Managing the pipeline effectively

MANAGING THE PIPELINE EFFECTIVELY

by

M. J. Ploos van Amstel
Philips International
University of Technology (Eindhoven)

HEADNOTE

Integrated logistics systems can be realistically viewed as a pipeline with delivery to the customers representing the end of the pipeline. Control of raw materials and finished goods in the pipeline is critical in today's competitive environment. Management needs meaningful performance indicators to measure the effectiveness of customer service lead times for the pipeline.

INTRODUCTION

One of the outcomes of the fiercely competitive business environment of the late 1980s has been the increasing attention paid to logistics in manufacturing businesses.

The demands of the customers of such businesses for greater flexibility and faster reaction to changed requirements have forced manufacturers to find new ways to manage their material flows. Concepts such as Manufacturing Resource Planning (MRP), Distribution Requirements Planning (DRP), and Just-in-Time (JIT) have been widely adopted, while the term "Pipeline Control" has become common parlance. The objective of most of these concepts involves reduction in inventory levels, improved customer service levels, greater flexibility in scheduling, greater velocity of inventory through the pipeline and, as a result, greater profitability.

In all this, one key aspect emerging from analysis is the effective management of the company's pipeline -- from incoming material/components to delivery of the end product to the customer. This aticle is concerned with pipeline control in an international context. It starts with a discussion of the concept of the pipeline, followed by consideration of practical aspects of identifying responsibilities and creating the means of control, and finally examples are given that illustrate the importance of performance indicators in measuring and improving pipeline effectiveness.

AN INTERNATIONAL DIMENSION

The necessity to control inventory in pipelines effectively is common to most manufacturing systems. In internationally based businesses the problems (and opportunities) of such management are exacerbated.

This is true whether the business concerned is genuinely multinational or whether it has production centers in a limited number of countries and sales organizations in many more. In effect, in each of these circumstances the company concerned will have many pipelines, each of which needs to be controlled and managed as a part of the whole. The challenges in effectively managing these pipelines are considerable, as are the benefits to be gained from doing so.

THE CONCEPT OF PIPELINE

In many organizations the control of the inventory in the pipeline is the responsibility of either a logistics or physical distribution organization. The definition of Physical Distribution used by our company in this context is:

> All activities pertaining to transport, physical administrative handling, storage, re-packaging, delivery to customers and the management of pipeline stocks -- all relating to both international and national goods flows of finished products, semi-finished products, raw materials and components.

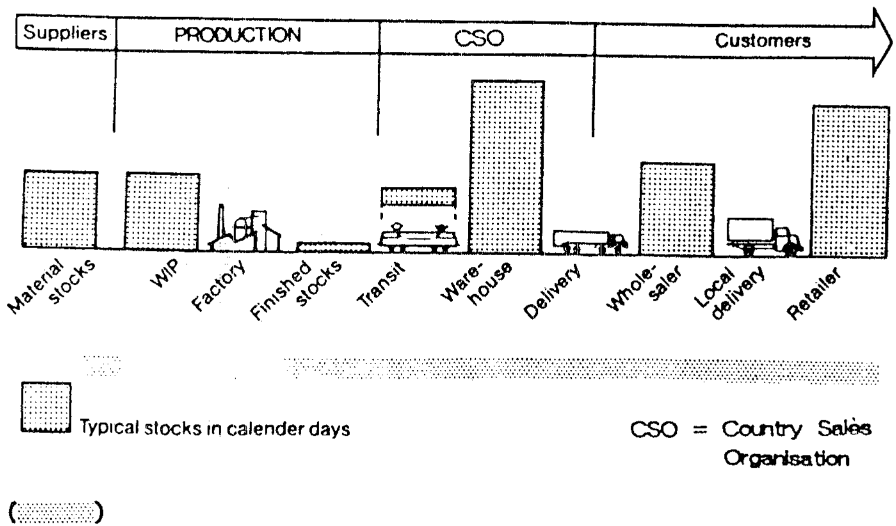
In other organizations such a spread of responsibilities would be considered to be Logistics. However, whatever title is given to the function, its role is concerned with management of the integrated system that is the pipeline.

DEFINING THE PIPELINE

Before discussing the question of managing the pipeline, it would be helpful to define what is meant by the term in the present context. A pipeline is the

FIGURE 1

THE PLACE OF PHYSICAL DISTRIBUTION
IN THE GOODS FLOW CONTROL



physical goods flow from the supplying organization to its customer. Thus, as shown in Figure 2, it covers the time from when the finished product is available for shipment in its required condition until it is delivered in acceptable condition to the customer and is recorded as being so.

