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Published: 01/01/2002

Document Version
Publisher's PDF, also known as Version of Record (includes final page, issue and volume numbers)

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The Contribution of Electronic Communication Media to the Design Process: Communicative and Cultural Implications

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Working Paper 02.10

Department of Technology Management

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September 2002
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Abstract

Innovation in a company’s design process is increasingly a matter of cooperation between the company and its customers. New Information and Communication Technology (ICT) possibilities such as electronic communication (EC) media generate even more opportunities for companies to collaborate with customers during the early stages of research and development. This exploratory study examined the design process of five Dutch firms and the cultural and communicative implications of cooperation in the design process between the supplier and the customer using EC media. We found that the selected use of EC media for communication between R&D and customers has a positive effect on the design process. We also discovered that the characteristics of the most suitable EC media depend on the design activity, and that the corporate and professional cultures of both the company and its customers involved in the cooperation seem to affect the communication media used. Finally, the future use of new ICT in the design area is discussed.

Index terms- design process, electronic communication media, information and communication technology, innovation management, national culture, professional culture.

Innovation is increasingly a matter of true cooperation between the customer and the company. Smith [1] found that in certain sectors, such as companies that produce scientific instruments, the user was the main source of 77% of product innovation; in the semiconductor/printed circuits industry, the user was the main source of 67% of product innovation. The customer was also a strong factor in the design process in the Information and Communication Technology (ICT) sector: out of 32 firms, Huizinga [2] found that 59% of all knowledge gained in innovation was acquired through external sources, with customer cooperation being the main one (28%). Although many factors affect a company’s design process, this study deliberately focuses on suppliers and customers because they are the most significant sources of knowledge and information for the innovation process over all other external actors, such as
universities, branch organizations, chambers of commerce, or government bodies like ministries and even innovation centers. The study by Huizinga [2] also indicates that the success of a company’s innovation performance relies heavily on customer involvement: roughly 30% to 40% of a product’s success and quality depends on company-customer cooperation. It therefore follows that new ICT possibilities, especially EC media, may create even greater opportunities for cooperation with customers in other sectors.

Because communication media can be used by companies to gain knowledge and information in the design process from external actors like customers, advanced collaborative tools are being used more and more to support and enhance the design process. We wanted to investigate the cultural and communicative consequences of design cooperation between the supplier and the customer using new communication media. We also wanted to explore how corporate and professional cultures affect the communication with the customer during design cooperation. A study by Cobbenhagen [3] showed that 20 front-running companies had a corporate culture that included the traits of lower uncertainty avoidance (i.e., high risk), and a greater innovative and renewing attitude (i.e., a flatter organization). Ulijn, Nagel, and Tan [4] found striking differences between technology push (TP) and market pull (MP) orientation in 12 Dutch and 12 German firms, and these differences had a strong affect on innovation regardless of the communication media used. For example, a company with a strong TP orientation often delivers a very sophisticated product which the customer has not requested. However, corporate culture is not the only cultural factor influencing the design process. According to Ulijn and Weggeman [5], innovation success might actually be more a matter of the fine-tuning of professional cultures than corporate cultures or even national cultures. For instance, R&D engineers may prefer a technology push direction because of the cultural characteristics of their chosen profession, whereas marketers usually think in market pull terms due to their specific professional duties and responsibilities.

**Communication and Culture**

Several studies have compared the effect of computer mediated communication (CMC) versus face-to-face (FTF) media (for an overview see Ulijn and Campbell [6]
and Lincke and Karakaya [7]) in business communication settings. Some of these studies also relate national culture to the communication medium, for instance in a negotiation context [8] [9]. In comparing national and corporate cultures, the work by Hofstede [10] [11] [12] is recognized as by far the most influential. His work will therefore be drawn upon to define the concept of culture used here, even though our article does not specifically address the implications of the five different Hofstedian dimensions for communications and the choice of the appropriate communication medium, FTF, CMC, etc. The latest edition of Hofstede’s classic *Culture’s Consequences* [11] refers to work by the second author of this article, but no clear conclusions for communication media have yet been drawn in this work. However, this article does not deal specifically with the encounter of national cultures in the design process (see for instance Ulijn and Kumar [13]). Hofstede’s work only compares national cultures and does not address the issue of the interaction between professional cultures in the design process, such as the culture of the supplier and that of the customer, which is addressed in other publications [4] [5]. From this perspective, it is regrettable that Verbeke [14] omitted Hofstede’s Parochial-professional dimension [12] on the basis of reliability and the validity tests of his Organizational Practices Scale. The parochial dimension might be an archaic concept, but the very fact that cultures relate to the different professional functions in a firm, such as engineering (R&D and manufacturing), marketing, and finance, shows that the lack of recognition of this important source of cultural variation, and its effect on communication (media choice) is an important aspect of content-validity.

