treaty of Nanking (1842), the prospect of the sale of British goods to the most populous nation in the world (and nearly in terms of a monopoly) excited the British imagination to the limit: little the merchants realized that such a prospect was little more than a chimera. China was not a colony, like India.

For the value of British exports in China in 1850, in spite of the special privileges of the five Treaty ports, showed no increase over that of 1843. In 1854, on the contrary, they were less. The China firms of the period speak of "depression", of the "unpromising aspect of things", and the "wretched position of your (China) markets." In June 1850, Jardine & Matheson, the most powerful firm in the China trade, reported:
Our last monthly advices informed you of the unfavourable turn our markets had taken for imports. This we confirm and advise serious fall in cotton yarn and shirtings, vessels with further goods causing glut that for a long period will not be easily got over (76).

Perturbed, a select committee of the Commons even considered lowering the duty on tea in the English market so as to increase China's import capacity. More bizarre disappointments included that of the Sheffield firm which sent large quantities of knives and forks to a people who had better reason to use chopsticks, and that of another London firm which despatched a number of pianos in the expectation of "a million Chinese ladies wishing to acquire a Victorian accomplishment" (77).

The China merchants, unable to understand why three hundred million Chinese did not appreciate the quality of Lancashire goods, began to imagine hidden reasons for it: they now began to demand an extension beyond the treaty ports and direct dealings with the provincial authorities to the exclusion of the Central Government. "Our trade with China," the Manchester Chamber of Commerce declared, "will never be fully developed until the right to sell and purchase is extended beyond the ports to which we are now restricted."

Thus the Second War (1858-60) and the treaties of Tientsin and Peking, which gave the Westerners twelve new Treaty ports, diplomatic access to Peking, and open navigation on the Yangtze. The results, however, continued to be bitterly disappointing: exports from China were still over 10 million pounds, and legitimate imports about 3 million. The balance was met by opium (4½ million) and bullion. As the consular authority, Alcock pointed out:

When the Treaty of Tientsin was made, the cry for more ports and the opening of the Yangtze to Hankow was equally unanimous and loud. Their desire was granted and with what result, let the universal bankruptcy, the nearly total transfer of foreign trade into native hands, and the unoccupied land at all ports... attest (78).
Now the merchants were sure that they must deal, not even with the provincial authorities, but directly with the consumers themselves. As Panikkar puts it:

Their openly expressed desire was that the whole country should be enlarged into a vast treaty port, with all authority vested in local officials, in dealing with whom the Consuls were to be given the right of calling up the gunboats as a final argument. They pleaded frankly for the establishment of a protectorate at least over the Yangtze Valley and promised in that case that Lancashire would have an unlimited market, and that "all the mills of Lancashire", as Pottinger said, "could not be making stocking stuff sufficient for one of its provinces" (79).

It is not that English consular officials were not cognisant of the real situation. An Assistant Magistrate at Hong Kong, who made an analysis of English commercial prospects in China, pointed out to the Foreign Office if it did not seem strange that ten years after all restrictions had been removed, China yet did not consume one-half of what Holland did:

When we opened the sea-board provinces of this country to British trade ten years ago, the most preposterous notions were formed as to the demand that was to spring up for our manufacture. Our friends in Manchester and their counterpart on the spot here... seem to have all gone mad together upon the idea of an open trade with "three or four hundred millions of human beings" (80).

One consul observed, after an experience of ten years, that "with the exception of our own domestics I have never yet seen a Chinaman wearing a garment of our long cloth, who had to get his daily bread by his daily labour." Other officials warned that "any hope of supplanting the sturdy household thrift of the Chinese" was unwarranted. What these officials indicated was but part of the truth; the Chinese, as we have noted in an earlier chapter, had still a flourishing cotton industry. In fact, in the first quarter of the nineteenth century, raw cotton was by far the biggest legal export to China. In 1827, for example, the East India Company brought to Canton not less than £470,000 worth of raw cotton; and private merchants, £700,000 worth.
Mark Elvin, attempting to explain one reason why China could not industrialize as far as this raw material was concerned, makes the following interesting calculations:

If the great size of the late traditional economy had any implications for technological advance they were probably negative. Any significant change in input-output relationships would have involved huge absolute magnitudes of materials and goods. Britain's consumption of raw cotton tripled between 1741 and the early 1770s, when effective machine-spinning of the fibre first appeared. To accomplish this tripling for China in a similar space of thirty-odd years would have been beyond the cotton-production resources of the entire eighteenth-century world. Between 1785 and 1833, the single province of Kwangtung imported on average from India each year six times as much raw cotton as all Britain used annually at the time of Arkwright's first water-frame (81).

The internal trade of China was still tremendous even in the 1840s, as one European traveller observed:

One excellent reason why the Chinese care little about foreign commerce is that their internal trade is so extensive.... This trade consists principally in the exchange of grain, salt, metal, and other natural and artificial production of various provinces. China is a country so vast, so rich, so varied, that its internal trade alone would suffice abundantly to occupy that part of the nation which can be devoted to mercantile operations. There are in all great towns important commercial establishments, into which, as into reservoirs, the merchandise of all the provinces discharges itself. To these vast store-houses people flock from all parts of the Empire, and there is a constant bustle going on about them - a feverish activity that would scarcely be seen in the most important cities of Europe (82).

From the period between 1867 and 1914, cotton manufactures did indeed rise from one-fifth of total imports to more than one-third, yet the major increase was in yarns from India, and later, Japan. These imports might have stunted the spinning industry, but it boosted the weaving section. At any rate, there was also conscious opposition to cotton yarn itself. In the last decade of the nineteenth century, Shantung having become a German "sphere of influence", cotton yarns poured in and caused severe unemployment among local cottage industries. The peasants knew per-
fectly well, according to an American missionary, that "before foreign trade came in to disturb the ancient order of things, there was in ordinary years enough to eat and wear, whereas now there is a scarcity in every direction, with a prospect of worse to come" (83. John Gittings puts this situation down as one of the rise of the secret societies, and the Boxer Rebellion itself.

As with India, however, so with China too, the country's image as a source of manufactures was gradually weakened. Between 1884 and 1914, China's export receipts tripled, but the joint contribution of silk and tea had fallen from four-fifths to one-third of the total trade. The increase in the export receipts was due to the rise of what is generally known as "muck and truck" goods: beans, bristles, eggs, feathers, hides, matting, oil-seeds, straw-braid and other miscellaneous products of low unit value: these goods constituted three-fifths of total exports in 1904. As Simkin notes:

China, had, indeed, ceased to be Asia's major source of manufactures and, like the rest of Asia, was reduced to exporting foodstuffs or raw materials, no very important ones at that (84.

As for agriculture, we might merely note with Perkins that Chinese society succeeded in raising an output always in excess of the rate of population growth up to the fifties of the twentieth century, but the per capita output was gradually declining. A Malthusian solution was prevented by wars possible through the political decline of the Ch'ing dynasty: Perkins estimates the number of people killed in the wars after 1850, including the Taiping Rebellion as about 50 million, and concludes that had at least the rebellion not taken place, rising population "in the late nineteenth and early twentieth centuries might have outstripped the ability of Chinese agriculture to provide adequate food supplies" (85.

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Properly speaking, what has been exhumed in this chapter (the relation between industrialization and colonialism) is closely connected with the industrialization of England studied in the previous chapter; the separate treatment is warranted, however, in view of its importance and to ease analysis.

The principal theme of this chapter is not the plunder of the colonies by an imperial power: too much has been written on that, and tends to distract attention from a more crucial issue: that the industrialization of England went hand-in-hand with the de-industrialization of the colonies subordinated to that Empire. India and China are examples, but the basic structure of the argument would stand as far as other colonies are concerned. The wider space given to India is justified as India was a colony of the British, and the opportunity to interfere in its economy was extra-ordinarily large. In contrast, China remained a semi-colony, and the opportunity on the part of the foreign powers there to interfere with the traditional or indigenous production system was greatly diminished. In the case of Japan, never a colony, such an opportunity was not even presentable.

Theories constructed around the industrial revolution in England and the effects it had on the indigenous industry in the colonies usually invoke a technological determinism to explain the disruption: the cheaper machine goods inevitably made hand-made products luxury items. The general theme of this chapter will upset this interpretation: it is easy to prove that political power was used to protect the machine in its early stages against cheaper hand-made goods; that political power was used to extend markets in the colonies. It was political power that enabled the machine finally, to cheat: exploit raw materials from outside English borders, to change production methods to service materials destined, not for the indigenous economies themselves, but for the mother economy. It is only a hundred and fifty years later, in our own times, that the chickens are coming home to roost: the increasing problems that the industrial nations must inevitably face as raw materials are re-oriented to the industrial needs of the new nations themselves.

The question of the resources that fed the machines in England is not to be found in most volumes on the industrial revolution in print. A technological system or any discussion of it, must include the question of raw materials. In certain cases, these materials are directly exploited from nature; in others, masses of men in the new nations are exploited to do the exploitation. The system is never open-ended, and the buck is always passed on down to the next person in the line.
(General note: This chapter is written in conscious opposition to William Woodruff's Impact of Western Man: A Study of Europe's Role in the World Economy 1750-1960 (1966), the last of the great volumes written from the viewpoint of western man. Woodruff's article (written in collaboration with his wife) in Technology and Culture, and titled, Economic Growth: Myth or Reality, is more to the point, but will be used only in the final chapter of this thesis)

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3 Panikkar K N, Asian and Western Dominance: p 66
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5 Needham J, Within the Four Seas (1969) pp 21-24
6 See, Panikkar K N, Ibid: p 42
7 Panikkar K N, Ibid: pp 42-43
8 See, Panikkar K N, Ibid: p 94
9 See, Panikkar K N, Ibid: p 94
10 Sansom G B, Ibid: p 145
11 Irwin & Schwartz, Studies in Indo-European Textile History (1966) p 10. A great deal of the information around this issue has been taken from this excellent little volume.
12 See, Sansom G B, Ibid: p 63n
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21 Moreland W H, From Akbar to Aurangzeb (1923/72)
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26 Qureshi I H, The Muslim Community of the Indo-Pakistan Sub-Continent (1962) p 219
27 Raychaudhuri T, European Commercial Activity and the Organization of India's Commerce and Industrial Production 1500-1750, in, Ganguli B N (ed), Readings in Indian Economic History (1964) pp 75-76.
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36 Gopal R, Ibid: chapter one contains a good description; but see also:
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38 See, Panikkar K N, Ibid: p 101
39 See Gopal R, Ibid: p 7
40 For literature on the drain theory, see:
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44 Dutt R C, Ibid: vol I p 179
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51 Maddison A, Ibid: p 55. See also,
   Gadgil J R, The Industrial Evolution of India in Modern Times (1957)
53 See, Dutt R C, Ibid: vol II, p 81
55 Harnetty P, Imperialism and Free Trade: Lancashire and India in the mid-nineteenth century (1972) p 51
56 Harnetty P, Ibid: p 6
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63 Woodruff W, Ibid: p 9
64 Darling M L, The Punjab Peasant in Prosperity and Debt, (1947) p 178

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79 Panikkar K N, Ibid: p 182
80 Panikkar K N, Ibid: p 183
81 Elvin M, The Pattern of the Chinese Past: pp 313-14
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The Renewal of Chinese and Indian Technology and Culture

In which we examine the indigenous Chinese and Indian attempts at technological and cultural independence vis-a-vis the dominance of the West. The period is after 1850. We begin with a description of what existed as indigenous technology in those decades and emphasize the adaptability of the worker and farmer to the internal and external changes of the two economies. Only after that, can we move on to the issue of the acceptance and import of Western technology in these lands: here the nature of the two nations' historical pasts determined their different choices of the elements of the Western productive system. What was not possible in China as a semi-colony, was possible in India, as the British attempted to discourage the rise of Indian industry. Our third issue is the depression of the value of Indian and Chinese culture in the eyes of their own members, in the face of Western superiority in technology, and the re-evaluation of the worth of these same cultures as part of the movements for liberation. Finally, we discuss the import of political independence in both nations (1947/49) and suggest the nature and consequences of Chinese xenophobia and Indian xenophilia on the technical and cultural development of their respective peoples.

The renewal of culture and of technical capacity in India and China, principally in conscious opposition to Western dominance in both areas, is the principal theme of this chapter. As we have done earlier, here too it will be easier, for methodological reasons, to break up this large theme into a number of smaller issues which can
then be examined individually in depth.

In the first place, our attention will be directed to what we have termed "material culture", that is, the technology of the village, of the large majority of people outside the influence of an alien technological system, and which, even until 1972 continued to play a significant role in the economies of the new nations. Much of this technology is indigenous, local, the gift of the past. The crucial point is this technology still continues to fulfill essential needs in the absence of realistic access to a better system of production, and its benefits accrue directly to the person exploiting it. The extent of this technology, today more than ever, had been greatly underrated, or ignored, in the blind allegiance of most men to the more grandiose Western technological version.

Our second issue deals with the implantation of elements of Western technology in China and India from a period beginning from 1850 until the political independence of both societies. How was this technology introduced, whom did it benefit, thus, why was it introduced? Did it absolutely threaten the traditional network or merely supplement it? How extensive was the nature of its influence after implantation? Did it increase general welfare? How appropriate was it to the technological and cultural needs of both societies?

Our third issue, equally important, is the renewal of Chinese and Indian culture and here we shall examine the see-saw movements of attraction and repulsion, acceptance and rejection vis-a-vis Western culture or westernization that involved principally the élites of these lands.

Our fourth issue has to do with the situation in both countries after political independence in 1947/49. Did this new variable provide for any significant break with some of the elements inherited from the period of subjection? What elements of the past restricted or favoured the new phase of nation building? What was the attitude of the new governments to the role of Western technology in the evolution or direction of their pro-
ductive systems? After more than 25 years of independence what have been the results for the majority of their peoples?

All these issues, if examined in depth, would fill four different volumes by themselves. We shall therefore be only concerned with trends, the reader being urged, if his interest be sharpened, to study the more minute details through the various references added to the conclusion of this chapter itself. We begin, first, with India, and take China next. All the four issues we have presented thus far will have these two aspects, Indian and Chinese, discussed side-by-side and on their own terms.

THE INDIGENOUS TECHNOLOGY BASE AFTER 1850

First, a brief overview of the agricultural economy of India during the period 1757-1947 and also the population question. We have already discussed the radical institutional changes brought about by the British in the service of Empire, and the effects these had on the mass of the population, particularly in the rise of parasitic money-lending and landowning classes that had little interest in improvements in agricultural technology. For example, the Central Banking Enquiry Committee of 1931, reported that total agricultural indebtedness in the provinces of British India had reached a (phenomenal) nine thousand million rupees - the major part of this was not ploughed back into improving agriculture and had been accumulated through exorbitant rates of interest.

It is, I feel, beside the point to criticize the activities and behaviour of these parasitic classes from the point of view of their non-contribution to economic growth. It was profitable for them to keep productivity below normal levels. They had, unlike gentleman-farmers,
little interest in improving the productivity of the land; their incomes were not related to larger outputs, but to high rents or rates of interest. Population pressure merely made it possible to increase rents or rates of interest. At the same time, the gradual drop in land revenues payable to the British (stopping finally at a low 2 per cent of agricultural income) raised the economic power of this controlling elite, and consequently, its political influence.

Thus, both from above and from below, the incentive to stimulate better agricultural techniques remained very low. Further, in cases where the moneylender was also the local merchant, it would have been disadvantageous for him to even permit the possibility of a better harvest. The influence of these grain merchants on the peasants to limit their output and keep prices high has not been sufficiently discussed (1).

Given these factors, it is more interesting to note (as Perkins' studies indicated in Chinese agriculture) that the pressure of population on land in India was met by an output that increased sufficiently to cover the minimum needs of the rise in numbers. In the first place, this was due to fresh land being brought under cultivation, the first almost classical response of a society to population pressures. The famine committee of 1880 placed the sown area of British India at 188 million acres. By 1901, this had increased by five per cent; by 1913, a further eleven per cent. Thus the overall increase of 17 per cent was not far short of the corresponding growth of population between 1880 and 1913 (in figures, from 257 to 304 million). Other figures indicate that in Madras, excluding South Kanara and Malabar, cultivated land increased by 25 per cent between 1852 and 1890. The total area under grains and cotton in Bombay increased from about 11 million acres in 1860 to 14.3 million acres in 1873, that is, by 30 per cent in less than 15 years. Irrigated land in British India increased from 24 million to 47 million acres between 1894 and 1913 (2).
One of the reasons why the Indian still continued to have little to eat was, of course, that large amounts of grain were exported every year to Britain, no longer itself self-sufficient in food production. Thus, before the opening of the Suez Canal, India was already exporting considerable quantities of rice: 8 million tons in 1833, twice that amount in 1843, more two years after that, with the Irish famine of 1845-46. After the Canal was opened, wheat was now added to the export trade and combined exports rose from £5 million in 1870 to £15 million in 1890. The exports continued during severe Indian famines. The disastrous famine of 1897-1900 merely reduced grain exports to £10 million, but by 1914, they had tripled to £31 million. By that last date, India was being forced to export one-tenth of its rice and one-seventh of its wheat outputs: the grain was collected from farmers and cultivators through the land tax, already discussed in an earlier chapter.

Returning to the population issue, what were the general trends and causes of population growth? In the 1870s the Indian population was static, in the 1880s, it rose 9 per cent, in the 1890s, 1 per cent, the first decade of the twentieth century, 6 per cent, and in the second less than 1 per cent. From 1910 to 1920, the Indian population increased from 302 million to 305 million: famines and epidemics, including malaria (encouraged by the irrigation schemes of the British) diminished any increases. After 1921, population began to increase by 3 million every year: what was the cause? Every book or study on the subject claims the cause was the introduction of Western medicine. We shall show that this is absolutely false.

In the first place, our new knowledge of nutrition indicates that population increases have rarely been the result of better medicine, but due primarily to the resistance offered by a better diet to the paralysis of disease. Illich has shown, quite conclusively, that most of the epidemics that continued to plague the West disappeared before
the advent of modern medicine and drugs. The continued exposure of the Indian population before 1921 to disease and famines was due to their lack of access to a regular supply of food: irregularities appearing primarily due to the reliance of Indian agriculture on weather conditions. Further, exports of food to Britain produced artificial shortages, a factor diminished after 1914, when imports into Britain were reduced due to the War.

The contribution of the English medical system to the health of the Indian people was minimal particularly at that stage. The following figures are revealing: the death rate rose from 41.3 in 1881-91 to 48.6 in 1911-21, and this was accompanied by a fall in the expectation of life at birth from 25 to 20 years. It is difficult to imagine how the population could rise from 305 million in 1920 to 310 million in 1922 because of the medical system. In fact the wide variations before 1910 in population growth absolutely wreck the medical hypothesis (p 269). In fact, life expectation at birth remained a mere 30 years even in 1950. Any scholar, finally, who knows the lack of medical facilities available even in 1976 in the rural areas in India, would have to admit that in 1921, the British medical system was even less extensive, especially since it had been introduced in India to service the British ruling elite and the army rather than the Indian populace.

The introduction of small-pox vaccination could hardly have made any difference, since it was already practised, and was also quite effective, before the British arrived on the scene. What then could have been the cause of the steady growth of population, three million every year, after 1921?

In the first place, in the two decades of the twenties and the thirties, there were no famines: the largest number of people due to fall victim to a famine did so only in 1944, and this famine has long been recognized by economists and historians as a man-made famine: grain merchants hoard-
ing stocks (3. The greater stability after 1920 may have been due partly to a lucky break in the weather cycle rather than even a new stability in agriculture itself (4. Further, the fact that medicine can no nothing effective as long as people suffer nutritional deficiencies has been recently established by a number of studies (5. Finally, when the British left India in 1947, the public health system was still so shoddy that India even then had the highest mortality rate in the world: 27.4 per cent.

We shall return to this issue in the final chapter and we will take up the question of Indian agriculture itself once more when we move on to the fourth issue of this chapter, when we will have occasion to compare the different responses to population pressure of agriculture and industry in Japan, Java, India and England. Right now, it is important to examine the industrial aspect of material culture in India and China.

We have already observed that the wholesale dumping of British goods on the Indian market displaced a great deal of labour and capital employed in industries producing similar goods in India, that Indian demand itself or the demands of the home market traditionally supplied by Indian craftsmen (for example, for the Mughal aristocracy) diminished as a new élite, preferring English goods appeared. Thus, cotton and jute industries suffered, so too did industries like iron-smelting and the making of glass. Natural dyes were displaced by synthetic dyes made in Germany (6. The imports of kerosene oil decreased the demand for vegetable oils which (as in England) had been used for lighting purposes, thus affecting the cottage industry using oil presses. In fact, raw jute, oil-seeds, raw cotton, raw hides were transferred to England in bulk as their manufactures became an English privilege. The export of the seeds rather than the oil made from them had consequences for Indian agriculture, as the Review of Trade in India pointed out already in 1878:
It seems strange that the wasteful practice of exporting the seed should continue. It causes great pecuniary loss by waste and damage of the seed in transit from the place of production in the inland districts of India to the place of manufacture in France, England and the United States. The unnecessary expenditure in freight is a serious consideration and lastly it should not be forgotten that under the present system India literally throws away enormous quantities of oilcake, that is, an invaluable food for cattle and fertiliser for land. It is really a national misfortune that India should send away all this oil-producing material in the crude condition instead of pressing the oil in the country (7).

The case of the sugar industry was not much different. At the close of the nineteenth century, the production of Indian sugarcane amounted to nearly 50 per cent of world output. Like cloth, sugarcane products were manufactured through a wide system of de-centralized, cottage industry: large quantities of sugar were exported. By 1860, however, India was importing sugar, not because she could not produce it herself, but because some market had to be found for Mauritius and Java sugar. The Indian sugar industry, employing traditionally a large number of cane-crushers and an equally large number of small sugar-making units, was gradually wound up, rendering literally millions out of their livelihood.