Controlling the Pipeline

For control purposes the pipeline can be divided into three elements. For present purposes these are termed:

1. the loading element;
2. the transit element;
3. the receiving element.

Figure 2 illustrates the span of each of these elements.

Point A is the position at the end of the production process where the product may only proceed to the next point (B) providing that it meets these four requirements:

1. The product is finished.
2. It has been approved as meeting the necessary quality requirements.
3. If necessary, it has been packed in an approved manner so that it is transportable and will arrive at its destination in the required condition.
4. The product has a destination.

Point B is the date of the actual departure of product en route to the customer, when the sales invoice is prepared and when the customer is informed that the goods have been dispatched.

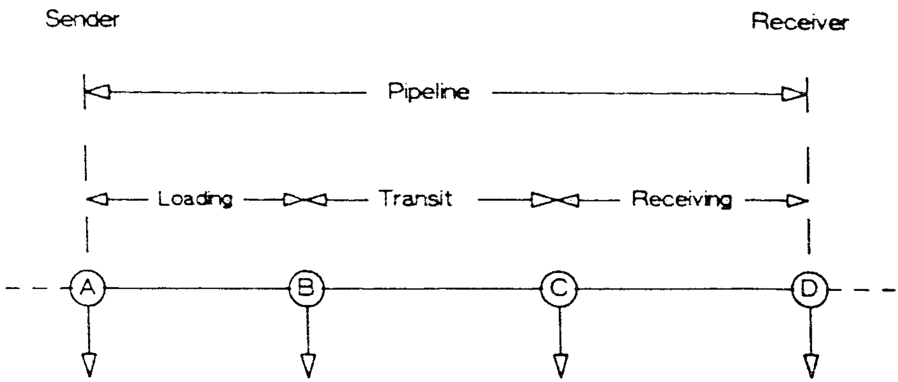
Point C is reached when the products have been delivered to the agreed address in line with the customer's requirements.

Point D is that when the goods have been registered in the customer's system as having been received in satisfactory condition.

The relevance of each of these points and of the three elements connecting them is considerable in respect of measurement and of the pipeline control. As will be seen, many problems occur in the management of the pipeline because generalized measures of total pipeline times are assumed without careful analysis of the variability of the elements and thus of the whole.

FIGURE 2

DEFINITION OF THE PIPELINE STRETCHES AND MEASURING POINTS



Availability date of: •finished products •in standard first protective packing •quality approved •with destination	Date of actual departure of shipment in first means of transport (= invoice date)	Date of arrival of shipment at door of the final destination	Date of registration of finished products in system of receiving organization

EXAMPLES OF PIPELINE LEAD TIME RELIABILITIES

As implied earlier, the reliability of the pipeline lead time is an essential part of integral logistic control. The following examples of lead time investigations in a multinational manufacturing company will illustrate the necessity for careful analysis. The examples relate to:

a. the supply of parts from suppliers located in two different countries to a given factory;
b. the distribution of finished product from a number of factories in the Far East, via a local groupage center and a European de-groupage center to a central warehouse in Europe;
c. the distribution of finished product from a factory in the Far East to the United States in full container loads to the store of the Country Sales Organization (C.S.O.).

Example A

In this case parts were supplied from companies located in two different countries to one factory. Since little was known about the actual lead times of these supply flows, an investigation was instigated with the following results.

As will be seen from the diagram in Figure 3, the variation in lead times was considerable. In the case of the German suppliers, the lead time varied from 0 days to 12 days with the average being 2 days. The lead time from the Dutch suppliers varied from 0 days to 6 days, again with an average of 2 days. Analysis showed that a key factor determining the variation in lead times was the number of transhipment or groupage centers utilized in the transit element of the pipeline. Not surprisingly, the lead time was always shortened when such factors were eliminated or their utilization was limited.

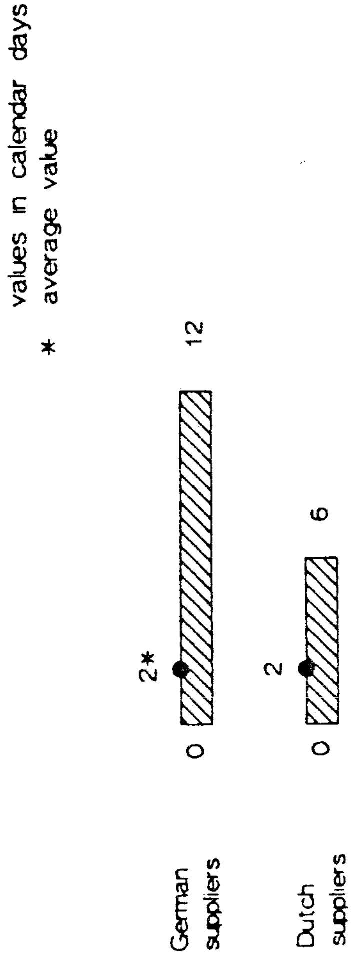
This observation resulted from careful analysis of the actual times of each element and, while the conclusion appears to be obvious, the fact remained hidden prior to the investigation.

