Future ICT systems — understanding the business drivers

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IT or ICT systems have been widely adopted by companies and are now part of the basic infrastructure of most organisations. ICT systems are evolving in response to both commercial and technical changes. This paper outlines some of the drivers for this continuing change, and discusses how these drivers may influence future evolution. The paper first discusses current trends and drivers, and then identifies a number of assumptions underlying current approaches to ICT system design. Criticism of these assumptions opens up new ways of thinking about the way ICT systems are designed and used, with implications for their future development.

1. Introduction

IT spend is now a major factor in many organisations' costs, and companies are seeking ways to reduce these. At the same time, the new IT systems are creating novel business models, which in turn imply new needs and expectations from the underlying IT infrastructure. Thus, IT systems are continuing to evolve.

The first section of this paper outlines some underlying commercial and technical trends and discusses some of the major drivers for change, from both the demand and supply side.

The second section discusses the vision, often presented, of a single integrated information and communications technology (ICT) system, linked to a company's strategic plan, that enables senior managers to see, in real time and at any level of detail, how the company is performing in relation to its strategic targets. This vision makes a number of assumptions about how organisations operate, and the way strategy is developed and implemented. These assumptions are critically discussed.

As IT or ICT systems become part of the organisational infrastructure, they will not only become a key enabler of change, but also place limits on what change is possible and how quickly it may occur. The final section discusses the emerging picture of a flexible, adaptive company capable of responding quickly and effectively to the highly uncertain and dynamic commercial environment increasingly faced by companies. The implications for future ICT systems is discussed.

2. Trends

2.1 Cost trends

Underlying the changes in ICT are a number of trends, both technical and economic. Of great importance is the rapid and continuing reduction in the cost of both processing and memory hardware. This is encouraging businesses to gather, store and process more and more information, and as costs come down, there is an incentive to find more areas of a company's operations that can be improved through the adoption of IT. Companies have, in the past, gained significant competitive advantage through their use of IT (e.g. WalMart, Dell) and this has acted as a further spur for IT investment. IT has increased productivity and contributed to overall economic growth. However, it is increasingly difficult to gain lasting competitive advantage through IT [1]. Best practices are quickly incorporated into software upgrades, and IT systems are becoming a basic infrastructure. Thus, the financial benefits of adopting IT systems are reducing, while the risks associated with the failure to adopt appropriate IT, or to control costs, are increasing.

IT spend is now a major part of an organisation's costs — IT purchasing (including telecommunications spend) accounted for 4.11% of corporate operating expenses in 2001 [2]. In some industries the spend can be much higher — 9.7% of operating expenses in the financial services sector, and 12.7% for telecommunications companies [3]. The continuing reduction in the cost of hardware has also resulted in other costs dominating. Breakdown of the IT spend figures [3] shows hardware only accounts for ~30% of

total spend, with another 20% for telecommunications service. Software spend is ~25% and a further 20% is spent on external services (outsourcing, systems integration). In the future, hardware costs are likely to fall further, while external services are likely to form a greater proportion of the total IT spend. As the base of installed software increases, a smaller proportion will be spent on new systems, and an increasing proportion on systems integration and the maintenance of the existing systems. As for many companies, maintenance costs are already a significant overhead for BT [4].

2.2 IT to ICT

The term ICT reflects the convergence of IT and communications systems. At one time, the communications element of an IT system was limited to a fixed LAN or WAN infrastructure carrying data only. However, modern ICT systems involve integrated voice and data access, enabling real-time working between geographically spread co-workers, who can not only speak to each other, but also access and share a wide variety of information. Furthermore, this capability is no longer restricted to a fixed specialist facility, but can be done on the move, from a wide variety of locations including wireless hot-spots, Internet cafes or simply PCs owned by other organisations — telecommunications services are becoming more complex and have to provide seamless access to data from many different IT systems.

Looking to the future, the vision of ambient intelligence or pervasive ICT anticipates a world in which unobtrusive, adaptive and sometimes unseen devices embedded in everyday objects create an environment which responds and adapts intelligently to the presence of the individuals within it, supporting users in their home and working lives [5]. Thus, future ICT systems will create a system of trillions of interconnected entities, ranging from the most humble object to the most complex. Each entity will have both communications and computing capabilities; they will be able to communicate information, interpret it and process it. In this future, it will no longer be meaningful to distinguish between communications and IT infrastructures.