Since this article deals with the intersection of organization communication and culture using a pilot study method, we found it more useful to refer to the work by Hall [15] [16] also. Hall is one of the few researchers who connects culture to communication in an inter-reliant way, and Ulijn and Kumar [13] have applied this relationship to the interaction between European and Asian communication in technology and business. Although Hall’s concept of High Context (HC) and Low Context (LC) is applied to national or ethnic culture, it is particularly useful in cooperation settings where ICT is used. Low Context in business communication is visible as the top of explicit, formal communication, whereas High Context is what takes place beneath the surface, for instance implicit or non-verbal communication. Since some communication media can be applied more easily to Low Context
communication, electronic communication might help to make such messages more explicit. In terms of corporate culture, if we assume that a company’s technology push orientation leads to contexts where all information has to be stated explicitly, such a design culture might be more willing to use explicit new media. However, the flow of information still moves slowly because everything has to be checked throughout the design process. On the other hand, companies with market push orientation would need the rich traditional communication media (FTF) in design cooperation because implicit or explicit information from, and interaction with, the customer is needed, if the designer accepts that the market pulls him or her to their mutual benefit. Hall directly relates culture to communication, and the high/low context has an immediate impact on communication media choice, in our view.

Since our study addresses both cultural and communicative interaction between companies and their customers, a definition of culture is needed. Ulijn and Weggeman [5] have described a range of definitions: Hofstede defines culture as behavior of people based upon mental programming and related with language and a way to communicate. The iceberg (Selfridge and Sokolik, 1975) and onion (Hofstede, 1991) metaphors illustrate well how Schwein (1991 and 1999) and Hofstede (1980 and 1991) visualize cultures. Both ‘iceberg levels’ and ‘onion layers’ terms describe the numerous cultural levels of communication, from the explicit, clearly visible artifacts and symbols, such as the law, written rules and procedures, to the implicit and invisible layers, which are the core of unwritten rules, norms, and values. This latter approach reinforces Hall’s [16] view of the impact of culture on communication. In this study, we use Hofstede’s basic definition of culture, but we include the influences of corporate and professional cultures, in addition to the national or ethnic culture. This article explores the role of new communication media on the corporate and professional cultural and communicative relationship between a company’s R&D and the customer.

**Electronic Communication (EC) Media**

The findings from Daft and Lengel [17] prove that not all communication media are suited for every task performed by companies. The media richness used depends on the communication task. In this study, we focused specifically on tasks performed in
the context of the design process. To take full advantage of electronic communication media, we studied how it was applied in the design process. In an extension of the ‘Impact-Value Framework’ of Hammer and Mangurian [18], Riggins [19] described the possibilities for electronic communication media to improve the interaction between a company and its customers. In this study, an adapted version of this framework was used.

*Insert TABLE I here*

We believe that an Electronic Commerce Value Grid should focus on a strategy that leads first to effectiveness and then to the efficiency of the process to reach the goals set. If a design process is shared by two actors, the supplier and customer, EC media may be used to make the product, to establish the relationships between the actors, and to maintain their interaction in spite of physical distance or the amount of time companies need for the design process.

By combining the three criteria of efficiency, effectiveness, and strategy with the five dimensions of product, market, interaction, distance, and time, fifteen total categories of potential advantages in electronic communication arise. But Hamfelt and Lindberg [20] and Sivula [21] pointed out that interaction for technological innovation mostly takes place in face-to-face, personal contact. Electronic communication media offer possibilities for contributions in interaction, but face-to-face, personal contact is, according to the literature, the best medium for technological innovation. Although EC media are not currently considered the best medium for innovation in the literature, we must still examine the cultural and communicative implications of EC between the supplier and the customer during the design process because EC has become such a widely used medium, particularly in international communication. Moreover, because the design stage is a major step after the initial idea stage in an innovation management process—a process where a kind of market pull situation requires different types of frequent direct communication (see the adapted version of Wheelwright and Clark's funnel model [22] by Ulijn and Weggeman [5])—we must look at the use of EC media during that stage. If we compare routinized Operations Management (OM) with Innovation Management (IM), Ulijn, Wynstra and Lincke
[23] conclude from their study that standardized ICT media might make Operations Management more efficient, which leaves the richer media for Innovation Management.

This study investigated the empirical differences in the contribution of EC media for interaction between the company and its customers during the design process to see how EC media could lead to a more efficient innovation process. Based on studies on the relationship between culture, communication, and electronic media, we developed our research question regarding (1) the contribution of EC Media versus traditional media to an effective design process, and (2) the choice of EC media for an effective design process.

More speed in transaction activities is expected because of low demands on media richness. Malone et al. in Wigand [25] pointed out that EC media make it feasible to communicate more information during the same time. Keating et al. [25] predicted that product development will speed up and take place on a larger geographical scale. With EC, interaction becomes less time and place sensitive [26]. Riggins [19] pointed out that electronic communication media create new advantages in bridging physical distances between people. A risk of EC media, however, might be the lack of involvement. Ulijn and Lincke [9] and Ulijn et al. [23] have shown that an innovation management context combined with CMC might lead to a lack of empathy, which is essential for success in such a negotiation context. Therefore, the first two hypotheses below will be used to verify the common experience that EC media can accelerate our activities and bridge distances in the Innovation Management context.

1. By using EC media, transaction activities during the design process can be delivered more quickly than by using traditional communication media.

2. By using EC media in transaction activities during the design process, distances can be bridged more easily than with traditional communication media.

Since EC media make it easier to exchange information across time and distance, new
forms of collaboration are created [27]. One such form of collaboration was illustrated by Dahan and Srinivasan [28]; their research described the use of the Internet as a forum where customers explicitly choose, via a simple mouse click, between different product concepts. This forum made it possible for companies to test more product concepts with their existing and prospective customers.

3. **By using electronic communication media, customers can be involved at an earlier stage in the design process than with traditional communication media.**

Bloch et al. [29] and Iansiti and MacCormack [30] stated that standardized and interoperational information and communication technology create opportunities for more efficient and faster information exchange and real-time decisions.