Example B

Once again the analysis of this Far East-to-The-Netherlands pipeline example illustrates the negative impact of variability. It also emphasizes the fact that

FIGURE 3

LEAD TIMES BETWEEN SUPPLIERS AND RECEIVING ORGANIZATION



the longer and more complex the pipeline, the greater are the variations within lead times in it. In this example, it was necessary to consider the intermediate points in the transit element. For present purposes the groupage element in the Far East country is omitted from Figure 4.

As will be seen, the goods in this case were sent by air from Taiwan to The Netherlands. On arrival in The Netherlands, they were transported by road to a degroupage center prior to going to the central warehouse. Once again the variations in the pipeline elements were considerable, and the overall result was exacerbated by the fact that the element B to C in the general model (Figure 2) was, in this case, subdivided into four constituent sub-elements.

The first of these relates to the elapsed time between dispatch from the two Taiwanese factories (shipping date) and the departure of the combined shipment from Taiwan airport. On average this time amounted to 4.5 days with a minimum of 3.0 days and a maximum of 6.0 days. Conversely the second element, the freight from Taiwan to The Netherlands, showed no variations.

However the time from the arrival of the goods at the Dutch airport until they were received at the (de)groupage center was shown to be an average of 2.3 days with a variation of from 1 to 5 days.

Similarly, the fourth subelement showed variations from 0 to 3 days with an average of 1.4 days.

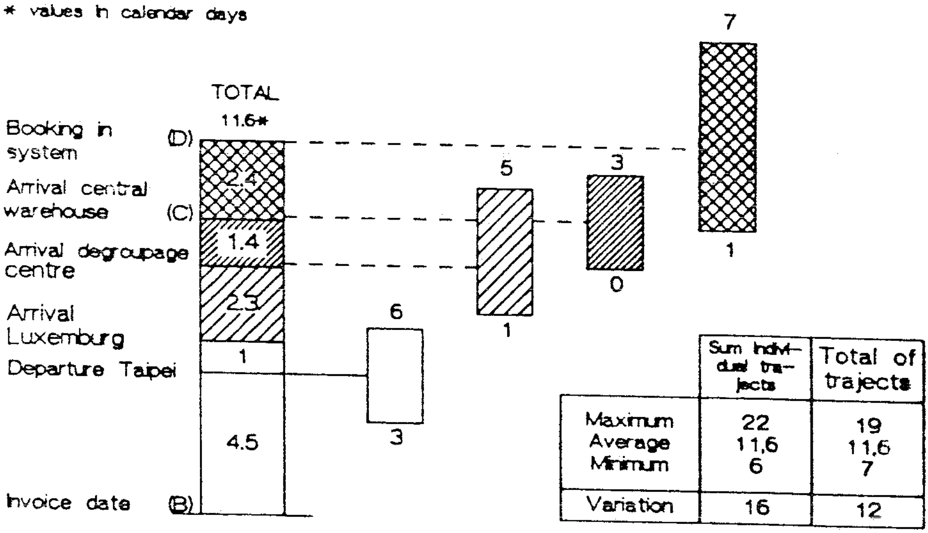
The final element (C-D in the general model) which measured the elapsed time from arrival at the central warehouse until the registration of the shipment in the system of the receiving organization took, on average, 2.4 days. The variation in this case was from 0 to 3 days, which illustrates that few cases of 0 or 1 day were recorded.

What the analysis showed was that if all the worst cases of each element and subelement were taken together, a shipment could be en route for 22 days while the best case would show 6 days. In reality the maximum number of days recorded when a shipment was en route was 19 days with the minimum being measured at 7 days and the average 11.6 days.

Quite apart from the general argument being developed in this paper, an important message that emerges from this example concerns air transportation. The case shows that the air transit subelement was extremely reliable and fast. However, in inventory and cost terms (to both seller and buyer), the true measurement must be the total elapsed time in the pipeline.

