INFORMATION TECHNOLOGY and INDUSTRY
(Strategic Issues and Opportunities)

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Summary

This report is intended to show the reader the way industry looks at information technology and how it deals with it. This relatively new technology must be regarded and utilized as an important, strategic cornerstone in all activities of an industrial enterprise. Strategy, use and quality of information technology will be discussed in three chapters. The benchmarking method will be elucidated in one of these chapters.
In chapters 5 and 6 a number of intrusive questions regarding the impact of information technology on running a business and the organization of an enterprise will be discussed. This could result in drastic organizational and even societal changes: downsizing, outsourcing and partnering.
In chapter seven a subject that has attracted great attention during the last couple of years will be treated: integration of computer-related activities and the integration of the enterprise. In the same chapter re-engineering and concurrent engineering will be discussed. These three subjects: integration, re-engineering and concurrent engineering have been combined into one chapter because of their inherent organization-related connections.
Chapter 8 will be devoted to customer serivce, probably the least discussed and researched part of the product's life cycle.
In a final chapter a number of important conclusions will be summarized point by point.

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1.0 Introduction

It is impossible to imagine where the industrial situation would be to-day in a world where information technology would not have any influence. To compare such a situation with to-day's reality challenges our imagination. In a way which it is as bizarre as trying to find an answer to the question of where in our body does our personality resides or how is it defined.
In the short period of some forty years information technology has changed our way of working, living, moving, entertaining, learning and thinking, and not always in the most positive sense. In many situations one can assume that this development has given the human being a better way of living and working and doing business. However, all that has happened at the expense of an enormous amount of changes, adaptations and costs. Since we never will be able to create a world as it would have looked without information technology, it is impossible to make a rationale judgement about the positive or negative aspects of this phenomenon. We are forced to accept the situation that has been created and we can only ask ourselves what we did wrong or where we were right or what we should have done differently in order to achieve an even better (or different) result.
Developments in information technology have led from enormous rooms containing immense cabinets with electrical and electronic equipment surrounded with long rows of magnetic tape readers and magnetic disk drives. Now we have devices which can perform many times faster and better than the early equipment, and can be held in the palm of our hands. It led from coordinated attacks on large amounts of data (cartography, nuclear experiments, meteorology) to the fascinating application of computer graphics, electronic mail and multi-media. And yet we are still not capable of predicting, in an orderly fashion, further future developments.

In all these tumultuous developments both industry and the academic world have done pioneering work. Industry has, as usual, been forced to do this in order to maintain or advance its competitive position and to improve its overall performance; the academic institutes got involved in this technology because it was new and it was necessary to provide this new engineering discipline and science with appropriate and fundamental theories and methodologies. In many application areas industry appeared to be ahead of academic research. This resulted in a situation where almost all new inventions could be credited to industrial research and development. After the initiating efforts of industry, the academic world improved and extended the industrial innovations and developments. This involved both the hardware and the software. It is remarkable that, however, not a single academic institute was involved in or rendered support to some of the most celebrated and most advanced consumer products of this century: the compact-disk and the laser disk. Yet, these were products that could not have been developed without the use of

information technology, and is based on a combination of advanced optics, electronics, mechanical engineering, high precision manufacturing and information processing techniques. We witnessed a similar situation of the relative absence of applied academic input in other areas where products are produced with the aid of information technology, and where the same technology is heavily incorporated in those products: telecommunication systems, optical systems, electronically controlled equipment, robots, (air) traffic control systems etc. However, the later improvements to these new technologies were often based on important theoretical and applied research studies carried out by a variety of universities and academic research institutes from different parts of the world.
Similarly the methods and techniques that enabled enterprises to improve their market position and competitive edge lacked a vigorous initial academic interest. Adaptation of internal organizational structures, educating their personnel, directing the management and control of a business enterprise, the application of computers and software and the way that non-strategic activities are being subcontracted (outsourced); these are all a direct or indirect effect of the changed industrial situation. Note, however, that in those situations the academic institutes have been successful in leading new research efforts and are attempting to place themselves more and more in the role of precursor or trendsetter. However, in these more business-oriented subjects, the academic world only became aware of them long after internal re-orientation forces within the businesses had been put into practice.

These forces arose from the changes in attitude and relationship of the customer vis-a-vis the manufacturer (supplier). Porter [1] identifies the following competing forces needed to be considered in any business strategy:

1. the bargaining power of the customers
2. the bargaining power of the suppliers
3. the current competitors
4. the threat of new entrants into the market
5. the threat of substitute products or services.

Porter's advice to the industry is: Utilize your possibilities in a very flexible way in order to conveniently enter a market, operate in that market and possibly, exit from it again. On the other hand a well-established firm has to create high obstacles to other companies in order to avoid any easy entrance into its market(s).
Most companies to-day are constantly besieged with demands from their internal divisions and departments for funds to enable them to implement their automation plans, plans that are intended to meet Porter's considerations.
Even under optimal economic conditions it would be foolhardy for a company to invest in all comers. Here an intelligent enterprise

has to separate the wheat from the chaff, and provide funds for only those projects that contribute positively to the company's profitability and productivity.
Many methods and techniques directly or indirectly related to information technology will contribute to that aim, and many firms and institutions have jumped enthusiastically on the bandwagon of the companies that introduced IT-related methods and techniques successfully.
The most important of these methods and techniques will be described in this report. Emphasis will be placed on the way specific industries or service-organizations have used these techniques, and how they managed to deal with Porter's five threats. That academic institutions were initially little involved in research into these emerging methods and techniques was because many companies in order to survive economically, had to shield off the attacks of established competitors and newcomers to their market segments. This situation is quite different for the majority of academic institutions. They have different objectives with respect to their research areas and are remote from the daily struggle for survival that companies have been in since the mid-eighties.

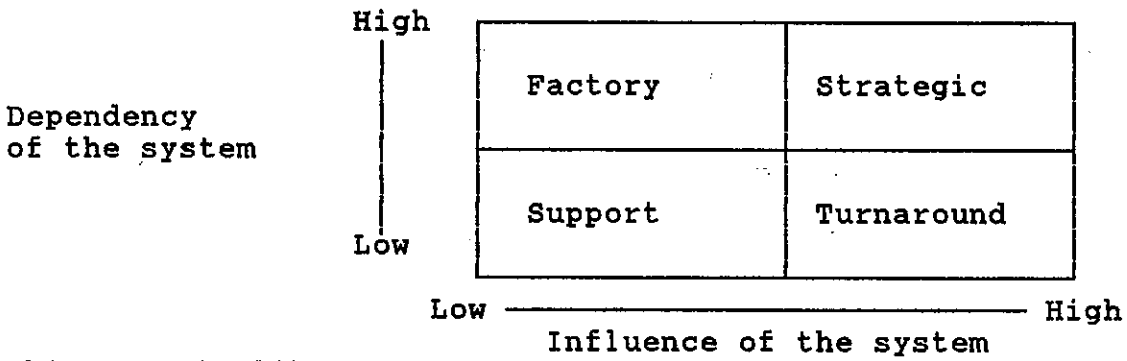
The subjects that will be discussed in this report and that are relevant to the importance of the use of information technology in a highly competitive market are the following:

- The strategic importance of IT for the manufacturing and service industries
- Advanced information systems (databases, artificial intelligence etc.)
- The Quality of information systems
- Benchmarking
- Downsizing and outsourcing
- Partnering
- Integration
- Re-engineering
- Concurrent engineering
- Customer service.

2.0 The Strategic importance of Information Technology (IT)

The greatest part of current developments in industrial processes and activities is the increasing application of information technology. Information technology also feeds industries that are going through a period of large organizational changes.
In a large number of firms where management was told that IT was the key to renewal, innovation and industrial successes, the introduction of IT did not yield the successes that one expected. In highly developed nations in several industrial areas there were enterprises that even lost their grip on their markets and lost their competitive edge. Without exception this can be blamed on the complete negligence of applying modern business strategies. In many situations senior management refrains from taking initiatives that could result in merging modern available technologies with business processes.
This report shows cases where information technology has been a key to success and/or survival. In all these situations members or a member of senior management who was conversant with technology and who was capable of judging the importance of IT correctly, joined forces with a knowledgeable technologist or team of technologists. These dynamic combinations had insight, experience and the knowledge of how information technology can be used strategically.

F. Warren McFarlan and James Cash developed a framework related to these strategic considerations. This framework assesses the strategic significance of a system to an organization.



This matrix-like function can help a company determine the classification of the company and determine the most appropriate way to manage the company's technological resources. The classification should be based on the answer to the question of whether those resources serve as a support function or whether they have a strategy determining role in the organization.

The figure is a two-dimensional representation of four different types of management environments:

1. Strategic forms (banks, movie-studio's) have a tight relationship to technology. They have an excruciating dependence

on technology, and the systems that they develop or acquire are critical to their competitive success.
2. Turnaround firms (transportation, retail shops) don't have quite the dependence on technology as do strategic firms. Their current systems are not considered strategic yet, but the development of new ones are making them crucial to the competitiveness of the organization.
3. In the manufacturing firms technology heavily supports their smooth operations. Technology is not seen as a major differentiator.
4. In support-oriented enterprises (cleaning firms, plant installation firms, repair shops) technology is considered important and useful. It is not on the company's short list of necessities.

The many forms of technology related to business strategies require different sets of techniques. In using technology to support the mission and strategy of organizations a well-know technique is "strategy set transformation":

* Identify the set of strategies important for the organization. This consists of a firm's mission statement, its organizational objectives, the organizational strategy, and strategic organizational attributes.
* Identify stakeholder groups within the organization.
* Identify the operating objectives of the stakeholder groups and the constraints related to the development or acquisition of systems.
* Develop information strategies using these results.

This set of steps is quite elegant in its simplicity. Its use assures the organization of a proper match between technology and business.

To support these strategy-changes it is important to compose an information plan. Such a plan must be deduced from the business plan(s), and contains (generally) a list of the used and required technologies, methods and systems. It also describes the current situation and the required IT-related environment of the company. It analyses the current technology and systems, and contains an enumeration of the tasks and actions required to achieve the desired environment.
Many firms that drafted information plans used IBM's Process Quality Management (PQM) technique. This technique applies the concept of critical success factors. PQM is actually a combination of methodologies that many companies use independently, but IBM brought these techniques together and created a method that is used to-day by many companies.
PQM is initiated by gathering, preferably off-site, a knowledgeable staff team. The team's members should represent all facets of the project. The team leader must have a mix of skills closely attuned to the projected outcome of the project. For example, a

PQM-team charged with improving the productivity of a factory needs a team leader who is an expert in process control, even though the eventual solution to the process consist of an enhanced automation system.
The first task of the team is to draft the team's objectives. Vague objectives must be accompanied with more concrete sub-goals that can be formulated more directly, and can be achieved more readily. In a brainstorming session the team must enumerate all factors that could contribute to failure of the project. Here the team should formulate those factors in a very short period of time (not more than 10 minutes) without much discussion. They must be stated in sentences of a few words only.
Then the team has to identify critical success factors (CSF's), which contain specific tasks the team must perform to accomplish its objectives. A consensus on these CSF's is very important. The next step in the PQM-process is to make a list of all the tasks necessary to accomplish any specific CSF. The description of these tasks must be declarative. Every action has to be stated with a verb such as: study, measure, reduce, negotiate, eliminate.
This process results in a project chart and a graph that contains the priorities. The project chart will contain enumerations of all tasks and the degree to which the task can contribute to the goals of the project. This is done by comparing every task with the set of CSF's. A special column of the chart enables the team to assign grades (A through E) to the tasks. For example, A is excellent, D is bad, E is not currently performed, etc.
The priority graph will steer the mission to a successful and prioritized conclusion. The two axes in this graph are Quality, using the A through E gradings, and Priority, represented by the number of checks that each task received.
The final task of the team is to decide how to divide the priority graph into different zones representing the first priority, second priority and so on. The definition of the appropriate project(s) to pursue and push for a competitive technology follows the activities of the PQM-project. Then the need for a productive and high-quality development effort becomes extremely important.
The case for productivity will be discussed now. The quality of information systems is treated in a separate chapter.

Aspects crucial to the development, introduction and application of software and that receive insufficient attention are: productivity of the software experts and improvement in efficiency by using information technology.
High quality of software developers, programmers and systems people go hand in hand with the efficient introduction of automation systems. According to Yourdon there is a 25 to 1 differential between the best people and the worst people, and a 4 to 1 differential between the best teams and the worst teams. The best way to improve productivity and quality is just to improve the hiring practices of the personnel departments. A method used

by a number of firms is to have the candidate software experts work out a complex problem. The better people will solve it many times faster than the less qualified. This selection method is not used throughout our industries yet. The heads of personnel departments still prefer diploma's that say little about the quality and the persistence of the person.
Another factor that improves the productivity of the people are the ergonomic conditions of their working environment. People who are locked up in office landscapes and are forced to work in small and noisy cubicles with artificial lighting perform considerably less than those working in offices with adequate space and normal daylight.
Productivity will certainly be enhanced when IT-personnel have the opportunity to regularly improve their knowledge by following well-structured and high-quality training courses. They will be able to augment their current knowledge with newer methods and techniques as well as tools that are constantly being updated and improved..

