11 Networked information processes

11.1 Introduction

11.1.1 In the previous chapter we already referred to the importance of information systems in creation of networked business processes as required to support extreme unpredictable heterogeneity in the market. The objective of this chapter is not so much to redefine information systems theory and practice, especially against the background of the avalanche of literature topic that is already available.

11.1.2 Looking at the current practice and literature, IT systems, while moving towards network configurations, fail to support the evolution of processes to true networked systems in the definition of this thesis. We have endeavoured to describe an number of limitations which we have come across in practice, which are underlying and illustrating the inadequacy of some of the current solutions offered.

11.1.3 Although the content of this chapter is largely oriented towards computerised ICT systems, some aspects of information exchange that are not necessarily electronic. Examples of this are the consequences for cost accounting. Nevertheless as most of these topics relate in modern companies immediately to electronic information processing, we have chosen to treat these topics under the heading of networked information processes.

11.2 Networked processes require ICT

The essence of interactive, self-organising properties is the lateral interaction between the nodes in a process chain. In this interaction, communication and information exchange is essential. The requirements for enabling such interaction between process nodes that are physically separate, are immediately translated into a need for electronic information exchange and communication technology (ICT). Management literature on customised and individualised processes generally recognises the central importance of information technology (IT).

11.2.1 Pine, Victor, and Boynton (1993) give a number of reasons why IT is important for achieving mass-customisation:

- For processes to be instantaneously linked, the wants of each customer must be defined rapidly and must be instantly translated into a customised product design. For this, successful mass-customisers like Dell Computer, Hewlett-Packard, AT&T and LSI Logic use special software that records customer desires and translates these into the design of needed components. In turn, this design is quickly translated into a set of processes, which are rapidly integrated to create the product or service;
- In order to add as little as possible to the cost of making the product, databases can be used that make available all information the company

has on its customers and its requirements for all modules. In this way, it is not necessary to regenerate information for every transaction;

- If processes are to be linked and instant teams are to work on these processes without friction, information and communication technologies are mandatory to find the right people, to define and create boundaries for the collective task, and to allow these people to work together immediately without ever having met. These technologies encompass communication networks, shared databases which allow everyone to view customer information, computer-integrated manufacturing, work-flow software, GroupWare tools, etc.;
- In order to speed up and customise the physical production process, modules can be automated by adopting, for example, flexible manufacturing systems.

11.2.2 We are not disputing the validity of such arguments, but one aspect remains untouched. As described in Chapter 6, self-organising properties of a number of entities relate to the ability to create a meaningful exchange of utility between these entities. In a hierarchical structure such entities follow instructions without the need to communicate directly. But network processes require direct interaction (as illustrated in the cross roads-roundabout example). Therefore, direct communication between such entities is required to enable this exchange.

11.2.3 When the entities are physically close together, often mere observation of each other's behaviour might be a sufficient basis for communication. Apart from the roundabout, examples of such interactive order are the Kanban production system, which uses cards that indicate replenishment requirements, or alternatively, the interaction between team players in a football match. The same is not true when the entities are physically apart, or when communication between machines rather than between human beings is required. This will be the case in most business processes; hence, the need for electronic information exchange in communication is not just a matter of efficiency, it is a necessity to enable self-organising properties. This view complements those as expressed by Pine, Victor and Boynton. Rather than merely stating the need for direct interaction, the above makes clear why this interaction is required

11.3 Inadequacy current ICT architectures

Atomised, re-configurable information flows are incompatible with the current ICT-systems that are largely product-integrated, as these form fixed (not interactively re-configurable) configurations. Also, most current systems of work-flow management (as a form of centralised work traffic control) are inadequate, as they inhibit self-organising interactivity.

11.3.1 Most current IT-systems in business processes are inadequately structured to support networked processes. For a start, applications and architectures are in many cases built on batch-mode processes, unable to create a continuous work-flow through the process steps. This does not just reflect the typical structure of an industrially efficient physical process, as can be seen in bank transactions, a supply chain which lacks a strong physical process component.