FIGURE 4

PIPELINE LEAD TIMES FROM TAIWAN TO CENTRAL WAREHOUSE IN THE NETHERLANDS



	Sum individual trajects	Total of trajects
Maximum Average Minimum	22 11,6 6	19 11,6 7
Variation	16	12

Example C

This is another example involving a Taiwanese supplier, this time sending goods in full container loads to a U.S. destination.

In the most favorable case only 17 days elapsed, while in the worst case 50 days were needed. The variation in the two constituent elements in Taiwan can be explained, in part, because in one case goods already invoiced were rejected in this process. Another reason was congestion at the docks in Taiwan that extended waiting time there. There were no such clear reasons for the variations shown in the element from the U.S. port to the store. Once again, this example illustrates the falacy of considering only the elasped time of transit via the chosen form of transport in isolation.

As has been stated earlier, all these cases emphasize the importance of understanding the elements within the total pipeline as well as the impact of variations upon lead time and inventory management performance. Many customer service problems may be traced to inferior and varied element performance, while the impact upon inventory levels and return on capital employed is always considerable.

CONTROLLING THE PIPELINE

As implied, pipeline control comprises the sum of activities that are designed to ensure that the flow of goods (raw materials, semifinished and finished products) moves as efficiently and effectively as possible. Figure 6, a development of Figure 1, illustrates the various fields of activity in which pipeline control has to be enacted.

To be effective necessitates the selection of the optimum organization of the pipeline, choice of route, and means of transport. Invariably the optimum decision relating to the total pipeline necessitates trade-off decisions being made with respect to the various elements. Thus, what would appear to be the optimum decision relating to element A to B in the general model may be the wrong decision when considered from the viewpoint of the pipeline as a whole.

Further, the pipeline control systems are closely connected with other control mechanisms within the organization(s) concerned. Thus the introduction of certain actions in setting out to control the pipeline will have repercussions in

FIGURE 5

PIPELINE LEAD TIMES FROM TAIWAN TO THE US WAREHOUSE

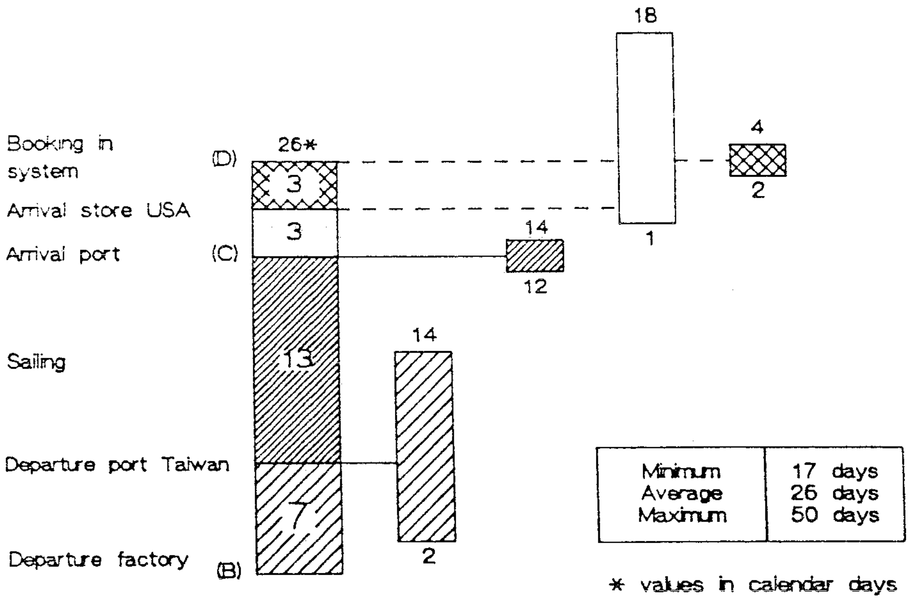
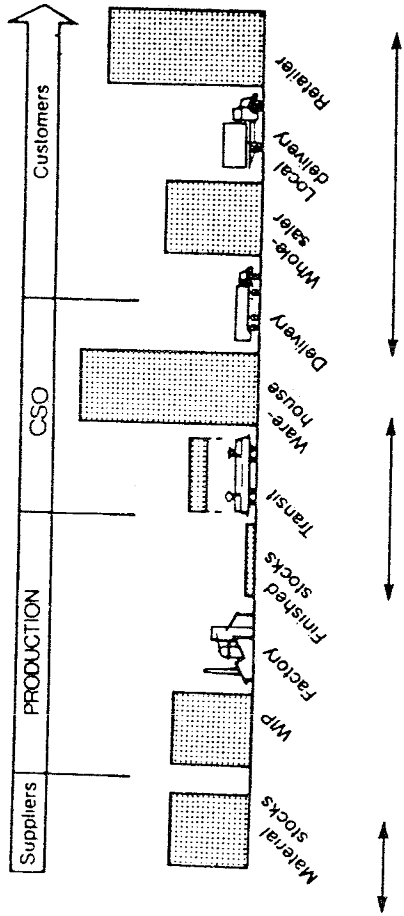


FIGURE 6
THE PLACE OF PIPELINE CONTROL IN
THE LOGISTIC CHAIN



related systems. Figure 7 suggests the several linkages that the pipeline has with other systems.