4. **By using EC media, transformation activities in the design process can be carried out less often than in traditional communication media.**

Daft and Lengel [17] emphasized that not all communication media are well-suited for every task. This means that activities carried out during design processes will make varying demands on communication media.

5. **In transaction and transformation activities, the demands on EC and traditional communication media depend strongly on the context of the activity in the design process.**

The need for feedback, personalization, social cues, and variety of language will be different in various transaction and transformation activities during the design process.

**AN EFFECTIVE DESIGN PROCESS BY NETWORKING: A MODEL BY HÅKANSSON [31]**

The above hypotheses were tested in this qualitative study. For the design of the study, Håkansson’s network model [31] was used (See Fig. 1). This network model was applied in the study to describe the dependencies in the design process, the
interaction of a company with its customers, and the use of communication media. The model was also used because it pinpoints a multi-party involvement in the IM process, more so than the rather linear approach of Wheelwright and Clark’s funnel [22], which suggests a big time gap between the design of a product and its shipment to the customer, when no supplier-customer contact is specified. According to Håkansson [31], any networking in innovation includes three elements: activities, resources, and actors. We suggest that this constant interaction creates a time-saving and parallel means of designing in collaboration with the customers in our case study.

Insert Fig. 1 here

The three elements of Håkansson [31] will be used to study the contribution of EC media, seen as resources in the design activities carried out by actors, such as a company and its customers.

The activities
Since the activities are of primary importance in a design process and they are repetitive, we start our description of the activities by using the iteration concept of Roozenburg and Eekels [32]. The design process is a continuous repetition of the activities ‘specify,’ ‘create,’ ‘simulate,’ and ‘evaluate.’ In specific activities in the iteration, collaboration with EC media is possible. Depending on the activity, the demand on communication media varies. In recent literature, the design process is considered to be a fully integrated, parallel process of different activities. The product design process allows for transformation activities like specification of products, simulating concepts, creation of products, followed by testing and evaluation of the product. This process is repeated until the product is ready for production. Thanks to this iterative cycle of design activities, the amount of information increases, and more information is codified in product documentation, in prototypes, etc. In this process, transaction and transformation activities are performed together with the customer. To determine the affect of EC media on the design process, we examined five Dutch companies that employ this design cooperation with their customers to their mutual benefit.
In transaction activities, resources are exchanged for other resources, often creating or building new resources. In this study, the ‘storing,’ ‘searching,’ ‘sending,’ and ‘receiving’ of information are transaction activities, which can be supported by traditional and/or EC media. Transformation activities are internal activities of an actor in which resources are improved. The activities ‘specify,’ ‘create,’ ‘simulate,’ and ‘evaluate’ are the transformation activities; they can also be combinations of both transaction and transformation activities. Like Roozenburg and Eekels [32], this study considers the design process as an information-processing cycle.

**The resources**

The resources, knowledge, and information from customers used for the design process are gained and utilized by using other resources: the communication media. In the following table, an overview of communication media is given.

*Insert TABLE II here*

Traditional and electronic communication media differ in the degree of media richness offered. The media richness depends on the number of social cues that can be transported by the medium. Social cues can be facial expressions, body language, and voice intonation [33]. According to Daft and Lengel [17], the content of the information should determine the choice of communication medium. The choice of the communication medium depends on the media richness, which is determined by four criteria [17] [34]:

- The immediacy of feedback
- The number of ‘social cues’ that can be used in the communication media used to transmit those ‘social cues’
- The extent of personalization
- The language variety that can be used.

The media richness needed in a specific activity depends on the amount of information made explicit in that activity. Ulijn and Strother [35] (Fig. 8.2 in their book) have explained this matter in the documentation hierarchy. The purpose of the
communication and the audience determine the language use and form of the documentation. Following the studies of Rice [36], Short et al. [37] and Kydd and Ferry [34], the media richness of traditional and electronic communication media is presented on a qualitative scale in Fig. 2.

*Insert Fig. 2 here*

Low media richness, on the one hand, is appropriate for storing documents meant for restricted technical audiences using specialist language. ICT use fosters effective retrieval in specific OM situations. High media richness, on the other hand, facilitates highly interactive communication with lay audiences while avoiding hermetic jargon, which is often also the case for customers who do not share the expertise of their suppliers. This is also in line with what we already stated about an MP effect of the professional culture of marketing that wants to speak the customer’s language.

During the design process, the amount of knowledge and information increases, and designs become more detailed, and information and knowledge is codified and becomes less abstract. The requirements of communication media also depend on the activity in the design process during which they are applied. The most suitable communication media are therefore selected according to the activities. Table III gives an overview of the potential use of communication media in the activities of the design process. Table III starts with the two extremes of Ulijn and Strother’s [35] document hierarchy. Information sending and receiving is a highly interactive process, and information searching and storing is often document-related. In addition, we matched the transaction and transformation activities of Fig. 1 to a prediction of the most effective communication media to be used.

*Insert TABLE III here*

The present developments and trends are marked by increasing interactivity and collaboration in the use of electronic communication media. If the notion of media richness in Fig. 2 is considered, it may be suggested that the activities of creation, simulation, evaluation and specification of an ICT software product all need high media richness, whereas the more communication-related activities 5 and 6 may
depend on the context of the activity. If a company wants to evaluate a new product prototype with a customer, it will use rich communication media, like 3D modelling to enable social cues, personalization, language variety, and immediacy of feedback (for example, Thales—see appendix). Information storage and retrieval may be restricted to low media richness, if less feedback is required there.