2.3 Integration of IT systems

At present a bewildering array of different IT systems have been developed (see Fig 1) to support the various aspects of an organisation's operations — major vendors, including SAP and Siebel, can refer to ERP (enterprise resource planning), SCM (supply chain management), CRM (customer relations management), ERM (employee relationship management), HRM (human resources management), HCM (human capital management), FMS (financial management systems), EAI (enterprise application integration), SPM (strategic performance management), SEM (strategic enterprise management), SRM (service resource management), SRM (supplier relationship management) and PRM (partner relationship management). In addition, we have business intelligence (enterprise, organi-sational, supplier, customer intelligence) and product and employee life-cycle management.

Generically, many of these integrated systems are referred to as ERP systems. Based on the extension of manufacturing resource planning (MRP) systems to cover areas like engineering, finance, human resources, project management (i.e. the complete range of back-office activities within any business enterprise), these systems offered, for the first time, integration and data sharing between previously disparate departments or functions of the enterprise [6].

There is a continuing trend to link these disparate systems together — back-office operations are now being integrated with front-office systems (e.g. CRM) to form a single integrated management system that can provide real-time information on the performance and operational status of the organisation, down to plant or even individual level if appropriate. These systems are increasingly integrated with the users' work environment, enabling the sharing of information 'anywhere, any time', and supporting both multi-tasking by individuals, and distributed team-working

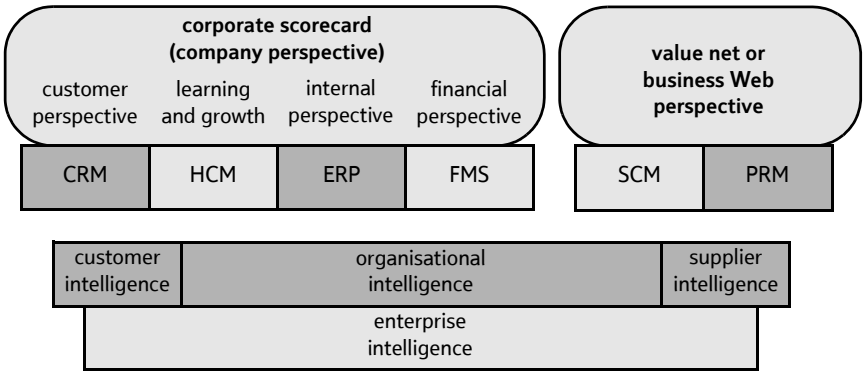

Fig 1 Enterprise management systems.

[7]. Unified datastores give managers appropriate access to a single view of the truth. Furthermore, the systems can be linked to a company's strategic plan, so that performance at any granularity (including individual) can be compared with targets and KPIs set in a suitable plan, such as a corporate scorecard. The vision is of a single integrated system that enables senior managers to see, in real time and at any level of detail, how the company is performing in relation to its strategic targets.

This vision makes many assumptions about how companies operate, what information is required and how that information is used to manage an organisation effectively. These issues are discussed in more detail below.

3. Drivers

The drivers for the adoption and development of integrated IT systems can be discussed in terms of demand- and supply-side drivers.

3.1 Demand-side drivers

3.1.1 More efficient use of resources

From a customer viewpoint, a major driver is cost reduction through enhanced productivity. This may be achieved in a number of ways:

- ERP systems enable more efficient use of resources,
- SCM systems can reduce inventory levels (and costs) and improve delivery schedules,
- business process re-engineering can reduce the number of people needed by the organisation.

IT systems also enable a new level of service to be offered to customers — this is one of the driving forces for CRM systems, which not only reduce the cost of providing support to customers, but can also enable products and services to be tailored to individuals, with the expectation that this will increase customer value.

Company-level studies have shown a clear correlation between IT intensity (IT capital per worker) and productivity, but also very wide variations in performance between companies [8]. High IT spenders rarely show the best financial results [1] — '… most companies spend too much [on IT] and get very little in return' [9].