For example, the data communication system by which information is transmitted from supplier to receiver must be integrated with any pipeline control system. Also, by its nature, the pipeline control system must be part of a cost control system (in the present case relating to physical distribution), while in many companies, the inventory in the pipeline is the concern of the physical distribution function.

A KEY FEATURE

As the cases discussed earlier illustrate, a reduction in the variation in the time that goods are in a pipeline has a direct bearing on the level of safety stock that is considered to be necessary at the receiving organization. The greater the variation the lower the reliability of the goods arriving on time. A direct consequence of this is that extra safety stock is required to help maintain a desired customer service level. A calculation concerning the level of safety stock required has to be related, of course, to the customer service level that is required. The example shown in Table 1 relates to an intercountry rail transport situation. Analysis showed that the lead time varied from 5 to 29 days with a calculated standard deviation of 4.8 days and an average pipeline time of 10.5 days. It was interesting to note that only 50% of the shipments were delivered within this time, although 95% of the shipments were delivered within 18.6 days.

Given the variability in these delivery dates, it was calculated that it was necessary to carry an additional safety stock of 8.1 days in order to achieve a customer service ratio of 95% relative to the average situation (50%). Clearly, if the variation in lead time is reduced, then so will the extent of this safety stock. The extent of the potential savings involved can be calculated if overall stock and turnover are known. Figure 8 illustrates the impact of improvement in a company with a turnover of £55 million.

As will be seen, the company has a total inventory value of £12.6 million pounds, which in terms of the pipeline (raw materials, components, subassemblies, work-in-progress, and finished stock) is equal to 84 calendar days. To put it another way, one day of stock turn has a value of £150,000; thus, the stock (£12.6 million) represents 84 days of turnover. It follows that for each day of inventory which is eliminated, £150,000 of capital will be released. Quite

FIGURE 7

RELATIONSHIP BETWEEN SUB-SYSTEMS IN PHYSICAL DISTRIBUTION

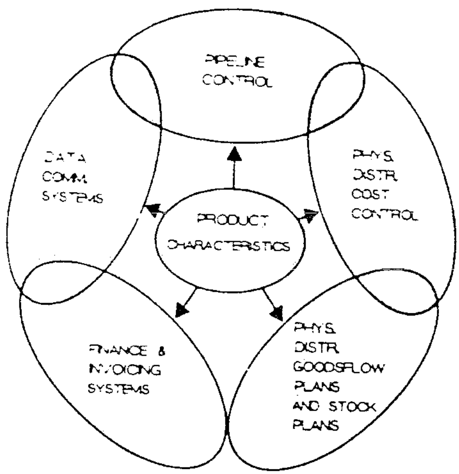
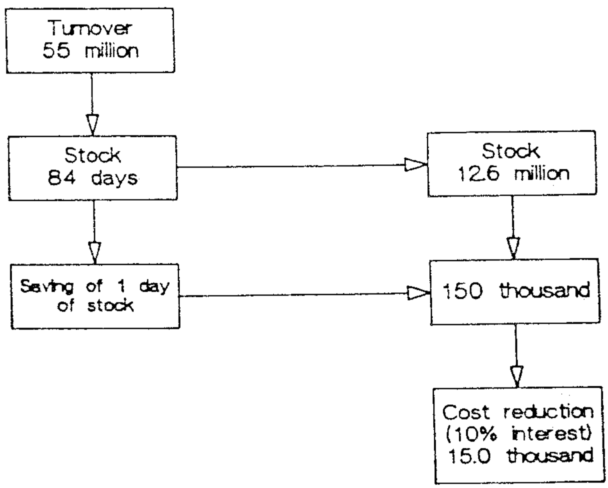


FIGURE 8

PIPELINE CONTROL, AS PART OF THE INTEGRAL GOODS FLOW CONTROL, AN IMPORTANT ECONOMY SOURCE



apart from the benefit of the availability of that capital (at a national interest rate of 10%) a finance charge of £15,000 for each day is avoided. The benefits to be gained from improved pipeline control are thus considerable in financial terms alone.