Thus, a large part of the small-units producing a variety of products were destroyed, and since the pressure on land was not quite anything it is today, people turned to agriculture, a movement precisely opposite to the one that took England on the road to the industrial revolution. But village industry, servicing village needs, continued to survive, and that, considering the size of the country, was not to be affected too drastically till independence. Most of what we write about now will be difficult to find in any standard text-book on technology, though 80 per cent of a population of 300 million used and held on to this traditional technics, as an added means of survival against forces they could not understand. To this we now turn.
The spinning and weaving of cloth for daily use is a good example. In 1930, Arno Pearse, a Manchester interest, made a study-tour in India to observe its cotton industry. "It is estimated," he wrote:

that there are in India intermittently at work 50,000,000 spinning wheels (charkas) which yield 48 lbs of yarn per spindle per year, and almost 2,000,000 hand looms.

It is amazing that he realized, even at that stage, the crucial contribution of these industries in the more general context of the village economy. The passage we quote below needs no elucidation:

Though the industrial cotton spinner will argue that with the existence of modern machinery it is a waste of valuable time to endeavour to spin by hand in competition with the machine, he ought to consider that there are in India some two hundred million people who have absolutely no occupation in between the agricultural seasons, say for three to four months, and even during the rest of the year they have a great deal of leisure. As these people have no school education, it is difficult for them to occupy their mind and body in any other way but by spinning or weaving, which, as we have shown in the first chapter of this book, was the principal industry of the country. It has still survived to such an extent that spinning and weaving are undoubtedly regarded as the second largest industry, spread over the whole of the country. Spinning and weaving in the East is analogous to knitting in the West. It means that the waste of time is turned into work and into some wealth, reducing simultaneously exportation of capital. This domestic industry has the further advantage that it provides a prime necessity of life, it is easily learnt and suitable for men, women and children. It offers scope for skill and art and prevents the brain and body from getting stale.

These words might easily have come from the mouth of Mahatma Gandhi himself, who, as we know, placed himself at the head of a national movement to resuscitate village industries. In 1927, cloth woven by hand looms continued to supply 26 per cent of total cloth consumption in the country. The adaptability of the Indian craftsman to changed circumstances should be noted: when he discovered that ma-
chine spun yarn was cheaper than hand spun yarn, he easily accepted the former; we shall see that the Chinese textile industry reacted similarly. Note the following figures, indicating the use by hand looms of machine spun yarn:

- 1925-26: 283 million lbs
- 1926-27: 324 million lbs
- 1927-28: 323 million lbs

In 1926, for example, cloth woven on hand looms totaled 1160 million yards, that produced by mills, 1581 million yards and that imported from England, 1405 million yards. Upto the 1940s, hand looms still continued to produce a third of output. Later, we shall examine the different attitudes of the Chinese and Indian governments to this traditional industry after independence.

In the urban areas, the artisan, still needed to supply old demands, was more flexible, and when he stood to benefit, he was willing to be receptive to non-traditional materials. In 1918, the Indian Industrial Commission made the following observation:

The weaver has taken to mill yarn, the dyer to synthetic dyes, the brass and copper smiths to sheet metal, the blacksmith to iron rolled in convenient sections. The tailors invariably employ sewing machines, and town artisans take to improved tools of European or American manufacture (10).

The village artisan continued his traditional activities in a relatively more isolated context. The blacksmith and the carpenter were indispensable for repairs to agricultural implements. The village potter too continued to be a local phenomenon. The leather artisan was equally needed for the manufacture and repair of leather containers and buckets, especially in irrigated areas. And the carpenter was primarily responsible for the phenomenal rise of a form of transportation that will continue to be in use in India for many decades to come: the bullock-cart.

For economies that celebrate the use of high-speed, incredibly large trucks for the transport of cargo and the
luxury of personal autos, the bullock-cart is an anachronism of the fuel age, a symbol of backwardness, as the cow is the symbol of the traditional, in India. What are the economic facts?

The transport of goods during the early British period was done through means of pack-animals, and carts running on solid, wooden wheels. The British were soon able to perceive the difference to their benefit if better means of communication could be evolved. The design of the traditional cart was improved by an Englishman, who replaced spoked-wheels for the normal solid ones. The cart as a whole was made generally lighter, could now be drawn by a single bullock, at the most two, instead of the eight or nine required previously. That the British had concrete interests in the improvement is evident from the following memorial sent to the Court of Directors in London, arguing the case for the cart against the pack animal:

First, two bullocks in a cart will draw on a proper road as much cotton as six in a pack. Second, bullocks in carts travel 20 miles a day - in a pack from eight to ten. Third, the time required for yoking 200 bullocks to carts ready loaded is not one-fourth of that necessary to load 600 pack-bullocks with the same quantity. Fourth, great damages to packages and loss is sustained in the use of pack-bullocks by the daily loading and unloading. These four circumstances combined, besides reducing the direct expenditure of transport to one-third of its present amount will have the effect of almost entirely obviating the heavy indirect expenditure arising from casualties among the cattle (11.

In 1848, there were already 90,000 bullock-carts in the Madras Presidency. In the Sholapur Collectorate, if there were 430 carts in 1834, they had increased to 1,907 in 1846 and to 2,643 in 1850. The increase in the number of carts lowered the price of hire. In Madras, in 1838, a cart carrying 300 lbs charged 14 annas a day. In 1847, a cart carried 1,000 lbs for the price of 8 annas. It goes without saying that the decrease in prices made possible a further decrease in materials and food prices; the industry's phenomenal rise might be taken as an indication
not merely of a vast employment potential that had arisen due to the decline in other industries, but also of the readiness of the economy in the rural areas to adapt to fresh demands.

In 1975, there were over 13 million bullock carts in India, which carried over 60 per cent of the farm produce from the fields to the markets. The total investment in this mode of transportation was a phenomenal 3,000 crores, compared to 4,000 crores invested in the railways and about 1,000 crores invested in road transport. Indian technologists have, only in the past two years, begun to seriously improve the efficiency of the cart, considering the crucial role it plays in the transportation economy of the country.

It is interesting to note that this village technology, in spite of the fact that it constitutes absolute functions of millions of people in the new nations, is not to be found described, as we said earlier, in any "modern" volume on technology, so far is the opinion spread that the productive tasks of today's world can be solved only through one form of technology: that which evolved in the West after the industrial revolution. From here it has been but a small step for the planners of the economies of the new nations to pay more attention to the task of transplanting traditional technologies through industrial ones, even though traditional technologies fulfill tasks in traditional contexts more efficiently than modern. But we are ahead of the more leisurely progression of our ideas in this chapter: the attitudes of the Indian and Chinese governments, for example, to the possible role of traditional technics in their industrializing efforts, should occupy us very much later. Right now, we can turn to China and examine traditional technics in that land between 1840 and 1949.

The political weakness of the Chinese empire that began to extend itself after 1840 has often been taken to include a corresponding weakness in the Chinese economy itself. We have already observed, however, how English interests, and later European ones, were sorely disappointed
by the indifferent response of the Chinese economy to the prospect of foreign imported manufactured goods, and how this response might be seen as but a natural result of a still strong, traditional productive system.

We have already described some of the elements of this traditional network in our third chapter; our ambition here is to take account of new studies on the nature of this traditional system as it continued to exist till the advent of the Communist Government in 1949. These studies emphasize the continued strength of the traditional economy, while not denying its decline. Perhaps, the term "decline" is inappropriate. The economic situation indeed was not as healthy as it had been in the early decades of the nineteenth century. But there is no evidence to suggest that after 1940, it had been weakened to such an extent that it could not have been able to operate more or less as it had always done and to show signs of regeneration or adaptability to changed conditions.

This is not to deny that the difficulties faced by the traditional system were becoming increasingly serious: the progressive breakdown of civil order and the pressures of a mounting population needed to be faced. Yet, even this should not be taken to suggest that China would have veered in the direction of total chaos or collapse. The common opinion that China and its economy as a whole was hopelessly degenerating was almost certainly formed in the light of the perceptions of scholars concerning the situation, after the 1920s, in the treaty ports and the surrounding areas, where modernization and national integration according to the Western pattern had been attempted and had failed.

There are two cases of overprojection here: first, the situation, admittedly deteriorating in the treaty ports and points of Western influence and control, has been, without cause, projected as existing for the entire Chinese economy. Second, the greater difficulties facing the entire Chinese economy after the 1920s which led to a state
of affairs in which the larger mass of the Chinese people had to do with a diminishing quantum of subsistence, have warped the perceptions of scholars and convinced them, again without cause, that these phenomena and their attendant results had been operating in China since the period of the unequal Treaties.

These scholars have also included contemporary Chinese historians, for, like Indian nationalist historians, they too have found it necessary to assert in the service of ideology, that Westerners or foreign capitalists "destroyed" Chinese domestic industry after 1840, a view that is belied by the actual state of the economy and the productive system not merely as it existed as late as the 1930s, as Albert Feuerwerker notes, but perhaps as far as 1949 (12).

G William Skinner's studies (in three parts) concerning the rural marketing system in 1948 indicates, for example that even in that year not more than 10 per cent of the traditional market networks in the entire country had yielded to modern or Western trading systems; in Szechuan, in fact, he found that none had so altered (13). As Rhoads Murphey puts it, this traditional network for the exchange of goods and services "was vigorous and flexible enough to adjust as was necessary to changes over time and population, regional political conditions, local disorder, and new commodities, but was rarely and briefly seriously disrupted" (14).

Murupey argues, and with good reason, that the attempt to introduce a foreign industrial system, because it was done through the Treaty ports, was in large measure restricted to the Treaty port areas themselves:

The two separate systems, traditional-rural and modernizing-administrative, touched one another very little, and their interaction was further minimized by the spatial concentration of the modernizing sector in the few scattered islands of the treaty ports or the political struggles centred in Peking and Nan-king. In what seems, especially through foreign eyes, to have been a catastrophically disintegrating China, the vast, predominantly rural bulk of the coun-
try, including its "little tradition" sector of livelihood and commerce, was only marginally affected (15).

One of the prime reasons for the misperceived idea of the general state of the Chinese economy itself is probably due to the fact that very few scholars have taken into proper consideration the sheer bulk of China and what that entailed. When Britain set out on the course of the industrial revolution, its population was a mere 2 per cent of the Chinese population of the same period. The difference in size and population simply made the two economies incomparable in any meaningful sense of the term. We have already mentioned, in the previous chapter, the voluminous trade that the Chinese economy embraced or relied upon: certainly, this large network was not built in a day or even a century; it had evolved as the country, already facing a hundred million people in the tenth century, gradually adapted itself to larger and ever increasing demands. Adam Smith, though his information came from secondary sources, came very near in his appraisal of Chinese trade to what the actual state of affairs really involved:

The great extent of the empire of China, the vast multitude of its inhabitants, the variety of climate, and consequently of productions in its different provinces, and the easy communication by means of water carriage between the greater part of them, render the home market of that country of so great extent as to be alone sufficient to support very great manufactures, and to admit of very considerable subdivisions of labour. The home market of China is perhaps in extent not much inferior to the market of all the different countries of Europe put together (16, emphasis added.

Not that contemporary scholars with a larger knowledge of China differ from this observation. John Fairbank, in assessing the impact of the Westernized treaty ports, noted that "China was too big a country (with its) great reservoir of inland provinces" (many on the scale of separate European states) "to be easily stirred by a marginal sea-frontier contact with foreign ideas." Or, we might add, with foreign products. Those who, like the Abbe Huc, did
make journeys through China, felt often that the influence of foreign commerce "is very little felt in this vast Chinese Empire and this immense population of traders. The trade with foreigners might cease suddenly and completely without causing any sensation in the interior provinces."

He went on to note:

European productions will never have a very extensive market in China... As foreign commerce cannot offer them any article of primary necessity (not already produced by themselves) nor even of any real utility, they will interest themselves very little in its extension, and they would see it stopped altogether not only without uneasiness but with a certain feeling of satisfaction (17).

The Abbe Huc was indeed wrong in some points of his assessment, but in the main the Chinese economy responded precisely as he had foretold. The Chinese did, for example, accept imported machine spun-yarn to some extent when they found it cheaper, as did the Indian weaver, than hand-spun yarn; they also accepted cigarettes and kerosene, both of which had been absent in the traditional economy. The point however we wish to make, and where Huc proved to be correct, is that even these goods came increasingly, especially after 1915 from Chinese producers, using Chinese materials.

It is here that the role of the Chinese entrepreneur is significant. The vast traditional productive system was serviced by an equally large number of successful Chinese entrepreneurs and merchants, whom the Westerners ultimately failed in trying to displace. The Chinese merchant controlled the domestic trade, but when opportunities did arise to profit in the context of foreign trade, he was able to bring that too under his influence. As Murphey writes:

After about 1860, and especially after 1920, (the Chinese entrepreneur) took advantage as investor of the new opportunities for profit offered by foreign innovation in steamships, mining, banking, and factory production in the treaty ports. One estimate gives a total of 400 million taels of Chinese capital invested in foreign enterprise in the late 1880s, by which time Chinese owned about 40 per cent of the stock of Western firms in shipping, cotton spinning, and banking, and held shares in roughly 60 per cent
Thus, the Westerners were continually thwarted by this control of the traditional Chinese merchant not merely over the domestic, but also the foreign and treaty port trade. In other words, they were attempting to invade a traditional system which was fully able to meet and beat them at their own game of commerce, on home grounds. There was not merely no need but no room for foreign traders to establish a "modern" marketing system along Western lines or with the participation of "modern" merchants. The existing system was fully capable of managing the country's commerce without outside help.

More revealing is the state of Chinese technology and the question whether it proved to be adequate in meeting the primary subsistence demands of Chinese society itself. Here we must set ourselves squarely against Mark Elvin's thesis of a high-level equilibrium trap discussed in an earlier chapter, and the principal features of which include the following ideas or discoveries: that the traditional Chinese system produced high agricultural yields, adequate manufacture of most essential goods (especially textiles), an efficient exchange linkage by low-cost water transport in the areas of densest population and production - therefore, there was a strong resistance to technological change.

The idea of a high-level equilibrium trap presupposes the view of technology and technological development that we have set ourselves against from the very inception of this thesis: the principle of technological change for the sake of technological change. Two civilizations, Britain and China, are studied practically in terms of a technological race. One undergoes an industrial revolution after which its technology is assessed as more "advanced"; the other, China, is compared to the first, found backward and stagnating, even after it is admitted that the Chinese system as it exists fulfils its function. Witness Murphey:

(But) a great deal of the Chinese reluctance or unwillingness to buy foreign goods or to adopt foreign business methods or technology was entirely rational
and not culture-bound: traditional Chinese goods and methods were equal or superior, and especially so in cost terms (19).

In 1866, the Commissioner of Customs at Tientsin made the following observations in his Report on Trade:

Cotton is grown extensively in China, and the people weave it into a coarse, strong cloth which is much better suited to the wants of the peasants and working men than the more showy but less substantial product of Foreign machinery. The customers of the British manufacturer in China are not the bulk of the people but only those who can afford to buy a better looking but less useful article.

He also pointed out that the British commodity was significantly more expensive per unit of weight:

...and the Chinese say that the superiority in strength of the Native article over the Foreign is greater than the difference in weight between them... No transit passes are applied for by foreigners to protect imported cotton piece goods from undue charges on their way into the interior, and it is to be inferred from this fact that if the inland charges in this part of China exceed the Treaty transit dues (that is, half of the import duty) the excess is so small that the native merchant does not think it worth his while to try to get his goods passed into the interior under foreign protection (20).

Yet Rhoads Murphey goes on to endorse the Elvin argument and in the process clearly betray total allegiance to the principle of technological change for its own purpose: it goes without saying that Elvin's case betrays a similar untenable attitude, and we might add, Joseph Needham's too: Writes Murphey:

But China's relative success economically, if only in keeping foreign competition minimal, helped to mask crucial respects in which China was technologically backward by comparison with the modern West and also to buttress resistance to technological change.

After this sentence, he goes on to actually give reasons why China did not find it necessary to accept technological change.

Although it became technologically backward by comparison with the post-eighteenth century West, its
degree of pragmatic success and self-sufficiency made it difficult to change (in that case, why change?). Western technology was resisted because it was not easily seen as advantageous, not simply because it was foreign. (Murphey then goes on to show in fact that technology, when seen as advantageous, was indeed accepted with alacrity). The most obvious exception, the speed and eagerness with which Chinese merchants took advantage of steamship transport, can be seen as a logical extension of the traditional system, which had also been for many centuries evolving its own increasing commercialization, growing long-distance trade and urban concentration (21 emphasis and parentheses added.

In a recent paper, Mark Elvin has found it necessary to qualify his earlier theories by observing that there were methods on hand to revolutionize hydraulic technology and that his high-level equilibrium trap argument does not indeed explain why they were not used(22Yet, in The Pattern of the Chinese Past he set out to explain the dis-incentives to technological improvement precisely on the basis of the trap argument: this shift, reversal or plain contradiction can be guaranteed to constitute the heavy baggage of the unwritten assumption that China did not produce technological change for the sake of technological change per se, that it should have produced technological change for the sake of technological change. The proper historical question to ask is whether there ever has been a civilization devoted to such a monotonous quest. From the Emperor Vespasian, who when presented with a design for a mechanical contrivance that would easily replace the labour of many humans, replied that he did not need it for he had his poor to feed, to the contemporary multinational company, technology has always been subordinated to the function of economic, political, religious goals: we have emphasized time and again that a technological system must be valued in terms of the context in which it operates: Western technology, however "advanced" was in relation to Chinese technology and Chinese tasks not "advanced", but irrelevant. This we have tried to show already, but a few examples about the condition of handicraft industry might deepen the quality of our hypothesis.
For example, as late as the 1930s in Hopei, one Chinese scholar's estimates indicate that small-scale handloom weavers still accounted for four-fifths of the total production. Another study suggests that the areas around Shanghai in 1898 were still using hand-spun yarn in important quantities. 25 miles from Shanghai, near Shashih:

The raw materials were either hand-spun yarn alone or a combination of machine-spun warp and hand-spun weft... The cloth was sold in Szechuan, Yunnan, Kwai-chow, Kwangsi, Hunan, and elsewhere, either by them (that is, local shops) directly, or through merchants/travellers (hao-k'o) sent out from these areas to lay in stock (23).

In other words, the system of production was clearly rational and commercially successful. Even as late as 1913, hand-spun yarn continued to be used on a large scale. The gradual shift in some areas to machine-spun yarn, but within the framework of handicraft weaving processes is further evidence that if traditional methods persisted, they also manifested a remarkable adaptability to changes in cost brought about by technological innovations.

Feuerwerker estimates that in 1933, the output of handicrafts accounted for 67.8 per cent of the industrial share, and that exports of handicraft products increased from Ch $104 million in 1873 to Ch $169 million in 1903 to Ch $444 million in 1930.

In general, on both theoretical and empirical grounds there is reason to believe that domestic demand for handicrafts did not decline in the twentieth century (24).

The main reason for the continuance of the handicraft industry was not the "traditionality" of Chinese cultural habits, but the increase in demand brought about by population increases. This large population, mainly rural, continued to use the product of handicraft industry, which, as Feuerwerker observes, "given low wage rates and the high price of capital, could produce traditional coarse goods at a lower unit of cost than modern industry." (25.)
All this is not meant to deny that in some areas, such as Kaoyang, Wuhsing and Ting-hsien there was no disruption of traditional handicraft industry: there was. And in areas like Chekiang and Wuhsing, handicraft silk reeling and weaving might have grown and flourished between 1870 and 1920, but then it did fall prey to technical obsolescence in the face of rayon and Japanese mechanically produced silk. Yet, as Feuerwerker so ably puts it:

Anyone who would claim that the Hunan or Szechuan peasant in the 1930s dressed in Naigaiwata cottons, smoked BAT cigarettes, and used Meiji sugar has a big case to prove (26).

Finally, neither is it worthwhile denying that the Chinese would at some stage have to face the problem of industrialization itself. It is doubtful however whether industrialization, if forced on the economy and without Chinese political control over its development, would have worked towards the benefit of the large mass of the Chinese people. After 1949, for example, China inherited a modern cotton textile industry which had grown since 1890, and also a traditional hand-weaving industry, which despite the growth of its modern counterpart had still survived. The Chinese communists immediately destroyed the basis for the traditional industry by eliminating surplus labour in the rural areas. Thus, contrary to what happened in India, the modern textile industry did not, between 1949 and 1972 destroy or displace traditional labour by flooding the markets with cheaper goods against which it would soon be impossible to compete: the problem in fact was solved by eliminating the basis of the problem itself. Labour was no longer "wasted" on tasks that could now be taken over by modern industry in a socialist state, it could be devoted to more constructive tasks. And the reader will bear in mind that in a large number of areas, unlike cotton, handicraft industry continued to contribute in rationally perceived or determined ways to the newly vitalized Chinese productive system.
It is important to remember, at once, that such elements of Western technology as were imported between 1850 and 1947 into India, and 1870 and 1949 into China, were not really important as far as their actual contribution to the economies of the period can be assessed. In the light of the events that took place in industrial production after 1947/49, however, they do assume considerable importance and significance, in so far as they did determine in part the quality of the Indian and Chinese responses as a whole to the question of Western technology after independence.

The figures deny outright any crucial importance to modernized industry in both lands in the colonial/semi-colonial period. According to Feuerwerker, the total share of Chinese and foreign-owned modern industry in 1933 accounted for only 2.2 per cent of net domestic product (27. (Murphey estimates a 1933 figure of 3.4 per cent of net domestic output)(28. Both figures propose little significance, especially if we note further that in 1933, the output of factories, handicrafts, mining, and utilities in China constituted just about 10.5 per cent of the net domestic product. If the population of China estimated in 1933 at 500 million is correct or credible, then the working population in agriculture was 212.30 million, and the working population in nonagricultural purposes, 46.91 million. Of the latter figure, 12.13 million were employed in handicraft industry, 1.13 million in factories, 0.77 million in mining, and 0.04 million in utilities (29. Thus, not merely did industry, including handicraft industry, occupy a small role in the Chinese economy, but within the industrial sector itself, modern factory production occupied a very small place. As Feuerwerker concludes:

Although twentieth-century China experienced some industrial growth in the treaty ports, some development of mining and railroad transportation, the extremely small numbers engaged in those occupations even in 1933 suggests that the occupational distribution of
China's population as a whole had changed very little from what it had been at the end of the Ch'ing dynasty (30).