11.3.2 This shows in modern workflow systems that enable the control and direction of work through the organisation. Such systems, though, are still based on a central authority that defines the routing of the work, although this authority has been given the tools to manage and configure the work processes much more dynamically than before. Work-flow systems are not based on interaction rules; they issue work instructions in a way that is not essentially different from a procedural, hierarchical approach. In other words, although many current IT-solutions look like networks, (which they in most cases technically are) they do not necessarily support (and mostly will not support) networked processes

11.3.3 Furthermore, even when systems have been designed with 'flow concept' in mind, most are dedicated to specific product lines, which means that elements (functional nodes) cannot be used in supply chains for alternative products. E.g. in the finance sector, where dedicated systems exist for most of the product lines like mortgages, personalised loans, savings, etc. Combining elements of various products into an individual solution creates insurmountable obstacles, because of the very way these systems have been structured and built. Even relatively simple aspects, like a common client database, are often very hard to achieve.

Campbell (1996) advocates the use of 'group-ware' technology:

> *"Group-ware, work-flow and document management systems are the technological solutions to the new organisational models, providing an infrastructure to allow people to work and communicate with each other.[...] to have access to all the necessary resources, regardless of the physical location. [.....] the attraction of group-ware technology is that it follows how work is organised, rather than the physical structure of the organization of the network".*

He adds, however, that although group-ware may seem to be an answer, the full benefits only appear if the organisation can match the concepts of group working, and when it appreciates that the new power lies in information sharing and exchange, rather than in control and ownership.

11.3.4 Although the group-ware concept takes a major step forward to create a networked IT-environment, by taking the work processes as a starting point rather than the physical structure of the organisation or the (IT) network structure, the approach still stops short of addressing the interactivity which is necessary for self-organising properties.

11.3.5 Achrol (1997) mentions that in dynamic environments, organisational efficiency is defined by a company's speed and agility in processing information - from detection of market signals to transformation into delivered satisfactions. Hierarchical control creates unacceptable levels of organisational inertia for turbulent environments and is likely to prove hopelessly inadequate in the knowledge-rich environments of the future.

11.3.6 Yet, in modern information systems the apparent networked aspects are becoming increasingly visible. Traditional hierarchical systems are increasingly replaced by PC network solutions, more and more in a client-server configuration. EDI-information exchange between companies and functions reflects this evolution as well. Internet itself is by its very nature non-hierarchical, an interactive set of independent nodes connected through communication links

11.3.7 In their article 'Managing by wire', Haeckel and Nolan (1993) state that information technology, by vastly reducing time and space constraints in acquiring, interpreting and acting on information, has driven much of a company's ability to respond to rapidly changing customer needs. In their concept of 'managing by wire' (cf. flying an aeroplane by wire) all business processes are represented in information language. The management then can provide steering on the basis of this representation. It can do this by 'hardwiring', i.e. by using the IT-systems to generate guidelines and instructions for all business units. While this works well in very stable environments, in complex business settings a more flexible approach is needed. This can be achieved by using object-oriented programming that creates 'building blocks' for the various business activities. These building blocks can be reconfigured in various ways, to make many different processes possible and to generate many different responses to the market. Typically, new processes can make use of a large number of existing building blocks, and in this way the IT-representation of total business activity can evolve, rather than having to be completely redesigned from time to time. This process of change bears an analogy to institutional learning: a continuous cycle in which an action leads to observing the results of that action, which in turn requires new orientation, decision and action.

11.4 Mirror image

Consequently, following from the need for interactive self-organising nodes, the physical nodal structure of process 'atoms' will have to be reflected in an 'information' image of this nodal structure and its inner interaction.

In the service sector most of the business processes are in effect information processes. Banking, publishing, accountancy, etc. have no or hardly any physical reality in their supply-chain processes, as the product/service itself is information. In industrial companies (or rather the 'make' industry) though, the real processes are physical processes. In order to create self-organising interactivity between the functional nodes of such chains, ICT is required when it comes to exchange of utility (see par. 11.2). Therefore the physical node itself needs a virtual (information) expression, like a mirror image of the physical node.

11.4.1 Rayport and Sviokla (1995) state that today businesses compete in two worlds: the world of physical resources and that of information. They use the words marketplace (physical) and market space (virtual) to represent these worlds. Companies can create value in both, but the processes are not the same in each.

11.4.2 In the physical view of the value chain, information is treated as a supporting element, not as a source of value. There is a lot of opportunity to create value through information. However, in order to do this, managers must get a feeling for the market space. Here, value is created through the virtual value-adding steps of gathering, organising, selecting, synthesising and distributing information.

11.4.3 Most companies today operate in both the marketplace and the market space. The virtual chain, they say, develops in three stages:

- *Visibility:*
  using information technology to co-ordinate the physical activities; this lays the foundation for the virtual chain;
- *Mirroring:*
  creating a parallel value chain in the market space through substitution physical activities for virtual ones;
- *Establishing new customer relationships:*
  applying the generic value-adding activities to the virtual value chain.