Although some companies have benefited from the introduction of new systems such as SCM or CRM, many systems have not met expectations. Ebner et al [10] give several examples of how CRM systems have failed to deliver expected benefits. They quote a survey of 300 managers which found that only 35% of managers contacted said expectations had been met in any of the three key functions of CRM — marketing-campaign management, call-centre management, and marketing analytics [11]. Similarly, Kanakamedala et al [12] studied the effectiveness of supply chains in a number of companies. They found that those companies that invested in SCM systems generally outperformed those that had not so invested. However, those companies that had not invested in SCM software outperformed the lagging third of companies that had, indicating that SCM software is not a magic bullet for improved performance.

IT can improve financial results but it is easy to spend too much on a system that provides unnecessary functions or which is not well integrated into the existing company structures and processes. Effective IT investment requires changes to company processes, organisational structure and the way people are managed [8].

3.1.2 Better management information — linking strategy, targets and operations

Integrated management systems offer great transparency — information can be readily shared between units in an organisation and, by eliminating the need for local data stores, duplicate and conflicting data can be avoided. More data can be gathered and in more detail, from anywhere in the company, processed and presented to senior managers in a variety of management 'dashboards'.

This ability to obtain more information in 'real time' will enable closer monitoring of company performance and much greater linkage between day-to-day operations, business targets and the overall strategy of the company.

3.1.3 Faster/better response to market changes

Finally, the accessibility of more real-time and detailed information on both company performance and market trends will enable managers to spot and respond to changes in market demand or structure. In practice, early ERP and other systems were found to be slow, complex to manage and inflexible, partly due to the components of the overall systems being too tightly integrated [6].

ICT is enabling new, adaptable business forms — value nets, inter-organisational networks or business Webs (b-webs), in which companies come together in a variety of different roles and relationships that pose a challenge to current IT systems. Thus, Tapscott at al [13] outlined a number of different ways companies

could come together in ICT-enabled b-webs, but noted that ERP, although hugely expensive and time-consuming to implement, did not support the b-web inter-enterprise approach to doing business: 'Current ERP applications from Oracle, SAP, Peoplesoft, etc, do not provide an approach to doing business that reflects what Cisco and Dell have been doing' [13].

The introduction of modular approaches to IT systems, and the development of Web Services, provides a flexible way of dealing with changing organisational needs. Nevertheless, the systems needed to support a flexible and responsive organisation in a dynamic commercial environment may be very different from those needed to support companies in more stable situations, where the emphasis is on production efficiency. As IT or ICT systems become part of the organisational infrastructure, they will not only become a key enabler of change, but also place limits on what change is possible and how quickly it may occur.

3.2 Supply-side drivers

IT system suppliers are responding quickly to the emerging and changing needs of their customers.

3.2.1 Commoditisation of IT — custom-built to COTS

Carr [1] describes how IT is becoming commoditised. Drawing a comparison with earlier industries such as railways and electricity, he argues that IT (or ICT) is an infrastructure industry that gains value from being shared as widely as possible. Thus, the history of IT is characterised by increasing interconnectivity and interoperability, enabled by standardisation of the technology and increasing homogeneity of function.

Traditionally, IT systems have been built to order, with companies creating proprietary systems in order to gain long-term competitive advantage. Increasingly, though, companies are abandoning this approach. IT systems suppliers are producing products with greater functionality with the result that companies are replacing proprietary systems with standard customer off-the-shelf (COTS) applications offering lower costs, as development costs are spread over many users.

The development of standard modelling approaches (e.g. UML) for applications, architectures and business processes, together with standardisation of data structures through XML, offers greater integration of processes and data access, both across the company and between companies. However, standardisation and interoperability make it more difficult for suppliers to differentiate their product or to charge a premium for additional functionality. Novel and useful functions can quickly be reproduced by competitors.

There are other pressures on pricing. The increasing sums spent on IT systems by companies mean that the costs of systems, and the benefits accrued, will be subject to much greater scrutiny. Customers will adopt more robust purchasing strategies, saving themselves money at the expense of the IT systems and software suppliers [2]. And underlying all this is the continuing price deflation of the underlying technology, as enshrined in Moore's law.