The Indian picture at Independence is not much different. In 1947, large-scale factory production in India employed less than 3 million people as compared with $12\frac{1}{2}$ million in small-scale industry and handicrafts in a total labour force of 160 million.(31.

We have already considered a number of reasons for this minimal contribution of industry, modern industry, to the two economies, chief of which was the still strong nature of the traditional productive system, which still succeeded satisfactorily in fulfilling basic and primary human needs. But there are more. India's early industrialization was consciously impeded through a colonial policy dictated by English economic interests. So we come to a rather paradoxical conclusion: because India remained an absolute colony of the British Empire, the chances of its emulating the sources of British industrial power were naturally diminished; because China remained a semi-colony, with some measure of effective sovereignty, its own traditional productive system could continue in influence as there was no external political power that could pressurize it to change. Thus, in India, per capita output of industrial goods fell between the period 1757 and 1857 as the home and domestic market for luxury goods was drastically cut and the resulting situation was further aggravated by the wholesale dumping of English machine-spun yarn and cloth. In 1850, modern factory production had not yet been started in any part of the country.

The semi-colonial feature of Chinese society and the total subjection of India vis-a-vis Western dominance was bound to have an equally significant impact on the elements of Western technology that were first felt necessary in these economies. Take the Chinese case.

Twenty years after the disastrous Opium Wars, Chinese
minds finally found themselves ready to enter a new phase, the "Restoration" of the T'ung-chih period. The first scholar to devote his attention to this attempt at "resuscitation", Feng Kuei-fen, immediately proposed that what the country speedily needed was a calculated scheme to adopt Western military technology:

What we then have to learn from the barbarians is only one thing, solid ships and effective guns. When Wei Yuan discussed the control of the barbarians, he said that we should use barbarians to attack barbarians, and use barbarians to negotiate with barbarians... In my opinion, if we cannot make ourselves strong (tzu-ch'iang) but merely presume on cunning and deceit, it will be just enough to incur failure. Only one sentence of Wei Yuan is correct: "Learn the strong techniques of the barbarians in order to control them."

Feng went on to suggest the establishment of a shipyard and an arsenal in each trading port; the invitation of "barbarians" to teach bright Chinese students and artisans military technology. He devalued the importance of the civil service examinations, proposing that one-half of the scholars should henceforth apply themselves to the pursuit of manufacturing weapons and instruments and imitating foreign crafts. He showed himself well aware of Japan's use of foreign military hardware to remain strong. Most striking, finally, is his insight about how best the Chinese might go about the proposed task, one which we shall argue is an essential condition for any new nation to develop its own technological program today:

Some suggest purchasing ships and hiring foreign people, but the answer is that this is quite impossible. If we can manufacture, can repair, and can use them, then they are our weapons. If we cannot manufacture, nor repair, nor use them, then they are still the weapons of others. When these weapons are in the hands of others and are used for grain transportation, then one day they can make us starve... Eventually we must consider manufacturing, repairing, and using weapons by ourselves... Only thus will we be able to pacify the empire; only thus can we play a leading role on the globe; and only thus shall we restore our original strength, and redeem ourselves from former humiliation (32).

Most of the documents in the earlier section of Fair-
bank's and Teng's *China's Response to the West*, betray this selective approach in the Chinese desire for western technology. For example, the chief architect of the Ch'ing dynasty's victory over the Taiping Rebels, Tseng Kuo-fan, in his writings, shows a gradual progress from the Confucian preoccupation of writing eight-legged essays to a more intense interest in Western ships and guns. As early as 1853, he prepared a memorial about the need for a naval force to improve China's defences. His interest extended from a keenness to study Western methods of training soldiers, to getting his people to imitate and manufacture foreign guns he had purchased. In 1855, he set up a small arsenal in Kiangsi; in 1861, he moved to Anking and set up another arsenal there and a shipyard. About the theory of self-strengthening that occupied the Chinese intellectuals of his time, he wrote:

If we wish to find a method of self-strengthening, we should begin by considering the reform of government service and the securing of men of ability as urgent tasks, and then regard learning to make explosive shells and steamships and other instruments as the work of first importance. If only we could possess all their superior techniques, then we would have the means to return their favours when they are obedient, and we would also have the means to avenge our grievances when they are disloyal (33).

Tseng Kuo-fan continued his work building arsenals: he established the Kiangnan Arsenal himself and continued to urge the building of steamships. Equally important in this scheme of defence-building was Li Hung-chang, one of the most powerful officials to emerge in the lower Yangtze provinces in the 1860s: his first contribution was to take practical steps to secure Western arms. Li's position of leadership in China was in yang-wu or foreign matters, which involved not merely diplomatic relations but the borrowing of Western technology. Fairbank and Teng summarize his wide range of activities and influence:

The foreign-style enterprises were begun mainly for military purposes and followed one another in a logical sequence. To suppress the rebellions and for
coastal defence, there were first, the establishment of arsenals and shipyards, and the building of forts and vessels. Secondly, technicians were needed to make these weapons and so schools were established and students and officers sent to study abroad. Since modern defence required modern communication and transport, the construction of telegraph lines and the organization of a steamship line were undertaken. Eventually, since modern defence also required money and material resources, a cotton textile factory was established, and coal, iron and gold mines were opened.

Thus the problems of industrialization were sought to be solved through a progression of ideas beginning with the strategy of "using the barbarians to control the barbarians" to employing Western arms, to the conviction that Western arms must be manufactured in China, produced by Chinese, and that Chinese must be instructed to make them; further, it was necessary that the Chinese take seriously a training in Western sciences in general. Both new institutions and elements of an important infrastructure were essential for the progressively enlarged aims. For example, in 1872 the China Merchants Steam Navigation Company was founded to compete with British shipping in China; it was soon to need a Chinese coal supply independent of foreign imports. In 1878, the Kaiping coal mine, a forerunner of the Kailan Mining Administration north of Tientsin, was opened to meet this need. And the earliest surviving railway in China was later built to connect with the Kaiping mine.

The emphasis on defence needs and the technological complex it entailed stands out more clearly, perhaps, if we observe that the modernization of textile production, an industry with less obvious strategic value, moved more slowly in comparison. Tso Tsung-t'ang put up a woollen mill in Lanchow, Kansu in 1878 with the aid of the Germans, but it did not flourish after his death in 1885. And an 1882 plan for a cotton mill at Shanghai prepared by Li Hung-chang was not set up till 1891: the new cotton mill, the first in China, burned down in 1893 after only a year of successful operation. Li soon reorganized it, this time
on a larger basis. At Wuchang, Chang Chih-tung set up a cotton mill in 1891; a cement factory was attached to the Kaiping coal mine; a match factory and flour mill were also opened.

Heavy industry got started even more slowly. Chang Chih-tung opened the Ta-yeh iron mine and the Hanyang Iron Works in Hupei in 1890, with German technical expertise, but these projects never developed into the big industrial complexes that Chang had hoped for. A list of the major developments during the entire period between 1863 and 1891 betray an overwhelming interest in the strengthening of the country through defence means (35).

In India, on the other hand, such a preoccupation with defence (which affected the choice of Western technology accepted not merely in China but also in Japan) was conspicuous by its absence. This is not to deny that the British undertook certain military expenditures in India, but these were directed to the purpose of safeguarding their hold on the "jewel" in the crown of their Empire. If the early industrialization attempts in China were initiated through official Government channels (viz., the kuan-tu shang-pan system), in India, the colonial Government was interested in the patronage of a technological system that would suit the interests of England, military or commercial.

Thus, the work of constructing metalled and bridged trunk roads in the early decades of the nineteenth century was started under the supervision of military engineers who constituted the Military Board: the roads were exclusively intended to connect important military centres. The lines of telegraphs established in 1817 and 1822 were designed for a semaphore signalling service for military purposes and the collection of intelligence.

Isolated attempts were made by Britishers to start industrial projects in India. Thus, the first steam en-
gine was imported from England in 1820 already, by the Christian missionaries of Serampore near Calcutta to operate their paper mill. Henry Gouger established a steam powered weaving and spinning mill in Calcutta in the 1830s, through which he produced 700,000 lbs of yarn. And under the patronage of the Madras Government, the Porto Novo Iron Works in 1825 were started by Mr Heath; by 1840, these works employed 3,000 workers, but they were finally closed in 1861 by Government itself.

That the British Government had a special interest in discouraging Indian industry on a large scale there is absolutely no doubt: any attempt to make inroads into the production of goods in Britain or the consumption of British goods in India was naturally hard to contemplate. Early in 1814, a proposal to begin production of iron in India according to English methods was rejected. An attempt by the Indian colonial Government to raise duties on imports of English goods into India, merely to meet the bad state of the Indian finances was hotly attacked by Manchester interests on the grounds that such tariffs were injuring British trade: Thomas Bazley claimed that there was in practice a protection of 25 per cent in favour of Indian produced goods and then went on to complain that mills were already being rapidly constructed in India for manufacturing purposes. (36.

Walter Cassels argued that even the small five per cent duty on imports (imposed for revenue purposes) operated as a protective duty:

I say they are protective duties. I do not advocate their abolition solely for that reason, I do not know whether you are aware that, for instance, in the Bombay Presidency, there are twelve cotton mills, employing (a very small amount, of course, for Manchester) 319,394 spindles, 4199 looms, and 8170 hands, consuming, I think, 62,000 bales of cotton of 400 lbs each annually (37.

"The increase of duties on English goods," noted Sir Bartle Frere, would have one direct result: they would stimulate production on the spot by diminishing consumption
of English goods. Recommendations of the Famine Enquiry Commission, 1880, to encourage industry and sponsor technical training officially were ignored for forty years. Early this century, the Government of Madras tried to break this pattern and set up a Provincial Department of Industry. Its activities are said to have "roused the opposition of the local European commercial community, who interpreted them as a serious menace to private enterprise and an unwarrantable intervention on the part of the State in matters beyond the sphere of Government..." (38. Thus, Lord Morley, Secretary of State for India, disapproved of the entire project, disbanded the Department, the leather tannery which had provoked the largest outcry sold, and the experimental handloom shops abandoned. Similar attempts elsewhere on the part of the Colonial Government were met on the same discouraging terms.

It was only in 1915, that the attitude of the colonial Government began to change; Lord Hardinge's declaration is significant in that it shows he had to plead his case for India's industrialization:

It is becoming increasingly clear that a definite and self-conscious policy of improving the industrial capabilities of India will have to be pursued after the war, unless she is to become the dumping ground for the manufactures of foreign nations who will be competing the more keenly for markets, the more it becomes apparent that the political future of the larger nations depends on their economic position. The attitude of the Indian public towards this question is unanimous, and cannot be left out. After the war India will consider herself entitled to demand the utmost help which her Government can afford to enable her to take her place, so far as circumstances permit, as a manufacturing country (39.

It should not be forgotten, however, that Hardinge still spoke within the imperialist framework. In 1918, for instance, the Montagu-Chelmsford Report emphasized that industrial development was needed for India's stability, but the interests of Empire were not far behind:

Both on economic and military grounds Imperial interests also demand that the natural resources of In-
dia should henceforth be better utilized. We cannot measure the access of strength which an industrialized India will bring to the power of the Empire.......
The possibility of sea communications being temporarily interrupted forces us to rely on India as an ordnance base for protective operations in the Eastern theatres of war. Now-a-days products of industrially developed communities coincide so nearly in kind though not in quantity with the catalogue of munitions of war that the development of India's natural resources becomes a matter of almost military necessity (40).

The serious claim, then, that till independence, British interests distorted the industrial development of India is difficult to refute. Only in a situation such as India's, for example, could British interests (after a small duty had been imposed for revenue purposes on British textile imports) succeed in imposing a corresponding duty (excise) on Indian goods to prevent these gaining a competitive advantage: compare this with the United States and France, both of which had already imposed protective tariffs as early as the first decades of the nineteenth century. Further, Britain continued (even after her free trade principles had hit the air) to grant preferential treatment to her own goods against those of other nations in the Indian market: in actual terms, this meant Indians had to pay more for goods in an allegedly "free" market. A proposal to do away with this system of preferential trade found the following response from the Government of Curzon(1903):

It is sufficient to say that this alternative is not, so far as we can judge, within the sphere of practical politics. All past experience indicates that in the decision of any fiscal question concerning this country, powerful sections of the community at home will continue to demand that their interests, and not those of India alone, shall be allowed consideration... If Indian industries are in need of, or should now desire a measure of protection, protective measures would necessarily seriously affect imports from the United Kingdom, and would only in a secondary degree affect those from foreign countries. We cannot imagine that the merchants of Lancashire or Dundee, to mention two interests alone, would be likely to acquiesce in such a course even though it were accompa-
ned by still higher duties against the foreigner... We therefore dismiss this alternative as beyond the range of the present discussion (41).

The crucial issue in all this is, of course, the technical abilities of the Indians themselves: since the Westerners held the advantage in technical-know-how and machinery, they were rarely interested in sharing their experience with the Indians and the wisdom of those fine words of Feng Kuei-fen in the context of the Chinese attitude to the adoption of foreign technology hardly ever had opportunities to appear in the Indian context. The British ignored technical training and neither could British firms and managing agencies (42, be expected to provide training or managerial experience to the people they exploited. The major contribution of the colonial Government was in fact non-technical: less than 20 years before 1947, tariff protection was finally granted Indian industries. Of the building of industrial plants, development banks, preference to local industry, we hear very little. The commercial banks controlled and owned in the main by British banking interests, continued to discriminate against Indian business in favour of English business. Sir Visvesvaryaaya expressed the problem thus, in 1925:

One of the chief difficulties in starting industries in India is finance. This arises from the fact that the money power of the country is under the control of the Government which... does not see eye to eye with Indian leaders in regard to industrial policies. Banks under the control of Indian business men are very few, and many of the larger banks are either under the influence of Government, or are branches of British and foreign banks (43).

Sardar Panikkar was one of the few Asian historians courageous enough to observe that the British entry into Indian political life in 1757 was made possible through a group of rich and influential Indian traders who had discovered British trade lucrative for their own purposes. The eighteenth century, in fact, had seen the consolidation of powerful Indian banking houses which handled revenue remitt-
ances and advances for the Mughal Empire itself, and also the Nawab of Bengal, the East India Company, other foreign companies and Indian traders, and which also carried out arbitrage between Indian currencies in different areas and of different vintages. These indigenous banking houses were largely pushed out of function by the British.

The first textile mill was started in 1851 in Bombay by Indian capitalists who had made their wealth through trading with the British and had acquired some knowledge of English. This mill and the others that followed it were launched with some essential financial and managerial help from the British trading companies: a situation precisely the reverse of what had happened in 1757. By 1945, indeed, these indigenous capitalists and their modernized textile mills had absolutely displaced British textile imports.

The rise of Indian capitalism and foreign industry went therefore, unlike in China, hand-in-hand. The goal of the Indian capitalist was to cut into the profits of British goods sold in India by producing these goods in India itself through means of production imported directly from an industrialized Britain: this is the reason we pointed out earlier the rise of the industry was indeed slow, as all manner of obstacles were placed in its path. Yet, by 1877, several cotton producing areas like Nagpur, Ahmedabad and Sholapur had their own cotton mills: most of them concentrated on the production of coarse yarns which were sold domestically and exported to China and Japan. India's textile industry preceded Japan's by twenty years and China's by another forty. Consequently, there was now a gradual change in the nature of her exports.

In the 1850s, India's exports, instead of the finished products of industry, consisted merely of raw materials like jute, wheat, cotton, oil-seeds and tea. At the same time, its market remained flooded with British goods, including luxury goods like silks and woollens, leather and leather products, cabinet ware and furniture, clocks and watches, earthenware and porcelain, glass and glassware, pa-
per, pasteboard, stationery, toys and requisites for games, scents, cigarettes, carts and carriages, and later, bicycles and motor-cars.

But after 1879, as Indian capitalist production established a stronger hold in the economy, things began to change once more. Thus, the proportion of manufactured exports to total exports from India rose from 8 per cent in 1879, to 16 per cent in 1892, and to 22 per cent in 1908; the proportion of manufactured imports to total imports also fell, from 65 per cent in 1879, to 57 per cent in 1892 and to 53 per cent in 1907.

Two important events gave the industry a shot in the arm. From 1905 onwards, the swadeshi movement, a national boycott of British goods in favour of Indian ones, aided not merely Indian textile firms and other industries, but also Indian insurance and banking. The First World War reduced imports from Britain. Indian finance reached out to control foreign managing companies suddenly short of funds. By the 1920s, for example, majority ownership of the largest organized industry, jute, had passed into Indian hands. Indian firms also tightened their hold of the home market for textiles and steel.

In 1914, Indian cotton mills produced only one-fourth of the mill-made cloth consumed in India; by 1935, their contribution had risen to three-fourths. By 1946, India had even begun to re-export textiles to Britain. The point to keep in mind is that the conflict between the traditional sector and the modernized textile industry, unlike as happened in the Chinese case, remained, even though control had changed hands.

A significant point to note is that Indian capitalists have continued to rely always on foreign technical know-how, not merely in the textile industry, but in most others. Textile machinery production is still under the control of foreign firms (44). The reliance on western know-how to the continuous detriment of Indian technical capacity can be illustrated through the example of the paper industry, which
as early as 1954, was scrutinized by J Eddison. He wrote:

Most foreign-made equipment was planned and constructed for use under contrasting climatic conditions, and with dissimilar raw materials, differing grades of chemicals, and more highly trained workers than are to be found in India. In consequence, this equipment often gives unexpected difficulties and generally operates at lower efficiency than it would in its native land (45).

Since the machines were not produced domestically, the industry contained a jumble of machine types: twenty-seven of the forty-six were British, seven German, four Belgian, and the rest Swedish, American, Canadian and Japanese. Nineteen were produced by one manufacturer: no more than five of the remaining came from any one firm. There was, therefore, no proper service organization in the country, and the paper producers were often forced to fabricate, as far as they could do so, their own substitute for worn or damaged fittings. But we shall return to this issue later.

THE RENEWAL OF CULTURE

We have observed that the degeneration of the technical capacity of a community must also result in the devaluation of that community's image of itself. Historically, this is evident in the cultural histories of both China and India in the period of Western dominance. If the technological power of the West offered its members the easy and gratuitous assumption of the cultural power of Western civilization itself, both China and India were forced to undergo periods of intense cultural depression, when they began to entertain doubts about the viability of significant elements in their cultural traditions.

Fairbank and Teng identify in fact two main study areas concerning the China of 1839-1923: one of these, the socio-economic, we have already discussed. The other, they term "psycho-ideological", and it is precisely this problem that concerns us now. Fairbank and Teng attempt to place
the issue in the following terms:

(The psycho-ideological approach) is concerned first of all with the traditional Chinese ideologies - the systems of values and beliefs which supported and sustained the old order. Secondly, it is concerned with the slow and many-faceted breakdown of those ideologies under the corrosive influence of Western power and Western ideas. Thirdly, it seeks to analyze the absorption and adaptation of those Western ideas which interacted with persisting elements of the old order. In short, this approach studies the ways in which modern Chinese have sought to create new systems of value and belief to replace the no longer adequate ideology of the disintegrating traditional order (46).

Fairbank and Teng conclude that the experience of modern China must be studied through psychology as well as economics and social organization. More important, they realize that this entire problem is usually a problem for élites: the selections in their work "represent the Chinese élite, not the common people." Or, "as the inherited institutions and habits of thought lose validity, intellectuals experience tension and anxiety, greater hopes and fears."

Alternatively, it is equally obvious that the majority of the Chinese people (and of the Indians too) did not undergo this strong period of self-doubt: for them, tradition still continued to provide a guide to action, and traditional technics a possibility of meeting their primary needs.

That the élites of both these large nations underwent a crippling sense of inferiority and humiliation vis-a-vis the West is so obvious that it need not be presented in great detail. What is necessary, however, is to distinguish the Chinese context from the others, for the Chinese feeling of inferiority was indeed different from the others.

For unlike India, China had a vigorously self-conscious cultural nationalism, national identity and a long tradition of an integrated state and culture for more than two thousand years before the arrival of the Westerners. The latters' point of entry, however, was restricted to the mechanism of the treaty ports, and served in fact merely to reform and sharpen traditional Chinese insistence and belief of their
self-sufficiency and self-satisfied identity and to provoke a distinct response to Western models.

In contradistinction to this, colonial rule in Asia might be said to have given rise to nationalism and a national consciousness almost de novo. Most politically conscious Asians, lacking their own national tradition, and already beginning to note serious inadequacies in their local traditions, were ready to accept a Western model and to see even a clear path to progress under British rule.

Thus, India, like Ceylon, and Japan and Southeast Asia, experienced a long identity crisis. In each country, to differing degrees, indigenous attitudes, cultural styles, techniques, patterns of thought, notions of political and social organization - the whole stuff of traditional society - were found wanting and to varying degrees rejected, directly or indirectly, in favour of outright Western models or a modified hybrid.

China never had such an identity problem during the semi-colonial period: the foreigners provided no model for progress, instead an example of banditry. Thus, the felt dominance of the West created a firmer commitment of the Chinese to their own cultural tradition, and heightened the sense of China's identity rather than destroying it: every document of the period emphasized the Chinese sense of crisis, not the cosmopolitanization of China. Second thoughts about Confucianism, the discovery of Science and Democracy, even the abandonment of certain traditional values, did not involve any abandonment of cultural membership or real loss of identity. No one in China wondered, in the turmoil brought about through the Western impact, in the armín of English, in the rejection of blocks of the Chinese past, who he was, as nearly all other Asian nationals did. China was in danger, writes Rhoads Murphey, "but not Chineseness."