TABLE 1

CONSEQUENCES OF THE VARIATION IN PIPELINE TIMES FOR THE SAFETY STOCK LEVEL

Percentage of the number of shipments carried out	within a period of ___ days
50%	10.5
75%	13.3
90%	16.7
95%	18.6
97.5%	21.4
100%	29.0

HOW CAN PIPELINE CONTROL BE IMPROVED?

A starting point is effective measurement. Simply stated, there is no substitute for facts in these cases. The assumptions of those involved as to the total pipeline lead time and the lead times relating to the elements should not be used as the starting point. Once the facts have been established and transmitted to the dispatching end of the pipeline, they become management-motivated to seek improvement. Thereafter overall control of the pipeline needs to be addressed.

As has been indicated, any pipeline has a number of interfacing control systems, and a typical one has a number of organizations involved in attempting to control it. Moreover, in traditional organizational terms, each of these organizations may be seeking to optimize the performance of its own element. And their best intentions may well be detrimental to the effectiveness of the pipeline as a whole.

Clearly, many variations exist in the types and structure of organizations along pipelines. Thus, for present purposes a particular set of organizations are assumed. The reader will be able to relate the discussion to his/her own situation.

In the company concerned with this example, the following organizations were identified:

- a central Logistics function;
- a Physical Distribution function in the supplying organization;
- a Physical Distribution function in the receiving organization;
- a Service organization in the transit element and a Physical Distribution Control function.

In this case, in order to achieve tighter management, the physical distribution control function had been charged with the task of coordinating the activities of all those involved in the pipeline in order to achieve higher control. The schematic diagram shown in Figure 9 is indicative of the relationship between the parties involved.

Since a number of organizations are involved in the pipeline, it is necessary to develop an information blueprint which indicates the organization in which information originates and for whom it is intended. Using the basic model, this information is then focused upon the element between each of the pipeline points (e.g., A to B). Consequently, it is necessary to establish at the outset what data should be created for each measuring point. Then, in order to indicate the various activities, goods flows, stocks, and related information, they are shown in Figure 10.

The foregoing diagram illustrates the flows that need to be controlled with respect to lead times, costs, and stocks via information systems. It should be noted that, for simplicity, the example used involves suppliers who deliver directly from a factory (supplying organization) to the central warehouse in another country of the Group, of which the factory is a part. Service organizations (e.g. carriers) may be included with respect to element B to C.