Companies that will win the competitive battle of this decade are those that will leverage their investments in technology to create new possibilities. What is needed to make IT a productive contribution are good management, good technical staff, good estimators and testers, good tools and a good methodology.
A methodology represents the processes or steps that a technology unit goes through in order to successfully specify, develop and then implement a computer system. Many companies develop or introduce a system without using a sound methodology. The Software Engineering Institute, located in Pittsburgh PA,
has made an in-depth study of this problem and has developed a framework that charts the maturity of IT in a company.
The framework consists of five steps:

1. The initial step. The IT-efforts take place on an ad hoc basis; there are few formal methods; the tools are informally applied to the process.
2. The repeatable step. The company has achieved a stable process with a repeatable level of statistical control.
3. The definition step. A foundation for major and continuing progress has been achieved.
4. The managed step. In this stage the company has gained substantial quality improvements and comprehensive process measurements have been introduced and are applied.
5. The optimized step. In this final stage of maturity major quality and quantity improvements have been achieved. The company will continue to work to further optimize its processes and enhance its performance.

The study of this institute revealed that 80% of the companies are still struggling somewhere between steps 1 and 2. This is because the user communities in these companies still don't know what they want and what they might expect from the available

technologies and tools. Many people still create their own methods, then look for the tools that will force them to apply those methods.

Summarizing, it is of extreme importance that modern companies first develop their IT-strategy and secondly select the systems that suit that strategy. At the same time they have to pay considerable attention to the productivity of their IT-staff (implementors. developers, analysts, system-managers) and make sure that the efficiency of the staff is supported by suitable and useful methods, techniques and tools.

3.0 The Industry and its use of Information Systems.

The term *competitive intelligence* is very much at the tip of the tongue in the economic circles of to-day. The term means that the competitive position of a company can be greatly improved by using systems with intellectual qualities that the human can not add to the operations of the company. Competitive intelligence is, however, just part of a larger view of the business world we live in. It is a subset of *business intelligence* and can be viewed as the radar of an enterprise. As with radar, the business environment has to be constantly scanned to avoid danger and to seize opportunities. Business intelligence can be seen as the other half of strategic planning (see chapter 2). One has to view the business intelligence as the cohesion of all activities with which the company monitors the competitors, the changes in the political situations, the behaviour of the customers and even affairs that concern our natural environment. Everything that happens in the ever changing world where a company operates influences the long-term aspects of such a company. Competitive intelligence transcends the boundaries of an industry and, if used correctly, provides the organization with an immediate advantage.
The methods and/or systems that can be captured under the term "competitive intelligence" are:

* Executive Information Systems (EIS);
* Corporate Data Bases;
* Benchmarking
* Strategic tools;
* Artificial Intelligence.

In the next paragraphs we will discuss these systems, methods or techniques and in a few cases examples of successful and useful applications of these subjects will be presented.

3.1 Executive Information Systems (EIS).

Executive Information Systems are important tools that can be used immediately to make information available in such a form that it can be used more effectively, especially for the managerial levels of a company. The purpose of an EIS is:

- to reduce the amount of data with which a manager is daily bombarded;
- to increase the relevance, the timeliness and the usefulness of the information that is brought to the attention of managers;
- to draw the attention of management and management teams to critical success factors;
- to monitor the progress of decisions that were made and to monitor the actions that were a result of those decisions;
- to intensify and improve communication with others;

- to take immediate notice of warning signals such as the actions that are considered or taken by the competition; demands or requirements that are formulated by the customers; the preparation or passing of laws that may influence the way a company conducts its business etc.

3.2 Corporate Data Bases

While Executive Information Systems provide a baseline for analyzing the business' intelligence, there will come a moment when software tools will be required to sift through collected data and uncover relationships that can be turned into profit.
In choosing an architecture for the company's corporate database, standards are important, and should be funded as well as supported by management. This process must not overshadow the more important issue of being able to navigate effectively through the data contained in the database. Standard database query languages easily retrieve information - but only the user knows specifically what she or he is looking for. One must use a more heavy-duty tool in case the request for information is vague.
A more difficult class of information that one must deal with is what can be termed as uncertain or fuzzy information. Upon analyzing a large database, it is possible to discover patterns, rules and unexpected relationships between data items that were previously unknown and unrealized. This is what can be considered the hidden treasure in corporate databases.

This constitutes an intriguing possibility and a challenge. However, it is a challenge on which only a few companies are embarking. This is unfortunate, since companies would certainly benefit from discovering some interesting correlations between, for example, sales data and customer financial data. The following practical situation will serve as an example.

3.2.1. The New York Stock Exchange (NYSE)

The regulating department of the New-York Stock Exchange is charged with ensuring that the brokerage firms that are members of the NYSE are financially sound. This is accomplished by requiring that these firms file huge amounts of financial data which financial analysts of the regulatory department of the NYSE then review.
The most important tool for this purpose is a program that is called EDR (Exception Disposition Report). This report is produced by comparing the data filed by the brokerage firm with a set of statistical algorithms such as: *"If the firm's excess capital is greater than 25 percent of its profits then flag an exception"*. These exceptions, formulated in the form of rules, were developed by the financial analysts by comparing and reviewing one information item against another. The rules, called EDR's, were coded statements concerning the relationships between financial data items.

The financial analysts met regularly to improve the rules of the system. There was the constant danger that these rules could be wrong resulting in incorrect relationships. This was because these rules were composed manually.
A greater problem was the absence of certain rules. A potentially dangerous financial situation would never be discovered in case of missing rules. The product would be considerably better if the rules could be deduced automatically. This alarming situation has been remedied with the introduction of expert systems (see also paragraph 3.5.).

3.2.3 IntelligenceWare and IXL

The market leader in these corporate databases is IntelligenceWare, a company that markets IXL (Introduction of Extremely Large databases). IXL is a unique system that analyses very large databases and discovers patterns, rules and often unexpected relationships. IXL uses statistical methods and self-learning techniques that generate simple rules. A very interesting case was discovered recently using IXL. The University of Southern-California conducted an investigation in lead poisoning. Analysis of the gathered information led to the discovery that a relation existed between the gender of a person and the level of lead in the blood that could result in damaging a kidney. This relationship was unknown and possibly catastrophic.

Meanwhile many firms started to explore this form of intelligent information processing using corporate databases. The fact that little is known about their efforts is understandable in this stage of the application.

3.3 Benchmarking

An increasing number of companies discovered the usefulness of starting activities where they gather information concerning the intelligence and the position with respect to technological situations and the lead of competing companies. It appears that it is not required for a company to have access to a mainframe computer for this activity. It is possible to do this with the aid of a personal computer. The technique of gathering the information of the competing industries is either called "Combustion Engineering" or "Benchmarking". We will use the latter term here. The objective of a benchmark activity is to analyze every separate competitor (or group of competitors) in terms of the strategies that they apply and their future developments. The most important difference between this technique and other methods is the direct participation of top management. It is not just a team of knowledgeable people that carries out this investigation and the analysis of the collected information. High ranked managerial functionaries are involved as well. They contribute in the analysis process and are crucial in deducing the strategies of the competitors in a logical way.

Benchmarking consists of five steps required to be able to perform a sound and useful analysis.
The five steps are the following:

Step 1: Initiating meeting. When the company that will be analyzed is selected, an initiating meeting is held. This meeting has to be attended by the relevant managerial staff as well as the CEO of the company. This group has to be complemented with the companies experts who are capable of making the various information sources accessible to the rest of the meeting. These information sources consist of information and documents that are internally available and those that can be obtained from external sources. A plan is made at this meeting. This plan contains further actions that will result in obtaining even more information. The plan will also formulate the way the total amount of available information about the competitor has to be analyzed.

Step 2: Information-exchange meeting. At this meeting every person will be allotted a certain amount of time in which he or she will have to present the information gathered by him or her to the others. The team will then perform a strength-weakness-analysis. This will be done for all the collected information. This analysis addresses two questions: "Is the competitor stronger or weaker than our company?" and "Has the investigated area of interest a potential that may influence our customers?".

Step 3: Analysis of costs. When the meeting feels that all areas of interest have been sufficiently well defined and isolated a comparative cost-analysis has to be carried out. First of all a division of the costs of the company's own product has to be carried out. These costs involve labour costs, manufacturing costs, costs related to goods, materials and services that have to be purchased, distribution costs, and costs related to the commercial activities and accounting. Next the costs of the competitor are compared with the cost figures of the company that carries out the benchmark. These costs are classified on a scale with four components: considerably higher, somewhat higher, somewhat lower, and considerably lower. This can be worked out in detail. It is also possible to establish a certain percentage between "somewhat" and "considerably", for instance 10%. It is now possible to calculate or assess the total costs of the competitor for a specific product by attaching weights to all these cost factors.

Step 4: Motivation of the competitor. This is undoubtedly the most difficult and least tangible aspect of the benchmarking process. The team has to analyze the motivation of the competitor. This can be done by determining how the competitor measures their successes and to assess what are their objectives and strategies. During this part of the investigation a senior manager and his or her staff has to collect a considerable amount of information on this subject. Using on-line databases informa-

tion can be obtained from: advertising material, brochures, annual reports, press releases etc. One should also obtain information from former employees of the competitor. This concerns (especially) information about the strength of the marketing department, analyses of the investments, the supplier(s), the customer, the production strategies etc. One should be able to deduce the motivation of the competitor from this information.

Step 5: Composing the total image. Further analysis of the collected data makes it possible to get an impression of the strong and the weak points and areas of the competitor. These points relate to the competitor's cost structures, his objectives and strategies. The team can now begin to develop an insight in specific areas and develop an understanding about possible next steps that will be taken by the competitor. The team can show, for example, that the competitor is stronger in his direct sales, has created a more profitable position in terms of his labour costs and is in the process of moving up from a pure regional operating company to one that will be more active on a national or international level.

When a company can carry out sufficiently large amounts of benchmarks, it will be able to adapt its own strategies to challenge the competition successfully and to even take a lead.
The use of proper methods and tools offered by the information technology in collecting, analyzing and synthesizing the relevant information is indispensable in a benchmark activity.

3.4, The use of strategic tools.
The apparently smooth evolution from handling data to processing information has been characterized by great improvements in the way information technology is currently being utilized and in the availability of appropriate tools and methods. The advent of fourth-generation languages, vastly improved application programs to which a certain amount of intelligence has been added, advanced communication means and the heavy reduction in hardware costs characterizes this evolution. Human productivity also increased due to the aforementioned developments. At the same time companies introduced new methods that assisted them in searching databases that contained massive amounts of information faster and more efficiently. Currently the management of companies can chose from a wealth of methods that permits management to retrieve the most relevant information almost immediately. Some of these methods will be described shortly.
The monitoring method provides the user with data on an exception basis. This can be variance reporting, where the system only produces exceptions based on a programmatic review of the data. Examples are: the review of credit card payments where only those accounts are displayed where the payment was not received or the payment into the account of the card holder is below the minimal allowable amount.
The advent of a fourth-generation language, a tool that enables

the end-user to access corporate databases with an easy to use syntax, has thrust the interrogative method of system tailoring to the forefront. This method takes the many occasions into account when the user cannot identify the information required to handle day-to-day, ad hoc analyses in complex decision-making situations. In these cases, all of the information elements need to be resident in a database that is constantly accessible.
A model-oriented approach consists of a series of methodologies. Human resources or facilities departments are appropriate candidates for descriptive models. These are, for example, organization charts or floor plans. A normative representation of information is well suited for budgeting problems when the goal is to provide the best answer for a given problem. Economic models are a good target for methodologies that have the ability to handle uncertain data. Operations management functionaries often apply game theories to those problems where it is required to find the best solution in spite of a profound lack of information. An example of a problem where this type of strategy would be used is a competitive marketing system where information about the competition is scarce or unknown.

Information technology is more than just software. Slowly companies have started to realize that the value of information has been augmented by improvements in computer hardware and communication technologies. The dominating position of mainframe computers of the sixties and seventies has been replaced by small equipment (personal computers) that can be used locally and can used as workstations by linking them to powerful networks. Thus the PC can use the complete potential of large computers remotely. With the introduction of distributed architectures (as in client/server concepts) the term "information system" is no longer one that is only applicable to the hardware of the eighties. With the advent of distributed concepts, extremely fast and reliable communication means and powerful information processing capabilities, industry should at last be able to embrace Information Technology completely and unconditionally.

3.5. The application of Artificial Intelligence (AI).

Industrial enterprises have begun to explore and use the specific area of information technology known as Artificial Intelligence (AI). The most important application of AI is the use of "intelligent robots", programmable machines equipped with vision and touch-sensitive devices. The second important applications are those of expert systems. In this report we will limit our discussion of AI to the application of expert systems.

3.5.1. Expert systems.

During the last five years more than 80% of all industries making the list of the "Fortune 500" have investigated and/or introduced expert systems and methods used to capture human expertise.