China suffered infinitely more, but at least in part because it never even briefly flirted with the idea of not being Chinese; this was perhaps a losing game after 1850, but to play any other was nevertheless unthinkable (47.

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Thus, at least up to 1949, Western technology provided an ideological function: in revealing to the Chinese their backwardness, it cut a deep wound in the Chinese psyche: China was "humbled". The imperial center was politically, technologically and ideologically powerless: the increasing regionalization of Chinese politics was blamed by the nationalists on the treaty ports, and those Chinese who "collaborated" with the foreigners in the treaty ports, especially those who adopted foreign techniques and attitudes were understood as traitors. Significantly, the revolution would come from Peking, never a treaty port itself: the first political activities to come out from that "spiritually" clean center took the form of protests and boycotts against the treaty ports and all they represented, "national humiliation". It was this new group, divorced both from the traditional order and from the treaty ports, which inherited modern China.

The abject feeling of inferiority in India was the result of a different set of circumstances, brought about principally by total subjection to British rule. Unlike the Chinese, Indians adapted at first to the roles that Empire required. The psychological and moral effects of British conquest and Indian subjection gradually spread and deepened. The disappearance of the warrior element in Indian society (the Kshatriyas) marked the disappearance too of basic components like courage and encouraged more superficial doubts among Indians about their technical ability to do anything about the overthrow of British dominance. British rule succeeded in making clear to the Indians themselves that they lacked power, and it strengthened the imperial opinion that qualities of passivity, weakness and cowardice were in fact norms of Indian culture and character. The process was no doubt aided when the British concentrated on providing educational and related service opportunities that required the tamer skills and temperament of the office.
rather than the scepter and sword. On the other hand, Britons were led to think that the superiority of British power and culture was an inherent rather than a historical phenomenon. What is even more surprising, the devaluation of Indian culture led to a contempt for the Indian physique:

The physical organization of the Bengali is feeble even to effeminacy. He lives in a constant vapor bath. His pursuits are sedentary, his limbs delicate, his movements languid. During many ages he has been trampled upon by men of bolder and more hardy breeds...His mind bears a singular analogy to his body. It is weak even to helplessness for purposes of manly resistance; but its suppleness and tact move the children of sterner climates to admiration not unmingled with contempt (48).

This is a passage from John Strachey's India, written at the turn of this century and a standard training assignment at the time for Englishmen undergoing probation in the Indian Civil Service. As the Rudolphs note, what is most significant about these distinctions is that most nationalist Indians half-accepted them, and no ideology legitimizing superiority-inferiority relations is worth its salt unless it wins at least a grudging assent in the minds of those dominated.

Within twenty years of the deliberate exclusion of United Province Brahmans from the Bengal Army because of their leading role in the rebellion of 1857, the idea that Brahmans lacked fighting qualities had become prevailing opinion. Reading recent history back into an undifferentiated past, Indians came to believe that they lacked valor and moral worth....Why inferiority in arms, technology, and organization, circumstances related to particular historical contexts that may be reversed, has led colonial peoples to more essentialist conclusions about themselves is not entirely clear. The fact that they frequently did come to such conclusions was one of the most degrading consequences of colonialism (49).

There were two clear responses aimed at meeting this excruciating problem and we can take them up each in turn.

The first is associated with Mahatma Gandhi, of course, and largely solved the issue. The young Nehru, often sceptical of Gandhi's political strategy and tactics, concedes again
and again his effect on the nationalist regeneration:

Much that he said we only partially accepted or sometimes did not accept at all. But all this was secondary. The essence of his teaching was fearlessness and truth and action allied to these.... So, suddenly as it were, that black pall of fear was lifted from the people's shoulders, not wholly, of course, but to an amazing degree.... It was a psychological change, almost as if an expert in psychoanalytic method had probed deep into the patient's past, found out the origins of his complexes, exposed them to his view, and thus rid him of that burden (50).

That description is indeed apt, for Gandhi did probe the nation's historical sub-conscious, with his unique sensibility both for the nightmare terrors of the Indian psyche and for its commonplace daytime self-doubts: the shape he gave to the national movement for independence, above all the technique of satyagraha, had much more than strategic significance; it provided a path for action that "solved" some problems of Indian self-esteem arising from acceptance of the negative judgments of Englishmen.

It is easy to misunderstand the nature of this "truth-force" or satyagraha, especially if one is conditioned to accept the Western definition of courage as stressing masterly aggressiveness or heroic acts of self-assertion. The error in the mis-perception of the nature of non-violence has usually been to see it as a failure of will or a surrender to fatalism. Gandhi, in fact, turned the moral tables on the British definition of courage by suggesting that aggression was the path to mastery of those without self-control, non-violent resistance the path of those with control: it is best to turn to history at this stage to provide a striking example of the difference.

In the previous chapter, we mentioned the salt march: the "Long March" in 1930, 200 miles to the Arabian Sea to collect grains of salt against British prohibition: Gandhi had staked everything on this Salt Satyagraha, and it would be in this campaign that the quality and essence of his non-violent methods would appear. There were about 2,500 volun-
teers that finally entered the Dharasana Salt Works. From here, our description passes over to Webb Miller, a British journalist, whose account of what happened has passed into the realm of the classic:

In complete silence the Gandhi men drew up and halted a hundred yards from the stockade. A picked column advanced from the crowd, waded the ditches, and approached the barbed-wire stockade... Suddenly at a word of command, scores of native policemen rushed upon the advancing marchers and rained blows on their heads with their steel-shod lathis (sticks). Not one of the marchers even raised an arm to fend off the blows. They went down like ten-pins. From where I stood I heard the sickening whack of the clubs on unprotected skulls. The waiting crowd of marchers groaned and sucked in their breath in sympathetic pain at every blow. Those struck down fell sprawling, unconscious or writhing with fractured skulls or broken shoulders... The survivors, without breaking ranks, silently and doggedly marched on until struck down.

They marched steadily, with heads up, without the encouragement of music or cheering or any possibility that they might escape serious injury or death. The police rushed out and methodically and mechanically beat down the second column. There was no fight, no struggle; the marchers simply walked forward till struck down... (51.

The very absence of violence incited the police to viciousness: feeling defenceless in all their superior equipment, all they could think of doing was what seems to "come naturally" to uniformed men in similar situations. They bashed in the volunteers' skulls and kicked and stabbed them in the testicles. "Hour after hour stretcher-bearers carried back a stream of inert, bleeding bodies."

Two months later, India's Nobel Laureate, Rabindranath Tagore, wrote triumphantly to the Manchester Guardian that Europe had now lost her moral prestige in Asia. But he had missed the point, as Erik Erikson points out: praising the Mahatma, Tagore had written that weak Asia "could now look down on Europe where before she looked up." Gandhi, notes Erikson, might have said it differently: Asia could now look Europe in the eye — not more, not less, not up to, not down on. And, adds the psychologist, "where man can and will do that, there, sooner or later, will be mutual recognition"(52.
Side by side with the Gandhian response was another, less restricted in number, more tame and compromising, in fact a new class of Indians, many of whom rejected Gandhian ideas and by the time of independence had constituted themselves as the new élite. The élites are a very important issue in all ex-colonial nations and it is important therefore to devote some time here to a comprehensive analysis of their "algorithms". We perform this analysis here by examining the mechanisms through which the Indian caste system operates: an unusual approach but an approach all the same.

The classical theory of the Indian caste system is the varna system, which comprises the rather well-known categories - Brahman (priest), Kshatriya (warrior), Vaishya (trader, merchant), and Shudra (labourer). What actually exist in Indian society, however, are not these four strict divisions, but a number of castes and sub-castes, and this is the jati system: the two, theory and practice, should not be confused.

Yet, there is a line that divides: members, for example who have been initiated in the sacred thread ceremony, are "twice-born" and belong to the three of the higher classes. The mass of sub-castes that form the Shudras do not have this privilege.

Put this way, the caste system would seem to restrict social mobility. In actual practice, considerable mobility does take place: the lowest castes adopt some of the key features of the upper castes and pass themselves off as "twice-born." M N Srinivas, India's leading sociologist, termed the phenomenon, "Sanskritization":

The tendency of the lower castes to imitate the higher has been a powerful factor in the spread of Sanskrit ritual and customs, and in the achievement of a certain amount of cultural uniformity not only throughout the caste scale, but over the entire length and breadth of India (53).

To be more specific, the lower castes normally adopt certain of the rituals of the higher castes, like the wearing of the sacred thread and at the same time try to command
the services of Brahman priests and use Vedic rituals. A Munda tribal, for example, who had established himself as a local raja, attracted Brahmans to his court, who Sanskritized his rituals and manufactured a Rajput genealogy for him, thus legitimating his position in the higher ranks of the caste scale. Such channels of social mobility are not restricted to India.

The movement is reminiscent of the democratization of gentlemanly culture and standing in eighteenth-century England that preceded the shift from a society of relatively closed ranks and orders to one of relatively open classes. Daniel Defoe, as well as other pamphleteers of class and manner, by providing the English with popular literary instruction in the art of becoming and being a gentleman, and by celebrating that status, facilitated the expansion of the ideal to those previously excluded from its fold. The only difference is such a democratization process came from above, while caste mobility is a movement from below.(54.

High up in the caste hierarchy, however, a similar movement was taking place, as the leading sections of the twice-born castes underwent "Westernization", a process in which they began to use English and adopt the occupations and cultural style of the West. They were continuing the process, though, in a different framework: this time the English had become the dominant caste, and just as the leading sections of India had once become "Persianized" under the Moghuls, they now found it beneficial to change their dress, language and diet, not in order to demonstrate that they had become modern so much as to show they were emulating the culture of the dominant class.

Contrary to the Dutch in Indonesia, the Portuguese in Goa and the Spanish in the Philippines, the English established themselves as a separate ruling caste: like other Indian castes, they did not intermarry or eat with the lower (native) castes. Their children were shipped off to public schools in England, kept to their clubs and bungalows in special suburbs known as cantonments and civil lines.
The close contact with the caste system strengthened British snobbery: the British civil service, with its tradition of generalists and brahminical status of the administrative class, is practically derived from the Indian model.

The new Indian élite was the product of English-created opportunities, and these opportunities were more easily exploited if its members successfully embraced Western, or more particularly English, ideas and manners. Political power was sought to be added to traditional priestly, commercial and literary power. Every one of these new élites would be found in the port cities of Asia: by mid-nineteenth century, it was obvious (with the aid of hindsight, of course) that all of them had already become fundamentally Westernized, and that it would be these Westernized élites emerging in Calcutta, Bombay, Madras, Karachi and Colombo who would inherit and shape South Asia's development after independence. By the end of the century, the same pattern was apparent in each Southeast Asian country (except Laos and Cambodia), where the new national élites were again to be found exclusively concentrated in the colonial ports. The point is not so much that these élites were so alienated from the large majority of their countrymen, but that in inheriting the power to shape the modernization of their countries, they would simultaneously inherit the power to choose the kind of technology with which they would seek to accomplish their purpose. And thereby hangs a tale.

The tale concerns the kind of technology normally attractive to élites of this sort. A concrete example of this process of acceptance of kinds of technology in an actual village situation in India will make it extraordinarily clear.

In the previous chapter, we presented a summary of Mahmood Mamdani's study of the village of Manupur, where we discussed principally the indirect influence of the money-lending class on the state of agricultural technology. We observed, with Mamdani, that any kind of technology
that might have proved useful to the general, agricultural section of the population in the village was not yet acceptable as the tenant or farmer realized that the possible benefits of its use would not accrue to him, the tiller, but to the money-lender, who was often also a member of the Brahman aristocracy.

It should therefore come as no unearthly surprise that the first radical departures in technology in Manupur in the first half of this century were those that benefitted the Brahmins. Mamdani makes a careful distinction:

The innovations introduced into Manupur in the 1920s and 1930s were the radio, the handpump, the watch and the bicycle, and their ownership was confined to the three leading Brahmin families. Significantly, these technological changes were on the side of consumption, not production; were external to the agricultural sector; and were, in their context, luxury items (55. (Emphasis added).

Changes in agricultural or productive technology were practically non-existent; iron gradually substituted wood in cartwheels and plough, and the old leather-bucket system gave way to the Persian wheel. The latter change affected only a minority of peasant farms, and all of their owners had not had to mortgage their land to the moneylender.

As long as the peasant producer remained subservient to the money-lender, and the money-lender reaped the rewards of increased productivity, the system remained highly resistant to technological innovation. For technological change to take place on the side of production, it was necessary that the producing classes be free from the grip of the parasitic money-lenders. A dynamic economy was not possible without a dynamic dominant class (56).

Change was possible only after an Intensive Agricultural Development Program (IADP) in 1960, provided loans to farmers for repaying their debts and for making changes in agriculture, and in the process undermined the material basis of the Brahmin aristocracy. The effect on productive technological changes was soon discernible after that. By 1970, 75 per cent of the farmers had taken loans to purchase
their tubewells. Mechanical chaffcutters replaced handcutters for making fodder for cattle. By 1970, there was not one farmer who did not use chemical fertilizers: manure was used merely as a supplement. In 1964, electricity enabled electric motors to run tubewells and chaffcutters. The watch proliferated among the agricultural class, as transactions in the nearby town of Khanna were determined there by the fact that the shops opened and closed at specific times. New seeds were rapidly accepted. By 1970, 75 percent of the families owned at least one bicycle and 24 percent a radio: both necessary, one for travel to town, the other for listening in to broadcasts from Government about agricultural news. Most significant, products of technology that made the least impact were those that could be called semi-luxury or luxury items, all entailing wasteful consumption expenditure. Electric irons in six households and coal-irons in thirty others were necessary as the newly prosperous farmer and trader would not be respected in town on transaction visits unless they emulated the ways of the town; the clerk and the school teacher were expected to wear ironed clothes to work. The least-adopted technological product was the ceiling fan: a luxury item, owned by 8 percent of the households, the most prosperous farmers, testifying to the phenomenon of a new rural bourgeoisie in the making. As for the Brahmins, their material base having disappeared, their religious dominance was also destroyed. As an elderly Brahmin noted:

(Once) only Brahmins performed priestly functions. The Jats (rural labouring class) couldn't even begin to move the plough until the Brahmin had performed certain rituals. Then, we were held in esteem and needed. Now, Jats say they are not Hindus and don't believe in our rituals (57).

Conclusion: only 5 per cent of the population of India earns more than 350 rupees a month. The top three per cent control one-fourth of the country's expenditure. A third of all the money circulated in the country remains within a restricted circle comprising at most ten per cent of the popula-
tion. This influential élite is still fundamentally Western in its tastes: it is also the only realistic market for consumer goods. The non-élite, 90 per cent of the population lacks any substantial purchasing power. Indian industry and foreign transnationals are both one, in so far as profit remains their principal motive, in catering to this élite; the kind of technology invested in or transferred is thus vitally distorted in its nature and purpose. In India, as is the case in practically every developing country in the world (there are a few exceptions), one finds the major portion of industry heavily prejudiced in favour of the production of consumer goods: luxury items and non-essential goods, which are actually non-productive in the context of the real needs of a large portion of their populations. In sum, these élites behave in exactly the same terms, as far as technology is concerned, as the Brahmins of Manupur in the 1920s-1930s.

The dependence of tastes on the part of these élites on the West - still looked up to - is repeated elsewhere, particularly in the sphere of ideas. Indian scientists, technologists, even professors of philosophy are deeply involved in issues that concern their counterparts in America or Europe, in order to gain a place in the "international community". An Indian novelist can make the grade in India only after he has published his novel first in the West. Knowledge may be power, but in the context of the dependence relationship that exists between the new nations and the West, power itself has become knowledge: Western scholars have, seemingly, not merely established the criteria for Popperian objective knowledge, but the knowledge that they produce is more objective than most other efforts. Part of this thesis has therefore concerned itself with examining the ethnocentrism implied in the production of Western knowledge. Bronowski was merely an excuse.

An excuse to establish the emergence of a new phenomenon: an international caste system, the amplification of the caste system from its limited moorings in India into the larger
face of the world. If the Brahmins once prescribed "dharma" (caste duty, the freezing of occupation-roles) to the castes below them, this was to their own advantage and since they had the best or the most superior role, they even rewrote the scriptures to enforce it. If they closed their eyes to lower groups attempting to "sanskritize" themselves, this is because they again realized that the process itself reinforced and legitimated the further acceptance of the system's authority. What might indeed have frightened them would have been a situation in which the lower-castes had suddenly lost interest in "sanskritization", thereby signalling a rejection of the worthiness of the Brahmanic model and its authority.

In almost similar terms, the industrial world continues to prescribe to the world's poorer nations how best they might help themselves. Walt Rostow's proposal was one such attempt; today, a new (but equally specious) proposal is making the rounds: "interdependence". Specious, for underneath, the strategy remains the same, to convince the new nations that their welfare will rise as long as they remain intimately tied to the Western capitalist framework. Part of this framework are a small minority of élites in the new nations, who by "sanskritizing-westernizing" themselves, have in the process accepted the legitimacy of the continued dominance of the Western paradigm. China's breakaway brought about a period of fear, which in the Western world was even reflected in the sphere of scholarship: witness the ideological quality of China studies from the period of the cold war till today.

Mahatma Gandhi distinguished himself from the rising Indian élite by his absolute rejection of the Western paradigm of human development. By 1947, however, he had been displaced from any position of effective political influence, for, as Nehru himself admitted, "much of what he said we only partially accepted or sometimes did not accept
particularly, did Nehru and his colleagues refuse to accept Gandhi's suggestion that the Congress Party be disbanded to form a rural reconstruction movement.

His disillusionment in the leaders of the Congress Party was so total: he went to the extreme limit of prophesying that the near future would find him leading a civil disobedience movement against them. How far the new elite had distanced them from his thinking is evident from the following extract from a letter of the first President of India, justifying his living in one of the costliest mansions the world has ever known: Rastrapathi Bhavan. Prasad wrote:

People belonging to the group which had adjusted itself during Gandhiji's time find it difficult to understand why it should be necessary for anyone to have anything in excess of what he had during Gandhiji's time, and they honestly feel that there is a decline from the ideal if there is any change from the austerity standard set by Gandhiji. All that can be said about such critics is that standards set during a time of struggle and accepted by the people cannot be expected to be equally acceptable when the struggle is over, and they are wrong in expecting such standards to be maintained at all times and in all circumstances (59).

For Prasad, the struggle was indeed already over; for Gandhi it was only beginning. The Gandhian conviction was however cut short with an assassin's bullet, though the core of Gandhi's thought evolved into the Sarvodaya Movement, a basically rural reconstruction force and the mention of which brings us to the examination of a very important issue.

Political scientists have often compared Mahatma Gandhi to Mao Tse-tung: as personalities, their role in their respective periods of influence has indeed been similar, as both men succeeded in mobilizing vast masses of men in the direction of a single purpose. There are differences, however, adequate enough to place the two men into two vastly different categories. Gandhi's rural reconstruction movement, which he intended to put into operation after 1947, outside the sphere of politics, has little to do with Maoist principles of revolution and social change. Instead,
the Sarvodaya Movement may only be realistically compared with the Rural Reconstruction movement symbolized in China by the Confucian holy man, Liang Shu-ming, in the thirties.

Liang was the founder of an influential project at Tsou p'ing in Shantung, which proposed local self-government (ti-fang tzu-chih) or rural self-government (hsiang-ts'un tzu-chih), implied political organization below the hsien level and thus, mass participation in Government. The project was in keeping with the atmosphere during the period of the Nanking regime, when reformers decried rural bankruptcy and collapse and argued and worked for rural renewal.

Liang's movement, which took root with the founding of the Shantung Rural Reconstruction Institute in 1931, is to be distinguished from two other Chinese developments of the same period. It was basically a civilian movement, different thus from the Kuomintang modernization program with the help of a bureaucracy, that proposed change and improvement from top to below. The latter kind of development is characteristic of the rural development, official programs of the Indian government after 1947.

Secondly, Liang's "old" school at Tsou p'ing was to be distinguished from the "new" school of the Yale educated, Jimmy Yen, the latter a philanthropic institution, funded with foreign aid and ideas. Yen worshipped Western culture, and was convinced that the 5,000 years of Chinese history and culture were the real "enemy" of the Chinese development program. He wanted to create modern, "scientific" rural villages, and in his ideas was not very different from many development experts from the Western world working in the poorer areas of the new nations today.

In contradistinction to both, Liang refused both foreign aid and ideas, and argued for a strategy where only the peasants could save themselves. His was therefore a typical Chinese style rural reconstruction ideal, whose fundamental spirit involved the use of the power of character formation to solve practical problems. The Shantung Institute was the
main intellectual and spiritual centre of the rural renewal movement, just as Wardha was, and continues to be, the equivalent centre of the Gandhi movement.

Like Gandhi, Liang was interested in a grandiose goal in the Chinese context - a new Chinese culture and society with implications for the whole world, which would aim at reaping the benefits of modernization while avoiding the evils of the West, but within the framework of Chinese sage wisdom and organization. Like Gandhi, Liang further argued that children should have a "basic" or useful education: knowledge of basic literacy, agriculture, general science, hygiene and civics. The training schools he established, involved Gandhian habits of continuous moral scrutiny of members and fellows, and even morning meditation. Like Gandhi, Liang proposed cooperative societies and "trustee" ownership.

Liang's movement collapsed with the Japanese invasion in 1938. Before that, however, it had already been heavily criticized, both by the "Yale" school and the Communists. The proponents of "wholesale Westernization" observed that Liang was an unscientific, old-fashioned restorationist, who had not quite understood the modern world, critiques made often in relation to Gandhi. But it is the criticism of the Communists that enables us to see the differences in Liang's approach and Mao's, and therefore, between Gandhi's and Mao's.