11.4.4 The question is, though, whether these worlds (the physical world and the information world) are indeed separate ones. We do not subscribe to this view. In fact, all networked business processes become information processes. The question whether or not there is a physical representation of a process node is determined by the nature of the business itself (e.g. service or 'make' industry). But even in the ‘make industry’, more and more product features are manufactured through information processes (embedded software). The nodes themselves are not the process. It is the relationship between the nodes which forms the process, and this relationship will increasingly reside in the information world. What Rayport and Sviokla describe as the third stage (and maybe even parts of the second stage), in fact represents high-level processes in a hierarchy of business processes. Moreover, as value will increasingly be differentiation value, a growing part of the value will arise from these higher-level processes. Yet, these processes should not be considered as separate, as Rayport and Sviokla do (as well as other authors on virtual organisations).

11.4.5 Representing nodes and interaction in information space suggests the need for decentralised information systems. This not necessarily true. It is quite possible to have this information space centralised somewhere in the company, although this may not be practical. In his reaction to the problems and inefficiencies that emerge from such ‘implicit’ decentralisation, Von Simson (1990) advocates a development towards centralisation of information systems (IS) organisation. Apart from cost advantages of licensing fees for systems software, and better opportunities for getting service and discounts, centralised information architectures have the following advantages:

- Centralised operations are more likely to use the newest productivity tools for data processing. In general, the bigger the centre, the better the quality of management and the more adept it is at using such tools;
- The need to attract and retain professional IT-staff is encouraging some centralisation, even where the logic of decentralisation is strongest: in application development. This is mainly because of the specialist knowledge needed to support the users;
- They provide un-departmentalised, integrated systems. This is becoming more and more important, as getting to the market makes it more urgent for a business to develop closer links between design, production and service activities. Von Simson:
  “A centralised IT department can see beyond the sometimes parochial objectives of the different departments or business units and break up bureaucratic information flows to take advantage of new business opportunities.”

11.4.6 Mathews (1996) states that software engineering has traditionally been conceived as an approach to the processing of data organised in terms of functional routines, dividing them into more and more diverse routines and sub-routines. Programming techniques have been designed to cope hierarchically with the increasing complexity this approach entailed. This approach has also led to a clear distinction between functions (routines, sub-routines) and the data on which they operate. As an effect enormous problems occurred whenever such a complex programme has to be updated, because altering the definition of the data structure affects all program routines, and changes in one routine can have considerable effects elsewhere in the programme. This leads increasingly to problems with regard to reliability, flexibility and productivity.

11.4.7 In contrast, object-oriented programming (OOP) defines problems in terms of their constituent objects, and then creates software 'objects' that match the constituent objects as the core operating units of the program. These software objects contain both data and functions; they are said to be 'encapsulated'. The OOP approach is thus one of creating small, discrete software entities that perform particular tasks and which can be used by a co-ordinating program without any need to know their inner workings. Once the object is defined, any part of a program can access the object by contacting it to request a performance. This message does not have to specify any data, it simply requests the object to perform a task with its current data; in other words, the autonomy of the object is ensured by the encapsulation of data (Mathews, 1996).

11.4.8 Two other features of OOP models are polymorphism, a different interpretation of the same message depending on the context in which it is sent, and inheritance of functions. This inheritance refers to the fact that objects do not have to be defined from scratch every time they are created. Objects can inherit characteristics from similar existing objects, so that only the distinctive characteristics over and above the ones that are inherited, have to be defined. These concepts allow OOP programmes to be defined in terms of general behaviour, in which objects are defined to possess general attributes and capabilities. These programmes can then be tailored to suit any particular occasion and will behave appropriately depending on the circumstances (Mathews, 1996).

11.4.9 In fact, the nature of ICT-systems should not be confused with the structure of 'virtual processes'. They are two quite separate issues (although not unrelated) and should be treated that way. Whereas the former is largely governed by the state of technology and the availability of suitable standards, the latter is governed by the nature of the business processes, which reflects the strategic choices the company makes with respect to its value creation.

11.5 Real-time requirements

As process chains aim to achieve zero lead times between event and response (if EVENT then RESPONSE), the information image must be real-time available to those nodes which (according to their rule set) can or should respond to the real events.