Expert systems are said to be able to copy the knowledge and the reasoning skills of the company's experts. It will permit the users to interact with expert systems and add the knowledge of the "tapped" experts to their own knowledge and capabilities. This will enhance their productivity. It underlines the power and possibilities of information technology.
The essence of an expert system consists of the knowledge which is stored into the knowledge base of this system. The first hurdle to be taken is to discover "expertise" and formalize it. Expertise is not necessarily associated with a smartness. Expertise is not so much the function of intelligence of a person but more the way that person has accumulated experience and uses that experience skilfully. It is the experience that one wants to formalize, formulate and store in the knowledge bases of expert systems. Experts have a solid and deep-rooted knowledge of a specific subject. If they are confronted with a problem they will be able to immediately create a clear view of the problem in the context of the situation that problem manifests itself. Inexperienced employees or employees who lack the ability to use their knowledge properly will often find themselves in a situation where they can not see the trees through the forest. The most interesting difference between the expert and the inexperienced employee is probably the fact that the expert is much more capable of organizing his or her knowledge and applying it. The expert learns to recognize certain patterns that are, as it were, burnt into her or his memory. A new problem exhibits quite often certain features and characteristics that resemble previous problems in certain instances, and are different from those that are stored in the expert's memory in other instances. The expert makes associations with his or her earlier experiences, identifies the differences and makes decisions about solving the new problem almost immediately.

The first generation expert systems could only handle superficial knowledge. This is knowledge collected during interviews with experts. The second generation expert systems is strongly supported by research in psychology and the neurosciences; research that has been carried out at a wide range of different universities. The conducted research helped developers of expert systems to obtain a better understanding of the way knowledge and experience are stored in the memory of experts. This research led to tangible and practical results, especially in the use of neural networks. These will be discussed in a later paragraph.

3.5.2. Some practical examples.

3.5.2.1. E.I. du Pont Nemours & Company became aware of the strategic value of this technology in 1985. The Company allowed the personnel who showed interest in expert systems to make themselves familiar with this technology and create their own expert systems. Now Du Pont uses more than 600 expert systems. What is even more important is that the company has saved between

1985 and the present more than $ 150. million by using the expert technology. The enterprise has expanded its share in the market and was able to enter new markets. That was demonstrated with the expert system "Packaging Advisor". This system has been successfully used in the design of rigid plastic food containers. It helped Du Pont to break into the very competitive barrier resin market.

3.5.2.2. Digital Equipment Corporation has installed more than 50 expert systems. The company states that it has saved about $ 200. million with the use of this technology. The most well-known of DEC's expert systems is XCON, a system that automatically generates the technical specifications of a customer-oriented computer. A human technical author will undoubtedly make many more errors than XCON when specifying a computer, especially since DEC's computers contain between 2000 through 8000 parts. DEC became a serious competitor to IBM in the early eighties with this system.

3.5.3. From expert systems to neural networks.

Neural networks simulate a network consisting of hundreds of interlinked units that work in parallel. Messages are transmitted between the nodes (the neurons) of a neural network with enormous speeds. The neuron's function in such a network is to receive messages and to respond to these messages almost immediately. This resembles the conventional ways that networks operate. Neural networks are actually programs that differ largely with the existing programs. First of all, neural networks can recognize low-quality input. This enables the neural networks to process incomplete data. Handwritten documents are an example of the application of a neural network. Several financial institutions use neural networks to recognize signatures. These signatures may be badly written. Even signatures of people who don't write their signatures in exactly the same way each time can be recognized.
A completely different application of neural networks is a PC-oriented neural network that predicts the value of stocks, gold and foreign currencies. The value of those stocks, gold and currencies are stored in a knowledge bank. These data have been collected over a 40-year period with 10-day intervals. When the net is switched on it searches for input patterns that will result in a specific output stream - in this case a decrease or increase of the value of the item that is being investigated. The larger the amount of stored information, the greater the accuracy of the prediction. That can be readily understood since the neural network copies the way in which the human being learns and it simulates the way our brains operate. If our memory contains many examples that lead to a certain result, then they can find a normative answer to received data. Our brains will anticipate the answer, even if the received data is irregular and incomplete.

3.5.4. Requirements that have to be met.

To-day there are many examples that show how AI-systems contribute to a company's strength compared to that of their competitors who neglected to take advantage of this technology. However, before acquiring, developing or implementing an AI-system a number of important aspects have to be considered and certain measures have to be taken.

1. All management levels have to be convinced of the usefulness and the need for an AI-system. They must support this activity without reserve.
2. Adequate training in AI-systems is very important. An expert system should not be regarded as another conventional system.
3. Potential systems have to be evaluated and reviewed by the pool of future users and the technical staff that will be charged with implementing or developing the system. Not all of the company's problems can be solved with the aid of AI-systems.
4. Don't use more than three professionals in the development of a system unless the company has enough experience in this type of technology. Differences in opinion among the professionals often lead to delays and errors.
5. The problem that has been selected to be solved with the aid of an AI-system has to be defined formally. The resulting system should not come as a complete surprise to the future users and to management.
6. Intelligence and automation systems can be enhanced with more than one solution that Artificial Intelligence has to offer. A well-formulated decision based on solid fundamentals and principles will help in making the right choice for the specific AI-technique that can be used.
7. In case an AI-system is developed, one should always start with the construction of a prototype system first.
8. The three most important activities to be carried out when developing and implementing an AI-system are: testing, testing and testing. The assumption that expert systems and neural networks can not be tested is a fable.

4.0 Quality of Information Systems.

This chapter is a natural continuation of the previous two chapters. Attention will be devoted to the quality of acquired, developed or otherwise implemented systems and their associated use. The quality of the products a company produces is not being discussed here. Orientation will only be focused on software quality.
However, the quality aspect of software is tightly connected to all aspects of a company. It is about the quality of its products, the productivity of its employees etc. It is part of the culture of the company; how it develops, implements and uses its technology. It has been proven that caring for quality on a short term basis leads to an increased productivity in the long term.
Quality is still neglected in situations where a company tries to implement (or deliver) systems before or exactly on the due date. Despite timing constraints or other pressures, one must continue to make serious attempts to enhance the quality of the output. That means that measures have taking to assure the quality of every implemented or used system. In assessing the quality use can be made of an enumeration of a large number of aspects that relate to the size, structure and functionality of a software system. These can all be measured and can considerably improve the software as well as the information content generated with the aid of software. Table 2 can be viewed as containing a fast evaluation of the achieved quality of software.

1) Number of lines of code
2) Pages of documentation
3) Number and size of the tests to be carried out
4) Summary of the functions
5) Number of variables
6) Number of decision trees
7) Module count
8) Depth of nesting
9) Number of required changes
10) Number of detected errors
11) Number of changed lines of code
12) Time used to design, code and test
13) Defect discovery rate in each phase of the development
14) Development costs
15) Number of external interfaces
16) Used tools
17) Reusability percentage
18) Variances in the planning of the development
19) Staff years experience of the team
20) Years of experience with the used language(s)
21) MAPS per person
22) Ratio of support personnel to development personnel
23) Ratio of time not spend on the project to project time

Table 1: Metrics Productivity/Quality

1) How easy is it to use?	1	2	3	4	5
2) How secure is it?	1	2	3	4	5
3) How is its level of confidence?	1	2	3	4	5
4) How easy is it to upgrade?	1	2	3	4	5
5) How well does it conform to requirements?	1	2	3	4	5
6) How easy is it to change?	1	2	3	4	5
7) How portable is it?	1	2	3	4	5
8) How easy is it to locate a problem and to resolve it?	1	2	3	4	5
9) Is the response time fast enough?	1	2	3	4	5
10) How easy is it to educate staff?	1	2	3	4	5
11) Is it simple to test?	1	2	3	4	5
12) Is the software efficient in terms of the computer capacity	1	2	3	4	5
13) Easy to couple with other systems?	1	2	3	4	5
14) Does the system utilize the minimum storage possible?	1	2	3	4	5
15) Is the system self-descriptive?	1	2	3	4	5
16) Is the software modular?	1	2	3	4	5
17) Is there a program for continuous Quality awareness for all employees?	1	2	3	4	5
18) Is the quality of the supplier checked regularly?	1	2	3	4	5
19) Is there a quality department?	1	2	3	4	5
20) Is this the correct system to be developed, implemented or used?	1	2	3	4	5
Circle the applicable number next to each measure. Add total score.					
1=positive; 5=negative					

Table 2: Quality factors. Rating these factors and totalling the score provides a way to measure the overall quality of a software project.

A good example of an enterprise where quality and productivity are best tracked is Hewlett Packard (HP); a company that produces electronic systems and equipment. This firm has implemented a Total Quality Control (TQC). TQC is defined by the fundamental principles that

1) all business activities can be scrutinized in terms of the involved processes, and that
2) metrics can be assigned to each process to evaluate its effectiveness.

This TQC approach places software quality and assessment high on the list of software development tasks. When projects are initially defined, the knowledge about the project to be automated is evaluated and the project team will define the metrics that are to be used to measure the automation process. When HP

decided to base the company's future on a new type of computer architecture they realized that the reliability of the equipment and the software would be a critical issue. The development of the operating system would turn out to be one of the largest development efforts in the history of HP. It was also an effort in which more than one division was involved. HP concluded that going over the budget by 50% and getting a product out on time reduces the eventual profits with approximately 4%. However, staying within budget and getting the product to market five months late reduces the profits with 60 to 70%.
HP was one of the first companies that introduced a System Software certification program to ensure measurable, consistent, high-quality software through the definition of metrics, goal setting, collecting and analyzing data, and certifying products before releasing them.
The results were impressive. Errors were detected and corrected early in the development stages. Those were stages where the costs involved in finding and correcting those errors were still relatively low. This all resulted in lower overall costs and a higher productivity of the departments and employees involved. At the same time it increased the quality of the products that were shipped to HP's customers.

This is one example of what a company can achieve with the appropriate use of development methods and sound information technology practices. Unfortunately this example has not yet lead to an overall higher interest in the HP approach at the majority of other companies and institutes.
Obtaining the ISO-9000[2] certificate is often viewed as a way to improve quality. However, the HP example shows that achieving quality requires enormous effort, much more than the effort involved in obtaining the ISO-9000 certificate. Those are limited to the definition and composition of procedures. This is complemented by teaching the staff and the firms' employees how to answer questions during the formal audits that are being conducted by ISO-9000 auditors. The answers to those questions are known and can easily be learned by heart.

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[2] It must be noted that the ISO-9000 certificate is based on the ISO-9001 standard. Companies that are serious in their quality efforts should at least aim for complying with the ISO-9004 standard. Even better is to try to obtain the Baldrige or Demming award.

5.0 Downsizing and outsourcing.

The term downsizing has different meanings for different people. It means making the hierarchy of a company flatter if it is viewed from the perspective of the human being. This phenomenon manifested itself more clearly after the collapse of the stock market of 1987, especially since that event was followed by a deep economic recession. Even during the recovery that started in late 1991 the trend of companies to continue this downsizing process continued. That was because the higher management of enterprises realized that this process resulted in a number of noticeable advantages and a higher efficiency of the company at large. Downsizing of a company made it necessary to conduct a thorough analysis of the kind of functions that have to be carried out within the company itself, the core functions, and tasks that can better be performed by outside specialized forms. That led to an increase in the sub-contracting of certain activities. A new term for this long practised activity had to be found and the industrial society started to use the term "outsourcing". (Note that the verb "outsource" is non-existent in the English language, whereas "subcontract" is). Many companies made extensive use of so-called "service bureau's" long before this term became popular. Its practice is as old as the phenomenon of corporate computer centers. In the era that preceded the cheap personal computers most of the information processing activities were carried out on mainframe computers. This was often a costly affair and was extremely difficult to calculate the profitability of the operations that were performed on these types of computers. Companies that did not have the financial means and/or the technical capabilities to perform certain automation tasks in-house started to buy time and services from a firm that could offer these services to a large variety of customers. Many of these service bureaus even started to specialize their operations and focused on certain branches of industrial activities. These services also included the choice of a wide range of application programs for the customers.

Downsizing and outsourcing did not stop when the economic situation improved in 1992. On the contrary, tens of thousands of highly skilled specialists lost their jobs almost overnight. The human tragedy that went hand in hand with the many downsizing operations created an enormous amount of human sufferings, something that would certainly have attracted more attention in the sixties and the early seventies. The author mentions this aspect since each of the success stories about downsizing and outsourcing ignore this human aspect completely. The impact on the quality of life of these "redundant" specialists and technicians is much more serious than is generally known. This becomes more evident by the large percentage of suicides, divorces and violent outbursts within the "protected circle" of the family of those technically high-skilled, well educated ex-employees of downsized companies.

5.1 Downsizing

5.1.1 Problems associated with the downsizing process

It has become clear that the downsizing process works best if the technological infrastructure of a company is well organized and well structured. Adding new components to an existing chaotic situation will result in more chaos. A company has to ask itself a lot of questions which, in case these can be answered, determines whether or not a company has sufficient grip on its own environment to successfully carry out a downsizing activity.

Concerning the position of the business the following questions have to be answered:

1. What are the most important strategies and tactical measures that contribute to the objectives of the company?
2. How are these applied in the various departments or divisions?
3. What are the critical success factors that will contribute to achieving the objectives.
4. Is the company growing or are its activities decreasing?
5. Are any acquisitions underway?
6. Are the costs efficiently managed?
7. What is the situation of the company with respect to its competitors?
8. What are the general technological principles that guide the firm's use of information technology?
9. Does the company use information technology to automate? To improve its effectiveness?
10. What is the company's view of information technology on the long term.