The actors

Actors perform activities, in which they utilize and exchange resources by means of other resources. In the utilization and exchange, the characteristics and forms of the relationships between actors play a conditional role. Forms of relationships can be long term or a very temporary customer-supplier relationship. In the way actors can exchange resources, this form is conditional. The characteristics of the relationship are influenced by the applied communication media. Sufficient trust and informal relationships are conditions for effective interaction between a company and its customer in the design process [38]. The intensity of the relationship, the information exchange, and the frequency of contact influence the effectiveness of this interaction. Continuity and interdependency are often characteristic of such relationships in design processes. Although this interdependency can have many forms, two dominant forms can be distinguished; technology push and market pull (TP and MP).

The form of interdependency between the company and its customers also depends on the corporate culture (CC), the professional culture (PC) and their interaction, as we have seen above.

RESEARCH DESIGN

A number of hypotheses were derived from the research question and investigated in five Dutch company case studies. The companies all use advanced information technology like Virtual Reality, videoconferencing, 3D CAD simulation and visualization. Table IV gives a short description of the five companies and their customers. The worldwide and European markets of four of the companies provided an opportunity to explore the improvements to cooperation with customers across great physical distances.
The data in Table IV are quantitative, except for the company orientation. The qualitative interviews gave an impression of the company orientation, which is represented here. Little or no research was carried out on the influences of interaction of electronic communication media on the design process, because this study focuses only on an explorative and qualitative data collection and analysis of EC media between the company and its customers during the design process.

The five companies in the study all maintain intensive design cooperation with their customers. (More detailed descriptions of the five case studies are listed in the appendix.) BPO is a strict design company, Cyco specializes in software development, and the other three belong to the industrial sector. Two firms, BPO and Cyco, have less than 100 employees and one, Thales, belongs to a multinational company with more than 500 employees. The others, TNO and Hydraulyn, can be qualified as small- and medium-sized enterprises. Given the fact that the interaction of corporate and professional cultures materializing in TP and MP might affect the nature of cooperation with the customer, we selected two MPs, two TPs and one company that is a combination of MP and TP. Only one product line was strongly related to ICT, that of Cyco, where document management software was particularly sensitive to the concept of media richness (see Fig. 2). The other products included synthetic parts, radar equipment, and hydraulic cylinders. TNO, a well-known innovation supporting service firm in the Netherlands, has a rather TP culture. It is the only one that serves the Dutch market within a short geographical distance. One, BPO, works for the European market and the remaining three—Cyco, Thales, and Hydraulyn—all reach beyond European borders.

Because this is an exploratory study employing the case method approach, we run the risk of asking too many research questions such as ‘who,’ ‘what,’ ‘where,’ ‘how,’ and ‘why’ [39]. Considering the nature of this study, we concentrated on ‘in what manner can different types of EC media be best used in these five cases?’ We interviewed one employee per company face-to-face, in a semi-structured way for one hour, using in-depth questionnaires. The interviews were also used to collect supporting documents.
and information for this exploratory study.

*Insert TABLE V*

The five interviewees, four men and one woman, ranged in age from 30 to 50 years. All were technically trained at B.Sc. or M.Sc. level, and comprise two directors, two project managers, and one manager of Engineering and IT. (See Table V for a description of the interviewees.) The employees were asked to describe their design process, the interaction with customers, and the effects of the deployed communication media on the interaction and the design process. From their positions in their respective companies, these respondents were able to represent their company, or were at least highly aware of the effects of the different communication media on the design process. At the end of the interview, the employees were asked to give their vision on future communication media that could support their design process.

We chose a qualitative type of data analysis, which is an iterative process, as Miles and Huberman [40] have shown. It starts with data collection, followed by data display and data reduction. These two activities are used to convert the data to enable us to draw and verify our conclusions. If drawing and verifying a conclusion led to new information demands, the data analysis cycle was followed again.

**RESULTS**

The study demonstrates that electronic communication media can play an important role in the interaction between the supplier and the customer in favor of technological innovation. We present a summary of our findings based on the five hypotheses:

1. *By using EC media, transaction activities during the design process can be delivered more quickly than by using traditional communication media.*

Also in the design process of the companies studied, sending and receiving of information was carried out faster using EC media. The preference for a communication medium depends on the context of the transaction activity and the relation between the actors. Searching and storing of information played a minor role
in the cases. There was no noticeable need for feedback and a clear preference for a particular communication medium was not found in this activity.

2. *By using EC media in transaction activities during the design process, distances can be bridged more easily than with traditional communication media.*

Sending and receiving, as well as the searching and storing of information, can be done more easily over long distances using EC media. The common experience of speed increase and bridging distances by EC media were verified in the context of Innovation Management, and found to be independent of a preference for synchronous or asynchronous communication media.

3. *By using electronic communication media, customers can be involved earlier in the design process than with traditional communication media.*

Use of online specifications, virtual reality and 3D CAD simulation offered the chance to involve customers earlier in the design process. The increased speed of transaction activities and bridged distances in hypotheses one and two increased these chances.