3.2.2 Modularisation and Web Services

Early monolithic IT systems proved slow and inflexible. In response, IT systems suppliers have moved to a more modular approach in which monolithic applications are broken apart into a component-based architecture [6]. This offers the possibility of mixing and matching components, from different suppliers, to produce a 'best-of-breed' system tailored to the specific needs of companies. In practice, integration of components from different suppliers is far from straightforward. 'Because data must be pulled from various sources ..... these applications make it hard to integrate and manage the system; the symptoms may include incomplete or incorrectly routed information, too many passwords or log-ins for users, inconsistent data models (the frameworks used to capture, access, and display information), and inconsistent guidelines for entering data in different units' [10].

Web Services offer the potential for a plug 'n' play approach to IT systems and all the major software suppliers are ensuring their systems are compatible with Web Service standards such as XML and J2EE. The underlying idea of Web Services is that companies simply obtain the functions (Web Services) they require, combining these to produce the overall system. In practice, integration may not be that simple and an interim solution is to buy a generic system from one of the main suppliers, and use Web Services to customise it to meet any specific customer needs.

Note that if the Web Services approach is successful, this will further undermine the value of software production — successful services will be readily reproduced, and because each Web Service only performs a specific function, development teams need not be large — entry barriers are reduced and competition will increase. The Web Services model will result in greater value lying in the overall design of the system and in the integration of the different components.

3.2.3 On-demand computing — the utility model

IT systems are an intricate combination of hardware, communications networks and software. As ICT systems become more complex and more pervasive, so the capability of any company to deliver all aspects of a

system becomes more difficult. This is having two effects:

- many companies are finding it more cost effective to outsource both the development and the management of their IT systems to external organisations,
- suppliers are often a consortium of companies including both IT and telecommunications companies, who bring complementary skills together in order to deliver and manage a complete ICT system.

Companies such as Microsoft and IBM are moving towards a utility model, in which both computing capability and applications are delivered on a pay-per-use basis. As the IT market slows and saturates, this provides the suppliers with a regular income and a point of contact for selling higher value services such as consultancy, systems integration and systems management. For the customer, a shift to a utility model means lower capital costs and greater flexibility: there is little need for up-front investment and operational costs are directly related to usage [14]. By aggregating the demand of many users, overall loads are likely to be less variable than those of single applications, thus reducing much of the cost associated with peak loads. This idea of shared capabilities, available on demand, underpins both grid computing and Web Services.

In the simplest models of grid computing, geographically dispersed computing resources are joined together by high-capacity communications links and a set of software programs that provide basic services such as authentication, authorisation, resource discovery, access, QoS, payments. Based on the aggregated resources and basic services, a range of applications can be developed (such as high performance computing) and sold to end users. A generic grid business model is shown in Fig 2. This basic model can also be applied to Web Services (where the resources are various business applications) and the Semantic Web (where the resources are data).

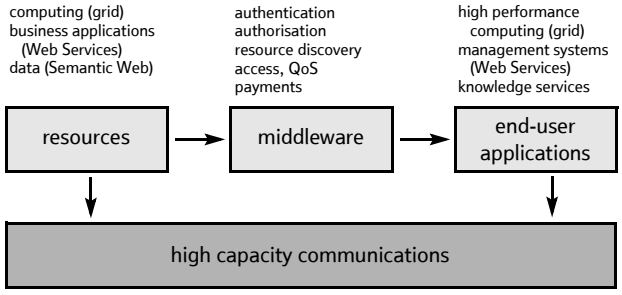

Fig 2 Basic business model for grid computing and Web Services.

In this generic model, potential sources of value are:

- leasing the resources,
- providing the 'middleware' that creates the platform,
- application development and provision,
- provision of the communications links.