The questions related to the use of information technology are:

1. Ho many functional departments are using information technology to-day on their own?
2. How do these departments use IT and for which functions?
3. What kind of equipment and software is being used?
4. Which application programs are deployed?
5. What are the relations concerning the deployment of information technology between the various functions of the department.
6. Are the applications standard within the company, standard within a department or are they for personal use only?

The questions concerning the users or user community are:

1. What is the level of experience of the application information technology of the user community?
2. Is it possible to categorize the users according to the following criteria: knowledge, skill, responsibility, interest?

The answers to these questions brings clarity to a number of

important aspects for a company beginning a downsizing process. Those aspects are:

a. The degree that management feels responsible for using information technology, and has committed itself to accepting that technology as a strategic component of the business policies.
b. The level of understanding of information technology within the company.
c. Whether the structure of the organization will change drastically after the downsizing process, or whether it will remain unchanged.
d. The speed with which the downsizing operation has to be executed. In general, downsizing can take place too fast and too rigorously.
e. Whether it will be possible to carry out the downsizing within a framework (or an infrastructure) so that the downsizing can be appropriately managed and controlled. A well composed information plan is a prerequisite.

5.1.2 Some success stories.

In this paragraph we will present a few success stories of downsizing operations that were carried out within industrial enterprises without any outside assistance.

5.1.2.1 AMTRAK

AMTRAK had two objectives when it decided to investigate the feasibility of a downsizing operation. It had to reduce the costs and augment the productivity of the employees.
This was not an easy task for a transportation industry. Many of the employees who would be involved in the downsizing process were working in the reservation departments. The job of a reservation agent is strongly influenced by the information technology that the agent uses. For instance, the reservation agent could be asked certain questions about departure and arrival times when he or she is busy with a booking operation. The agent must suspend her work and consult the various train schedules. This situation was a source of high costs and low productivity. AMTRAK's solution was to renew its complete information infrastructure. The old Honeywell terminals, used by the reservation agents were replaced with 2200 AT&T workstations, a $ 14. million contract. The savings were enormous. The agents could now handle approximately 34 million transactions each year. They were equipped with highly flexible hardware and software and could simultaneously ask questions on their Windows-based workstations about schedules, prices etc. while being involved with a booking procedure. The agents could now access the various types of information by a simple click of the mouse or press a push button that resulted in a display of multiple windows with the requested information on their screens.

This transition resulted in savings of more than $ 250.000.- a year. The cost of maintaining the systems also dropped. This led to total annual savings for the booking agents alone of more than half a million dollars.
Unfortunately, this success story does not reveal how many agents became redundant.

5.1.2.2. Pillsbury Brands

Pillsbury Brands is a division of the food sector of Grand Metropolitan PLC. A downsizing operation yielded positive results in this company as well.
Pillsbury decided to downsize its operations after they analyzed the information processing activities that were carried out on a number of (older) mainframe computers. The analysis showed that the company needed to improve communications between the headquarters in Minneapolis, the locations of the factories and the commercial organizations. The solution was to install a company-wide network of terminals based on microcomputers. Pillsbury was able to distribute the processing capabilities to the various nodes in the network and to the locations where processing would be most appropriate and profitable. LAN-servers which could provide easier access were also added to the network. The activities in the company were streamlined in such a way that common automated business processes and applications could be used throughout the company. The net result was a system that could be maintained better and easily, a reduction of costs and a tighter management of information related activities throughout the enterprise.
In this case it is not known how many employees lost their job with or without pay.

5.1.2.3. Administration of Social Security.

The question raised at the end of the previous chapter can be answered when the American Social Security Administration was downsized. In this situation an obsolete structure of hardware and software was replaced by a superior network-oriented system. Here 20.000 of the 80.000 employees lost their jobs. It is not known what happened to these unfortunate "outsized" American citizens. This success story does not mention whether they were able to be employed elsewhere, received a pension etc. However, we are convinced that if the Administration would have been successful in finding other employment opportunities for these 20.000 unfortunate people, it would certainly have been reported.

5.2 Outsourcing.

In this paragraph we will explore and discuss the risks of and the reasons for outsourcing related to information processing. A limited number of cases will also be described.

5.2.1. The risks of outsourcing.

Does a company have to outsource certain activities? If the answer is yes, then the next question is, what departments or what functions are best suited for such a drastic step? The sales organization? The computer Center? The personnel or accounting department?
An answer to these questions can hardly be given. The number of success stories are too few to be able to deduce a reliable trend from the few well-known and published cases. Computer models do not answer the question of whether or not a company should outsource certain activities. Even if these models are very detailed and are being used for other complicated organizational situations they appear to be unable to answer the questions raised at the beginning of this paragraph. Also, with respect to outsourcing, the company has to face a number of serious questions before it decides to even consider outsourcing seriously.

Those questions are:

1. What is the real pressure on a company to outsource certain activities? Is it saving money? Is it lack of certain areas of expertise? Or is it an activity that does not add any value to the product or services of the company?
2. Does the competitiveness of the firm improve or worsen after outsourcing activities? Is it possible to react as fast to threatening factors as before? Is that also possible if opportunities arise where the company can improve its competitive edge?
3. Can the chosen outsourcing firm do all the work, and can the firm deliver as promised? Often, one can select out of more than one supplier. In that case the performance and the quality that the chosen supplier has to provide have to be investigated. The most important questions in that case are: What is the reputation of these firms? Do they have customers that can be compared with our company? How do those customers value the supplier of outsourcing activities? Can the chosen supplier perform our functions better, just as well or worse than we used to do?
4. Will the costs of the outsourced functions indeed be less? The greatest danger here is that the dependency on the chosen supplier will become great especially in case the outsourced functions have been completely dismantled in the company. This may invite the chosen supplier to jack up the prices.
5. What are the controlling mechanisms and what measurements can be taken to insure a relationship where the supplier will continue to deliver high quality services and good work?
6. Will the company be forced into a situation where it has to use the products of the supplier eventually? If IBM is chosen as the firm that will carry out certain outsourced functions, will IBM insist on using its own equipment or

would it be willing to use DEC-computers and vice-versa?

7. Which functions within the company are good candidates for outsourcing?
8. Is it possible to undo the outsourcing once the decision has been made and executed to move certain functions to selected suppliers? How fast will the company be able to carry out those functions itself again? This is probably the most important question that should be asked. Even if the outsourced activities are reducing the costs and improving the profitability, it is still necessary to draft an emergency plan. Such a plan must contain the measures that have to be taken to reinstall the outsourced functions. This is especially important in situations where the expectations of the benefits of outsourcing are not met. This is a situation that occurs quite often.
9. Will the company lose its own high qualified personnel if it decides to outsource? Many technical experts are often attracted by a technical environment and not necessarily by a specific company. One has to make sure that the consequences of outsourcing will not degrade the technical competence of the enterprise.

Despite the risks, a large number of American companies have started to outsource one or more operations related to information technology. This is justified with the argument that they have no other choice since the costs to carry out these functions within the company have become enormous. This is especially true for medium-sized and financial solvable firms. This is not the case for the larger corporations. The IT-expertise stays in-house because many applications are developed within the company and because the company considers information technology a strategic asset. It does happen that the actual processing of many programs and systems is outsourced to specialized data processing firms.

5.2.2 Some examples of outsourcing.

5.2.2.1. Continental Airlines.

A couple of years ago Continental Airlines signed a contract with a supplier of IT-services. The contract which had a value of $ 2.1 billion, stated that the supplier would carry out all of CA's IT-operations. Included in those outsourced services was the reservation system of CA. It is important to note that CA was getting close to being declared bankrupt and that a judge ordered CA to move its IT-operations to another company. This case, and many others, have supported the wide-spread belief that a bad financial situation is the reason to outsource this very important strategic function of a company.

5.2.2.2. Meritor Savings Bank.

As was the case with Continental Airlines, Meritor Savings Bank was also sagging under a heavy load of debts. The bank was under the threat of being declared bankrupt and the top-management

concluded that outsourcing its IT-functions would be the only way to save the bank. However, in doing so the bank formulated strict requirements. The bank succeeded in finding a supplier who was willing to accept these requirements and Meritor closed a 10-year contract with the supplier.
The result of this operation was that Meritor managed to save $ 9 million in a period of two years and managed to stay out of the bankruptcy danger zone.

5.2.2.3. Zale Corporation.
In the spring of 1991 Zale Corporation, a chain of jewellery stores, closed a 10 year outsourcing contract with Integrated Systems Solutions Corporation (ISSC), IBM's youngest offspring. The contract was worth several hundreds of millions of dollars. Zale was forced to take such a drastic step since it had a debt of almost one billion dollars. ISSC bought all of Zale's IT-equipment and transferred the applications of Zale to an IBM mainframe. Six LAN's connect the AT&T supplied automated cash registers of almost 2000 stores to the mainframe.
Consistent with most other outsourcing arrangements, someone remained within Zale to oversee the applications developments and manage the contract with ISSC. The 90 Zale employees who manned Zale's data center were offered jobs at ISSC. It is not known whether or not they kept their old salaries and/or positions.

5.2.3 Reasons for outsourcing.

Electronic Data Systems (EDS) is the largest firm that provides outsourcing services. It is the company that has carried out these services longest and their vision on outsourcing may be considered the most authoritative. Analyzing their customer base EDS states that a decision to outsource operations is driven by four important considerations:

1. The gap between expectations of IT and how top management is informed of its results. Those results are in almost all cases too optimistic.
2. The demystification of computers and IT.
3. The trend within companies to focus on their core business and subcontract a lot of operations that fall outside direct involvement in the tasks related to the core business.
4. The increased legitimacy of outsourcing as a function of the number of service bureaus that entered the market and that perform outsourced operations.

The first consideration is best expressed by a senior manager of an American company:
"I know that information technology is integral to the success of my company. Accordingly, every year I, along with my colleagues, decide to increase our IT budget so that we can create bigger and better IT systems for the good of our enterprise. In return for this annual budget increase (sometimes disproportionate to the

rest of my cost structure), I expect to likewise increase the competitive advantage that I gain through the use of IT.
To my chagrin, I've found no real increase in productivity, no real reduction in my cost of goods and services, and no marked increase in the quality over and above that of my competitors that I can attribute to these budget increases. Rather than delivering the promised competitive advantage, these technology investments have given me, at best, competitive parity".

Of course we are dealing here with a situation of creating expectations that can't be realized quickly and easily. Another question has to be answered here too: "What would have happened to this company if it would not have invested in information technology at all?" There are many complaints of this sort, especially about promises that were never realized or painting pictures that were too rosy about positive effects of information technology. Too late and too often top management never bothered to try to understand this new technology or acquire adequate and knowledgeable assistance in this technology on their own level. Decisions were made at lower echelons in the hierarchy of the company instead of making IT as important as, for instance, the companies logistic processes.

The second consideration refers to the fact that the computer has established firm roots in the businesses of companies and society at large. The era where one-eyes rule in the kingdom of the blind is definitely past with the advent of personal computing.
This author remembers how in 1964 being assigned membership number 33 of the Netherlands Computing Society, he was one of the very few in The Netherlands who knew what a computer was and what its potentials were. He is now in a position where his knowledge is definitely insufficient to meet the qualities that are required of to-days programmers. The gradual dismantlement of the mystique elements of IT has lessened the fear of computers and accelerated its acceptance. With this acceptance clear and well documented Returns On Investment for IT-investments became a normal requirement.
The third consideration coincides with the fact that companies are focusing their attention much more on specified core tasks. Those companies see the need to excel in these tasks and are willing to subcontract a large number of supporting operations to specialized companies.
The fourth consideration is, in the author's opinion, the weakest. The appearance of companies that claim that they can perform certain IT-tasks better than those that want to outsource these tasks does not guarantee that quality a firm seeks for its outsourced operations. The number of companies that want to outsource has increased steadily. As a consequence, the firms that try to pick a grain from this table of opportunities have risen as well. It is of extreme importance for any company that considers certain outsource operations to thoroughly investigate the bidders. Too many firms have lost more by outsourcing to less

qualified firms than they have gained.

The focus of attention on the strategic value of IT and its applications will give any company a very important argument for outsourcing those operations. The success of a company is highly dependent on the right choice, acquisition and operation of the technological elements that contribute best to the objectives of the company. Those elements may be found in information technology.
This argument also applies to the firms that specialize in carrying out outsourced operations. The message to them is clear: Their success can only be achieved through the business successes of their customer base.