4. *By using EC media, transformation activities in the design process can be carried out less often than with traditional communication media.*

The phases in the design process were completed faster and customer contact was completed earlier. Fewer iterations were needed, because virtual reality, 3D CAD simulation, and videoconferencing resulted in more meaningful exchanges in the feedback on transformation activities.

5. *In transaction and transformation activities, the demands on EC and traditional communication media depend strongly on the context of the activity in the design process.*

In transaction activities, the transformation activity, where the send, received, searched or stored information is used, sets demands on the communication media
used, but also mutual trust between the actors and their cultures influence the context and thus, the demands on the communication media. The improvements from using electronic communication media on the cooperation in design between the companies and their customers are summarized in Table VI.

Insert TABLE VI here.

By selected use of communication media in the design process, more knowledge was gained, which was necessary for design activities, such as specification, creation, simulation, and evaluation. It was striking to see there was strong consensus throughout a variety of sectors, TP or MP orientation, or distance to the customer, whether in the Netherlands, Europe, or worldwide. By using synchronous and rich communication media based upon advanced information technology, customers could also be reached across great distances.

In the design process, the preference for communication media depended mostly on the need for feedback, trust, and personalization. Mutual trust and empathy played an important role in interaction in the design process. At the beginning of the design process, there was more need for face-to-face contact, which may also have led to more efficient use of EC media during the remaining of the process. The need for feedback seemed to be large at specification, so that a synchronous and rich communication medium was desirable. For an activity like creation, an average, rich asynchronous communication medium like e-mail was sufficient. For simulation and evaluation, much feedback was needed, and synchronous and rich media like face-to-face contact and videoconferencing were used. For evaluation possibilities, feedback and personalization were important and videoconferencing and visualization were frequently used. However, face-to-face communication was still needed for specific activities like negotiations and strategic and commercial decision-making. In Table VII the findings of the results are applied to the adapted Electronic Commerce Value Grid by Riggins [19].

Insert TABLE VII here.
One can see in table VII that in our study, EC media made different contributions to strategy, effectiveness, and efficiency. On the product level, design cooperation with the customer led to a strategic need for more knowledge sharing in a collaboration which made the production more efficient (Thales), but not more effective. A strategy for more interaction with the customer through EC media was obviously presented given beforehand, but the transformation activities with customers were made more effective by rich media (BPO and TNO), whereas EC media increased the frequency and quality of information supplied by the customers. Surprisingly, on the other hand, overcoming great distances between actors might have made the market bigger (BPO) or information supplied by customers more efficient (all five), but not necessarily more effective.

**DISCUSSION AND CONCLUSIONS FOR AN EFFECTIVE USE OF EC MEDIA IN THE DESIGN PROCESS**

Once the scores of the companies for the three criteria of the Electronic Commerce Value Grid were counted (see in Table VIII) an interesting picture appeared.

*Insert TABLE VIII here.*

Cyco had the highest scores in all three criteria and seemed to apply the communication media in the most strategic, effective, and efficient way. Why? This firm already focused on document management which is sensitive to media richness, as we stated earlier. It used this communication media in a balanced way across its design activities (see TABLE VIII). It had an MP orientation and their customers came from all over the world (TABLE IV).

Not surprisingly, a company which works in computer technology itself had the most balanced design process with its customers working on strategy (2), effectiveness (2) and efficiency (3) out of a maximum of 5 for each aspect (total 15) with a global MP culture (Cyco). The weakest was Hydraulynne, where IT seems to serve only the efficiency aspect of designing the hardware of hydraulic cylinders. BPO, another MP company, was second best (1,2,2), specializing in the design of synthetic products and parts, more or less on an equal level with, surprisingly, a TP firm: TNO (1,1,3). Thales
concentrated rather more on efficiency (1,0,4), notwithstanding its MP/TP mix which might have predicted a better balance of design aspects. If we were to use the Electronic Commerce Value grid by Riggins [19] as a check list for strategic, effective, and efficient design cooperation, with the customer as part of the innovation management (IM) process, and 15 is the ideal score (5,5,5), we found that our five Dutch companies still have a long way to go.

The case method approach used in this exploratory pilot study [39] [40] might have suggested some limitations for the reliability and validity of our conclusions. Eisenhardt [41], however, indicates that theories can be built from case study research if the validity questions are rightly addressed. Moreover, the multiple-case comparison approach for the five Dutch firms increases the reliability of our conclusions. With criteria outlined and exemplified by Ulijn [42] on the basis of European intercultural communication research, the five above hypotheses should certainly be refined and brought into the empirical cycle again to test better formulated questions on these issues. The last section of this article will address this matter to be sure that ICT solutions are both valid and reliable for the future design process in which supplier and customer cooperate.

POSSIBLE ICT SOLUTIONS FOR THE FUTURE OF THE DESIGN PROCESS AND RESEARCH QUESTIONS RELATED TO CULTURAL AND COMMUNICATIVE IMPACT

To generalize the practical impact of our conclusion, many more interviews per company would be needed, but even with a limited number, some suggestions for wider application of ICT use in the design cooperation between customer and cooperation can be made. Our findings imply, however, that there is a demand for ICT solutions suited to the different tasks in the design process. In a study carried out at Philips Design by Van de Sandt [43], improvement opportunities and potential ICT solutions for the design process were suggested: Collaborative product development tools to support interactivity and synchronous communication and high quality videoconferencing to improve trust and immediacy of feedback.