The Communists termed Liang at once the most reactionary and the most progressive of the leaders interested at the time in agrarian socialism; he realized that both imperialism and the Chinese warlords were the true causes of Chinese peasant poverty. At the same time, his approach did little to eradicate these peasant enemies. They noted that his cooperatives received loans from city banks, where foreign interests were heavily involved, and that his plan for the resuscitation of rural industries was collapsing precisely because of the imports of foreign goods. As long as imperialism remained, his plans for cooperative socialism were
in essence chimerical; and as long as his movement did not prevent the consolidation of the rule of landlords and big peasants (in any case, it was directed against them), it was bound to be revolutionary in a conservative way, for peasant interests are not identical with those of their more privileged neighbours, and vice versa. Willem Wertheim has made a similar point about Gandhi's tactics (61).

Yet, there are also similarities between the Maoists, Liang and Gandhi which we cannot underestimate, but they serve to unhold the radical nature of the differences. More important, they concern the nature of the renewal of culture that has occupied us in some portions of this chapter.

In the first place, Liang shared with Mao a peculiarly Confucian faith (as Gandhi in the Indian context) in the influence of the human environment and the efficacy of intimate group contact in rural and intellectual improvement. All three, in fact, conceived of internal virtue (be it a rectified heart, a proletarian consciousness, or the Indian ideal of Brahmacharya) as linked with external political, military and economic success. According to all three, the good society was to be achieved by continuous spiritual transformation of the whole society, a never ending moral drama (for example, Gandhi's autobiography), which would solve their country's economic and political backwardness and, at the same time, avoid the de-humanization of urban bourgeois society: all three were apprehensive that selfish mundane desires might extinguish the spirit of self-sacrifice. Mao and Liang distinguished man from animal and Chinese man from Western man precisely on his renewed ability to act against his material self-interest for moral reasons. Mao differed from Liang and Gandhi in that for him the purpose of self-sacrifice was the nation state and its people, whereas, for Gandhi and Liang, sacrifice was an end in itself, not a means. It was an expression of the tao, and only secondarily a means for the benefit of the collective.

It was the Maoists in the end who realized Liang's ul-
timate goal: the revival and reintegration of China based upon an impassioned man's commitment to a common ethic, "a religion that was not a religion", as Liang often described Confucianism. The Maoist revival also incorporated many other aspects of the Liang program: the emphasis on small rural industry, local self-reliance, independence from foreign ideas and aid, small-group dynamics and agricultural development through the peasants themselves.

Probably, the most striking difference between the Maoists and the Liang-Gandhi movements lies in the fact that the former effected a radical re-distribution of power and property before 1949. One has only to read Jan Myrdal's *Chinese Village* report to see that the bulk of the kulaks must have been liquidated during the course of the Long March itself. Both Gandhi and Liang had not yet reached this stage, and not having reached it, would soon come to discover that most of their efforts to produce social change would be ultimately blocked. The Chinese people, on the other hand, the majority of them freed from an exploitative past, were now ready to work with the new revolution, for they now had a stake, a vital stake, in its continuance.

POST-INDEPENDENCE RESPONSES

Finally, the attitudes of the Indian and Chinese free Governments to the role of technology in the renewed development of their societies.

Chinese xenophobia and Indian xenophilia explain in large measure the respective, and totally different attitudes of these two civilizations to the question of indigenous and foreign technologies in the context of their individual development programs. Indian xenophilia first.

These attitudes, we have already seen, had an historical basis. In India, it was already evident after the 1850s, as Indian capitalists imported British textile machinery regardless of the consequences - the further disintegration of village industry. The argument supporting
this import was that a mechanized Indian textile industry would keep profits within the country itself. The First World War reduced British imports, and brought large profits to the Indian capitalist: in 1920, 35 companies which controlled 42 mills declared dividends of 40 per cent and more; ten of these companies controlling 14 mills paid out a dividend of 100 per cent; the dividend of two mills shot up by 200 per cent.

The Second World War raised profits to greater heights: 61 Bombay cotton mills, whose paid-up capital totalled 139.3 million rupees, made a net profit of 6½ times this amount in five years. The Indian textile industry even then employed half a million workers, as against 10 million still engaged in the hand-weaving industry. The mills needed 104 persons to produce a million yards, while the traditional industry employed 6,250 persons to produce a similar quantity.(62.

After 1947, British control was replaced by Indian capitalist control, or step-in-your-shoes nationalists, as Angus Maddison terms them. The history of the Indian Government's response to industrial development is a history of continuous compromise with the private, capitalist sector, with the latter in the ascendant about 1972. The Indian capitalist was not a solitary entrepreneur, but formed part of a tightly-knit, family, reinforced by caste and community ties. In 1951, for example, the Birla group or family controlled 245 companies and was substantially interested in another eleven. Of the 195 public companies in the complex (eight of which were among the fifty largest in the country at the end of the decade), seventy-one were engaged in investment financing, thirty-four in trade, twelve in cotton, eleven in engineering, nine each in sugar and tea, six in property, five each in jute, publishing and managing agencies, four each in food and insurance, three in plastics and glass, two each in coal-mining, power, non-ferrous metals and transport, and one each in mining other than coal, rayon, chemicals, paper, construction, fireclay and banking. Another of the larger groups, the Tatas, had
68 public companies that ranged over at least twenty industries in 1951; the Dalmia-Sahu-Jain group's 63 public companies over eighteen industries; the Bangur's 33 over fifteen industries; the Thapars' 30 over twelve industries and so on. (63.

Most of these companies, producing principally consumer goods, were weakened in their output capacities by a certain amount of technological backwardness; two foreign exchange crises brought the foreign multinationals into the picture, since it was thought that more foreign investment would increase the country's exchange position. It did not. We have already spoken of the "technological mix" in the paper industry. Also, we need not deny that the Indian Government once brought sharp pressures on Indian industrialists to find substitutes for imports. The preference for foreign technology, however, has remained.

The fact that this foreign technology is irrelevant in the larger productive needs of the Indian economy reduces absolutely the importance of this substitution process. In fact, the transfer of western technology itself is in large part an irrelevant problem, for apart from cotton textiles, India is not a mass-consumption economy; only ten per cent of the population enjoy the bulk of industrial production. The West, on the other hand, is interested in the transfer of technology for it is highly profitable. The Indian capitalist collaborates, because even though foreign technology may be too expensive for the nation, high profit margins within the country make the enterprise lucrative. The xenophilia pervades the entire scene: from the Government through the industrialists, down to the urban consumers, particularly the urban affluent sections.

From the very beginning, in fact, (1947), the Government realized it would have to work fast towards the building up of a strong, industrial infra-structure that would provide the basis for the general development of industry: the Indians Plans were consciously patterned on the Soviet industrialization model. For this, the Government found it had very often to purchase technology or turn-key projects
from abroad, either from the market economies or from the socialist economies; in the early stages, most collaborations were sought for the electrical and machine goods sectors. Later, however, as momentum lagged, Government found it needed technical aid in mining, petroleum, machine tools, and the production of all kinds of metals and chemicals. In preparing its contracts for the purchase of industrial goods, it often gave the preference to firms with foreign collaboration.

An example will suffice: the fertilizer industry. From its very inception, this industry has proved to be an example of how foreign business interests, with assistance from Indian collaborators, have succeeded in sabotaging authentic indigenous development of industry. This has happened despite the existence of a competent band of Indian scientists and engineers in the Planning and Development division of the Fertilizer Corporation of India, who could well have carried this particular industry to self-reliant sufficiency. In fact, official quarters did entrust responsibility for the development of the industry to these technicians in the late sixties and early seventies. But for some reason not till today established, the local technical agencies were soon spurned, and affairs climaxed with the decision to return to turn-key arrangements with Japanese interests, for the construction of new fertilizer plants even though the Indian capability in the field was thereby left underemployed, and despite the readiness of international agencies to give credits for the construction of the fertilizer industry in the public sector (64).

Such solutions are unthinkable in the Chinese context. The Chinese refuse to believe that they need technical aid, at least from outside their borders. Does India need such aid? In 1961, there were 28,000 degree holders and technical personnel unemployed; in 1971, their number had risen to 2,88,487. This number, large as it is, does not exclude lesser educated labour power, much less unskilled, uneducated labour. In fact, there is little scientific and technical
knowledge and experience that India needs that is not available within the country itself. The psychological damage of technological dependence is worse: the attitude that "someone else is better qualified and can do it for me" saps a people's energy and initiative, reduces the role of local people to that of bystanders. As in the industrial revolution, the poor have become a burden in most of the new nations. In India, their number has not changed, rather it has increased, in absolute terms, since independence.

To argue, therefore, as Prof. Jan Tinbergen as done, in the RIO report (1975) that multinationals have no alternative but to engage now in research and development that will have direct relevance to the problems of poverty of the new states, is not merely to endorse continued technological dependence, but to imply that the people of the new nations cannot solve their own problems by themselves: at any rate, they did so before the rise of Western dominance and the colonial period.

Technological dependence is usually paralleled by dependence in every other sphere of life. Here, the new states are not alone, for in relation to the United States, even Europe will soon function as a satellite, functioning more and more under licensing agreements based in that country. In part, technological dependence is part of a larger problem that the West has still not shown any keenness to resolve: the fact is that technological dependence is profitable to those who not only feed it, but transmit it, either in Europe or India. The fundamental issue unresolved is how to separate the aims of the democratic state from those of private industry and to make the latter responsive to the former. If the West is unable to solve this problem, it is doubtful that India, already well on the way to a similar situation, will ever be forced to solve it too.

Thus, to Chinese xenophobia.

China, like India, did not sit down like Rodin's thinker, to think out the best thing to do. But perhaps its choice concerning its own technological development was ren-
dered easier precisely because before it even got down to facing the question of technology, it had provided for itself a firm context for any action in that direction through non-technical means: the effecting of a truly revolutionary redistribution of power, through which it acquired the capacity to choose and implement its policies effectively on behalf of the peasants and workers - whereas India did not. This, indeed, is a very brave statement, but it should be understood as constituting merely the beginning, not the end, of an analysis.

The key indicator of the validity of such a proposition is to examine the manner in which each society (China and India) provides for its lower-income groups, whether unemployed or underemployed. John Gurley's statement below appears to be amply justified by the evidence on China available today:

The basic, overriding economic fact about China is that for 20 years she has fed, clothed and housed everyone, has kept them healthy, and has educated most. Millions have not starved; sidewalks and streets have not been covered with multitudes of sleeping, begging, hungry and illiterate human beings; millions are not disease-ridden. To find such deplorable conditions, one does not look to China these days but rather to India, Pakistan, and almost anywhere else in the underdeveloped world... The Chinese - all of them - now have what is in effect an insurance policy against pestilence, famine and other disasters (66).

Gurley might have added that rich Indians have indeed got richer, and that no Indian equivalent of the Chinese "insurance policy" is available to 90 per cent of the Indian population.

No useful purpose is therefore served by beginning a study of modern China by dubbing it as a totalitarian state. John Fairbank is a fair example, when he writes of the Chinese people having "surrendered to a totalitarian communist faith." But then, he has also been known for his pontifications concerning the role of the Western nations in the Opium War:

The adjustment of modern China to the multi-state sy-
stem, her proper functioning as part of the world community, will remain incomplete until this sense of grievance at her modern history is exorcised by a rational perspective on it. (67)

That indeed is a little difficult to accept. But Fairbank, as we noted, is an example. Lewis Mumford cannot mention China without speaking of totalitarianism at the same time. Sinologists who see China "from the other side of the river" are rare and far between: Charles Bettelheim, Joan Robinson, Joseph Needham, John Gittings. The latter is one of the few to accept that the Chinese should be granted the right to determine their own view of human development:

At the same time China is a different society with different ideals and social goals from those of the capitalist countries of the West, and no useful purpose is served by trying to pretend that the Chinese are "just like us", even if they are similar in many respects. Intense political struggle, sometimes leading to violence, has been an important part of the mechanism which has driven the Chinese revolution forward from the early years of land reform to the Cultural Revolution. And while everyday life for the Chinese has much in common with our own, the forms of social organization and (much more important) the collective spirit behind them is altogether another matter (68).

It is generally accepted that the Chinese have attained some of their egalitarian goals, but some Western economists are not quite sure whether these have been achieved at the cost of economic growth; the Chinese willingness to subordinate some strictly economic goals to other considerations is ignored. Others are still prescribing to the Chinese what is good for them. Rhoads Murphey, for example, tries to explain away the Chinese decision to de-urbanize industry as a result of the humiliation associated with the foreign experience at the treaty port cities:

This and the other cardinal sins of "bureaucratism" and "status quo-ism" are no doubt inevitable products of urbanism, but without urbanism the industrialization which Chinese Communism so determinedly wants is literally unattainable. Chinese improvements on West-
ern models – for which there is certainly plenty of room – should be sought in other ways (69).

Alvin Gouldner, in his brilliant article on Marxism and Maoism, has his own explanation concerning Mao's lack of enthusiasm for industrialized urban centres:

In one part, Maoism's hedging about urbanization is an effort to arrange China's social order so that, if it must, it can survive even nuclear warfare. (70.

Mark Elvin wonders if the Chinese experiment will not develop deep fissures as the country's advancing industrialization will place it into closer contact with a "corrupting" West. We could go on.

On the other hand, J Gray has argued that behind the political thought of Mao Tse-tung is a strong economic policy, and that in fact, the two should not be seen as contradictory. Gray's analysis is in keeping with one of Mao's key talks on Chinese industrialization: On the Ten Great Relationships. Charles Bettelheim, in his recent work, has a splendid analysis about how the Chinese have succeeded in improving productivity and in arriving at solutions transcending a narrow technical outlook precisely because they believe in the Maoist dictum, that "politics should always be in command." (71, 72, 73. His analysis also shows that it is no longer possible for non-Chinese to entertain the view that China is a "totalitarian" society.

Sinophiles, however, rarely emphasize the trial-and-error approach that has underlied Chinese industrialization strategies. During the fifties, for example, China relied heavily on Russian technical assistance to develop its modern industry. In fact, the Chinese policy of self-reliance might have appeared much later in the day, if the Soviets had not suddenly pulled out in 1960, thus forcing the Chinese to learn much by doing by themselves (74. In the early sixties, China's production priorities had changed, calling now for a major expansion of petroleum and chemical fertilizer production: the unfavourable foreign exchange position at the time meant that most of the plant and equipment would
have to be produced by the domestic machine-building industry. China did meet the challenge, while India, in a similar foreign exchange crisis simply sought the easier way out by inviting foreign aid, financial and technical.

The Soviet pull-out thus only convinced Chinese leaders that technological self-sufficiency must be promoted at all costs and the role of foreigners drastically limited: this has led in China to a very considerable indigenous technological base. In India, on the other hand, whether in the public or private sector, it would be difficult to find more than a handful (in the very literal sense) of large factories built with indigenous know-how, not to speak of capital equipment. This has had significant results. In China, for example, the Taiching petroleum complex which began in 1960 after Soviet supplies were halted, was soon under way to making the country independent of foreign supplies altogether. Bettelheim writes:

The result has been that China now holds the world record in terms of international drilling norms. Annual production of crude oil continues to increase by about 30 per cent. In terms of its oil requirements, China is now self-sufficient. Taiching represents for Chinese industry what Tachai represents for agriculture. It points to the socialist road of industrialization(75.

In India, on the other hand, Western-based oil companies have got away lightly with Indian socialism or the Government's ability to compromise. An opportunity to develop self-reliance in the petroleum industry and reduce foreign permanent dependence, as Cuba, for example did, was easily given up (76.

"Walking on two feet", intermediate technology, the encouragement to innovate and experiment are part of the broad Chinese consensus favouring a high degree of national and regional self-reliance in the manufactures of machinery and other producer goods. The results of such a policy especially at the local level are bound to be mixed. Thus reports of thriving factories of Kwangtung's prosperous Chungshan county, alternate with reports of failure, as in
Hopei's Kaoch'eng county, where efforts to combat drought foundered because locally produced engines turned out to be useless. The Chinese however tolerate such failures in their continued desire for more widespread industrial experience as a long term policy.

Richman, an authority on the industrial experience of both India and China, draws the conclusion:

the point is that the Chinese can produce practically anything they wish to, though in limited numbers and at great costs in many cases. I feel that Red China has a significant lead - perhaps five to ten years - over India in overall product development and knowhow in spite of the considerable amount of foreign collaboration and assistance in India's industrial sector.

In general, Red China appears to be substantially more self-sufficient in technology and product development and much less dependent on foreign assistance or imports than India. These are critical factors to be considered in assessing future technological and product development prospects in the two countries, and in predicting their industrial and economic growth potential (77.
Summary six

This chapter examines the period before and after western dominance in China and India. It correlates the feelings of cultural inferiority experienced by these civilizations with a corresponding feeling of technical backwardness in the face of the technological power of the West, and then proceeds to show how the resistance to Western power through attempts at industrialization was accompanied by corresponding attempts to revitalize traditional culture to meet contemporary situations.

Here it is interesting to note that the past history of both nations influenced their attitudes to Western technology before their independence. The strong nationalist and cultural traditions of China inclined its leaders to learn Western military techniques in an effort to fight the barbarians on their own terms. In India, on the other hand, the first elements of Western technology imported for use in the country's industrialization had to do with textile technology, even though such importation merely served to continue the aggravation already existing between machino-manufacture and manu-facture.

Further, in the case of India in her position as a colony, attempts to industrialize were thwarted by the colonial authorities, a natural tendency, as the colonial power would have been cutting its own throat should it have allowed indigenous production to corner the Indian market where it could always have had a natural advantage. The world Wars, however, thwarted the English intentions in turn, but the harm had been done. Though Japan, for example began her industrialization after India, she had succeeded in overtaking India before the turn of the century.

Though important aspects of the past continued to influence actual economic and technological behaviour after independence in both countries, China at least, as is well known, inaugurated her period of independence through an institution of wide-ranging social and economic reforms: within that context, the building up of a renovated culture (incorporating large elements of the past) aided the building in turn of industry on a level that coincided with the larger interests of Chinese society in general. In India, such reforms were proposed, but have never been seriously implemented and pressures continue to operate that on a village level depress productivity to less than ordinarily available levels. This is not to preclude the very real possibility that India will eventually reach the status of an industrial power in Asia: our point is that this goal, desired urgently by its leaders, will only arrive later than it should have and through the mediation of greater human suffering than the country has ever seen in all its history. Looking back into the history of such attempts, we should not forget that the industrialization of England had to complete a hundred years before the majority of its population had passed beyond the level of mere subsistence.
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Chapter Seven

The Logic of Appropriate Technology

In which we present our conclusions, in the form of a general summing up. Three principal parts to this chapter. In the first section, we carry on the trends established in chapter six, and notice the relativization of the Western paradigm and consequently, the loosening of its monopoly over the determination of the world-picture. In the second section, we take up the consequences of such an event for the world of academia. In the third, and final, section, we recall our universalized Homo faber model, examine its inadequacies and proceed thus to widen its interpretation and application.

Our final chapter consists of three main parts: a summing up of the trends established through the thesis, and especially in chapter six; an analysis of the consequences of these trends for the presentation of ideas and understanding; a guideline, not a strategy, for our footsteps into the future - a more inclusive Homo faber model.

The first part will examine the relativization of the Western paradigm and relegate its preoccupations to its legitimate, geographical position. The consequences of such an event for the societies of the industrial nations will then be presented.

In the second section, we will introduce once again the necessity of a new ground-plan for understanding tech-
nology and culture, a new problem that will arise with the relativization of the Western paradigm.

In the third section, the homo faber will be re-examined, its inadequacies explained, its scope widened. Here we shall particularly concern ourselves with the relation of politics and technology and finally indicate our understanding of "progress".

THE RELATIVIZATION OF THE WESTERN PARADIGM

In the very first chapter, we proposed a new anthropological model to provide a new framework within which we found it easier to clarify the nature of man; we emphasized in that model, man's capacity, even necessity for dealing with his life-world through his two principal creations: technology and culture. This was an abstract model, so we "tested" it against the facts of history. In Latin America, Africa, Korea, the Islamic world, India and China, thus, not only in the Western world, we found various kinds of science (understood as systematic thinking about nature) and technologies created in the service of the members of these cultures. Different cultures, different goals or different webs of meaning and we saw this difference, even uniqueness, reflected in the nature of techniques.

The free ability to determine their own cultural programs was reinforced by their inborn technical capacity, which led in turn to a certain degree of independence concerning their relations among themselves and with the West. Till it became possible for Western conquest and political dominance to disrupt and negate this independence. After that impact, the older civilizations were no longer in a state of health - their capacity for culture and technology had diminished. As Ribeiro puts it, they had now been traumatized. By the 1950s, these civilizations and cultures consisted of peoples who had been taught or had taught themselves to accept the idea that they had nothing
to offer, that they must look to the outsider for ideas, for expertise, for capital and even for what they ought to think.

The industrial revolution, we have tried to show did not cause this disruption, which had begun earlier through political conquest: the example of pre-Columbian America is stark proof. Farmers in Bengal, India, were forced to change their agricultural systems and grow opium much before the industrial revolution had goods to sell. But the industrial revolution provided a good reason to carry on, perpetuate and deepen the disruption— to destroy local methods that might compete with the machine, and secondly, to provide markets in situations politically designed to put indigenous labour and goods at a disadvantage. The rise of modern industry in these regions was prevented as such industry would cut into the productive power of the colonial empire and eat up raw materials destined for its machines.

The process of technological dominance was paralleled by a feeling of cultural superiority. The anthropological model (to use the terms of this thesis) was de-universalized and assumed the flesh of the Western experience of human development: thus did the Western paradigm appear as a model, even parade as one, and Western technology and culture as criteria for the understanding of other societies. All other paradigms were relegated to the heap of antiquated human experience: some of this we have already dilated on in the introduction to this thesis. It also became possible to argue that the goal towards which the world should be, or was moving to, was its "wholesale Westernization", Toynbee's image of the East succumbing to the West. The foundations of such a new world culture would, of course, indisputably be laid in the image of Western man.