11.5.1 The ability to meet unpredictable demands depends critically on the response speed of the process chains. We have already argued that network processes should aim at 'zero lead time', first by eliminating all waiting time, and secondly by reducing all processing time downstream from the Customer Decision Point (CDP). However, if the physical processes move towards this goal, matching this in the information world becomes of paramount importance, as the process chain interaction is largely created in the information space. There is no point in speeding up the physical process if the information process cannot follow. Hence, the information representation should be real-time, or at least real-time should be sufficient to cope with the highest frequency in the physical nodes. For instance, if components are supplied to a factory six times per day, the information should preferably be real-time within a maximum of an hour, so as not to lose the responsiveness of the chain. The higher the process frequency, the higher the real-time requirements.

11.6 Integrity

The quality of the physical process essentially depends on the integrity of this virtual image (the match between the real world and the image in the information world).

11.6.1 Since processes are located in the virtual world, the quality of their performance is critically dependent on the quality of the information in that world. This is quite different from a situation in which the information is largely used for management decision-making and accounting.

11.6.2 Apart from the problems, which may arise from bad management decisions as a result of inaccurate accounting, inadequate information in networked processes will cause the execution processes to fail in serving the clients. As modern information systems have already penetrated the execution processes, many of these processes are already highly depending on the quality of information. For instance insufficient quality of information in banking systems, causing faulty execution of transactions, faulty building specifications for cars on the assembly line, or mistakes in mail sorting, causing mail to be delivered to the wrong address.

11.6.3 In order to prevent such performance inducing errors, many of today's systems have been equipped with safety-check procedures that verify the validity and possibility of execution requirements. Such safety procedures, however, are mostly built into batch-execution procedures. Checking validity of account numbers in banks, assortment compliance in supermarkets and availability of stock for delivery requests are all examples of such procedures. These precautions do not only create processing overhead, as they are linked to batched procedures, they will also cause roadblocks in the event-driven execution of flow-oriented processes. Therefore, networked information systems require a much more sophisticated way of securing information integrity, not by inspecting and correcting at the time of execution, but by continuously securing the validity of the information in the systems.

11.6.4 In practice, this does not just pose problems at the operational IT-level, but also impacts on the accountancy practices and standards for automated procedures. As accountancy is based on tracing and inspection, it is often difficult to convince the internal and external auditors that the information integrity requirements of networked automated systems are substantially higher than in conventional systems. The information space has to present a correct picture of the cost and performance of the organisation in the various processes - not just periodically, but at any given moment.

11.6.5 One could almost say: If the processes perform up to standard, the information has to be an accurate reflection of the physical reality, and does not have to be wrapped in surrounding auditing procedures. Accounting in the world of information is just adding up the numbers the right way, every time the financial statements are needed. In such worlds, the creation of such financial statements (as far as the operational side of the business is concerned) does not have to take weeks or even days, it can by default be done instantaneously.

11.6.6 Information integrity starts with securing a correct representation of the physical world, at any moment, in the information space. The emphasis must be on automated data collection to prevent human error (data entry mistakes) and secure real-time. A good example of these systems is the use of scanners in manufacturing logistics for tracking and tracing goods in their movement through the different steps in the supply-chain process, as with Federal Express. Yet, in some situations it is unlikely that such systems alone will secure the integrity of the basic information. For a number of reasons (e.g. shoplifting in a supermarket, breakage, etc.) small differences will occur which accumulate over time. In some cases inspection will still be required; that should happen not once a year when the balance is made, but continuously, to make sure that deviations are corrected. However, the areas to be inspected and the frequency of those inspections can mostly be predicted through such intelligent mechanisms as experience- and plausibility-rules. Experience might tell which articles are sensitive to shoplifting; plausibility might tell that negative physical stocks cannot exist.

11.6.7 Lack of integrity, however, not only relates to the data-capturing process. Computer systems themselves can fail and change information that was correctly captured. For instance, information space can show stock disappearance, whereas in reality stock is still there. Bar-code readers can stop functioning, which means there is no information input, etc. Integrity has to cover the integrity of the systems themselves as well.

11.6.8 And lastly, a very sensitive and difficult point: the ‘fixed’ information retained in databases, which the processes need to do their work, is of crucial importance. Examples of such fixed information are article, client and channel databases containing supplier information, price levels and customer requirements. Here, mistakes will lead to a correct execution of the wrong process. Often these databases will be manually filled and maintained; for many organisations they are a continuous nightmare.