4. Integrated management systems — challenging the vision

In practice, the introduction of new management systems is far from straightforward. The design of management systems and the way benefits are described are based on some very specific assumptions or models of both organisational operation and human behaviour. The vision of an integrated management system (Fig 3) foresees operations closely coupled to company strategy through detailed performance targets

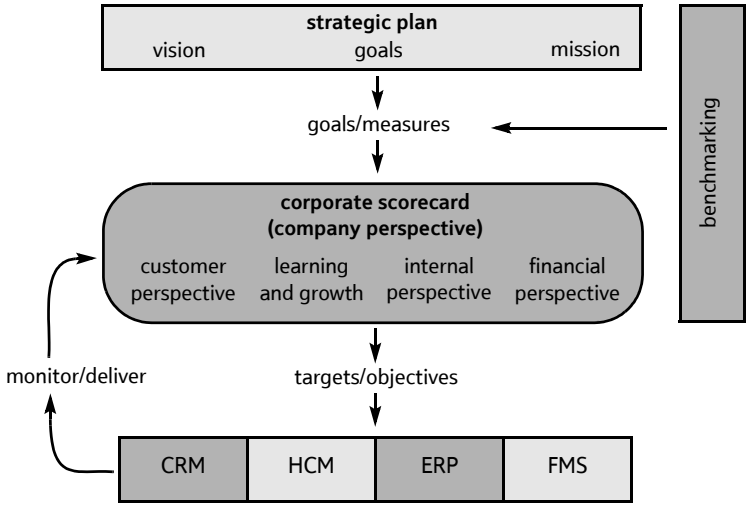

Fig 3 Integrated management system — business processes, embedded in software, are hard-wired to the strategic plan.

and real-time monitoring. The guiding principle is very much one of centralised control.

This vision makes a number of assumptions, which are open to challenge:

- strategy is mainly planning,
- business decisions are primarily 'simple' puzzles [15],
- more information leads to better performance,
- companies can be considered machines for implementing the strategy,
- these machines are complicated, but not complex, and can be analysed through a reductionist approach.

4.1 Strategy as planning

For most companies, a strategy is still a plan of action. Many companies have a long history of planning and, especially those with a scientific or engineering background, tend to have a positivist view of the world and a rationalist approach to strategy.

However, the idea of strategic planning has come under criticism for failing to acknowledge the very real uncertainties faced by managers and the social/political processes that influence decision-making in practice [16, 17]. This has resulted in greater recognition of the human and social aspects of decision-making through concepts such as soft systems methodology [18] and organisational learning [19].

4.2 Business decisions — 'simple' or 'wicked' problems

All companies seek to develop a strategy that will ensure sustainable competitive advantage. However, this is becoming increasingly problematic in a dynamic commercial environment in which competitive pressures are increasing and technological change is continually speeding up. Pidd [15] highlights the different way the term 'problem' is used (see Fig 4). He suggests a spectrum of usage including the following as examples:

- puzzles — where it is clear what needs to be done and how this can be achieved; by applying a standard method (e.g. a mathematical approach), a solution can be found,
- problems — where it is clear what needs to be done, but not obvious how to do it,
- messes — where there is considerable disagreement on what needs to be done and, hence, it is impossible to say what should be done; messes are similar to 'wicked problems' [20].

problem type	what needs to be done	how to do it
puzzles	✓	✓
problems	✓	×
messes (wicked problems)	×	×

Fig 4 Different types of problem [15].

For many firms, developing a strategy is a wicked problem in which uncertainties (lack of knowledge) about both the present and the future make it difficult to develop either a convincing picture of the firm's future business or a route to get there. An individual can usually agree on 'what needs to be done'. For the most part, the impact of uncertainty is on how best to achieve those ends. The problem becomes more complex when in a group setting. Individuals will have different objectives and priorities as well as differing views as to how a particular objective might be achieved.

But even when the strategy is agreed, we may still be left with 'problems' in Pidd's terminology — that is, we know what needs to be done but it may not be clear how to do it. Yet, the process by which high-level goals are incorporated into the company processes and transformed into individual targets assumes this to be unproblematic. Simon [21] suggests '… two persons, given the same possible alternatives, the same values, the same knowledge, can rationally reach only the same decision'. This may be true, but only for the most trivial of cases. Can anyone have the same values and the same knowledge? Will all treat uncertainty in the same way? And will all recognise the same set of possible alternatives?