What we have tried to do since that first chapter is to separate the model from the paradigm to which it had become attached or with which it had turned out to be indentified through the process of history. The di-
vorce was necessary as a prelude to an argument to re-establish a plurality of paradigms, a result that historically would approximate to a situation that existed before the disruptive impact of the Vasco da Gama epoch. Today, it might conceivably be possible to identify three competing paradigms, three independent paradigms: the Western, the Russian and the Chinese. No more. Such indeed is the poverty to which the mind of man has been reduced.

Let us hark back to the history of nations during the past twenty-five years. It seems immediately obvious that the Asian historian, Sardar K M Panikkar was wrong in terming the withdrawal of the Western colonial empires as the end of the Vasco da Gama epoch. For, the economic de-colonization of the newly independent nations had hardly begun. It was, in fact, the OPEC action that first signalled the beginnings of the end of the da Gama epoch.

Before that, it is not difficult to see that the Western nations had not even been preoccupied with the question of the kind of economic independence that the new nations were worried about. The primary proposal of the West to the new nations came eventually through Walt Rostow: we have already noticed the real intent of Rostow's book, its ideological leanings, evident even in policy terms in Rostow's "positive" contribution to the Vietnam war. Here we are concerned with Rostow's thesis itself, that the experience of the Western nations with industrialization was being repeated by the new nations. Rostow put the Indian "take-off", for example, in 1952.

The Stages of Economic Growth had no doubt an intellectual appeal difficulty to resist, specially by the new nations: it contained the hope of discovering the laws of development, if not the philosopher's stone, a set of conditions which if properly reproduced in the poor nations could bring about those processes which
characterized the growth of the industrial nations.

According to Rostow, societies pass through five distinctive stages in the process of economic development: the traditional society, the preconditions for take-off, the take-off, the drive to maturity, and the age of high mass consumption. He emphasized further, that these stages of growth are not merely descriptive but "have an inner logic and continuity. They have an analytic bone structure, rooted in a dynamic theory of production" (1. The presentation of the stages and the theory behind them are both outlined in the first sixteen pages of the book. For the reader looking for any substantiation of the theory, there is of course none. There are not even specific criteria for the definition and the dating of the stages of growth. For example, "maturity" is said to be attained when new, modern techniques spread throughout the economy. But if "modern" refers to what is most advanced at the time, then neolithic Europe was a mature economy with techniques in advance of those of the old stone age. If, on the other hand, it refers to the adoption of techniques familiar to us now, this criterion of maturity is a piece of historical parochialism on the part of an observer whose criteria are confined to his own age: a point we have consistently inveighed against during this thesis.

The most serious criticism of Rostow's theory flows from the nature of our thesis itself: Rostow treats the progress of different economies mostly quite separately. Both the interdependence and the continuity of international economic development are obscured at important stages in the argument, which treats the development of the separate national economies largely in isolation. As a result, the progress of industrialization is represented as the development of many disparate units instead of the interrelated process it was.

In the light of this thesis, however, it is possible to show that the technological and economic development of the Western nations was intimately connected with special and non-recurring circumstances. If this is true,
if the rapid increase in the material well-being of the West depended on novel elements (rather than upon ordinary and continuous and universally applicable elements), then a good deal of Rostow's ideas on the growth of nations is based on false assumptions and therefore, false analogy. If history cannot repeat itself, future developments will arise out of new and ultimately unique circumstances. The Western past is unrepeatable and therefore, new nations should no longer believe that their futures can be determined according to the Western past.

What were indeed these special and non-recurring circumstances that facilitated the industrialization of the Western nations? Most of them have to do with the extensive phase of the Western nations, as they colonized old and new worlds. The industrialization of England, for example, cannot be understood without this experience that extended and facilitated the grasp of the hand of Western man.

We have examined in detail how mechanization was politically aided in its conquest of other forms of production, specially in India, where political domination was exploited to disestablish existing trade and industry, replace these with trade controlled by the colonists. Further, political power was used to turn the Indian economy from a manufacturing economy to a purely agricultural one, and to turn it at the same time into a market for British goods. Finally, political power prevented the industrialization of the Indian economy itself. On the other hand, China, which remained never completely colonized, provided less opportunity for political interference or disruption of traditional industry, which continued to remain strong enough to ward off the imported goods of the machine. The industrialization-de-industrialization fact is rarely dealt with in works that detail the rise of the machine.

The second crucial element concerns the populations of the West, which after explosions, found a safety outlet in the colonizing of newly settled areas: another feature
not available to the new nations and their rising populations today. Population pressure on English land not merely induced a migration to the urban areas, but made migration from the country itself an economic necessity. International migration on a scale which is no longer possible contributed to raising labour's average productivity in the agriculture of the home countries.

Further, the colonization of underpopulated regions, primarily North America, but also South Africa, Australia and elsewhere by European settlers made possible the supply bases of European industrialization. And while capital obtained from the exploitation of the colonized (e.g. India) trading regions was transferred to Europe, capital was exported from Europe to the overseas regions settled by European migrants. The result was a sustained net transfer of resources during much of the nineteenth century from non-white colonies to white settled underpopulated regions.

Thus, as the Indian economist, A K Bagchi has concluded, the very processes that led to rapid industrialization in the advanced capitalist countries and their overseas offshoots led to the stagnation or worse of the underdeveloped countries, and "that this parasitic mode of growth in the nineteenth century makes capitalist growth non-replicable in underdeveloped countries of today" (2).

We have already rejected the view that the industrial revolution in England was a matter of conscious design, for such a view does not indeed explain why the majority of the English population had to go through a period of intense suffering and hard labour for at least a hundred years after the revolution began to move: further, it should not be forgotten that this majority was able to attain a decent standard of living only after labour and trade union struggles. The myth that the machine brought about an automatic distribution of prosperity is to be found only in text-books.

Further, we have argued that England was in a period of ecological imbalance which forced her population to bring about a new resource base. The late eighteenth and early nineteenth centuries provided her with comparatively easy
outlets through which she could soften the transition. First, population migration, as we noted, eased the pressure on land. But it was precisely the migrants who would soon set about supplying England with raw materials (a possibility the Chinese were excluded from). On the other hand, real colonial territories were reduced to supplying other raw materials, like food, which was exported from India, for instance, even in times of famine. The manufacturing capacities of these territories had to be decreased to further free raw materials for the consumption of English machines. To talk of the new nations today, then, in terms of their being "traditional" societies, is to travesty the historical facts. To think in terms of them as industrializing their economies in free isolation is to ignore their continued subordination to the economies of the industrial nations.

Ever since Rostow's proposal to the new nations (that the shortest road to prosperity was development on the Western model and integration into the capitalist economic system) was discovered to suffer serious inadequacies that devalued its application as policy, the Western nations have begun to soft-pedal the "take-off" thesis and to attempt to replace it with an equally speculative concept: "interdependence". It has been suggested that only a few changes need be made in the existing international economic order in such a way as to produce greater equality and make interdependence a reality. It is a measure of the new consciousness of the leaders of the new nations, that whereas a few years ago, they accepted Rostow's thesis uncritically, this time they have rejected the "interdependence" idea without a second thought, precisely because the proposal has come from Western hands.

The Tanzanian reply to this promise of "gains to all parties within a benevolent framework" has been total rejection: interdependence among unequal partners can only result in the exploitation of the weaker partners. A close adviser of the Dutch Development Ministry,
Prof. F van Dam has narrowed down this thesis or proposal as actually applying to but a few countries in the non-Western world. But he accepts the substance. What is the precise nature of this new Western proposal?

At first glance it is obvious that there is a great deal of interdependence between the industrial and new nations today. It is not a disputable fact that exports of primary products - raw materials and other commodities - are crucial to the incomes of the new nations. At the present time, between 80 and 90 per cent of their export earnings are derived from primary products and more than 80 per cent of their foreign exchange accrues from exports to the industrial nations. But, surely, it is quite another thing to assume, as the idea of interdependence really does, that the international division of labour which this implies reflects an immutable law of economic life.

The arrangement of the world in which the new nations serve as sources of raw materials for Western industry and as export markets for Western manufactures is not one pre-ordained by divine purpose. "It is true", noted the distinguished, West Indian-born, Princeton economist, Sir W Arthur Lewis, "that the prosperity of underdeveloped countries has in the past depended on what they could sell to the industrial countries, but there is no reason why this should continue." (3

Except that the West and its key representatives think it should. Daniel Patrick Moynihan could tell an absolutely incredulous assembly that "if global progress in economic development falters," it would be the poor countries that would submerge first. The economic health of the industrial countries, Kissinger has pontificated, "is central to the health of the global economy." Another commentator went to the extent of observing that "the most important single thing the OECD countries can do for the Fourth World is to continue to prosper."

In this case, while the representatives of the new nations reacted by rejecting the proposition that the improvement of their condition must "remain a mere footnote
to the prosperity of the developed world", it was Sir Arthur Lewis, again, who shocked his fellow economists by flatly rejecting even the theoretical worth of the new proposal. Lewis asserted that there was no reason on earth why the countries of Asia, Latin America and Africa should not continue to develop, "even if all the rest of the world were to sink into the sea." (4

Lewis based his arguments on the fact that the free flow of trade and investment - at least in recent times - had done more harm than good to the new nations. On every ground, he observed, it is now possible to state that some of the new nations might be better off closing themselves off from the West. That it made better sense for the new nations not to compete with OECD nations in OECD markets, but to build up trade among themselves, an idea already proposed, but cut down by the IMF (5. The underdeveloped countries have all the resources needed for their own development. Taken together they have a surplus of fuel, fibres, iron ore, copper, bauxite and practically every other raw material. In agriculture they are perfectly capable of feeding themselves, through exchange with each other: it is then perfectly ridiculous to beg the United States to buy more coffee and tea so that they can pay for American grain, when they could produce more grain for themselves. (6

It was better, continued Lewis, to expand tropical trade with tropical countries, instead of with the temperate lands. Further, there was little sense in the new nations using their best lands to grow coffee, tea, cocoa, sugar, cotton and rubber, "all of which are a drag on the market", when there was a booming trade or market for cereals, livestock, and other feeding stuffs. As for industrialization, it again made little sense to develop light manufactures - textiles, footwear, electronics and the like - where competition is cut-throat and the market already rapidly saturated. There was no law of nature that laid down that the new nations must concentrate on light

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The real issues, it will be seen, are not more votes at the World Bank, new rules for multinational corporations, reduced tariffs and better terms of trade, not even the stabilization of raw material prices in a constantly fluctuating market - though the arrival of these might be seen as short term objectives. On the contrary, they concern the industrialization of the new nations themselves, and thus a radical turnaway from their present role as export economies.

The nature of these export economies has been well known and needs no sharp description (7 . Their almost crucial characteristic has been the diversion of land - almost always the best arable land - from basic food crops (millet or sorghum, for example) to profitable cash crops for export. The almost inevitable result is that it becomes necessary to import an increasing quantity of basic foodstuffs from abroad. In fact, cereal imports of developing countries rose from 12.4 million tons to 60 million tons between 1951 and 1974, and prices rose accordingly. Theoretically, exports should have paid, or more than paid, for imports. In real life it proved to be otherwise. In the Ivory Coast, for example, imported protein in canned meat, milk, and fish cost eleven times more than the revenue de-
rived from protein exported abroad in the form of peanuts and oilseed cake. The result of subordination to the world market, in short, was that, by the end of 1975, the non-oil producing developing countries were spending almost as much on imported grain as on imported oil.

What would the industrialization of the new nations, using their own resources, involve. In the first place, the new nations have announced their determination to raise their share of world industrial production from its present level of 7 per cent to 25 per cent by the year 2000. Such a program would wreck the absolute position of the West in the productive system and relegate it to a relative position. How?

The increase from 7 per cent to 25 per cent as been termed as "a modest objective"; it could be more. Conceivably, it could be absorbed without dislocation, if we assumed a continuing high level - 8 per cent per annum or more - of world industrial growth. On current projections of an average annual growth rate of 5 per cent the picture is very different. According to one calculation, this is barely more than is necessary just to keep unemployment in the United States down to its present inflated level. Add to this an increasing share from the part of the socialist economies, and the new program, if implemented, would disrupt the West's traditional hold over the world economy and drastically limit its ability to manipulate it in its own interest. In other words, the wheel which carried the West to pre-eminence in 1900 will have turned again in 2000. Our conclusion runs as follows:

It is the Western nations (including Japan) that are going to be increasingly dependent on the new nations - not the other way around. The resources of the new nations are their own to use - for their own industrialization. We have returned to the pre-Vasco da Gama period in theory. The coming years will see this worked out in practice.

Obviously, the West will fight back and attempt to keep the existing order more or less in tact. Chile, Greece and Vietnam are not isolated examples, merely the more gla-
ring examples of the struggle of the Northern Hemisphere to preserve as many nations as possible within the frame­work of the Western capitalist system, spear-headed by the United States. Therefore the demand of the new nations in the Charter of Economic Rights and Duties, for "full perma­nent sovereignty" of every state over its "natural resources and economic activities", including the right to nationa­lize, expropriate, and transfer ownership whenever necessa­ry to ensure effective control. It is in this light that the Indian nuclear explosion should be understood. Seen as one more support in the attempt to bring equality between weaker nations and the industrial ones, its political ra­tionale is perfectly faultless. Faultless if we remember Henry Kissinger's surmise that "we are headed for an era in which economic problems and political challenges are solved by tests of strength."

The question is, at what cost. For the United States cannot stand sentry forever garrisoning a hostile world, any more than the Roman legions could permanently hold back the people beyond the Imperial frontier, or King Canute hold back the waves with his royal fiat. But the United States is not alone: both Germany and Japan have proclaimed it their task to continue to make the best use of the merits of the free trading system - indeed, to improve and strengthen it. As for the other European countries, they have already acknow­ledged the obvious. Both France and Norway have supported the long-term program of the new nations for an increased share of industrial production, notwithstanding the far­reaching changes in their own economies such a redeploy­ment of world industry would necessitate. The whole pro­blem, the French foreign Minister, M Sauvagnargues, declared, was whether the rich countries were ready to accept "the principle and the consequences of accelerating industriali­zation" in the new nations. The Norwegian representative termed it the "challenge" all industrialized countries must face.
The Chinese have already provided an excellent example of the trend towards which the new nations are determined now to move. They have, of course, obviously been aided here by the influence of their own historical past. The isolationism in Chinese thinking is a quality of Imperial China which was scarcely confronted by the problem of "things foreign" as a result of its own assumed cultural superiority in most fields, which led in turn to a feeling of self-sufficiency and even complacency. The Chinese, for instance, have never pressed their economic development model on other new states, although these days the new nations have themselves come to the conclusion that the Chinese way might have more significance for their futures than the models sold to them by a missionary West. Mao's commitment to a mode of technological development that does not attempt to imitate industrialization as it exists in its present form, but to form a base of industrial activity in spheres where it becomes the leading edge of agriculture, is not, of course, a policy set forth from the Chinese Revolution of 1949; at most, it was after a great deal of trial and error and the Soviet experience of 1960, that the present strategy was concretized: the new nations are merely fifteen years late, but they did not have the advantage that was provided by the Chinese in their context. And it should not be long before the new states adopt the political maxim that foreign trade is only a supplement to internal development. (8).

The vast size of the Chinese domestic market and the availability of most of the important raw materials locally mean that Chinese economists do not have to seek foreign contacts, a conclusion new nation economists have come to see as equally realistic for their own economies. If Lin Piao's policy of striving for "things big and foreign" has only recently fallen by the wayside, one cannot be realistic that the new nations, learning valuable lessons only now, will change overnight. The important thing is that twenty-five years ago, new nation economists and planners
did not think the way they are doing now, which signals in fact a thorough-going revolution in consciousness about strategies, most of the new ones proposed being in fact increasingly divorced from the Western paradigm.

Industrialization and its acceptance as a leading factor in the economies of the new nations is no longer a matter of dispute: most of the new nations at least see the necessity of it, and if this decision has been taken with a view to the circumstances of their cases, and if we grant the relevant leaders concerned the freedom to make their decision about it, there is very little to say, except perhaps indicate how the new nations might just about go into it the surest possible way: here the experience of China is invaluable.

The Western engineer who is also a craftsman will easily understand what follows. The transition from "manufactures" to "modern industry", as Arnold Pacey has so well brought out, may have meant abandoning traditional skills, yet the relatively gradual and continuous transition which was effected in Europe meant that some knowledge, skill and experience was usefully transferred from the older form of industry to the new. In India, on the other hand, some of the older forms were destroyed, and most of the ones in existence today are simply being allowed to go to waste or left unattended, while new ones have then to be planted necessarily on barren soil. Michael Polanyi has beautifully analyzed the meaning of craftsmanship elsewhere, but here the Chinese approach to the problem might just as well suffice.

The Chinese capital goods industry is presently dominated by two distinct groups of firms: one, the recipients of major investment outlays and Soviet equipment imports during the 1950s, including a few with pre-1949 histories of Japanese ownership; the other, smaller enterprises, but much older, and which constitute the legacy of pre-war industrial advance in the private sector. This group received relatively minor infusions of investment or imported
equipment. And in the 1960s, a decade in which economic difficulties and international isolation forced domestic producers into larger attempts to improve quality, variety and manufacturing techniques, it was the second "traditional" group that came to the rescue and established a clear position of technological leadership. Why? The simple answer might be that this group substituted experience for investment and stressed the accumulation of skills in enlarging China's production possibilities - and this accumulation of skills had a remarkable period of continuity, evident in the history of a representative firm like the Talung Machinery Works of Shanghai.

These works began in 1902 and principally used ship repair specialists, who later moved on successfully into textile machine repairs, parts manufacture, and only after that, into the production of complete sets of cotton-spinning equipment. It was the skills acquired by the Talung veterans and other private firms, and by those who had studied abroad or worked in railway shops or foreign-owned factories that enabled a rapid growth and diversification of the entire machine industry during the final pre-war decade (1927-37). It was the presence of these skills that made the transition from repair work to manufacture less difficult than it would have been otherwise.

The new Communist Government, however, ignored these older and smaller units during the first decade, and instead concentrated nearly half of overall industrial investment in 145 Soviet-aided projects. With few exceptions, these were either created anew, such as the Loyang complex, or expanded Japanese-built plants, such as the Anshan steel-works, in which earlier Chinese participation had been limited to supplying semiskilled labour. Shanghai, the center of China's inherited industry, which turned out 22 per cent of machinery output and 19 per cent of national industrial output in 1957 received only three of the Soviet-aided projects and a mere 2.5 per cent of overall investment during 1953-57.
China's second Five Year Plan (1958-62) continued to be drafted with the expectation of continued large-scale acquisition of Soviet blueprints, equipment, and technology, but was disrupted by the sudden withdrawal of Soviet technicians in 1960, of Soviet supplies of petroleum, military goods and equipment needed to complete unfinished construction projects. It was precisely the enterprises and regions that had gained little investment in the 1950s that now rose to the challenge. The petroleum industry, which has achieved a tenfold output increase since 1960 is equipped by primarily converted engineering plants including former textile machine repair works, including the Talung Machinery Works mentioned above, and the old Lan-chou General Machine Works, a provincially managed descendant of a nineteenth century arsenal. The Talung Works, which have pioneered in manufacturing petroleum equipment, compressors, and machinery for producing artificial diamonds, illustrate the continuing innovative success of older engineering firms.

Capital investment cannot be the key to the explanation of why these older and smaller firms have proved more capable to develop new products and techniques: we have noted that investment bypassed them in the 1950s. Nor is the fact that they are small readily relevant, for at Shenyang's Machine Tool Works, a Soviet-built enterprise employing over 5,000 workers, organization is swollen, technical control highly complicated, the potentialities of the equipment and personnel cannot be fully developed and utilized and production technology is not likely, according to Chinese reports, to improve - a situation that exists today with many of India's capital goods industries built with foreign technical aid.

The strength of Shanghai and Tientsin is a matter then of experience. Their veteran skilled workers and superior development of inter-enterprise cooperation enable these old industrial bases and firms to tackle complicated technical problems easier than new enterprises and new industry bases. Further, it is these enterprises that act as technological intermediaries between the mass of Chinese pro-
ducers, whose mission is to attain "advanced national levels" of quality, cost and technique, and the outside world, whose standards become the target of Shanghai's technological aspirations.

Thus, the import of foreign capital goods and equipment may be the quickest and cheapest method of injecting new activities into a traditional economy, but its long-term effects are negative, as it curtails the skill formation process. It also prevents domestic firms from learning to implement new techniques without purchasing equipment. Should exchange problems or political trouble disrupt foreign equipment supplies, domestic capacity to absorb new methods suddenly becomes a constraint on the productive system as a whole.

In China, the sequence of repair, parts manufacture, and full production is encouraged in both urban and rural areas. Former repair shops have begun to manufacture trucks, locomotives, and agricultural equipment. Small rural producers of fertilizer, cement, iron, power, coal and machinery are expected to repair and often even to manufacture their own equipment.

This accumulation of skills, as the preceding paragraph indicates, is not restricted to capital goods industries, where the Chinese in the pre-1949 years did learn a great deal from the West. It has also direct relevance in the industrialization of the rural areas, which means the diffusion of industrial skills to large masses of the Chinese population. A clear case here is the Chinese adoption of the use of vertical shaft kiln technology in most small-scale cement plants. The number of these plants increased from about 200 in 1965 to 2,800 in 1973 and total output increased from roughly 5 million to an estimated 20 million tons.

Jon Sigurdson thinks one of the reasons for the speedy adoption of the small-scale plants is probably the high transportation costs needed to transport cement from large-scale plants using rotating kilns. But he is also keen to observe the impact of these plants on the diffusion
A large number of people are being trained in industrial process technology. A sizeable number of people have, inside production units, received training in organizational skills. A smaller number, but still sizeable have been trained in administrative skills related to the procurement of machinery and raw materials, distribution of products and co-ordination with other industrial units (9).