11.6.9 Therefore, networked information systems are extremely sensitive to data integrity on a number of counts. Processes will simply not work when the integrity is not adequately maintained.

11.6.10 This necessity will have an enormous effect on size and staffing quality of the administration and accounts functions in mass-individualised companies. As nowadays, 25-50% (or even more) of the work in these departments is either data-entry or correcting/inspecting errors (e.g. invoice matching), that work will largely disappear. Networked processes simply cannot operate under such conditions and integrity will have to be secured at the front end. Data will be acquired automatically in the process, and fixed data, usable for all relevant systems, will only be entered once.

11.7 Data-mining

As process chains are responsive and not predictive, eventually only responding to actual events, networked information systems do not require large amounts of historical information (referred to in IT-terms as 'data-mining'). Such information might (off-line) be required to design, simulate and test new interaction rules.

11.7.1 The increasingly unpredictable behaviour in the marketplace has caused many companies to invest massively in data-mining: collecting large amounts of internal and external event information (e.g. about transactions or about factors that can potentially influence buying behaviour), in the hope that this information will enable better forecasting.

Bessen (1993) explains the necessity of data-mining:

> *"Marketers must collect detailed demographic and life-style information about large numbers of consumers in order to determine effective market segments. Then they must integrate this mass of information into a concrete understanding of what products different customers might be willing to pay.[......] Yet, when the number of market segments and the number of products dramatically increase, traditional means of exchanging this information become overloaded. [....] Within a few years, customer information systems will handle tens of thousands of characters of information about tens of millions of customers, ultimately requiring trillions of characters of computer storage. Marketers can now get storage up to hundreds of gigabits of on-line data, fairly inexpensively, via massively parallel computer architectures [.....] Still, for many small retail or manufacturing companies, the cost of storage space alone makes new information systems hard to accept. Even more challenging is the corporate task of making this huge amount of data accessible and meaningful to the many marketing personnel who could benefit from it."*

11.7.2 Stannack (1997) disputes this view. He states, referring to a complex delivery system:

> *"[....] systems need a steady flow of real-time data to make the new delivery scheme work; a requirement that cannot be met without a responsive information technology architecture, but one which is built around processes and the human resource architecture which supports the systems architecture. [....] the conceptual explosion of terms such as 'organisational learning' or 'knowledge engineering' often masks disappointment and low returns from investment in information systems. Group-ware and other collaborative working tools adopted by many companies have generated their share of endless, unused decision databases. The present fad for the creation of intra-nets will likely yield a new generation of little-used internal web-sites which add little value to the management of the enterprise - extended or otherwise. Information systems, which support complex strategies, require careful design. In the same way that factories have been redesigned to use 'materials pull' systems, 'information push' systems need to be replaced by 'information pull' systems."*

11.7.3 The last point in Stannack's observations represents a very fundamental problem of principle in ICT systems, which requires more research from a new angle of perception (see Chapter 13.3.16).

11.7.4 Much like database marketing is at the brink of despair in trying to predict client behaviour, data-mining represents the equivalent in process control.

11.7.5 For process control purposes the need for prediction is proportional to the process lead-time. The longer the lead-time, the further into the future predictions have to be made and the more difficult (and inaccurate) such predictions will be. Thus, it is considerably easier to forecast the weather in an hour's time than next week's weather - let alone next month's. It is easier to forecast product sales for this Friday afternoon, based on this morning's result, than to forecast next Friday's sales. Ultimately, if we have true zero lead time, no prediction whatsoever is required any longer, as any need can be met instantaneously. Data-mining therefore, as an aid to prediction, will likely prove to be the wrong answer to the problem.

11.7.6 However, though they do not require real-time/on-line information to be available at the execution level, recorded events are of importance as an artificial reality for developing and testing new and improved IF/THEN rules for the processing nodes. Although in principle (and also in reality) the learning process, in the sense of finding better interaction rules, could take place in the real world, such learning will have its limitations:

- In the real world we can only do a day's cycle in a day. In a simulated environment we could accelerate the learning considerably;
- In simulated environments, while still using 'live' events, we can test alternative rule sets to the same reality, which cannot be done in the real world or only with great difficulty;
- In simulated environments we can test considerably more 'dangerous' rule sets and hypotheses than in the real world.

11.8 Interaction principles

Chain composition is achieved by identifying the best performing chain out of the available nodes. Beneath the IF/THEN rule structure which governs this chain build-up, a number of possible basic schemes can be distinguished: intelligent nodes vs. intelligent goods; train, taxi and vacuum models.