5.3 Some remarks concerning macro-economical aspects.

The downsizing process results mainly in reducing equipment and personnel. The equipment is mostly sold or transferred at a (reasonable?) price to the company that will carry out certain operations of the downsized company. In some cases the superfluous people are transferred with the equipment. That happened in two of the earlier mentioned three examples on outsourcing.
However, if a migration of the redundant personnel does not take place and if they can't find another job, severe problems arise. Those problems not only involve the people but also the economy of the country where the company is located.
In many countries the payments for social premiums by the company and the social premiums paid by the employee will come to a halt if an employee who is made redundant is not capable of finding another job . The redundant employee will probably be eligible for unemployment payments (normal in most civilized developed countries) and a variety of other governmental agencies will be asked to pay the bills of the hospital or doctors in case of illnesses (not unlikely in this situation). These expenditures are not covered by any income. The result is that society (the taxpayers) pays the price for successful downsizing of commercial enterprises. In order to cover these costs the premiums of social securities and/or taxes have to be raised. The still employed workers will consequently observe that their net income is being reduced and will be compensated for that by their company. This is a most fortunate situation for the employee. This means that part of the gains and profits resulting from downsizing will be absorbed by the increase in direct or indirect salaries. This is a very simple scenario, but not without a realistic analysis of what happens on a macro-economic level. In the USA redundant employees may be put in a situation where they can be employed by the company that will carry out the outsourced operations of the downsized company. In many cases these people will only be employed on a part time basis. The term "part-time" generally means that these people will not be covered by health care insurance and sometimes their new company will not even have to pay social premiums. This can also be the situation where the

neatly transferred employee finds herself in. It is clear that in such situations the results of downsizing (and outsourcing) are favourable for the industrial enterprises and that society at large has to pay the price for it. That is, unless society is either not willing or incapable of caring for its redundant workforce. In that case human beings are more than redundant. They are expendable and quite often treated as such.

6.0 Partnering.

Companies have always tried to maintain a large degree of independence. This often resulted in a situation where certain firms positioned themselves as islands in a hostile environment and considered every competitor an enemy. This principle proved sound during the many years of economic growth. In the present economy it appeared that the multiplication of redundant and non-competitive projects, financed by single companies, demonstrated a great amount of waste of scarce resources (people, materials, time). It often led to severe economic damage in these firms.
Nation wide evaluations of these wasteful projects and an analysis of better strategies resulted in situations where companies made combinations with other companies in specific areas that could be labelled strategic or pre-competitive for the companies involved.
Similarly, as in the case of quality, the Japanese have taken the lead in constructions where companies formed partnerships in order to combine efforts in specific areas of interest. The four major Japanese companies that trade in stocks have standardized the hardware and software for home computers and have chosen the Nintendo Family Computers for that purpose. They also standardized the protocols, architectures and commands for these systems. This all happened at the same moment that the banks in the USA left their homebanking market and outsourced their strategic information systems to specialized companies. The result was a much stronger position of the Japanese in this specific area and an improvement of the Japanese banks in the whole of the financial world. A part of this success can be attributed to the more cooperative approach of the Japanese. This despite the fact that they are heavily competing with each other in the Japanese home market.
In an early phase and even before partnering became "fashionable" Philips of The Netherlands had the insight to follow a partnering strategy. It combined forces with Sony. Philips and Sony developed the Philips invention of the Compact Disk into a marketable and high quality product, standardized the disk format and launched a product that can be considered one of the greatest consumer products of this century. Philips would certainly have lost its important share of this market if it would have continued its efforts to develop and introduce the Compact Disk alone. The company undoubtedly learned from the catastrophic experience and the trauma after the Japanese success with the VCR, another Philips invention.

6.1 Partnering in the computer industry.

The computer industry has by and large taken the lead in combining companies and forming strategic partnerships between separate companies. Notice that partnering does not involve the friendly or hostile acquisition of other companies. A partnership is a strategic alliance that two or more companies will enter

into with the expectation(s) that together they will be more successful than they would be if they had to continue alone. Three months in 1991 give an impression of the various activities in the USA in which important (friendly and hostile) acquisitions and partnering arrangements were concluded.

April 9 Compaq, along with 20 other companies, launches the Advanced Computing Environment Consortium to establish a new standard to compete with Sun, Hewlett Packard, and IBM.
April 12 The Federal Trade Commission widens its investigation into Microsoft for possible antitrust activities.
May 1 CompuCom purchases Computer Factory (both companies are retail computer stores)
May 6 National Cash register (NCR) agrees to be purchased by AT&T, a hostile take over turned friendly.
June 4 JWP buys Businessland (both are computer retail chains).
June 13 Tandy, reversing its stance on independence, agrees to carry products from Apple, Compaq, and IBM in its stores.
June 18 Wang forges agreement with IBM to resell IBM products.

In about the same period Philips sells its computer industry to DEC, Mercedes-Benz acquires AEG and many other European and foreign firms are merged or are acquired by other companies. Much more than is the case in other branches of industry.
In every friendly or hostile take-over strategic considerations play a dominant role. However, those considerations are mostly valid for the company that will be in charge and that initiated the acquisition process. AT&T needed to buy another computer company since its earlier alliance with Olivetti was not very successful, and its own computer division was losing too much money. In most cases companies that are more than willing to pay a high price for the stocks of the firm they want to acquire do not face too much opposition. The owners of the stocks know that they will, more than likely, never get a similar offer again.

A partnership is different however. It requires a greater effort from the companies that decide to form a strategic alliance, combining their efforts. The communication lines between these cooperating firms could tend to become vague and chaotic. Being able to integrate new game rules can make the difference between a successful partnership (SEMATECH) or one that ends in acrimony (i.e. IBM and Microsoft) and possible market repercussions. We will discuss a few of those alliances in a later paragraph.

Information partnerships between corporations may be the next wave of the future. They run the gamut from links between suppliers and customers to joint ventures (JV's) between companies in

the same industry, to collaborate on R&D[3], development[4] or marketing[5]. In all of these partnerships, the common entity will be a shared information resource. Sharing of information will require exacting managerial efforts. Widely dispersed companies must provide a commonality in areas of data definition, relationships and even search patterns. Even into the second half of the 1990s, companies are having difficulty in creating an internal information resource, common to all divisions within a single company. Developing an intercompany information resource will be even more difficult. Thus the following activities, industrial processes and subjects are of extreme importance when embarking on a joint venture.

1. One has to make sure that the used terminology will be standardized in those parts of the companies that are involved in the JV. In the original JV of Philips Telecommunication Industry (PTI) and AT&T Network Systems the American partners continued to write the date as mm-dd-yy while PTI continued to use the internationally agreed notation yy-mm-dd. (dd = day, mm = month, and yy = last two digits of the year). The result was complete chaos with respect to deliveries, plans, tax records, bank transactions etc.
2. One has to compose a good managerial team. In this type of alliance all partners have to be equal. The managerial team must be recruited from all participating companies and each member of the team must have equal authority. The function of this team consists of establishing short term plans and be responsible and accountable for proper execution.
3. One must determine the boundaries of information exchange. Data links between participating companies can be unidirectional or bidirectional. A supplier posting new product information may require a one-way link. In other situations two-way links may have to be established.
4. Redundancies and inconsistencies have to be eliminated. Too often the partners in a JV want to maintain their own independent policies and activities concerning the collection, processing and dissemination of information. This causes great harm to the efficiency of the JV. It results in operations that are executed more than once and inconsistencies in the disseminated information. It is important that all JV-related information must be processed in one central location or in one central computer center. The other centers can retrieve the information from the central one, and if the employees involved have the discipline not to change the information at the decentralized locations,

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[3] IBM and Microsoft

[4] Philips and Sony.

[5] IBM and Apple.

the imminent inconsistencies in the information can be avoided.

5. Allow for various levels of sophistication. When building information systems for multiple partners, it should be remembered that each partner will have a particular level of sophistication, each with its own requirements and characteristics. It is necessary to develop a combined system with many interfaces. These interfaces cover the range from the interface of the least sophisticated user to the interface for the extremely knowledgeable user.
6. One must be ready to compromise. A system can be individually tailored if that system is used by not more than one user. This is not possible in a system intended for general use. The management team has to create solutions for difficult conflicts. These solutions will require concessions from all parties.

6.2 Some examples of strategic partnerships.

Partnerships appear in two different areas:
1) Partnerships between competitors, and
2) Partnerships between suppliers and customers. In the following paragraphs a small number of practical examples will be presented.

6.2.1 Partnerships between competitors.

6.2.1.1. The IBM - Apple alliance.

In computer expert circles the alliance between IBM and Apple is called the greatest agreement of the last decade. Why this alliance? Apple is a prestigious and still profitable company that still dominates an important part of the PC-market. It is, however, also a firm that developed with a supersonic speed from an atelier in a garage to an enterprise with plants of many square miles of floor space that dominate the City of Cupertino. The big surprise in this alliance is IBM, one of the largest and most powerful computer firms in the world. IBM was considered unbeatable some ten years ago. The alliance between Apple and IBM shows that this perception of IBM was not true. It also shows that IBM possesses the required flexibility to decide to use the concept of partnering in economically difficult periods. The alliance between Apple and IBM differs from the one between IBM and Microsoft[6]. Apple was never a commercial partner of IBM. This alliance has two reasons:

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[6]IBM's alliance with MicroSoft consisted of an agreement in which MicroSoft was contracted to develop an operating system for the IBM-PC's.

1. The computer industry has become very complex and diversified. This means that no single company is capable of developing all the required technologies and simultaneously binding the customers.
2. At some point in time the computer industry knew only one standard: IBM's standard. With the growing number of new and progressive newcomers, the number of standards increased as well. The combination of IBM and Apple attempts to reduce the emerging standards to more acceptable proportions.

6.2.1.2. Marriot, Hilton and Budget Rent-a-Car.

The hotel and rental-car reservation systems that are currently needed are very costly. They must be based on real-time processing and must be able to provide users of these systems with up-to-date information about the availability of rooms or cars, the prices, the reductions etc. The profits of (especially) hotels have been marginalized. This means that developing or installing or even maintaining such a complex reservation system is difficult to justify. However, given the budgetary constraints on the one hand, and the requirement to deliver high-quality customer services, it appeared that partnering was a viable option in this specific area.
Marriot Hotels, Hilton Hotels and Budget Rent-A-Car started a joint venture under the appropriate name: "CONFIRM". They worked together with a spring-off of American Airlines: AMR Information Services, a company that offers services in the development, installation and use of reservation systems. Although CONFIRM started as a strategic partnership between the three companies they have expanded their activities and are now also offering reservation services to other hotel chains. The basis for CONFIRM's technology can be found in SABRE, the customer reservation system of American Airlines which is considered the most profitable in the world. It consists of three components: a management component for the processing of transactions, a central reservation system and a system with which decisions can be made. The latter component is capable of processing all historical data and data concerning the customers, and will automatically propose decisions in areas of conflict, in offering customers the best services for the lowest prices etc.

6.2.2 Partnerships between suppliers and customers.

The most impressive example of a partnership between a supplier and a customer is provided by the McKesson Drug Company. This supplier of pharmaceutical products uses a strategic information system called "Economist". This system is used by a large number of pharmacists that, if connected to the system, can place their orders with McKesson on an on-line real-time basis. This gave McKesson a tremendous advantage over its competitors.
McKesson's concept for its system was developed in the early seventies. At that moment the pharmaceutical market was heavily

fragmented. More than 150 suppliers tried to get their business from more than 50000 customers. Those customers generally had more than one supplier and it was normal practice for a pharmacist to place his orders daily at more than one supplier. McKesson was at that time experiencing a low productivity level. The company had more than 100 regional warehouses where all its products were stored. Serving customers and the delivery of products was done manually and appeared to be too costly. The "Economist" system had to improve this situation. The purpose of the system was to reduce the costs and improve customer service. The ultimate goal was to become the sole supplier of the majority of the retail market. After installing the system it was clear that the combination of technology and excellent planning and control of the system were decisive. Customer orders were forwarded directly from the customer's Tandem computers to McKessom's computer center. An immediate confirmation of receipt of the order is transmitted back to the ordering Tandem computer where speech synthesizing techniques are being used. The order is then placed in a batch of jobs that have to be processed and processed by a central mainframe IBM 3090 computer. Every distribution center is equipped with a minicomputer which regularly receives the orders, stored in McKessom's mainframe via a downloading mechanism. The orders are being picked, they are labelled with bar-coded labels, loaded on the relevant trucks and transported to the customers. In most cases the order is delivered the same day it was entered into the customer's computer. This system is not just advantageous for the supplier. The customers are served immediately and are kept informed about all other business important in the supplier/customer relationship. For the customer this system has all the benefits of a Just-In-Time concept; a minimum stock and maximum service from the supplier. The benefits for the supplier are a large and loyal customer base, better controlled warehouses, less warehouses, less paperwork and greatly reduced costs.

The examples described in this chapter show the tip of the iceberg, and it is expected that strategic partnerships will have become a normal phenomenon around the year 2000. The way these combinations of enterprises have to be organized and the way the activities have to be coordinated, technically as well as financially, is an affair that these partnerships have to work out themselves in each separate situation, while learning of the many pitfalls and problems they may encounter in their endeavour.

7.0. Integration, concurrent engineering and re-engineering.

In this chapter we will discuss a number of very important subjects that receive maximal attention within the industrial environment as well as the academic institutions. They are placed in one chapter since they are strongly inter-related. Concurrent engineering is unthinkable without the introduction of certain integration aspects, and re-engineering must be viewed as the result of attempts to integrate parts, or the whole of an enterprise in a very short time period.