India's case can be seen as moving in a diametrically opposite direction. Indian experiments with vertical shaft kiln technology thus far have concerned four plants: two have failed. The development movement itself was stalled when larger manufacturers intervened: it is well known, at least in the 1960s as the movement might have been taken seriously, that the Cement Adviser to the Government of India also happened to represent a large Danish cement machinery manufacturing firm in India. (10 Further, it should not be overlooked that many of the proven existing mineral resources for the manufacture of cement have been leased to established cement manufacturers who have obtained industrial licenses for their activities.

Perhaps, however, it is possible to argue that the transfer of technology through foreign firms might at least lead to a diffusion of skills concerning modern, large-scale processes. The evidence, says Michael Kidron, in his comprehensive study, points the other way:

Research and development are invariably conducted abroad; the fruits of development are invariably imparted, if at all, at very high cost in royalties, fees and other payments, and not always in their entirety; through their production and staffing policies the major investing firms attempt to systematize a continuing control of know-how; and much else in the same vein. Since the Indian partner is normally assigned - and readily accepts - a narrowly specialized range of functions, the diffusion of skills that does take place is largely fortuitous. Indeed, since the typical modern investing firm owes its dominance and income largely to its technological monopoly, a different outcome would be surprising (11.)
Sales of techniques or know-how come through collaboration agreements, signed between Indian industrialists and foreign companies and the majority of them are dictated more by the Indian industrialist's eagerness to exploit western technology for quick profit than for any other more meaningful purpose, and more often than not they are meant for the production of non-essential goods: vacuum flasks, lip-stick, toothpaste, cosmetics, brassieres, ice-cream, gin, chocolate, beer, biscuits, dry batteries, ready-made garments, just to give a representative sample. All these are high-income wants in India.

Perhaps, in the Government sector of the economy the situation is different. Who is in charge of the Indian Planning Commission or Indian planning? Evidently, Indians. In reality, foreign experts supplied by international corporations through private or government channels. Multipurpose river valley projects, atomic power plants, flood control programs, agricultural research, geological surveys of mineral and oil resources, town planning, railway expansion, road development, bridge construction - in each of these areas foreign technical experts have been preferred against Indian engineers. The latest instance is the second Hooghly Bridge near Calcutta.

The project report was initially broached by an organization created by the Ford Foundation, and approved by the Foundation's traffic experts. The World Bank prepared to finance half the construction expenditure. The techno-economic survey was done by Rendel, Palmer and Triton of London. Finally, Freeman, Fox and Patterson of London were asked to design the bridge. Germany's LUNA concern was also invited to join in. The fees for all these services: 10 million rupees. The Indian engineer was ignored, not because he has no experience, but because foreign aid for the bridge, as for other development projects, comes tied with the demand that foreign expertise be used. The day when the Indian engineer will have to take up in his own hand most of these projects is continually postponed.
If India is representative for Asia (excluding, of course, China), Nigeria may be regarded as representative of Africa in a similar situation. Nigeria is one of the most advanced of African economies in terms of the investment in technical training and the quantity of trained manpower available. Yet, here too much of this training is wasted. The Nigerian Society of Engineers placed the following advertisement in local papers on September 11, 1970:

The Society is amazed that in a country with two or three Universities producing graduate engineers, most of whom have not been able to secure employment in the engineering field, government officials should continually feel that our development projects can only be conceived and executed by foreign engineers... For instance, the Kainji Dam, the largest engineering project ever undertaken in Nigeria, produced no benefit to the country in engineering manpower development... If Nigerian graduate engineers cannot get employment on engineering projects in Nigeria, how are they to obtain their practical training and experience? We note that the various governments (that is, of Nigeria) are obsessed with the recruitment of foreign engineers. The Society believes that the whole purpose of University education and manpower development will be defeated if concerted plans and legislations are not made to enable young engineering graduates to be assimilated into the economy of the nation by way of "on the job training". The Nigerian Society of Engineers has been endeavouring to get people in government circles to make it obligatory for foreign engineering firms who control the bulk of the consulting, construction and manufacturing industries in this country to employ Nigerian engineering graduates...(12

Contrast the Indian and Nigerian cases with that of the former secessionist enclave of Biafra: what happened with regard to this area's technological development can be shown to have occurred similarly in the European, Japanese and American technological histories. The Chinese, after the Soviet withdrawal, provide a further example.

During the Nigerian civil war, Biafra found itself blockaded from the outside world, thus forcing its engineers and technologists to go to work. The result needs hardly any comment. A broad range of consumer and non-consumer goods were soon indigenously produced, all in small-scale units and at a fraction of the capital/output of equi-
valent installations in Europe or in the rest of Nigeria at the time. The goods produced included not merely petrol and diesel, soaps, engine oil, protein extracts and salt, but even vaselines, chalks and biscuits.

Pure salt was produced with small locally-fabricated units at a cost no more than £3,000 and capable of a little over 10 tons a month. A refinery, the result of a wide range of adaptations and innovations, and capable of producing petrol, diesel and kerosene quantities of 15,000 tons a year was set up with £50,000. The mechanical parts were fabricated and welded on site. The high capacity furnace of the normal high-scale sophisticated refineries was replaced by very simple but effective home-made burners. Compared with a refinery built in Nigeria by Shell-BP, this unit gained as much as 400-500 per cent in capital/output. A large number of home-made "cooking-pot" refineries were begun to produce crude petrol at costs as low as £300. A soap factory, cost £25,000 was producing as good a product as a £1 million, foreign-owned soap factory in Algeria.

The plan to produce cement in small-scale units was ultimately disrupted by the advance of the Federal forces. This inverse correlation between the absence of foreign technical aid and the spurt in indigenous productive capacities is available even in the case of some Indian industries.

Early in 1924, the colonial Government of India imposed a small tariff on the foreign match-making industry in India. The tariff was introduced to protect the local match-making industry. The Swedish Match Company, against whom the tariff had been directed, changed tactics, and began to manufacture matches through two new subsidiaries, with Indian names: the Western India Match Company and the Assam Match Company. By 1945, its eleven factories in both subsidiaries, were supplying 80-85 per cent of the demand. Further, it even continued to provide the necessary raw materials, including wood, chemicals, to the indigenous industry. The small-scale units, mostly cottage-based, continued to disintegrate, until the Government, after independence, intervened to restrict the output of the Swedish units.
The consequences were obvious: cottage industry expanded its production three and a half times between 1949-61. (The problem, however, still remains fundamentally unresolved: Swedish Match still continues to produce three-fifths of total output, and still controls nine-tenths of the production of potassium chlorate, one of the main ingredients in matches).

The second example, concerns Unilever, with an Indian subsidiary operating under the name of Hindustan Lever. This firm today holds the commanding position in the soap and detergents industry. Immediately preceding the Second World War, it was producing nearly one-third of total factory output. It cornered 70 per cent of the market after soap-rationing was ended in September 1950, with the result that the largest indigenous producers were operating at one-half to one-third of installed capacity compared to 94 per cent at Lever. In 1960, Lever was still selling 83,000 of the 152,000 tons produced, the decrease having come about when Lever realized that it would be better to cut down production than to further antagonize indigenous producers. The cut-down resulted in the rise of the indigenous sector itself (13).

For most development experts or élite planners in the new nations, any process that does not use "advanced" Western technology techniques is at least theoretically out of date. The Biafran experience was belittled as the octane value of the petrol produced in the small-units was 80-85, thus not as efficient as "advanced" units. Schumacher would indeed have termed it "intermediate technology". The real question is whether any technology is more advanced than another. If the term "advanced technology" is used merely to refer to a technology suited for areas of high level economic status, there is then no basis for any attitudes which seem to suggest that advanced technology is any more dignified or complicated than technology suited for other areas. The skills and ingenuity of engineers and technologists are needed in each economic area and the task is no easier whether the area is economically advanced or not.

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Each technology requires the same level of resourcefulness and originality.

Further, the initial stages of the development of any productive system are bound to produce problems of efficiency and loss. The first products of any new system are "raw", it took, for example, more than fifty years before the thermal inefficiency of Newcomen's steam-engine was reduced. And if we consider the number of years it took European and American refineries to achieve their present octane values, it then becomes easily apparent that the Biafrans, in obtaining such high octane values in less than twenty-four months were simply better engineers. The same observation might be made of China and its engineers, in a constant race to keep pace with demand. In such a situation, quality and efficiency standards are not allowed to delay production in order to modify processes that may take years. At the same time, Chinese engineers are constantly attempting the greater efficiency of various industrial processes.

We will later examine the "advanced" nature of the Western technological system itself. Here, we are still concerned with how much Western ideas about development still continue to distort genuine development in the new nations. One of the areas in which Western influence leads to distortion is, of course, the rational use of resources. Local raw materials have always a place in any traditional economy where in spite of inefficiencies and poor application, they are however used to some purpose. Any improvement in technology should be related to developing and extending these uses.

On the other hand, a technology introduced from outside usually begins with raw material inputs which do not necessarily correspond with local resource endowments. It starts, in fact, with raw material preferences related to the country in which the technology was originally developed, with the result that not merely manpower lies underutilized, but even raw materials remain unused. Here, again, India provides a clear example.
India has large deposits of coal; in fact, Indian coal is still one of the cheapest in the world. No research was however done on substituting other fuels, like oil, with coal. In fact, the use of oil seems to have been encouraged by keeping its prices artificially down. Three major oil companies still manage their hold on the supply of oil to the country.

The most troubling case of foreign influence however is the New Agricultural Strategy, termed the green revolution. It has by now become obvious that the strategy concentrates on the upper sections of the agriculturists in already irrigated areas (barely 20 per cent of the total) who will be provided with cheap credit to buy fertilizers, pesticides and all sorts of farm machinery in order to meet the food deficit and build stocks at the earliest.

First of all, no one has made any cost-benefit study to show that this strategy is more efficient than the alternative of extending irrigation to newer areas and continuing with traditional modes of cultivation. The latter would raise the productivity of the land, enable multiple cropping, and use more intensively the semi-idle resources of man and bullock power. Moreover, the foreign exchange cost of the latter strategy would be negligible compared to the former. Some studies are even indicating that the second strategy might have a bigger pay-off. Yet, the first alternative continues to be encouraged. Already in the period of farm mechanization in 1968/69, farm mechanization should have reduced the demand for farm labour in the Punjab and Haryana (two of the more famous green revolution states) from 644 to 575 million man-days, a drop of 11 per cent. Further, there is still little evidence that mechanization as such raises output, and apart from the relatively few people engaged in producing and repairing the implements, it has an entirely labour-saving character. Indigenous production of farm machinery has a high import-content, most of the firms being either foreign-controlled or having collaborators abroad. Further, there is a considerable import trade in these goods (14.
This brings us immediately to the significance of appropriate technology. It would be safer, in the very first place, to begin by declaring that our understanding of this important concept does not co-incide with the one proposed by E F Schumacher (15. The latter understands it as a step behind an advanced technology: we have already disputed the characterization of any technology as "advanced". And in the light of the future developments seen as possible in this chapter, it would be perfectly intelligible to propose that the "advanced" technology of the Western nations is certainly backward in relation to the future productive systems that the West must inevitably adopt.

It seems to be more logical, therefore, to examine the ideas of ir Ben van Bronckhorst, whose understanding of appropriate technology falls within the logic of the ideas here proposed. Van Bronckhorst would find little difficulty in accepting our criticisms of the Western paradigm in its relations to other paradigms. In one of his discussions on the subject, he wrote:

It has been taken for granted that the historical process ran along one line only, in which some countries were the precursors and others got stuck at the beginning. Development was, without much trouble, equated with scale-enlargement, progressive specialization and increasing concentration. In this framework, intermediate solutions could only be seen as falling back on earlier phases in development: as a sign of regression. And it is precisely this model of development that needs revising.

For it is a model that starts from the principle that the Western countries are in the lead and orders all other countries according to the extent in which characteristics of a western structure are present. This approach actually puts the West in a central position and from there measures the distances to the various other countries in the world. This line of development is indeed no more than a reflection of the approach in which distances to other countries are adapted to a scale that represents the Western countries in the highest degree of development. In observing
this, we have brought to light one of the deficiencies of this development model (16).

Van Bronckhorst has also suggested that the coincidences of different characteristics determining the Western productive framework (for example, high-energy usage and high degrees of specialization) are no indication that they must always go together. It is possible to envisage, both from historical and theoretical models, that low levels of energy usage could be combined with high degrees of specialization. But there are numerous other possible combinations available in what he terms "the solution-space for human existence."

More important, he accepts the fact that the changed circumstances involving raw materials from the new nations and the energy crisis make inevitable a number of changes in the technological system of the West itself, thereby dismissing the negotiations of raw material prices with the aim of stabilizing them as a long-term irrelevant issue, with which this last chapter of our thesis agrees:

The search for new ways is not restricted to the countries of the third world but certainly involves the rich countries themselves. It is essential to indicate case by case in what direction the solution must be looked for.... This has given the discussion of techniques a new shape: the issue is no longer the contrast between modern and alternative technology, but the necessary technological development needed in each country (17).

His description of "appropriate" technology is obviously more realistic than Schumacher's, because it clearly denotes

the fact that we are dealing with a connecting link, a technology that makes it possible to change the present situation into a more desirable one (18).

In other words, appropriate technology does not so much deal with technology so much as it deals with the way in which a solution may be found. It is therefore the result of the historical process. There is no question of going back to an out of date past.

Yet, after the conclusions we have already drawn in
the earlier portion of this chapter, it would indeed be remarkable if we did not find some crucial points on which we might disagree with the Eindhoven engineer, who more than any other Dutchman, has probably spent more time on the entire appropriate technology issue. Van Bronckhorst still believes in some kind of "transfer of technology", which means he sees some need for it. We have argued to the contrary, for there are in fact very few reasons to encourage this channel of action. We might sum up the negative reasons as follows:

It is important to remember through which channels technology is transferred to the new nations today: multinational corporations and private industry generally from the West. It is inconceivable that such agencies, who care little beyond the maximization of their profits in selling the technology over which they have monopolies (through the patent system biassed in favour of the West), have the welfare of the poor of the new nations in mind. Further, little of this technology can solve the problem of poverty. There is no reason to go over all the other reasons again.

The more important reason, however, is that transfers of technology, even expertise, even the idea that the poor should continue to expect aid "from the white gods from over the seas" cripples technical capability among the peoples of the new nations. The fact is that the transfer of even relevant technology therefore has inverse effects. Perhaps, the cardinal argument against transfer is the fact that there are unemployed technicians in the new nations. Why then is it reasonable to train Westerners to go to work in the developing countries, for them to "acquire insight into the nature of social systems, the ability to work with people of an entirely different culture, and the ability to live in circumstances that differ strongly from those of the West", when our unemployed technicians are already one-up on such secondary training?

Finally, it is a fact that development workers from the West have created more damage in their well-meaning efforts in the poor nations than was the situation before
they arrived. Van Bronckhorst is not unaware of this problem: the point is whether he is pursuing it far enough. He accepts for example the fact of the "survival algorithm" we proposed in the introduction:

One could ask oneself whether it is a sensible thing to strengthen a poor economy, and moreover, is it at all possible to help the poor? For in spite of everything they are greatly attached to their current ways of living, and they are right because now they at least know what they have. They have seen many examples of improvements that have failed, and they have learned to trust in this structure of existence since few get a chance to benefit permanently from the richer economy (19).

When Van Bronckhorst argues that there is still an opportunity for trained people to go to the new nations, he is in fact implying that the poor have "learnt" a wrong lesson. The fact is a development worker (with a fat salary) is intent on producing results, increasing risks, changing traditionally-sanctioned survival methods. Normally, he lives in the area for a short time. The people he must work with are interested in precisely the reverse of his attentions. He can afford to experiment with other people's lives: for, should the experiments fail, the farmer is often forced to sell his land, go into debt, and regret the fact that he ever deserted his ways after receiving advice contrary to his best intuitions. Rarely can a development worker with a non-survival algorithm ever confront a peasant with a survival algorithm without ending his term in despair and a few uncomplimentary adjectives about the people he came all the way over to help.

We have often tried hard to discover some reason for such persistent tendencies or the continued belief that "transfers" of the knowledge and skills Western technicians have somehow "must" be. It is certainly not true that the reasons have been proposed on purely theoretical grounds. Far from it. It is the practical experience of poverty of every Westerner involved in the larger world of the new nations that is probably the root-cause. In one way, it a continued testimony to the fact that human sensiti-
ty has not been lost. In another way, it might have dan-
gerous results.

For the political attempts by élites to keep their
own peoples in poverty through neglect or repression is well
know. Willem Wertheim has devoted pages to his discussion
of the issue (20. But it is precisely because Westerners
and other well-meaning people are prevented from effecting
political solutions, that they are forced to adopt the al-
most classical Utilitarian ideology of attempting to solve
political problems through technical means. If the poverty
of the industrial revolution could only disappear through
the struggle of the lower classes, why should it not be
possible for the poor to bring their élites to task? And
have people in power ever been unhappy when strangers came
over to do their dirty work?

The conclusion we can now propose is not to be un-
derstood as a solution to the technological problems that
involve the new nations, but more as a kind of necessary
pre-requisite for some new thinking about these problems -
there are in fact so many solutions, and if they have in
large part collapsed, this at least is not due to any lack
of their being widely publicised, but that they were mainly
invented without the relevant people having participated in
that process. Our conclusion to what has gone in the prece-
ding pages might be summarized as follows:

To the measure that the new nations increase their
dependence on the foreign technological system, they
proportionately diminish the technical abilities of
their own peoples.

This conclusion goes not against the West itself,
but against Western interests - who have an interest in the
perpetuation of the state of technological dependence, parti-
cularly, in regard to the technology they have to sell in
the large markets of the new nations. (We exempt the West
itself since we believe that the West is based on the prin-
ciple that nations have the right of self-determination. A
good example is the American War of Independence against
British control).
Thus the issue of a continued transfer of technology dissolves into irrelevance. The RIO report of Jan Tinbergen, one of whose proposals includes advice to the transnationals to begin relevant research for new nation development, contains a prescription worse than the disease - as we noted earlier, it presupposes that only outside aid can continue to finance development and implies that useful technical capacities among indigenous peoples are lacking.

THE NEED FOR A NEW GROUND-PLAN

This brings us to the other principal element of our homo faber model: thus far we have restricted ourselves to examining the issue of technology, how best the technical capacities of the new nations might be deepened, and the movements of these new nations in that direction. It now remains to examine and discuss the importance of culture in this general development. For, once the monopoly of the West over technology is restricted, the event will create legitimate problems at the level of ideas, and the world of learning will never again be the same, having entered a new phase, where the question of what constitutes knowledge and history will find as many answers as there are cultures.

In their great eagerness to "catch up" with the West, the new nations we noted tried to take over the means used by the industrial nations. What is not so easily realized is they also took over the goals of the societies or models they set out to imitate, resulting in a de-valuation of a faith in their own values, culture and civilization. To put it differently, the normative structure of the West was sought to be inculcated, and more often than not, this structure of norms went directly against the grain of what the new nations had inherited from the past. This disrupted their possibility of preserving their older culture and their ability to create newer adaptations in continuity with the old. Further, once the normative ideals of the
West were adopted or seen as superior, it became necessary to force people to adapt to the allegedly superior culture.

We have, in this thesis, tried to make an indirect distinction between the actual history of the West and its recent advances to power and the presentation of the Western paradigm by Western intellectuals and scholars. What are the key elements of this paradigm as proposed by men of learning?

In the most general terms, and following Louis Lefeber, the West sees its development as having required the transformation from a state of rural, agricultural underdevelopment to the dominance of an urban industrial sector. "As urban industrialization accelerates, the relative share of agriculture in the total labour force and in the national product decreases. Higher wages rates motivate migration from rural to industrial urban areas which, together with capital investment in agriculture, increases the average productivity of labour in agriculture to levels approaching those obtained in industry." (21. This pattern of sectoral change has been similar to all nations currently considered "developed": a continuous absolute and relative growth of sectors unrelated to agriculture with a concomitant population transfer from rural to urban areas.

Admittedly, this is merely the basic structure and there are a host of other elements needed to complete the overall picture. In the first place, this sectoral change is seen more or less as a matter of conscious design. As Rajni Kothari observed, the seeds of progress are seen as being sown with the rise of modern science and rationalism in Western Europe, and its intellectual flowering in eighteenth century "enlightenment". "Everything that followed was an unfolding of the enlightenment - the commercial and industrial revolutions, the growth of representative institutions, rational bureaucracy, the egalitarian ideology, the socialist state, the modern city and its culture."

Max Weber, as a sociologist, would introduce the concept of "rationality" in order to define the particular form of ca-
pitalist economic activity, bourgeois private law and bureaucratic authority. Parsons' alternative-value orientations we have already seen in the introduction.

More significant for identification of the Western paradigm is the economic and technological system of the relevant nations. Economically, the West believes it owes its success to the efficient operation of the free market system, and therefore, private enterprise. As far as technology is concerned, Western technology is seen as the most advanced, supplanting all other modes of production that have preceded it, particularly since the Western invention of the art of invention itself: scientific technology.

Western medicine is identifiable with the unifying principle of allopathic medicine, whose philosophy proposes the treating of illness by counteracting the symptoms of illness. Further inventions that characterize the particular nature of the West is its invention of childhood, the educational system in which children lost of earlier functions, must spend long years of their life to be prepared to take their role in their society's life and system. The political system of the West favours the democratic consensus; the philosophical foundations of the West require that the individual be free to undertake his own purpose; psychologically this involves allowing the individual to develop his own personality to the full. This in turn is based on a more essential base in philosophical anthropology, where the individual claims for himself a historical identity, apart from those about him.

The Marxist view can be closely identified with this framework. If the aim of science is to discover laws independent of human will and determinative of it, it follows that ascertaining those laws (that presumably determine human will), will allow those having technical knowledge of these laws to apply their knowledge in a technological way and to formulate the problem of social change as a technical problem. Here both the Western and the Russian paradigms converge.