*Insert TABLE IX here.*
In spite of all the advantages of electronic communication, the directed application of EC media still needs careful attention. Earlier and more frequent deployment of electronic communication media in the design process offers more possibilities for customization and acquisition before production is started. In general, directed application of electronic communication media can help companies to gain strategic, effective, and efficient advantages in design processes. For example, in a collaborative virtual environment [44] the design activities are supported by various communication media in the relationship between a company and its customers.

We offer some ideas for future research on the culture and communication interaction triggered by ICT in this design context. In the introduction, we presented culture as a combination of technology push and market pull in the design cooperation with the customer and of the professional cultures of the actors involved (engineers versus marketers for instance). Moreover, Hall’s [16] high/low context distinction was used to predict some effects of ICT on formalizing and making the process explicit. In the five cases of design cooperation between supplier and customer, both the size of the actors involved and equality in their professional cultures seem to be factors which help decide what combination of electronic and traditional forms of communication could be most effective. Two more specific hypotheses related to culture and communication in this context can be posited for future studies:

1. *The bigger the actors, the stronger the corporate culture and hence the more need for explicit communication: ICT will be very welcome.*

2. *The more the two actors share the same professional culture, the less explicit their communication needs to be.*

Moreover, a TP x MP mix would definitely need more explicit communication and, would therefore require a wider range of media, including face-to-face, more than in the non-mixed situation.

Finally, this study addressed an IM process of design cooperation with customers
using ICT. That same ICT could reduce the time needed for the more routine jobs of OM and logistics, i.e. the automation of the process of placing, processing and delivering orders. The nature of our comparison of five design cooperation processes might lead to a third hypothesis for future studies:

3. The more communication is standardized by ICT in OM, the more time there is for Innovation Management with the customer.

Therefore, not only the design activity, but also the culture of the two actors involved in the cooperation (big vs. small or a difference in the corporate and professional culture mix) seem to affect the combination of traditional and new communication media they need. The future use of ICT, particularly EC media, in design cooperation as part of IM would benefit from more specific hypothesis-testing studies to address the interaction between culture and communication. To apply the multiple-case method effectively, several interviews per company, taken across the different professional cultures on both the supplier and customer sides, would be required to lead to valid and reliable conclusions for business practice.
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1999.


APPENDIX: Description of case studies

CYCO SOFTWARE (CYCO)
Cyco software is a vendor of standard document management software. It does not produce tailored products so the software programmers do not have any contact with their customers. Notifications of bugs in the software are handled by a web form. Cyco uses e-mail, a web discussion forum, web forms and web analysis for interaction with customers. This leads to easy direct contact with customers. The internet offers the possibility of sending questionnaires to customers, allowing much information to be gathered with little effort. Such questionnaires would be time consuming and expensive using traditional communication media. Cyco pointed out that they also gain new contacts by e-mail and web forms. The most important information collected by the different communication media relates to the way in which people work and use their software. Such information can lead help Cyco improve its products. Cyco uses web analysis to find out which information and features are important to the customer.

In general, Internet makes it easier to operate independent time and location and gather information at an early stage but it has not changed the software design process. However, one activity in which e-mail is not appropriate is negotiation. The electronic communication media also help Cyco avoid the situation of realizing that a requirement is important requirement too late in the process.

BPO
BPO is an engineering company that designs, develops and improves products for a wide variety of companies. The design process is the melting pot of customers and BPO’s knowledge. The company collaborates over large distances with its customers and through different communication media. At moments when decisions are needed, it shares its computer screens with its customers, using video-conferencing. Another way it structures decisions is by sending an informative e-mail and then holding a telephone conference referring to this e-mail. Important strategic decisions can be made faster and more effectively in face-to-face contact.

THALES NEDERLAND (THALES)
In December 2000, Hollandse Signaalapparaten changed its name to Thales Nederland. The company produces short- and long-range radar equipment and is running a pilot project (Fast Reactive Extended Enterprise) in which it collaborates with other companies. It uses an electronic design environment. In the communication with customers it uses a web-based system, CITIS. This system makes it possible to draw up specifications with the customer. This activity is then completed faster and the customer is fully involved in the design process. It also establishes early contact with the customer. The relationship with the customer has changed in recent years: in the past, designers were not often allowed to contact customers but the contact frequency has now increased and it is now recognized as a necessary part of the process. The customer’s trust, however, is still obtained by face-to-face contact.

**TNO INDUSTRIE (TNO)**

TNO supports companies in product development, production technology, material research and product research, by carrying out research and tests. At the start of the design process, it holds a face-to-face meeting with the customer. A trend seen in the work at TNO is the increased interaction and information exchange. The communication media used depend on the phase in the design process, the product and the role of the customer. It has experience using video-conferencing in combination with CAD modeling in a collaborative project. In interaction with large groups of people or in commercial meetings, this video-conferencing is less appropriate. Video-conferencing demands careful preparation. For detailed discussions, face-to-face interaction is used. In the relationship with customers TNO is becoming more and more dependent on information and communication technology. The continuity of the relationship, however, does not depend on the electronic communication media, but on trust.