7.1 Integration.

Most companies have structured their IT activities along the hierarchical lines of the company. The hierarchy has often penetrated deep into the organization and contains all the features of a large segmentation of tasks. These tasks are either assigned to departments, or departments have been created to perform the tasks. In this construction every department considers itself as very important (or most important), and as a result of their own image place themselves in an isolated position vis-a-vis the other departments of the company. Communication between departments are, at best, often characterized as political skirmishes. Technologically this resulted in a large variety of partly or completely duplicating activities. Some of these were even made redundant with the continuing technological developments. This assessment of the larger American and Western-European firms is too often a picture of the real situation. A situation that may be different in certain companies or groups of companies. Even if a firm experiences full and willing cooperation amongst its departments, its corporate hierarchical structure has worked against it in producing discrete, stand-alone work environments. This, in turn, has been reflected in the creation of automated systems as stand-alone as the departments in which they run. In their self-created isolated situation they soon lost contact with the real world. In many cases companies created large centralize independent departments (programming departments, data centers, and archiving departments) to avoid the fragmented approach. These centralized organisms achieved positions of great independence and power. This organizational model can be viewed as the status quo during the last 30 to 40 years. At the same time it became clear that the benefits of the introduction of IT were much less than could be reasonably expected. In many cases this was caused by organizational structures that were difficult to change or adapt. The often dominating position of a corporate automation department in an enterprise has largely contributed to the meager results.

7.1.1. Levels of Integration.

In treating the company's integration aspects directly connected to IT, a clear distinction has to be made between three levels

(or types) of integration.

The first and most fundamental integration activity is the one where the equipment can be coupled to avoid distortion or loss of information transmitted between control devices sending and receiving information. Many companies decided to have these interlinked networks installed by only one supplier. It is difficult to point at the responsible supplier in case a network is installed with equipment coming from more than one supplier. Even in situations where a company chooses only one supplier, integration on this level is not guaranteed. (IBM's CEO stated that explicitly with respect to IBM's own products - June 1995). Apart from that one should never forget to include the automated design and production equipment in this effort. A company will continue to struggle with wrongly transmitted information when workstations used in the product realization process are not included in this level of integration. Every other integration effort within a company will prove to be ineffective if this basic condition is not fulfilled.

The second level of integration concerns the integration of the product information (or the integration of the information that is directly connected to the rendered services). A distinction can be made here between the integration of IT-independent product information and those that are part of installed and used IT-systems. IT-independent information is information that has always been used to define the product. It is information that without exception has been made part of IT-systems with the aid of IT-techniques. The problem of integrating the IT-independent product information begins with the creation of this information. Unambiguous, consistent, and rigorously formalized product specification techniques are still lacking for most of the engineering disciplines, with the exception of some strongly mathematically oriented products (digital and logical switching systems or circuitry). This means that the commercial departments and the departments responsible for product management compose their specifications in an inconsistent and ambiguous way. Interpretation is left to the development engineers who hand their ambiguous product documentation to the manufacturing engineers. These again use their own mind sets to deposit their (re-interpreted) information on the factory floor. The customer (or the market at large) has to wait and see what the end result of this clumsy process will be.
Converting the product information that has been created in this way into a computer-readable and interpretable form is equal to using a highly sophisticated numerically controlled machine where the operator is in full control of all processing, and guides the machine tool by positioning it from point to point manually.
The author of this report has made passionate pleas years ago for

enforced academic research[7] into the possibility of formulating formal specification methods for other engineering principles than those used in the digital and logical engineering disciplines. He made this plea on behalf of a group of industrial enterprises. To this day nothing has been done. The same research world that the author addressed is now gearing itself up to point industry towards different (less difficult?) ways of integration. This is a situation that needs attention from academic circles considering the fact that industry is still waiting for a usable and understandable product specification methodology for the total product realization cycle and that can be applied to a wide range of different products.
What remains on this level of integration is integrating the available types of product information. That integration effort is dedicated to standardizing the well-known and conventional ways(s) that product data is formulated, and tries to provide that information with a "fitting jacket" with the aid of standardized "formats". The best well-known international efforts in this area are IGES (partly successful) and STEP, an effort that still has to make a major breakthrough. AUTOCAD has been more successful with its exchange format DXF (Design EXchange Format). DXF made the practically faultless exchange of information between AUTOCAD stations a reality. A large number of industries have already been successful in the area where the developers of STEP are struggling along. Be it that they developed their own company oriented methods. The activities of STEP are labelled pre-normative. One tries to find an answer for this problem for a very large variety of industries and develop a standard that subsequently will be used by all these industrial enterprises. It is clear that many companies can not wait for the end results of this tedious and long process. They have to resolve these integration problems now. The result is that many companies have developed their own transfer structures and formats. Philips Telecommunications developed UDIF in the mid eighties and companies like IBM and AT&T have been highly successful in transferring product information between various types of equipment, using a multitude of automation systems.
How far these companies are capable or willing to continuously support the STEP-efforts remains questionable. To that extent STEP has to prove that it provides a better alternative than the methods developed and successfully used in-house.

Let us assume that it has been demonstrated that the first two levels of integration show they provide an acceptable solution for many problems within a company. If a company is content with the results, it may start to look at other enterprise activities

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[7]These were made in 1974 at the IIASA Institute in Laxenburg (A), in 1977 at an international workshop at Grenoble and again in 1983 at the opening session of the first international CAPE conference in Amsterdam.

that need attention. Those activities might be the production practices, communication between departments and/or people, communication between management and lower echelons, the composition of the hierarchical power structures etc. In many cases a company will conclude that adaptations to all of these activities and situations have to be made to meet the pressures of lower costs, higher quality, better competitiveness, shorter time-to-market etc. This might mean that a number of processes have to be carried out immediately after each other, or even better - simultaneously (concurrent engineering). It may mean that the processes have to be scheduled in a different way, or that the supplier or even the customer must be involved in the production activities. In trying to deal with these kinds of problems the company has arrived at the third level of integration called enterprise integration. However, it is an activity, up till now, that has created more interest amongst academics than in the industry at large.
Following in the footsteps of academic involvement in integrating the enterprise (sometimes without knowing the particularities of the enterprise) we witness the emergence of another term, the "virtual enterprise". This is supposed to be an enterprise where the three levels of integration have been implemented successfully and where the supplier, the enterprise and the customer are combined as one entity. That assumes that both supplier and customer have reached the same level of integration sophistication. This is an illusion when one considers the way IT has been introduced, applied and implemented in the vast majority of industrial enterprises (see the remarks in chapter 3).

Notwithstanding these critical remarks, we do believe that integration of various parts of an enterprise constitutes an important subject. The way and the approaches to it deviate strongly from the way it is proposed in various research projects conducted by some internationally operating working groups. The industrial approach will be highlighted in the next paragraphs.

7.1.2. Enterprise integration.

The last couple of years have shown that there is a tendency of companies to create flatter organizational structures. That means, in essence, departmental boundaries that are easier to cross (and to break down), leaner support structures, a reduction in management levels, departments that can carry out more than one basic function, working with teams and team structures that cherish the notion of quality and customer satisfaction, direct contacts with customers, better relationships with suppliers, etc. The result is that many companies can react faster to market demands and market requirements. Many companies changed over when they (gradually) transformed themselves from rigid closed hierarchical monsters into firms with an open structure where teamwork became essential. Two actual situations, one from the service and one from the manufacturing sector are presented here

as examples for the need to integrate c.q. restructure the enterprise.

The integration of software environments in the financial sector can be seen as the result of new product developments. The financial service industry discovered what was required to offer their customers more competitive products some ten years ago. Flexibility and innovation became important supporting elements in this strategy where information technology had to be redistributed and had to be made accessible for both the naive user and the more experienced end users. Financial institutions that specialized themselves in a specific branch of providing financial services thus started ten years ago with a large restructuring programme to be able to provide their customers with integrated financial service. The result is that the differences between commercial banking, investment banking and the insurance industry have all but disappeared. There are only vague distinctions between these types of financial activities. In addition the financial firms discovered that the boundaries between the various financial transactions became even more diluted when they introduced trading stocks, obligations, bonds and derivatives as another part of their activities. Most of the restructuring activities were directly linked to integrating the new services provided to the customers. This resulted in enormous movements and changes in the structure of the banking firms, adaptations in the tasks of the employees, the systems that supported these tasks, etc.

In the manufacturing sector the road to a larger integration of activities was different from that in the banking world. Here integration was not a result of new products. Integration was itself a new product. Manufacturing companies were probably hardest hit by a number of economic variables. A very intense international competition and the labour costs were just two of those variables. Most dramatic was the fact that much of the equipment in the factories quickly became obsolete. That resulted in a strange paradoxical situation. For example, in the USA the American factories took a lead in automation. However their production equipment started to lag behind in this process because re-equipping a factory is a costly affair. The threat of a total collapse contributed to many firms taking the important step in replacing their old equipment with modern machinery and manufacturing systems. This happened despite the large investments involved. This new equipment presents the image of what is considered computer integrated manufacturing (CIM) - the integration of equipment and software - and was followed by attempts to adapt the business processes to these new manufacturing processes. The heaviest emphasis was placed on improving communication and supporting activities where knowledge and experience play a dominant role. The average employee in a manufacturing firm devotes some 50% of her time to communicating with others and only 33% of his time in activities of a more intellectual

nature.
Contrary to the financial service industry where new products made way for an integrated infrastructure, computer integrated manufacturing can be seen as the solution to many problems that confront the manufacturing world to-day.

The most successful integration projects start with the composition of a model of the enterprise. This ought to be a model of the complete enterprise and must contain the information, the information flow, the materials and the flow of the materials, the processes and services. After having composed such a model, smaller parts of the company are being identified and selected for further detailed studies. The studies of these separate sub-projects must result in the formulation of strategic plans for each of the sub-projects. These plans should, in turn, serve an efficient restructuring of the studied information and processes.

The time of this study should not be unnecessarily long. A study that stretches over a period longer than three months will yield a failed mission.
There are several definitions of an enterprise model. Some of them only differ in the semantics used,while others differ fundamentally both in scope and in the approach to be followed. Where some experts view an enterprise model as a strategic entity, others may treat it as a formal representation of the business including planning, control, management, operational activities and the all the strategic issues. Those who are more technically oriented view the enterprise model as a subset of modelling the information or modelling of the information flows as part of the more technologically oriented business processes.
Most important in an enterprise process is understanding the technology in terms of the goals (objectives) of the company, the business strategy and the way the business is run. That means that the model has to incorporate the most important components of the company. After an enterprise model based on the business strategy has been composed, the information flows running within the company have to be charted. This model must contain the business functions and the information structures since integration is strongly dependent on the internally structured functional and information related aspects. An important requirement is that the model can be easily interpreted and understood.

7.1.3. The modelling process.

First and foremost the modelling activities that deal with enterprise functions and information structures and flows have to be tackled in industrial environments where problems related to strategic organizational problems are being dealt with. At this moment no single company is able to model other relevant views (economic, social, financial, legal, human-related etc.) within the available means (time, people, budgets, work pressure). Consequently, this report will only focus on the two modelling

activities considered most important for the industrial community. Those two activities relate to the modelling of the business functions and its related information.

7.1.3.1. Modelling the business functions.

This modelling process is mostly carried out with schema's and diagrams. Unfortunately, well designed formal languages are still unable to describe the business processes and its inherent functions in an accepted modelling specification language. (A business can be viewed as a product; hence it would be as beneficial to construct a formal language for specifying this product as it would be for any other product).
Using a diagrammatic technique the model of an enterprise will look like the old-fashioned organization charts. However, the details are different, and the information contained in these models are more precise and informative. The composition of an elaborate schema can generally be done with automatic tools. This enables storage of the model and is an easier way of correcting or editing the model. One of the first tasks in this modelling activity is to formulate the objectives of the company and its constituent parts. This will be followed by detailed descriptions of the functions of the those constituent parts (divisions, departments, groups, projects, etc.). Those descriptions have to be associated with the diagrammatic model of the company.
Having arrived at this point one can discover more than one organizational unit that will carry out similar or overlapping tasks. It may become clear at this stage that some tasks can better be assigned to other organizational units. This is the first and beneficial result of a modelling process that has barely started.
In this way the person in charge of the composition of an enterprise model in the Bankers Trust Company, discovered in the early phases of the modelling activity, that it would be better to divide the currency exchange department into two separate groups[8]. In a short period of time this financial institution saved hundreds of millions of dollars with this move. It shows that in the early stages of a modelling activity a thorough analysis of the way the functions are divided and executed within an enterprise may be very profitable. Complex theories or systems are not required; common sense will do the trick. Care must be taken though, that existent defects are not introduced into the final version of the model.
The members of the team that carry out the modelling activities will soon discover that intense consultations with the managers and the employees of separate departments or groups are required

[8]The opposite of the notion of integration! An important aspect that has to be kept in mind continuously. Integration is not always recommendable. It may even conflict with the idea of independent, small self-sustaining work units.

and indispensable. In all known cases where companies carried out this type of modelling effort one discovered that functions were carried out that did not appear in the first versions of the model, and that other functions assigned to certain departments, were not carried out at all. These situations must be remedied immediately. Towards the end of this part of the modelling process, a list has to be made. This list must summarize all the business functions for every individual business unit, no matter how small. The list must also be supplemented with a list that contains all the activities that have to be carried out in order to carry out the functions.