FIGURE 9

RELATIONS BETWEEN THE ORGANIZATIONS INVOLVED

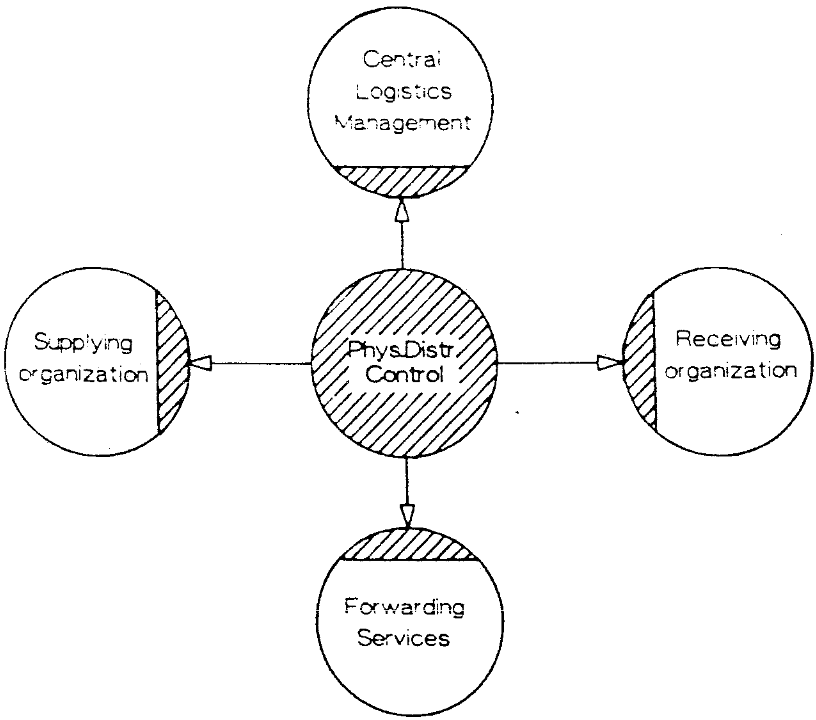
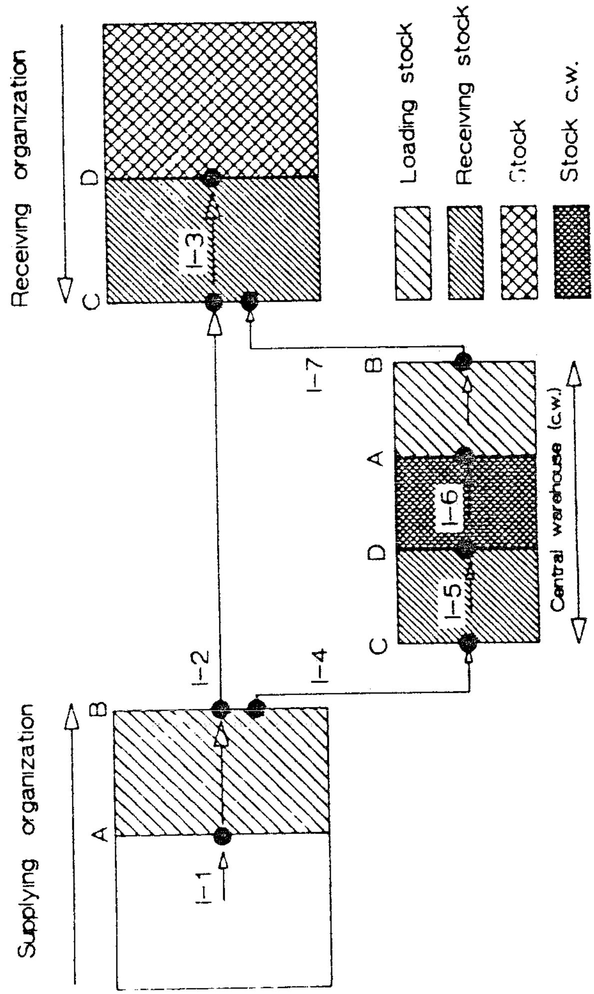


FIGURE 10
BASIC STRUCTURE FOR THE INFORMATION BLUEPRINT



The arrows in the diagram indicate the various elements that are requested to be controlled. The small circles show the points where the necessay information should be available or should be created.

THE PIPELINE CONTROL PROCESS

The key steps applied in controlling a pipeline are:

- determine the pipeline norm times;
- measure the actual situation;
- periodically report on the actual situation with respect to the stated norms.

Figure 11 shows a schematic representation of the process to be controlled, once again using the basic model.

In the case in question, the responsibility for determining the norm lay with the physical distribution management of the company (which is part of the central logistics functions). In setting the norm, the aspects that needed to be taken into consideration included where the supplying organization and the receiving organization were located and the manner in which the transit element of the model was organized. Clearly, the selection of the means of transport is a significant factor in making the decision. In setting the norm for the pipeline as a whole it was important to set separate norms for each of the elements in the basic model. Further, it was necessary for the norms to be given permissible tolerances, which were amended periodically as performance improved.

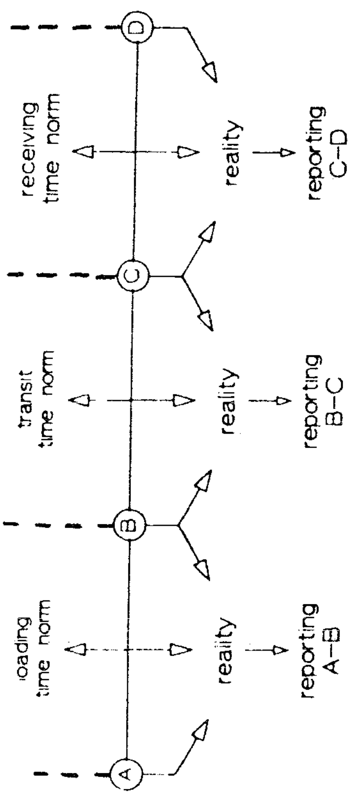
RESPONSIBILITIES FOR PIPELINE ELEMENTS

When ascertaining who is responsible for what in the pipeline, several questions need to be addressed. For example:

- Which function in the organization is responsible for setting the norm times?
- Which function is responsible for matching norm times in practice?

FIGURE 11

CONTROL OF THE PIPELINE STRETCHES



- Which organization is responsible for tracing and tracking shipments?

In the present case, the answer to the first question was the central physical distribution function in conjunction with the supplying and receiving organizations. It was found to be particularly important to ensure that the various measuring points were clearly and correctly defined.