11.8.1 Processes in the information space are constructed by chaining up nodes to form a moment-specific response to an outside event, such as a request from a client. As we are aiming for self-organising chains that have no central planning and command, the mechanism by which nodes are selected as a part of the chain is a critical one. There are two possible, different principles which can be applied to this chain-building process: 'intelligent' nodes and 'intelligent' products.

11.8.2 When the nodes are intelligent, they carry the rules which enable them to interact with adjacent nodes. The objective is to forward the goods of information to an appropriate next stage in the process. An example of such mechanism would be the application of the rule: *"If goods arrive at this particular node, they are forwarded, at the first opportunity, and in the right direction."* The goods themselves do not know where they want to go and the node obtains the destination information, for example, because there is a standing request for those goods from further down the line.

11.8.3 The alternative is intelligent goods, which can be physical or virtual. Under this principle the goods will tell the node which new direction to select, in order to leave the node again. This principle is used for example in mail sorting systems, where the letters and parcels, carrying the destination address, are interrogated at all switch points in the sorting process, either physically (human sorting) or automatically (machine sorting).

11.8.4 Much like John Holland’s (1995) description of interactive self-organisation, alternative nodes refer to the preceding nodes to acquire the ‘order’. This order will be granted as the subsequent node is selected based on utility requirements, both nodes participating in the interaction. For a supply chain such utility exchange will normally include expected through-put time for the subsequent node, as well as the cost incurred by that node.

11.8.5 The driving power between the gradient (which drives the goods through the chain) could be based on various models, which could be combined throughout the whole of the chain. Examples of such models are the train model, the taxi model and the vacuum model. In the train model there is a fixed set of transport opportunities; goods will normally take the first available opportunity to ‘take the train to the next station’. In the taxi model the goods could call for transport or for that matter any other value-adding activity) when either the goods themselves, or the node at which the goods currently reside, judge this appropriate, based on rule set.

11.8.6 The vacuum model behaves very much like a system driven by gravitation. Removing a product at the end of the chain creates a kind of 'vacuum', which sends messages up the chain requesting the vacant spot to be ‘filled’. It is in fact a ‘pull’ mechanism, whereas the train model could imply a ‘push’ mechanism. The taxi model could be either, as it could be driven from the incoming as well as from the outgoing end.

11.8.7 It should be noted that these models and principles govern the interaction between nodes in the chain, in the way the selection of appropriate nodes in the chain is achieved. While the event triggering the chain response will in most cases be market ‘pull’, the propagation of goods and activities in response to that event through the chain might well be pushed down the chain.

11.8.8 Choosing from these principles and various models at particular parts of the chain is governed by practical considerations, the state and cost of technology, and performance optimisation.

11.9 Process accounting and ABC costing

The learning mechanism underlying process performance improvement is based on two mechanisms:

- **At the process level the competition between alternative nodes to become part of the chain (in/out);**
- **At the node level the competition between functionally identical nodes as to the best process goal/cost performance.**

To control and improve such process chains, performance and cost information is required on a real-time basis, both at the level of the process as a whole and at the level of the individual nodes. This implies the necessity of ABC-type costing.

11.9.1 Two mechanisms drive the continuous performance improvement of the chains. On the one hand, the set of IF/THEN rules, together with the interaction model, determines the way the chain is built up to serve specific events at the client interface. By trial and error, parallel experimentation and memorising successful vs. unsuccessful combinations (in terms of cost and performance) the rule sets, which govern the interaction will gradually evolve to ever-higher levels of performance. This principle is based on combined exploitation and exploration, using recombinant techniques and proliferation of experience and knowledge throughout the system's structure (see Chapter 6.11).

11.9.2 This process of finding ever-new combinations will stop when the maximum performance with currently available nodes is achieved, as no longer better combinations can be found. It is therefore required that at a nodal level each node will, by changing its internal work processes, aim for improving the performance vs. cost at the nodal level, and so create better propositions in the competition to become part of the chain.

11.9.3 This mechanism requires a new form of accounting: process accounting. In fact, processing accounting measures not just financial utility, but the whole of the relevant utility for the process concerned. Not based on average performance and cost allocation, but reflecting the real momentary performance of the respective nodes.

11.9.4 Therefore, an expression of process performance is required which can be broken down into meaningful performance indicators at the nodal level, while still being able to aggregate to the process level as a whole.