Nevertheless, Simon's view of the world may indicate why 'transparency' and the sharing of data across the company are seen as beneficial — if everyone has the same information, then they will reach the same rational conclusion. However, Checkland [17] in his 'Soft Systems Methodology' highlights how an individual's *weltanshauung* (that core set of beliefs, memories, experiences, etc, that shape how we view the world) determines how they interpret information.

4.3 More information = better performance?

In moving from puzzles to problems to messes, there is a significant increase in uncertainty, both about the nature of the problem, and about its solution. Spender [22] identifies three different (but not incompatible) interpretations of uncertainty:

- the positivist view is that uncertainty is simply ignorance and while, at one level, this is uncontroversial, there is, however, an implied assumption that if we can obtain enough information then the uncertainty will go away — this ignores issues of interpretation and values,
- a second view is that uncertainty is related to indeterminacy, and therefore strategic outcomes may be dependent on others' (unpredictable) response — more generally, we know that it is not possible to predict the future,
- finally, uncertainty is due to incommensurability — different types of knowledge may be relevant and can provide different answers both to the question as to what needs to be done, and to how this can be achieved.

The positivist assumptions underlying much strategic planning mean that other assumptions have become associated with the process. Thus, ideas of profit maximisation encourage managers to seek a best or 'optimum' strategy. But the uncertainties associated with looking to the future mean such an optimisation is impossible. Nevertheless, considerable energy can be spent on gathering more data or information in order to reduce that uncertainty. Such an emphasis on information may reflect the assumption that uncertainty is simply another word for ignorance — one of the selling points of advanced ICT systems is their ability to gather and present real-time information at almost any level of detail.

But an emphasis on getting more information may be misplaced. A number of studies have shown that managers' perceptions of their environment are often highly inaccurate [23, 24]. More significantly, Sutcliffe and Weber [25] showed that there was a negative correlation between a manager's perceptual accuracy and the firm's performance. For what is important is not so much the information available to a manager, but their ability to interpret it and make sense of the commercial environment. Sensemaking is driven by '… plausibility rather than accuracy' [26].

4.4 Organisations — purposive machines or social networks

Checkland and Holwell [27] identify in the literature two strands or approaches to organisational theory. The first is the 'hard' functional strand. This regards the organisation as a socio-technical system in which people and resources are combined to form a goal-seeking machine. In this model, the primary role of a manager is decision-making-in-pursuit-of-goals [28] and the purpose of IT management systems is to support the making and implementation of decisions.

Although this model has been heavily criticised in the literature (e.g. Checkland [18], Mintzberg [16], Stacey [17]), it underlies much of the way IT systems are being developed and used. The type of integrated management system outlined in Fig 5 is the natural outcome of the 'hard' approach to organisations.

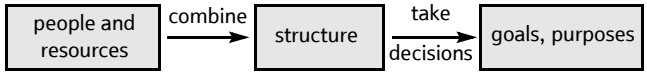

Fig 5 The 'hard' functional model of organisations.

A second, complementary model of organisations is the 'soft' interpretative strand. This strand sees organisations as a network of (social) transactions in which social processes of conversation legitimate shared norms and standards, and in which a social reality is constructed and reconstructed. This social reality influences the way people (and hence, organisations) both interpret and respond to events or new information. A limitation of this approach is that it has not, in general, offered '… clear-cut sharply-defined models of organisation which might underpin this approach' [27], although Stacey's concept of an organisation as a set of complex, adaptive processes [29] may be one such model. Not surprisingly, this approach does not lead to a well-defined objective for IT systems. However, the approach does draw attention to the social context in which IT systems operate, and warns of potential dangers in thinking about organisations in a purely mechanistic way. There are plenty of literature examples of IT systems that have failed because the social context of the users was ignored (see, for example, Introna [30]). This is one reason why people should be treated differently from material resources. Unlike resources, people will respond to changes imposed upon them. This response will be influenced by their beliefs, aspirations and expectations, and may support or negate the impact of decisions in which they have had little or no involvement.

4.5 Companies — simple machines or complex systems

The process by which an overall strategic plan is broken up into a number of high-level goals that form the basis of targets at a variety of levels, down to the individual worker, makes severe assumptions about how a company is structured. In particular, it assumes a model of the company as a complicated, but not complex, machine. Although companies contain many elements, these are all assumed to independent of each other — an individual's attempt to meet or beat his or her targets, for example, has no impact on those of other workers. Furthermore, breaking down the high-level targets to individual ones is assumed unproblematic — the whole is simply the sum of the parts.