Left to itself, such a paradigm or the Western un-
derstanding of its own development experience, might hardly have created problems. However, the West found itself facing a host of nations that in their constitution hardly approximated to its own image of itself. And, if in 1500, the European nations had begun a century of wonder on meeting Asia face to face, in 1950, Asia had begun a similar quarter-century of wonder as it observed the wealth, power and technology of the West. In relation to that picture, the new nations found themselves, and were taught to find themselves, backward, traditional, underdeveloped or developing societies.

Much of the messages of Western culture came through the educational system and preached the view that local cultures were incompatible with the productive system the West had evolved. In the words of Ivan Illich, the education system, the media and a host of other influences "schooled" members of the new nations in the dominant ideologies of the West; the means the West used, to take just two examples, education and medicine, were sought to be widely disseminated in the traditional cultures. Traditional medicinal systems, with their non-Western approaches were dismissed as quackery. And the idea of making everyone literate ignored the question whether literacy was a precondition of development. Certainly, it was not so in the industrial revolution, which was an empirical creation nor in the Chinese revolution itself. In the process, traditional forms of transmitting knowledge were disintegrated. The African, for example, is a member of a rich oral culture, in which a three-dimensional diagram is preferable to the conventional plan and cross-section technical drawings, yet he has been forced, though culturally unprepared to use technical drawings. But this as a direct result of the idea that if the African worker is unfamiliar with any technical tradition, the best thing to do is to change him to meet the needs of Western technology. That the technology might itself have been modified to suit his needs was ignored.
Technical assistance for new nations in education, community development, youth leadership, has more often than not been accompanied by a propagation of liberalism, individualism and the personal freedoms of the West. The fact is most of the cultures of Asia, Latin America and Africa have long traditions which endorse the primacy of communal approaches to work and life. Thus, a lot of the criticism of the West against non-Western cultures and their approaches is misplaced. China has replaced the individual entrepreneur with the commune itself as an entrepreneur. Individualism has little history in China, where traditional culture has always felt that the individual finds his identity in his family relationships: without his family, he is nothing, a psychological cipher. The commune has merely replaced the family, albeit on a larger scale. There is no question here of the hope that the Chinese man will one day be liberated into personal freedom. There is merely a question of the inability of the West (in its criticisms of Chinese totalitarianism) to understand that men in other cultures might find their psychological selves in other ways that the West might find necessary for its own.

Western democratic systems are what they are - Western. Other cultures should be free to determine their own political means of self-rule. After Chile and Greece, it is difficult to imagine the supposedly most democratic nation in the world as fighting to make the world safe for democracy. And after the recent revelations of corruption, black-listing of leftist elements, etc., in the United

*The irony involving the sixty-strong CIA team in Athens that considered it more important that Greece could be a bastion against communism than that its democratic Government should be preserved (in the very birthplace of democracy) lies further sharpened with the following quote from a letter of President L Johnson to the Greek ambassador, protesting the American plan: "Listen to me, Mr Ambassador. Fuck your Parliament and your Constitution. America is a elephant, Cyprus is a flea. Greece is a flea. If those two fleas continue itching the elephant they may get whacked by the elephant's trunk, whacked good". See, Times Literary Supplement 1976:952.
States, it is difficult to see how the West might act as the moral arbiter of the non-Western world. Our next conclusion is as follows:

The displacement of the West in its monopoly over the productive process, will be accompanied by its displacement in its monopoly as the arbiter of what is proper for the new nations in the realm of culture, ideas and ideals. Cultural paradigms are value-systems. One paradigm may not be criticized through the criteria of another.

In other words, the period of ethnocentrism in the realm of ideas and in the determination and constitution of ideas is over. It has no place in scholarship, and itself leads immediately to the second, the closing of all options for the future in respect of basic configurations of political structures and policy choices. This closing of options must be seen not only in respect to space (the new nations) but also time (future generations in both old and new nations).

A clear example of such ethnocentrism tyrannizing historical possibility is Murphey Rhoads, when he notes that "without urbanism the industrialization which Chinese Communism so determinedly wants is literally unattainable". More examples have already been discussed in the introduction. But this chapter can be expected to present a more comprehensive view.

A large part of our criticism of the Western paradigm has already been accomplished in the preceding chapters and in the main it has had to do with the intellectual presentation of the Western understanding of the world. Thus, we have concentrated our critical review on Western studies and attempted to point out that a large number of such works betray an embarrassing ethnocentrism and are, therefore, from the point of view of objective scholarship, unreliable. In fact, we have had to collect most of the material on non-Western technology from non-western works - there is scarce material in any Western histories, though these parade often under the title of universal or world histories.
We have shown this to be true in the field of the history of technology itself, where a wealth of material on non-Western technologies has been ignored, giving the impression that there has been but one essentially important and superior mode of production, the Western one, that if others existed, they were merely footnotes. This is being hardly objective. It is a historical fact that for four thousand years (and now with Thailand, even more) the non-Western world has provided itself with technologies that can with little sense be termed Western. And it is a contemporary fact that a large part of the non-Western world even today engages its primary needs without any of the elements of Western technology.

A scientific theory that does not take into consideration as many facts that are available as possible is generally unacceptable. It is time to propose that a work that deals with the history of technology, but which is merely a history of the technology of a part of the world is certainly no history of human technics and certainly does not deserve the title of A History of Technology. This proposal should be seen as extending to histories in other fields. A History of Ethics (which ignores the fact that China, and not the West, has been the most ethical civilization in the world, is unimaginable, but has been written and published.

That Western students at Western universities, studying such restricted descriptions of the past are not being provided with more objective information is not the problem of this thesis - though it is a problem that only Western students might have to solve. We wish merely to indicate a situation now appearing in universities and with scholars in the new nations, who have been educated in Western ideas of objectivity, only to find on opening Western works that these are hardly objective themselves. The recommendation of the English philosopher, David Hume, (albeit in another context) is increasingly becoming the recommendation of new world scholars in relation to Western
When we run over libraries, persuaded of these principles, what havoc must we make? If we take in hand any volume; of divinity or school metaphysics, for instance; let us ask, Does it contain any abstract reasoning concerning quantity or number? No. Does it contain any experimental reasoning concerning matter of fact and existence? No. Commit it then to the flames: for it can contain nothing but sophistry and illusion (23).

This is all very well, of course. But does it help matters? The raising of a host of questions about the more wholesome documentation of ideas is after all an élite question, and anyone evading the élite question: the government of the new nations by self-interest élites, is ultimately also evading one of the central problems of the poverty of nations. When men speak of the Third World in general, of the need for the new nations to work towards self-reliance, of new solutions and strategies to tackle poverty, they normally ignore the élite question, although it is more than evident that these élites have appropriated most of the benefits of "development" over the past twenty-five years, are the key channels for the entry of the multinational corporations into local economies, and in many countries have begun to use the power of Western arms to repress their own peoples.

We have therefore consciously evaded the proposing of any facile solutions to the poverty of the new nations, for we do in fact believe that the most beautiful proposals have indeed been proposed and yet may not really make a dent into the problem, as long as the élites continue to possess the abnormal power they have today, and the West in many direct and indirect ways is interested in their further continuance. This should not be taken however to mean that we disprove of the new moves for greater solidarity among south Asian nations, new proposals for an independence press service, a new Third World Bank and other mutually beneficial institutions. We are interested in movements that will first weaken monolithic powers: a new Third World bank, for example, cannot be expected in any conceivable
terms to manipulate the further control of its creditors by the Western capitalist system.

The élites, however, are all cognizant of the situations that increase tensions and decrease their control. The increasing import of arms by the new nations is an indication that pressure among peoples ignored by the élites is gradually reaching explosive proportions. The élites are also conscious that the non-implementation of more realistic policies that give precedence to the development of the countryside will increase migration to their overcrowded cities, further unemployment and tensions; these could lead to anarchical political situations which have in the past destroyed élites.

Further, one should not underestimate the possibility of more and more members of these control groups deserting the cities and focusing more and more of their attention on the rural areas. Twenty-five years ago, a technologist would have laughed at the idea of improving the efficiency of the bullock-cart. Today, there are Institutes of Technology that have begun to be concerned with this and related rural technological problems. The younger economists filling the seats in the Indian Planning Commission begin their discussion on the basis that the Western paradigm is irrelevant to any realistic approach to India's economic problems. Indian political scientists, including American educated Rajni Kothari, have come to the conclusion that Western-style democracy is totally inappropriate for India, and have now begun to propose new political forms of decentralized government, albeit that development at least has come a bit late in the day.

But there is also need of a frontal attack, which could most easily be effected by indirect guerilla warfare: choking the cities by making the villages more self-sufficient. It is also recognized that the more the rural areas offer possibilities for better employment, the more people will stay in them instead of migrating to the cities. Alternative, but indigenous medicinal systems, based on a more comprehensive preventive system of
health, will cut into the power of outside concerns. This aspect of confronting multinationals has not been sufficiently assessed. Once the West is given up as a model, the possibilities for alternative choices are tremendous.

These problems of the rural areas will have to be tackled by Indians, not foreigners. Since the political nature of some of the more important issues is obvious, they are the only possible agents of realistic change. Most of the efforts will be concentrated on removing the barriers that make the poor less productive—and once the poor are convinced that they can indeed benefit from a new situation, they will accept it, especially if their intuitions (which are the ultimate test) allow them to feel they might be better off on long-term bases.

It is precisely such a situation that links the condition of the poor with that of the unemployed and a sizeable majority of people in the Western nations also interested in fighting power interests in order to bring about a more human world and a more gentle technology. The number of Westerners who have come to regret that their societies ever placed their economies higher than man himself, and that in such a situation, man will be the loser, is not to be underestimated. We are conscious that people all over the world would prefer to work towards making man's potency more fully manifest, so that men might then make their history consciously rather than blindly.

The followers of Marcuse might claim that the proletariat of the industrial countries have had their fires defused and been accommodated into the attractive lure of a capitalist-induced, consumer economy, and they may in fact be right. But such an occurrence, hypothetical or real, has happily been followed by the rise of militant non-poverished groups. The Dutch contribution against the United States in Vietnam is known all over the world. So is now the famous Nestlé case, where a militant group ultimately paid a mere 300 francs to devastate the reputation and force a change in the tactics of that international company. Here, it is easily seen that interests coincide, and
can form the basis for further cooperation in the coming struggle to tame the power of the transnationals.

Coercing the transnationals to be answerable to the peoples of the nations in which they are based will remove one more obstacle standing in the way of the poor being able to help themselves. Ben van Bronckhorst has put the matter quite strongly indeed:

In general, however, I think it reasonable to ask that the institutions of scientific and technical education should show a sense of responsibility for poor economies in the third world. They may do this by helping to stop activities that further impair the poor economy, or at least by showing their students to what extent the western network is capable of interfering with the existence of the people, without necessarily producing any change for the better. So in addition to carrying out direct activities, these institutions must also work indirectly. Contributing to the establishment of socially appropriate technology therefore means omitting certain things as much as doing others. (24)

It is no longer an irony therefore to discover that those who have argued for a socially appropriate technology for the new nations, have had to end up arguing for a socially appropriate technology for their own societies. The only question is whether the decision to initiate change and to propose the kind of changes needed will come from the technicians or the non-technicians. Engineers and technicians will naturally tend to opt for the first alternative. Van Bronckhorst, for example, seems to favour the first approach when he notes that the reason why engineers cannot carry out any realistic technology assessment is "lack of the necessary data", which implies that once the data are available, once the social sciences have matured enough to collect it, the technicians might be able to better assess the appropriateness of their activities.

Engineers and technologists, however, by this approach rarely touch the deeper issues: the distribution of power, the concentration of it in the hands of private interests or concerns. The politics of technology therefore
often turn out to reinforce the status quo and the question remains: who is going to impose solutions and where are the politics to promote their imposition? How does an engineer help separate the aims of a democratic society from those of private industry and make the former control the latter, especially if the engineer is himself a part of private industry's network of relations?

As an example, take the environmentalist movement, which did not face the issues in these terms. What has been the actual result? The promotion of government bureaucracy, especially at the federal level, if we have the United States in mind. The private companies have in practical terms already captured this bureaucracy which had been set up to supervise them. For, as it turns out, only a large corporation has the resources to finance the economists, lawyers, lobbyists, tax experts, and so forth necessary to guide it through regulatory obstructions. In short, environmental regulations and laws tend to provide merely the refinement of the system under which the corporations dominate the state.

Charles Bettelheim has made a detailed analysis of the manner in which the Chinese people have gone about bringing their technicians under control. There is much indeed to learn from the Chinese system of bringing popular participation into the tasks of management and planning. How much control indeed has a person in a Western society any control over what goes on in the laboratories of the productive system of which he is a part?

RUMINATIONS ON HOMO FABER

If I have repeatedly turned to China, this is not because I think that the Chinese have answers to all the problems we face; nowhere too would I wish to propose the replication of the Chinese paradigm with regard to the other nations of the world. Neither the Chinese nor the West has any monopoly about the way the world should be; or, in the long run, about
how life may be lived.

What I do appreciate about the Chinese paradigm is its revolutionary perspective about the role of people in the evolution of a society and its goals. There have in general been two major approaches to this issue: one has been direction from above, the other, participated direction from below. In the latter case, participation from below is merely another phrase for the horizontalization of the members of a society. China tends to the second alternative, and I tend to it too: Roland Berger has emphasized the very early nature of the Chinese trend:

In his August 1945 speech Mao Tse-tung used the phrase tzu li kong sheng which literally translated is "regeneration through our own efforts." This more accurately conveys the true meaning of the policy than the term "self-reliance". "Regeneration through our own efforts" also makes it clear that this is a policy radically different from "self-sufficiency" or "autarchy". It is in fact the mass line applied on the economic front and stems directly from Mao Tse-tung’s consistent emphasis that "the people, and the people alone, are the motive force in the making of world history" and that "the masses have boundless creative power".

China has, indeed, more than any other society, released the creative capacities of its people. Within the space of a mere twenty-five years, this country has passed through its industrial revolution without any of the suffering that accompanied other nations while they underwent or undertook the same process. Chinese creativity means, in real terms, their capacity to invent and carry through the goals they have decided on, on their own terms, with little interference from outside.

What about Western society? Who creates? Who decides what should be produced? The free market. The Economy. Western Governments seem to be concerned with these, not with more crucial problems, which by definition, are secondary. It is significant that even today the worker movement is more agitated about the division of profits than deciding the kind of goods they should be
producing. So we have forty-per cent of the world's best technicians engaged in the production of weapons to kill. This is the largest industry there is; it is also the only industry that is so secret that to talk in terms of democratising it is also to talk in terms of destroying it. Yet, the arms industry brings large increases in comfort and wealth to the people of the industrial nations. And our civilizations have atrophied so deeply in spirit that we can continue to prefer wealth and comfort to the enhancement of life.

At one side of the spectrum is the engineer engaged in the destruction of human life, at the other end, is the survival technician, engaged in the preservation of his life: the two are already meeting as the Western world and that other megamachine, Soviet Russia rush arms to new nation governments increasing-ly resorting to violence to quell the despair of their hungry peoples. Is this civilization? Or is this madness? If this madness is a human creation, then it is possible to dissolve it through human means: why is that not coming to pass? Can the engineer from the industrial nations and the survival technician, both human beings, only meet as dogs of war?

Perhaps, the answer to that lies in the fact that we have simply ignored how half the world lives. In Indonesia, the old saying: the man who kills, also kills himself, bridges the gap. Needham is right. Has Europe invented any symbols for a new world? Or have we to look for them elsewhere? But the way history has been written thus far has precluded our looking elsewhere, for this elsewhere was never European and was therefore never important, even never quite human perhaps.

As Barraclough once said, we are at a watershed in history. The old world is past, the old way of looking at life is past. Barraclough, however, does not quite go deep enough: it is all very well to extend one's
canvas: and as we have argued in this thesis, that is necessary and must be done. Yet, even after that task is over, I am afraid that we will still have no idea of how one-half of the population of the world lives. What is worse, they might just about have some very good answers.

If, with Geertz, we have practically demonstrated in the writing of this thesis, that an adequate understanding of new countries demands that one pursue scientific quarry across any fenced-off academic field into which it may happen to wander, right now, here, I wish to go beyond even the field of academia itself: that, for example, if we wish to define what technology is, we begin with a study of what exists all over the world, the production systems used not merely by the West, or by China, but those used to support the everyday lives of people left to their own devices. If after more than two centuries we still can keep to our restricted box-eyed perspectives, then we have not learnt very much during and after that long period, when people looked at every object and human being through the perspective of a single culture. Here the Chinese are a great help, especially if we examine what has happened in such an academic field as Chinese archaeology.

People have been exposed to the view that the Great proletarian Cultural Revolution of the late sixties was a devastating experience for Chinese archaeology. The Red Guards did indeed shout of smashing every relic of tradition associated with the old emperors and their concubines, and everything tainted by the West. Was it indeed, as most Western scholars were ready to believe, the virtual end of Chinese field archaeology? It was decidedly not, thanks to the Chinese genius for reversing not merely their past, but the interpretation of their past. Writes William Watson:

The anger about the imperial past had spilled over
into threatening demonstrations against some imperial sites and treasures, but it had steadied and been channelled into a more constructive attitude: that the treasures of the past demonstrated the ageless skill and genius of the working class who made them, not the genius of the emperors who had enjoyed them.

The message had indeed turned on itself: China's past belonged to the people and it was the people of China, the workers, peasants, soldiers and archaeologists who would take a concrete interest in preserving it. The Yukang Cave temples might have spread the message of religious superstition which helped bolster the feudal regimes. However, as great works of art and sculpture, they occupy an important position in Chinese present history. They reflect the superb creative talents of the labouring people of ancient China and remain priceless relics for critical study and assimilation.

Is it possible to bring about a similar attitude to the technology of the majority of the peoples of this world? That survival technology we have spoken about, is it possible to devote more attention to it than we have in the past, not because it may be improved, but simply because it has fulfilled some purpose in keeping so many people alive, and at the same time, has involved so little damage of nature, so little harm to animals and man?

We need then (and very badly, too) a completely revolutionary way of studying and appreciating technology and culture. Each system of production has its own value, provided it does not exist on the continuous disruption of other systems of production, of processes, of being. Every value system in turn, presupposes a mode of production, otherwise it would cease to exist. From a technology and culture, there must be a bridge to technologies and cultures. Not only human cultures; nature is a culture herself, the Mother of invention and engineering, as Paturi has so eloquently shown; nature in plant and animal. And human. Everything teaches and creates. The Tao is nothing more than the interconnectedness of things.
SUMMING UP

There have been different levels of argument in this thesis.

In the first place, we began by indicating the existing frameworks for our understanding of technology and culture, too exclusively oriented to the Western paradigm. The Western paradigm of human, social and technological development is what it is - a paradigm, a view of a part of mankind, prepared by a configuration of experiences in England, then in Europe, at a particular stage in history. I should not be misunderstood. While I would strongly deny that what other societies need is more of Western technology or culture, I have no reason to neglect the fact that the Western experience contains a few important lessons that the new nations embarking on an industrialization program out of choice, would do well to remember: a simple fact, for example, that the transference of skills from craft to machine manufacture in England took long periods of time, and that therefore, in no sense can the technical problems of the new societies be solved if they continue to rely on Western engineers doing their work for them.

The appearance of the reaction against the Western paradigm is not fortuitous. Two hundred years ago, the now-industrialized nations set about appropriating to themselves the monopoly of production and soon after that of culture, their culture. Before that, the ex-colonial nations neither had need of the goods nor the wisdom of the West. In the coming quarter of this century, however, it is possible to see the monopoly over technology and culture being increasingly eroded.

For, the re-establishment of the ability to produce for physical needs will be accompanied by a similar re-establishment of the right to culture and the world of ideas, including the determination of what constitutes knowledge. Here too, as with the skill-lesson we just mentioned, a similar issue holds. The new nations would be better off renewing their own institutions or philosophies or adapting them to face new situations, instead of attempting piece-meal transplantations of Western institutions and ideas.

The new nations have everything they need, techni- cally and culture-wise to meet their own challenges: they even have their own raw materials. Therefore, the colonial argument that sets to make the West guilty for the present situation is finally rendered irrelevant and no longer holds. From now on the new nations are on their own: any responsibility for failure should rest squarely on them.
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After a long prelude, a lengthy introduction and a practically limitless thesis, the afterword will be brief.

My stay in the Netherlands would not have been as pleasant as it turned out to be, had I not been befriended by a number of extraordinary Dutch men and women. I cannot name them now, for they are too many even for the space of this page.

Permit me then to dedicate this thesis to the people of the Netherlands, whom I have come to love as much as I love my own.
STELLINGEN

I The increases of population in non-Western societies cannot be attributed to the impact of Western medicine.

II Literacy is no essential or necessary pre-condition for a society engaged in a development process.

III The arms industry is incompatible with the framework of a democratic society. The two are inversely related.

IV The analysis or interpretation of an alien culture's meaning system can only be a prelude to an understanding, not a judgement of it.

V To talk in terms of a world culture in the present context is to make a less meaningful statement than has been up to now supposed.

VI The management of the mind through the mass media in the West is a form of totalitarianism akin to the other, more obvious management of the ability to speak in the sphere of politics.

VII The separation of state and church must now be complemented by the separation of state and science.

VIII The "advanced" technology of the West may be considered an advance on its earlier technological experience in the past. This implies that this same "advanced" technology may be "backward" in the eyes of what may be desirable in the future.

IX In no country has a population control program led directly to a decrease in population numbers. Except where such a program might have been accompanied by force.

X There is a catch in this "proefschrift" being written within the portals of a Western university (TH-E). The thesis will be confirmed if it is accepted, in so far as what it predicts has already come to pass in some degree. The thesis will be confirmed if it is rejected, in so far the act of rejection will tend to confirm the criticisms of the thesis.

C.A.Alvares 9 november 1976