**HYDRAUDYNE CYLINDERS (HYDRAUDYNE)**

Hydraudyne cylinders is a part of Mannesmann Rexroth. It designs, produces and sells special and large hydraulic cylinders throughout the world. With each customer it has to deal with widely different demands. It is therefore very important to learn the customers’ requirements. For this it uses a special system called the ‘product configurator’, which then translates the specifications into a cylinder design. To win
the customers trust, Hydraudyne needs face-to-face contact. Electronic communication media have helped it to operate in a manner less dependent on time and location. In the future Hydraudyne wants to use simulations and video-conferencing in the interaction with its customers.
Fig. 1  
THE NETWORK MODEL BY HÅKANSSON [31]
Fig. 2
MEDIA RICHNESS IN A QUALITATIVE SCALE
<table>
<thead>
<tr>
<th></th>
<th>Efficiency</th>
<th>Effectiveness</th>
<th>Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product</strong></td>
<td>Automate tasks using software agents</td>
<td>Provide online decision support tools</td>
<td>Bundle information, products and services Create dependency to lock-in user</td>
</tr>
<tr>
<td><strong>Market</strong></td>
<td>Alter role of intermediaries</td>
<td>Engage in micro marketing to look small</td>
<td>Users interact via online community</td>
</tr>
<tr>
<td><strong>Interaction</strong></td>
<td>Make use of extensive user feedback</td>
<td>User controls detail of information accessed</td>
<td>Achieve global presence</td>
</tr>
<tr>
<td><strong>The distance between actors</strong></td>
<td>Improve scale to look large</td>
<td>Present single gateway access</td>
<td></td>
</tr>
<tr>
<td><strong>Time needed for the design process</strong></td>
<td>Accelerate user tasks</td>
<td>Eliminate information float</td>
<td>Establish 24x7 customer service</td>
</tr>
<tr>
<td></td>
<td>Traditional</td>
<td>Electronic</td>
<td></td>
</tr>
<tr>
<td>------------------</td>
<td>---------------------------</td>
<td>------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Synchronous</td>
<td>Face-to-face, telephone</td>
<td>Videoconferencing, desktop-conferencing, chat, whiteboard and document sharing</td>
<td></td>
</tr>
<tr>
<td>Asynchronous</td>
<td>Letters, documents, memos</td>
<td>Instant messaging, e-mail, File Transfer Protocol, newsgroups and netcasting</td>
<td></td>
</tr>
</tbody>
</table>
## Table III
COMMUNICATION MEDIA AND ACTIVITIES IN THE DESIGN PROCESS

<table>
<thead>
<tr>
<th>Activities</th>
<th>Communication media</th>
</tr>
</thead>
<tbody>
<tr>
<td>Send and receive information</td>
<td>All different communication media, but dependent on the context of the activity</td>
</tr>
<tr>
<td>Search and store information</td>
<td>All different communication media, but less need for feedback</td>
</tr>
<tr>
<td>Specify</td>
<td>Synchronous and rich communication media and the need for feedback, personalization, language variety and ‘social cues’</td>
</tr>
<tr>
<td>Create</td>
<td>Asynchronous rich communication media; less need for feedback and personalization but added value from language variety and ‘social cues’</td>
</tr>
<tr>
<td>Simulate</td>
<td>Synchronous rich communication media and the need for feedback, personalization, language variety and ‘social cues’</td>
</tr>
<tr>
<td>Evaluate</td>
<td>Synchronous rich communication media and the need for feedback, personalization, language variety and ‘social cues’</td>
</tr>
</tbody>
</table>
### TABLE IV
GENERAL CHARACTERIZATION OF THE FIVE COMPANIES.

<table>
<thead>
<tr>
<th></th>
<th>Industrial sector</th>
<th>Company size</th>
<th>Company orientation</th>
<th>Kind of products</th>
<th>Market / customers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyco</td>
<td>Software, B-to-B</td>
<td>10 – 100</td>
<td>Market pull</td>
<td>Document Management Software</td>
<td>Worldwide</td>
</tr>
<tr>
<td>BPO</td>
<td>Design, B-to-B</td>
<td>10 – 100</td>
<td>Market pull</td>
<td>Design of synthetic products and parts</td>
<td>European</td>
</tr>
<tr>
<td>Thales</td>
<td>Industrial, B-to-B</td>
<td>100 – 499</td>
<td>Pull/ push</td>
<td>High-tech defence solutions</td>
<td>Worldwide</td>
</tr>
<tr>
<td>TNO</td>
<td>Industrial, B-to-B</td>
<td>10 – 100</td>
<td>Technology push</td>
<td>Support in product- and production development</td>
<td>Dutch</td>
</tr>
<tr>
<td>Hydraudyne</td>
<td>Industrial, B-to-B</td>
<td>100 – 499</td>
<td>Technology push</td>
<td>Hydraulic cylinders</td>
<td>Worldwide</td>
</tr>
<tr>
<td>Company</td>
<td>Gender</td>
<td>Age</td>
<td>Education</td>
<td>Function</td>
<td></td>
</tr>
<tr>
<td>----------</td>
<td>--------</td>
<td>------</td>
<td>-----------</td>
<td>-----------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Cyco</td>
<td>M</td>
<td>± 40</td>
<td>M.Sc</td>
<td>Director of Product Management</td>
<td></td>
</tr>
<tr>
<td>BPO</td>
<td>M</td>
<td>± 45</td>
<td>M.Sc.</td>
<td>Director</td>
<td></td>
</tr>
<tr>
<td>Thales</td>
<td>M</td>
<td>± 50</td>
<td>B.Sc</td>
<td>Project Manager IT Services – Development</td>
<td></td>
</tr>
<tr>
<td>TNO</td>
<td>F</td>
<td>± 30</td>
<td>M.Sc</td>
<td>Project Manager Product Development Division</td>
<td></td>
</tr>
<tr>
<td>Hydraudyne</td>
<td>M</td>
<td>± 45</td>
<td>B.Sc.</td>
<td>Manager Engineering and IT</td>
<td></td>
</tr>
<tr>
<td>Activities</td>
<td>Communication media</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sending and receiving</td>
<td>Electronic communication media speed up this activity and bridge the distance to the customer. In negotiation, strategic and commercial decisions, face-to-face communication is needed.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>information</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Searching and storing</td>
<td>Electronic communication media speed up this activity and bridge the distance to the customer. In the case studies this activity played a minor role. There was no noticeable need for feedback. A clear preference for a communication medium was not found in this activity.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>information</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specify</td>
<td>The need for feedback seems to be greater in this activity. In two case studies, however, this was not the case, and online specification was possible. The respondents clearly pointed out that a synchronous and rich communication medium like face-to-face contact is desirable in the specify activity.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Create</td>
<td>In the activity create there seems to be little need for interaction. Therefore there are not many demands on the communication media used in this activity.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Simulate</td>
<td>In simulate a lot of feedback is needed and therefore synchronous and rich communication media, like face-to-face communication and videoconferencing were used.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evaluate</td>
<td>In evaluation there is a need for feedback, personalization, the transfer of ‘social cues’ and variety of language. In these activities videoconferencing and visualisation are deployed. For the activity evaluate, synchronous and rich communication media are needed.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TABLE VII
CONTRIBUTIONS OF ICT FROM INTERACTION IN THE STUDY OF FIVE CASES