7.1.3.2. Information modelling.

Every single activity that is defined in the function model needs information to carry out its activities, and will generally create information that has to be passed on to other functions. The list of activities mentioned towards the end of the previous paragraph has to be supplemented with information that must be acquired from external (re)sources and internally created or modified information. These now must be passed on to specified units. Next, an information model has to be constructed. Such a model will generally contain two parts. One activity will deal with the composition of a complete list with all the business functions and their related inputs and outputs. Each of these inputs must contain a description of the source of the information and the ownership of the information; the department, group or person that must be held responsible for the correctness of the information. Each of the outputs must indicate about where the information will be routed. Both inputs and outputs must contain a certain identification stating the importance of the information.
One of the by-products of this process is that one soon finds out that much of the information within the company originated at external sources instead of having been generated internally.

Arriving at this point one could manage this information internally and keep it updated.
The second information modelling activity has to yield an information model. The information technologists will play a dominant role in this process. These experts will have to combine and identify the collected information and to convert it into a logical structural representation where the standardized and to be standardized information elements will have to be used as the atomic entities of this structure. The information experts can use many available techniques for their modelling process. The most widely used is that of composing Warnier-Orr diagrams. These resemble the diagram techniques applied in the construction of organization charts. More advanced and more suitable techniques are those of the entity-relationship-attribute-diagrams or the data and control flow diagrams. Many computer aids are available to aid this process, especially the latter ones. During this

process it is important to compose a data dictionary. The companies that have standardized the used information or data elements will discover quickly how useful that standardization process has been. One will certainly discover where inconsistencies in the information, and consequently in conducting their business, were introduced.

7.1.3.3. Analysis of the function and information models.

The mutual relationships between the business functions, and between the information patterns and the relations between the functions and the information can be further investigated. This will be possible after the models of the business functions and the information have been completed and a total picture of the organization has become available. Many conclusions can be drawn during this analysis. The following overview presents a number of those possible conclusions.

There are business functions that need data that is not provided by the other business functions.
The business model (the combination of the function model and the information model) shows the relationships between the business functions clearly. Source data, originating in specific functions that have a relationship with other functions, must generally be provided to those functions. This may not be the case. This omissions may be caused by three different situations. First of all it is possible that the data is not part of an automated process. Secondly the function that should receive information may still be in a state where it has not automated its processes. Thirdly it is possible that the business functions involved did not realize that data has to be passed from one to the other(s).

Data is transmitted to other functions without the necessity of doing so.
Although this situation does not occur as often as the above mentioned one, it is possible that time and energy are wasted in the transmission of data to functions that do not need them. Most of the time this is caused by a previous superfluous link between functions that have no mutual relationship. Those links were established during a period when people carried out exaggerated integration activities. Information links must never be established when functions don't have a mutual relationship.

Redundancies occur between business functions when the same information is monitored and stored.
The composed models will show that it is quite common that the same information is collected, managed and stored in more than one business function. In most cases this is information that is customer-specific since customers generally have more than one point of entry with the company. This rather annoying and expensive situation is quite common in the service industry. It will happen more than once that a customer receives information from

her financial institute that has been partly mailed to an old address and partly to the most recent address. This is dependent on the department responsible for the services it provides the customer.

The company handles information that is not adequately forwarded to business functions that should receive that information.
A problem that often occurs is that important information that has to be passed on between the various hierarchical layers of the company gets stuck in one of the layers, or gets lost entirely. The integration team must understand that information is more than the information elements as they appear in a report or a file when composing the enterprise model and the integration plan that will be deduced from that model. Information also includes the scribbles that have been jotted down on a piece of paper as a result of a telephone conversation, the minutes of meetings (board, staff and departmental meetings), information that is received via the normal or specific news media, information concerning the latest technological, financial and even political developments etc.

7.1.4. The composition of the integration plan.

Defects in the way the enterprise has organized itself will soon manifest itself when investigating the models. It will become clear that activities required to carry out a correct integration of the business functions will require a major effort, and can not be carried out in one single project. The team will have to investigate alternative projects and plans where the emphasis must be put on partitioning the total integration plan into manageable subprojects. Those subprojects will have to manifest the characteristics of an evolutionary approach, meaning that project B should succeed project A in a logical way. This will create a building-block approach on the route to a total integrated enterprise situation.

In this way a number of projects can be defined. It is highly unlikely that many enterprises have the financial means and resources to realize a completely worked out integration plan by the turn of this century. This means that subprojects have to be defined and assigned clear and definite priorities.

It will take at least six months before an integration team will be able to process all the steps of an integration plan that has to be composed. This time period depends on the size of the company and the complexity of the information flow within the company. Clear milestones in this integration process are very useful. The most suitable ones are those where the following actions have been successfully concluded:

1. A revised statement concerning the scope and objectives of the company.

2. The same for the separate organizational units.
3. A plan for the reorganization of those units.
4. A plan for the reorganization of the functions within those units.
5. A complete information model of the company.
6. A model of the enterprise that combines all business data listed in points 1 through 4 with those of the information model.
7. An overview listing all deficiencies with respect to:
   - redundancies:
   - information not processed with the aid of automated systems;
   - information that exists but not available at the locations where it's required;
   - information passed on without any need to do so;
8. A complete integration plan with assigned priorities and implementation schedule.

There are various institutes, nationally and internationally active working groups and committees that are working currently on formulating methods to support integration efforts. Many of those methods do not pay attention to the typical culture within an enterprise, and don't consider the cooperation of all employees a first requirement for success. Cooperation of the people in a company becomes difficult when the personnel realizes (or suspects) that their cooperation may make them redundant at a later time. The social implications and complications will prove to be larger than the technical ones.

7.1.5. Industrial achievements in enterprise integration.

Two important integration efforts will be elucidated in this paragraph. It concerns the efforts of Ingersoll Milling Machine Company and Du Pont. These examples have been taken since these two companies are both manufacturing companies, but their manufacturing methods and their products differ widely. It must be observed that the examples show integration activities where "integration" may have a different meaning for these companies than the meaning attached to this notion by non-industrial organizations. However, their efforts are impressive and the results very encouraging.

7.1.5.1 Ingersoll Milling Machine Company.

Ingersoll was one of the first companies to seize upon the principle of integration. Back in the 70's, Ingersoll was an extremely competitive producer of machine tools. However, it was facing increasing threats from outside. It was then that the vice-president in charge of planning and systems sold the chairman of Ingersoll on what was considered a very risky business. It was this business of integration.

Ingersoll's integrated system was completed as early as 1982[9] at a cost of five million dollars. It helped. While half of the American machine tool manufacturers have folded since the 1970's, Ingersoll's shipments multiplied more than tenfold over the same period. They shipped for nearly $500 million in 1990, an amount that since that year has steadily increased.
Ingersoll was one of the first manufacturing companies that made the push for integration. It certainly is not the last.

7.1.5.2. Du Pont.

Du Pont is probably one of the largest of the companies that jumped on the integration bandwagon. The company made a business decision to tie all of their 80 business lines, located in over 50 countries, together into a uniform information network. Du Pont expects that this project will take about five year to complete at a cost of $ 200 million. This is a considerable expenditure and a risky one, since this amount represents more than 25% of Du Pont's annual information system budget. The fact that the network must span so many countries makes it riskier than was the case for Ingersoll.
Du Pont started down their long road to integration about twelve years ago when the company decided to standardize all divisions to s standard of IBM mainframes and DEC and Hewlett-Packard minicomputers. Over time Du Pont put into place other pieces of the integration plan, such as a worldwide network linking 80.000 of its 150.000 employees, and an executive information system that supports some 300 top executives with key numbers that are updated daily. Du Pont also replaced many of their varying types of distributed control systems used in their continuous manufacturing processes. The 40 different types were scaled down to two.

7.2. Re-engineering the enterprise.

Probably the most drastic method used to make a lagging company competitive again is to completely "redesign" it. The slogan "re-engineering" is undoubtedly the most used slogan in the industrial society in this part of the last decade of this century.
Re-engineering has the same objectives as enterprise integration and is being carried out with the hope of increasing speed, services and quality of the company's functions. Information technology plays a crucial role in this process. Integration is carried out over a longer period and has the characteristics of an evolutionary approach. With re-engineering one attempts to achieve the same result in a much shorter time frame. The battle cry of some the most enthusiastic supporters of re-engineering (mostly found outside the walls of the companies) is: "Don't automate, destroy!"

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[9]This was years before national and international activities started to address the issue of integration.

Re-engineering combines the redesign of the environment of information technology with the reconstruction of the way business is conducted. According to many industrialists, the organizational changes connected to this method are painful and extremely difficult to implement. Apart from that, they are very costly. One will be confronted with high costs since the tactics of re-engineering consist of a dramatic reconstruction of the existing business processes. This has to be carried out and concluded in a very short period. The amount of money that has to be reserved for this operation runs in the order of many millions of US dollars. A large part of that amount will disappear into the pockets of external consultants.
The list of companies that used this method is imposing. Ford Motors, Kentucky Fried Chicken, AT&T, DEC and a limited number of European firms allowed themselves costly adventures in this technological no-mans-land. However, none of these companies is very generous about releasing the costs that were made and/or the results that were achieved. So far, the best information that could be obtained comes from an insurance company. Their efforts and results will be discussed next.

7.2.1. Progressive Insurance Inc.

Progressive is an insurance company that shares the problem of skyrocketing costs with the rest of the insurance industry. Their goal in moving towards re-engineering was to increase profits and cut costs. This was done by tackling one of the largest automation projects ever undertaken at this company. Their re-engineering goal was to build a completely overhauled claims processing system. The company started this project in 1986, took 5 years to build and cost 28 million US dollars. It was implemented in conjunction with a change of policy that dictated an immediate response to all accidents, no matter how small. The goal of the system was to automate every piece of paper involved in a claim to reduce the number of days it takes to move from claim to the check paid to the claimant. Underwriting for each policy is accomplished at the workstation level. An expert system is used that accurately assesses cost estimates and detects possible fraudulent actions. The "immediate response" program began in selected areas in 1991. In this program adjusters are dispatched immediately to the scene of the accident often handing out a check at the location of the accident. Adjusters work in each area from a number of vans that are equipped with PC's and modems that link this system to the headquarters of the company. These vans are also equipped with faxes and cellular telephones, permitting them to easily take claims information, evaluate and review them and issue checks. They can even make tow-truck calls and hotel reservations for stranded policy holders.
The use of this system altered the way the company did their business tremendously. In the past, adjusters were glued to their desks most of the day. To-day they are out in the field with current and prospective clients. The changes were felt in the

rest of the organization as well. For the first time, the insurance agents were not in compete control. Power sharing with the adjusters had to be made. The rest of the company had to change as well, moving from the traditional slow pace insurance industry to a more reactively paced, aggressive company. All objectives were achieved. After two years of operating this system the costs were down and the profits up.

The question of whether this example can be considered a successful re-engineering activity has to be left unanswered for the time being. The time required for this project is longer than the time that the proponents of this method claim it should take. It is an example of a very clever implementation of what information technology can offer, combined with a re-orientation of the business functions and an impressive reorganization of functions and tasks of the insurance agents and adjusters.

Philips' Centaurus project, aimed at making the consumer electronics businesses of the company profitable again against the aggressive attacks of the Japanese, was highly successful. However, it was never carried out under the banners of "Re-engineering". The company referred to it as a thorough re-organization and re-orientation of this part of its business.

It looks as if re-engineering is first and foremost very profitable for those who advise the companies that were talked into using this method. Despite the slogans, the thick reports and the smooth commercial advertising re-engineering does not differ dramatically from impressive projects aimed at reorganizing a business. The Philips example is evidence of that. That this renewal process is mainly driven by the information technology raises another question. Every renewal process must be driven by the business of a company. Not by information technology. One should not forget the cultural changes in a company when it decides to drastically change its processes. First of all the personnel has to be educated and trained to be able to cope with the new situation. (Progressive Insurance Inc. spent more than 1.3 million US dollars to re-educate its work force). An even bigger problem is the often unnoticeable feeling of discomfort among the employees. That feeling may manifests itself in a "silent" obstruction of the renewal process. This will often lead to an early abandoning of the activities. The author is convinced that the longer-term, well defined and carefully implemented integration attempts are to be preferred over the revolutionary and often rigorously implemented re-engineering method.