11.9.5 Similarly, the cost incurred by a particular transaction in the node should reflect the real cost made by the node to complete this specific transaction. For that integral costing and arbitrary cost allocations are inadequate, because they falsify the proposition the individual nodes will make to become part of the chain and will lead immediately to sub-optimal decisions with respect to chain composition.

11.9.6 Hence, some form of ABC costing (activity-based costing) will be required, in order to create a correct real-time expression of the costs which nodes incur for performing certain tasks, and enable them to express improvement as a better proposition to their environment. We will not further elaborate on the concept of ABC costing. It should be noted though, that any expression (even as a proxy) that reflects the real cost performance evolution of the work processes in the node will normally be sufficient. Usually, 100% bookkeeping accuracy is not required. The aim is only to make the utility-exchange processes possible, as described for example by John Holland, who bases on a reflection of changes which take place in the utility proposition.

11.10 Human interfacing

As to networked information systems, human interaction is required on three interfaces:

- **The first is policy change in the business itself (assortment changes, outlet changes, etc.). This is in fact the implementation of corporate policy and goals by professionals executing their craft (=What);**

- **The second is the evolution of process rules, bringing the interaction between process nodes to higher performance levels.
These activities take place in a simulated environment, capable of designing and testing various models, principles and rule sets (=How);**
- **The third concerns the interaction with the marketplace, where at higher process hierarchy levels, there will be more and more information exchange with the clients, in order to help them express their moment-specific needs to the business processes, and satisfy these needs.**

11.10.1 Because of the availability of modern information technology, much of the communication between the nodal structures as part of the various process chains will take place between machines. Nevertheless, at least three points interfacing with humans is required. The first interface concerns the way in which professionals within the company obtain information upon which to base the execution of their policy decisions.

11.10.2 Nolan and Croson (1995) say on decision-support information:

> *"Information flowing through the IT infrastructure is valuable only to the extent that it makes organisational decision-making more intelligent. Even the best information is without economic value if the decision-making process cannot use it. [....] Lack of an appropriate organization-wide incentive scheme to promote the capture and use of information dooms an organization to realising little or no measurable benefit from its IT investment. Data becomes information only through evaluation and classification into decision-making aids, which in turn, are valuable only to the extent that their use improves the speed and consequences of management-decision making. A policy for the value realised from the use of information, easily the most important source, is only vaguely defined in most organizations. The network structure's reliance on a knowledge reservoir rather than a set of information pipelines necessarily dilutes ownership of information and, hence, the rights of benefits derived from its use."*

11.10.3 In this view, Nolan and Croson are fairly optimistic compared, with others. In an article on the commercial value of Internet, Hagel, Bergsma and Dheer (1996) state that the characteristic that gives networks their chief strength, i.e. providing access to an extraordinarily wide range of resources, may also represent their greatest weakness. The challenge for users is to sort through all of these resources to find the quality offerings they require. Search engines are only of limited help; indeed, they have become part of the problem. Requests for information will generate hundreds of thousands of citations, all of them relevant, but few offering reliable, high-calibre information. Users face a potential replay of Gresham's law, in which bad information drives out good information. This is indeed something which we face, not just in Internet applications, but also in large organisations, which collect vast amounts of information underlying decision-support mechanisms for professionals in their craft. As stated before, much of this information is gathered and used with the intention of improving predictions. However, as predictions in zero lead time processes are becoming irrelevant, such large quantities of historical information will no longer be required in networked processes. On the other hand, professionals need information with respect to the events taking place in the market, and driving their business, to enable policy changes such as price judgement and assortment adjustment. Merely communicating these market events to them only provides them with data, not with information. Emphasis will have to be put on turning combined events into meaningful expressions in the craft they exploit. As the events carry the footprint of the client, most of the information which is normally obtained by market research, can be obtained by intelligent interpretation of the actual behaviour of clients observed in a marketplace through, for example, point-of-sale information.

11.10.4 Nonaka (1988) is quite optimistic in this respect. According to him, the question whether order is formed in a process depends on whether or not information is created. Nonaka takes the view that:

> *"As long as one maintains the viewpoint that there is a limit in the human ability to process information, the inevitable conclusion leads to the paradigm that the efficiency of systematic information processing is achieved by hierarchy, division of labour, and operating procedures. The paradigm of information processing is a view of the world, which evolves around the axis of syncretic information. At the root of this kind of paradigm is a pessimism about human abilities".*

He continues that his own ideas are, in contrast, based on the view that humans do have the ability to create order (information), seeing humans not as simple, limited processors of information, but rather as creators of information.