As far as the second question was concerned, the answer differed by example. However, in our case:

- The manager of the supplying organization was responsible for all activities from measuring point A until the goods arrived at point C.

- The manager of the receiving organization was then responsible for all activities from measuring point C until the goods had been registered and deposited physically in the system (measuring point D).

The objective of clearly defining these roles is, of course, to determine unambiguously who is responsible for the timely passage of goods between the various measuring points. Clearly, the managers of both the supplying and receiving organizations can delegate the various tasks involved (e.g. to a third party carrier), but the responsibility is theirs. It also is true, of course, that the negotiated terms of delivery can affect the division of responsibilities. For example, in shipping, C.I.F. (Cost, Insurance, Freight paid) implies different responsibilities from F.O.B. (Free On Board).

PERFORMANCE INDICATORS (P.I.s)

Mention was made earlier of the use of Performance Indicators. In this final section an example of their use in drafting a report on the reliability of pipeline times is described.

Performance Indicators may be used to:

- indicate the average lead time, and

- indicate the variation in lead times.

The following example demonstrates the use of both types of Performance Indicators.

In analyzing the particular situation, the lead times in the B to C element were noted for 15 invoice lines over a period of one month. Table 2 indicates the results of the analysis and as will be seen, it appears that the minimum transit time is four calendar days while the maximum is nine.

TABLE 2

MEASUREMENT RESULTS OF PIPELINE STRETCH B-C

Number of calendar days (1)	Number of invoice lines (2)	(1) x (2)	Norm time	Number of invoice lines ≤ norm time
4	2	8	5	2
5	3	15	5	3
6	4	24	5	0
7	3	21	5	0
8	2	16	5	0
9	1	9	5	0
Totals	15	93		5

The formula used in this case for calculating the Performance Indicator for the average pipeline time is:

$$\frac{\text{Number of invoice lines norm time}}{\text{total number of invoice lines}} \times 100\% = \frac{5}{15} \times 100\% = 33\%$$

which means that one-third of the total number of invoice lines were delivered into the system within the norm time.

The performance indicator for the variation in lead time is calculated by multiplying the number of days (column 1) by the number of invoice lines (column 2) and dividing the result by the number of invoice lines. Thus:

$$\frac{93}{15} = 6.2 \text{ calendar days}$$

By relating the average real pipeline time to the norm time the performance indicator for the lead time variation is obtained. Thus:

$$\frac{\text{Norm Time}}{\text{Average actual pipeline time}} = \frac{5}{6.2} = 0.81$$

In the case in question this result was disappointing and signaled to management the necessity for corrective or preventative action. Consequently the performance indicators served their purpose as a simple tool for management to evaluate the quality of pipeline lead times.

CONCLUSIONS

From the foregoing discussion it will be clear that, in striving for effective pipeline control, there is no substitute for facts. Further, the division of a pipeline into elements enables responsibilities to be clearly defined while measurement is facilitated.

By reducing lead times (and the variations in those times) considerable financial benefits may be accrued. However, perhaps more importantly, customer service levels may be improved, and system effectiveness is enhanced.

A prerequisite for such improvement is that top management should ensure that adequate attention is paid to these important logistical matters. Everything else apart, awareness of the problems and opportunities involved, measurement of performance, and the careful monitoring of progress will always result in improvement. In this work, performance indicators invariably prove to be effective tools.

Finally, the classification of responsibilities and a collective awareness of the mutuality of pipeline tasks are aspects that are essential for success.

ABOUT THE AUTHOR

M. J. Ploos van Amstel graduated in business economics at Erasmus University in Rotterdam and specialized later in management consultancy. In 1962 he joined Philips to work in the Material Management and Planning section of the Central Organization and Efficiency Department, where he was charged with the implementation of planning and replenishment systems. After that he worked at Philips Nederland for a considerable time, the last few years as head of their Organization & Efficiency Department.

He later worked for several years as a management consultant with the NKF (Dutch Cable Factories) Group. As a member of the Goods Flow Organization Department, he was directly involved, together with McKinsey, in the logistic investigations in the Video, Audio, and Lighting Divisions. In the last few years his attention focused on making the activities in the physical distribution function controllable. Since the beginning of 1984 he has led the Physical Distribution group of Philips International. He is author of more than 25 articles.

Outside of Philips he worked in various functions in the metal industry: in production control, as a purchaser, and as a sales manager. Since January 1989, he has been part-time professor of international distribution logistics in the Faculty of Industrial Engineering of the University of Technology at Eindhoven.