7.3 Concurrent engineering.

During the last ten to fifteen years industry has been confronted with yet another method of enhancing the competitiveness of enterprises. This method is somewhat different from earlier described strategic approaches. Integration and re-engineering

are not necessarily part of it, although the measures that a company has to take to start its integration activity can well be used here.
The approach aims to shorten various lead times by attempting to carry out as many processes at the same time or to drastically shorten the waiting times between the various production processes. With this philosophy, and in its extreme form, all the design, engineering, manufacturing, and testing activities have to take place simultaneously. Such a situation almost never occurs. A possible exception might be the old-fashioned way of making a software product. But testing, after production, which is required can hardly be done while the software is still being produced. In general, one will try to have the various processes overlap each other as far and as much as possible. However, this is certainly not new, and has always been practised by numerous companies. For example, a manufacturing engineering department will be responsible, among others, for an optimal product creation process. This department will work closely with the developers and the fabricators and will constantly pressure the development departments to release the design data and the product requirements in its most infantile state. In a number of companies special departments have been created for that specific purpose. These form the link between design-, engineering, and drawing offices on the one hand, and the manufacturing preparation, manufacturing, and test departments on the other hand. These departments will make sure that every bit of information (technical as well as logistical), every engineering change, and every piece of releasable technical product documentation will be communicated between the involved departments immediately. They will also maintain continuous contact with the quality departments and where required the commercial departments. These organizationally cross-functional and cross-departmental activities will support an optimal production process.
Problems with optimally applying concurrent engineering practices occur in situations where it is inevitable to produce pilot products or prototypes. For that purpose, the company may reserve and equip a part of the factory for the purpose of manufacturing them. In such a model factory or model shop, new equipment that may be required for a new or adapted product, can also be tested. In some cases the above mentioned model factory will be a separate unit and not part of the existing manufacturing organization. This occurs in companies whose products are being manufactured in small series, or where the products are predominantly customer tailored. A disadvantage of this approach is the lack of direct contacts between the model factory and the actual manufacturing facilities which may hamper a smooth transfer of new technologies. An advantage is that the employees of the model factory will not have easy access to the normal manufacturing people and facilities that delay their schedules.

It may, however, be useful and/or required to analyze and review the existing practices in order to optimize the product

realisation process even more. The objective will always be a shortening of the total lead time (specification, functional design, product design, manufacturing preparation, manufacturing, testing, final testing, packaging, shipping and delivery and installation). A model of the functions and the information content of and dataflows in the company will prove be an important aid in this process. Use can also be made of available workflow management programs. However, one must realize that the final result has to be implemented and used by people. Their experiences, knowledge, preferences and even prejudices require much more attention from management than any program or consultant is capable of delivering. The observations made at the end of the previous paragraph are also valid here.

The structure of the enterprise and the list of activities required in the preparation of an integration plan will prove to be of high value in determining what activities can be shortened, overlapped or carried out simultaneously (see par. 7.1.4.). However, one must take into account the type of products, their manufacturing requirements, the complexity of the product, the manufacturing process(es), the intensity of the tests that have to be carried out, and the required customer service when drafting plans to schedule the various production activities tightly and concurrently. The introduction of new technologies may be another factor that can easily upset already introduced concurrent engineering implementations. The author witnessed situations where companies producing electronic equipment started to use the surface technology (gluing components on a board in stead of soldering them in a board) in too early a stage. Many production schedules collapsed because the technology proved to be immature. Simultaneous processing in a model shop could have prevented these micro-disasters.
Also the approach where companies manufacture partly on stock and partly on order have to be given due and full consideration. Certain practices can not be changed easily without creating a chain of (sometimes disastrous) consequences.

Knowledge of the product, knowledge and experience with the technologies applied, understanding the organization, making sure that the employees are well educated and motivated, well-balanced control and management techniques, proven and thoroughly tested company-specific computer aids, and most of all the use of common sense are more important for a fast, efficient and qualitatively high-valued concurrent production line than slogans, lectures, advice of consultants that can't be held accountable, unproven theories, and expensive and unwieldy solutions.

8.0 Customer Service

Even though the decade of the 1990s has been termed the "decade of customer service", the idea of applying information technology to customer service and using the combination as a competitive weapon is not new.
In the 1980's a well-known clinical laboratory provided terminal hook-ups to physicians who, for a small fee, could retrieve medical information and test results. At the time this laboratory was competing in a tough market where services to customers were similar, leading to a lack of customer loyalty and frequent price discounting in order to buy this loyalty.
Probably the best example of using information technology in this manner is the creation of Sabre and Apollo, the reservation systems of respectively American Airlines and United Airlines. These systems were installed at thousands of travel agencies. Even though these systems list all the flights at all airports, they contain a bias toward the developer of the system. A travel agent using the Sabre system will invariably see the flight schedules of American Airlines first, even though it may not be the most direct requested route and/or the least expensive. This prioritization procedure can lead to as much as 20 percent additional business. Whether it also creates customer loyalty remains an open question. Critical customers may find out that their trips take longer and cost more. This type of customer service does not have to go hand in hand with customer satisfaction. British Airways (BA) and KLM employed information technology in a completely different way. Their objective was to employ IT to minimize delays and maximize carrier occupancy, at the same time providing excellent cabin service. Both companies were also active in partnering, respectively with US Air and North-West Airlines. These practices and their results must have impressed the customers more since both BA and KLM are highly profitable to-day, while American Airlines and United are both in their fourth consecutive year of losing money.

Obviously customer service is hard to provide. Markets change continually and rapidly. Often too rapidly to keep up with. This is why computers have become a staple technology. Many experts agree that the computer will become the key to building market shares in the rest of this decade. Some companies are using information technology in new and unexpected ways to find the distinctive edge. This will be elaborated in the next paragraph.

8.1. The OTIS case.

We mentioned the struggle of the major airlines in order to become more competitive and/or more profitable. However, there are other companies that specialize in transportation systems and that are beginning to look at information technology in a different light. One of those companies is Otis Elevator. For Otis the idea of applying IT to customer service came in the late 1980's.

At that time, most elevator companies were providing good, reliable elevators. In searching for a way to differentiate itself, Otis decided that providing extra-ordinary service was the lift it needed. The company had already installed a toll-free telephone line so that customers could call to request a repairman. It was the application of information technology to this phone line, the Otisline, that made headlines.
The first step Otis took was to load all information about repair calls into a customer data base. This database was made accessible to a repairperson who could check a customer's file and receive a complete repair history. But this alone was not what helped Otis increase its sales in 1990 by 21 percent from the previous years. The technological innovation that performed this miracle was the introduction of a tiny computer chip into each Otis elevator. This chip monitors the elevator continuously. If it detects a problem, it can alert Otis headquarters so that a repairperson can be immediately dispatched. Sometimes Otis calls the customer about a problem in the elevator before the customer is aware of the problem.
What Otis and others have discovered is that the new battleground for the 1990's is being able to provide the most satisfying ownership experience for customers; in two words: "customer service". Not only can a company not be competitive without a high-quality product, neither can it gain much market share without product improvements alone.

According to the American Market Association, it costs five to six times as much to cultivate a new customer as to retain an old one. According to industry studies the following statistics and behaviours are directly related to services offered to customers:

- The majority of customers switch banks because of poor service.
- 60 percent say past satisfaction, 32 percent say low prices when asked why they purchase from a particular company.
- 70 percent of the time a supplier is dropped is because of its "indifference" to the customer.
- Companies that implement a customer-service program increase their market share by 2 points, even when they increase their prices.

Many companies have started to vigorously pursue IT-related programs in this most important area. It will turn out to be the best investment an IT-budget can buy.

9.0 Conclusions

In this final chapter a number of important conclusions will be summarized point by point.

1. Information technology must be introduced and applied as a strategically important foundation of the activities of every enterprise. It will, when applied properly, strengthen the competitiveness of many companies.
2. Information technology is not the end. It must be made subordinate to the objectives of the company, and the business processes that result from these objectives. Including information technology in the line activities of the company is strongly recommended.
3. The quality of many automated systems must be improved. Advanced software engineering principles, proper quality assurance procedures and adequate cost evaluations have to be carried out before considering the application and/or implementation of information technology. The workforce has to be educated in all relevant aspects of this technology.
4. Conducting well organized and planned benchmarks develops better insights into strategies necessary for introducing (new) automated systems.
5. Extreme caution must be exercised when a company decides to downsize its operations or outsource activities. A company must avoid the risk of outsourcing important strategic functions or losing highly qualified people. Outsourcing functions to specialized companies asks for a thorough investigation into the ability of those companies to perform the outsourced tasks. The problems created for the workforce must be properly dealt with.
6. Partnering can result in improved market positions and competitiveness when properly implemented.
7. Enterprises must be aware of the value of its employees more than ever before. A company has to continue to create a good working environment. Employees must be guaranteed their professional future in case they are requested (or ordered) to participate in projects that will lead to a decrease of the workforce. It is not unthinkable that employees will implicitly or explicitly resist any technological change in situations where companies will start applying the life-cycle principle to their employees.
8. The academic world must inform itself (even) more of the needs of industry. To monitor the industrial developments and to raise it subsequently to the level of "research" is not very productive. Research must be conducted in areas for which industry does not have the time, the required experience, or the intellect. Examples are formal specification methods, artificial intelligence, improved distributed client/server operating systems, improved applied operations research techniques, dynamic system behaviour, etc.

9. Integrating the enterprise is an evolutionary process that, once started, will take over several years to develop and implement.
10. The most important and tangible parts of an enterprise model consist of two sub-models: the functional model and the information model. The responsibility and ownership of enterprise information must be explicitly addressed when composing these models.
11. The dangers of a revolutionary re-engineering approach are many. Estrangement and demotivation of the employees, speedy and badly conducted reorganizations, expensive consultants who can never be held accountable for their (possibly low quality) advice; these are just a few of the many problems that may occur in a re-engineering process.
12. Concurrent engineering can best be defined within and by the enterprise. Industry continues to apply this principle. It is often dedicated to the reduction of the various lead times (delivery lead time, design lead time, manufacturing lead time etc.). The use of an enterprise model will support and enhance activities that may further reduce the lead times in many sectors of the enterprise.
13. Customer service and customer satisfaction must be placed high on the list of companies that are competing in tough markets. Information technology can play an important role in attracting customers and in securing their loyalty. Access to the latest information concerning the details of ordered or required products, the delivery schedules of ordered products, and quality and/or test reports are but a few types of services that must be provided real-time and on-line to interested customers.

10.0 References

10.1. Literature & Video Lectures

1. Porter, M.E., "How Information Technology Gives You Competitive Advantage", *Harvard Business Review*, jul/aug 1985
2. Cash, J.J. and F. Warren McFarlan, "Competing Through Information Technology", *Harvard Business School Video Services*, 1989
3. Keyes, Jessica, "The New Intelligence", *HarperBusiness"* 1990
4. Sheeline, W.E., "Who Needs the Stock Exchange?", *Fortune*, 1990
5. Stern, R.L., "A Dwindling Monopoly", *Forbes*, 1991
6. Eichenwalt, K., "Wall Street's Cutbacks Sidestep Fat Budget's For High-Tech Trading", *The New York Times*, 1991
7. "The Shrinking of the Big Board", *The Economist*, 1991
8. Cone, E., "Trading In A New System", *Information Week*, 1991
9. Brennan, P.J., "OTC Trading Systems Lead in Race to Automate", *Wall Street Computer Review*, 1990
10. Van Slyke, R., "Rust on Wall Street", *Information Strategy: The Executive's Journal*, 1990
11. Forsythe, J., "The Big Board: Boxed In By Automation", *Information Week*, 1991
12. Avery, Christopher M., Debra R. France, Larry D. Browning, Michael S. Oswald, *BEST Customer and Supplier PARTNERING PRACTICES in the US Semiconductor Industry*, SEMATECH Inc, Austin TX, 1993
13. Hess, G.J., *Advanced Systems Technologies in the Metal Cutting Industry*, A Case History of Ingersoll Milling Machine Company, 1994
14. Vlietstra, J., "Informatietechnologie en de Industrie: Quo Vadis?", *Handboek voor de Produktie-automatisering*, 1995
15. Patankar, A.K., and S. Adiga, "Enterprise Integration Modelling: a review of theory and practice", *Computer Integrated Manufacturing Systems*, 1995

10.2. Consulted Magazines and Journals (various articles).

Byte
Computer Integrated Manufacturing Systems
De Automatiseringsgids
Financieel Dagblad
Fortune
Manufacturing Engineering
Manufacturing Review
Mother Jones
NGI Magazine (Netherlands Computer Society)
Technology Review
The New Republic
The New York Times
The New Yorker
The Wall Street Journal
The Washington Post

Times Magazine

10.3. Consulted Databases.

DIALOGLINK, front-end for Dialog
Nexis News Plus, front-end for Nexis
Pro-Search, Front-end for Dialog and BRS

10.4. Quoted Companies, Organizations, Institutions.

Administration of the US Social Security System
American Airlines
AMR Information Services
AMTRAK
Apple
American Telephone & Telegraph (AT&T)
AT&T Network Systems
Bankers Trust Company
British Airways (BA)
Budget Rent-A-Car
Businessland
Compaq
CompuCom
Computer Factory
Continental Airlines
Digital Equipment Corporation (DEC)
E.I. du Pont Nemours & Company
Electronic Data Systems (EDS)
Ford Motor Company
Hewlett Packard (HP)
Hilton Hotels
International Business Machine (IBM)
Ingersoll Milling Machine Company
IntelligenceWare
JWP
Kentucky Fried Chicken
Koninklijke Luchtvaart Maatschappij (KLM)
Marriott Hotels
McKesson Drug Company
Meritor Savings Bank
MicroSoft
National Cash Register (NCR)
New-York Stock Exchange
Otis Elevators
Philips' Telecommunicatie Industrie
Philips' Gloeilampenfabrieken
Pillbury Brands
Progressive Insurance Inc.
Sony
Sun Microsystems
Tandy
United Airlines
Wang
Zale Corporation