<table>
<thead>
<tr>
<th></th>
<th>Strategy</th>
<th>Effectiveness</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product</td>
<td>Need for product already present from sharing knowledge and collaboration: Cyco and TNO</td>
<td></td>
<td>Sharing knowledge about products: Thales Nederland</td>
</tr>
<tr>
<td>Market</td>
<td>Make use of knowledge from the customer for a directed approach: Cyco</td>
<td>Less transformation activities: Cyco</td>
<td>More knowledge on needs and trends in the market: Hydraudyne</td>
</tr>
<tr>
<td>Interaction</td>
<td>Transformation activities with customers by rich communication media: BPO and TNO</td>
<td></td>
<td>More and better information from customers: Cyco, Thales and TNO</td>
</tr>
<tr>
<td>The distance between actors</td>
<td>Bigger market: BPO</td>
<td></td>
<td>Information from customers at great distance: Cyco, Thales, TNO, BPO and Hydraudyne</td>
</tr>
<tr>
<td>Time needed for the design process</td>
<td>Faster introduction of new products: Thales</td>
<td>Less and faster transformation activities: Cyco, BPO</td>
<td>Gaining information from customers earlier and faster: Cyco, Thales, TNO, BPO and Hydraudyne</td>
</tr>
</tbody>
</table>
TABLE VIII
SCORES OF THE CASE STUDIES ON THE DIFFERENT ASPECTS (MAXIMUM SCORE 15)

<table>
<thead>
<tr>
<th></th>
<th>Strategy</th>
<th>Effectiveness</th>
<th>Efficiency</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyco</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>BPO</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Thales</td>
<td>1</td>
<td>0</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>TNO</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Hydraudyne</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>
TABLE IX
POTENTIAL ICT SOLUTIONS IN THE DESIGN PROCESS [43]

<table>
<thead>
<tr>
<th>Improvement opportunities</th>
<th>Innovative ICT solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interactivity and synchronous communication</td>
<td>Collaborative product development tools</td>
</tr>
<tr>
<td>Trust and directness of feedback in particular</td>
<td>High quality videoconferencing</td>
</tr>
<tr>
<td>Various ways to express designers ideas and intention</td>
<td>3D model viewer and collaborative product development tools</td>
</tr>
<tr>
<td></td>
<td>All round collaboration tools: videoconferencing, chat, whiteboard, application sharing, desktop sharing</td>
</tr>
<tr>
<td></td>
<td>Virtual Reality</td>
</tr>
<tr>
<td>Continuous interaction and modelling overcoming heterogeneous infrastructures</td>
<td>Internet portal</td>
</tr>
<tr>
<td></td>
<td>Standards like XML, Java, TCP/IP</td>
</tr>
</tbody>
</table>
ACKNOWLEDGMENT

This study is based upon an MS thesis [45] of one of authors (Antoon van Luxemburg). We wish to pay our gratitude to the five key participants of the five business cases for their cooperation. We would also like to thank Dr. Leon Oerlemans, Dr. Bart van den Hooff, and Prof. Hans de Stigter for their supervision of van Luxemburg’s MS project; the co-editors of the second author (Jan Ulijn), Prof. Theo Bemelmans and Prof. Doug Vogel; and the anonymous reviewers for their valuable comments. We are sure that the original version increased a lot in quality thanks to them. Any remaining shortcomings, of course, are our sole responsibility.

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Nicole Amare is completing her doctorate in Composition, Rhetoric, and English studies at the University of Alabama. She also teaches writing full-time at the University of South Alabama. Her current research interests include the professional culture of technical communicators and ethics in writing research. Her most recent work, with coauthor Michael McMyne, is *Real Life University*, a college success guide.
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02.05 K. Heimeriks

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