11.10.5 Hagel, Bergsma and Dheer (1996) ask whether aggregation of information, valuable to users, is best performed by providers or by users themselves. They state that, to a large degree, the answer depends on the pace of technological innovation in this field.

> *"Intelligent agents that can serve as tools for network users aggregating their own content and services are already under development. MIT has recently announced Firefly, an agent that can, amongst other things, identify network users whose CD purchases suggest they share similar music tastes. Such tools are still in their infancy however."*

Referring to pattern recognition techniques as described in Chapter 9.4, it is evident that the quest for describing meaningful, relevant information to professionals is vastly connected to the ability to find underlying logic and order in the vast amount of events which take place. The example of CD purchases is one way of identifying such underlying order. If we were to presume that events are purely random, unconnected noise, then such expressions could not be found, and it is questionable whether any sensible response in terms of policy decisions (other than reacting to all individual events) could be defined.

11.10.6 Professionals change policies, but should not be concerned with the mechanisms by which these policies are implemented. Implementation is taken care of by the underlying processes, governed by nodes and striving for improvements in chain composition and interactive organisation. Some aspects of this evolution (see 11.8) might be self-organising evolution processes; yet, for example, designing completely new nodes, new interaction principles and models, or changing the nature of the process from intelligent nodes to intelligent goods, is not normally something which will emerge out of the day-to-day processing.

11.10.7 Therefore, a second group of professionals, process engineers and system designers, is required to help maintain and evolve the system, not just in IT-terms, but in all work processes. This group of people, successors to the old time-and-motion operational analysts, are becoming crucial when it comes to creating sufficient evolutionary space for the processes and making sure that such changes do not draw the evolution of these processes back to a starting point that lies well below the actual performance. The information required by these professionals is largely recorded real events, because this enables them to create an artificial reality as a test bed for simulated solutions. Simulation, in fact creating an off-line management game, might prove to become the single most important tool to realise the environment for continuous business process improvement. Yet, as already stated, it is likely that this does not require massive data collection and real-time availability of this information.

11.10.8 Finally, information exchange takes place with consumers. In previous chapters (e.g. in Chapter 9.7 on marketing, but also in par. 10.4.7, describing the interaction required for collaborative customisation), it became evident that this passing on of data to clients will probably not be adequate to create the desired utility exchange with these clients. Therefore, designing interfaces becomes a very critical craft and such interfaces must be capable of expressing client requirements in terms they can understand, while converting their actions and instructions into meaningful statements for the various processes which serve these needs.

11.10.9 Hagel, Bergsma and Dheer (1996) state here that:

> *"Mass market consumers will have little time to screen out dozens of false leads. They may well prefer to rely on an aggregator that seems to understand their needs and is able to provide them, with a selection of useful resources. Just as brand names in the consumer market serve as a powerful filtering device offering the promise of consistent quality in the face of proliferating product choices, so certain aggregators will develop a reputation that will make them valuable to consumers. 'Branded' aggregators like these are likely to become popular refuges from the overwhelming diversity and variable quality of the broader network."*

In conclusion we could reason that, while information and communication systems can bridge part of the gap between processes or entities that have different N/K solution topologies, some sort of human 'buffer' is still needed to regulate this connectivity, either between internal or between internal-external entities or processes. In Chapter 12 we will further elaborate on this human factor.

11.11 Conclusions

11.11.1 As advanced as information systems currently might seem to be, their advancement, in relation to requirements of networked business processes, is largely technical. The ability to technically create islands of information processing systems, the increase in processing speed and capacity, the growth in memory, capacity and the improvements in the user interfacing, technically necessary building blocks for the evolution toward ICT systems which can truly support networked business systems.

11.11.2 However, step required in thinking is not a technology step, it is the recognition of how order networked systems arises, and instrumenting the exchange of equivalencies required to serve the mechanisms underlying this emergent order. And in this respect ICT systems currently, also in the so-called state of the art practice, are falling short of delivering such benefits. In some cases, e.g. data-mining, applying sheer computer power might prove to be the right answer to the wrong problem, causing investments and energy to be deployed in the direction which might not yield the results anticipated.

11.11.3 The good news however is that all of the technology required to support network systems seems to be available. So the creation of the information systems required for mass individualised companies is not a matter of further technological development, but a matter of implementing appropriate architectures and paradigms.