Other than simplicity, there is little to recommend this model. The reductionist approach described above does not reflect the reality of organisational processes and structures — even in the absence of people, the various processes within an organisation are interconnected so that local changes introduced to improve local performance can have a negative impact on other parts of the business and even on the overall performance of the organisation. To understand the impact of a change in one part of an organisation, it is necessary to adopt an holistic or systemic approach [18, 19, 31]. Rather than seeing companies as complicated machines, it is better to think of them as complex systems.

The introduction of corporate scorecards [32] intrinsically recognises this. If objectives could be set independently, then the senior managers could simply use one parameter (profitability or shareholder value) to measure performance, as all other measures and targets would be derived simply from this prime target. In fact, pursuit of short-term financial goals can have a serious effect on staff development, process improvement and long-term customer satisfaction. These are not independent variables, and seeking optimal performance involves trade-offs between long-term and short-term aims, and between internal (company-focused) and external (market-focused) measures. This is not to say there is no point to targets, but a systemic viewpoint suggests that effective target setting needs a sophisticated understanding of how the various measures link to each other, and what is the most appropriate granularity at which to set the targets. A generic (COTS) system is unlikely to have such an holistic view of the company embedded within it.

5. Future ICT systems — supporting the flexible company

The classical view of management sees the manager as a 'controller' and management as an act of rational control. In line with a scientific approach that distinguishes clearly between the observer and the observed, the manager is seen as separate from the processes managed. The emphasis is very much on rational decision-making and is consistent with a 'hard' approach to organisations. This is the approach enshrined in most current ICT systems; the systems control core processes and are designed to speed workflows. Recent work by Head [33] suggests that the introduction of advanced ICT-based management systems (such as enterprise resource planning and customer relationship management systems) has led to a deskilling of the work, with strictly enforced work practices and constant, real-time monitoring of performance. This approach works best in a stable environment, where reliable forecasts of customer demand, materials cost, etc, can be made, and where strategic emphasis is on optimising processes to minimise costs.

However, in an environment that is changing rapidly, it becomes increasingly problematic to plan for a predicted future and monolithic, centralised management systems can prove too rigid. It is when the commercial environment is unstable and dynamic that adaptability and innovation become more important elements of strategy than cost control.

There is increasing interest in designing companies that are flexible and responsive to the changing environment. Kishore and McLean [7] outline 'Next Generation Enterprises' (NGEs) that will operate on a 24×7 basis in a rapidly changing market environment, characterised by shorter and shorter cycle times for product development and delivery. NGEs will gain competitive edge through constant innovation and rapid adaptation. Characteristics of NGEs include:

- fluid organisational structures and boundaries,
- virtual teams drawn from different companies,
- 'flexible' strategic alliances,
- inter-organisational information (and management systems).

Such companies require a very different approach to both strategy and the management infrastructures that support their operations. In particular, IT systems are required to be flexible, so as to accommodate changing organisational requirements and to co-ordinate decentralised global operations [7], including operations across organisational boundaries.

This description of an NGE implies a different approach to management in general, and is more in line with the ideas of complexity management theorists, who typically emphasise [31]:

- in an unpredictable and changing environment, a fixed plan for change is no longer possible,
- the ideal organisational form is adaptive, decentralised and self-organising — examples of effective adaptive systems include Linux, the Internet, the human immune system, and markets,
- organisational policies and goals are emergent and indeterminate.

5.1 Strategy as adaptation

The complexity viewpoint often draws on biological metaphors, and especially that of evolution. As well as strategy being a plan, an alternative definition (e.g. Encarta), derived from biology, describes strategy as

adaptation important to evolutionary success, or, in evolutionary theory, a behaviour, structure, or other adaptation that improves viability.

Looking at strategy from an evolutionary viewpoint does not mean abandoning planning completely — humans need a sense of direction and even today many industries have to make decisions about major investments five or even 10 years in advance. However, the emphasis shifts from the plan itself to the process of planning and to the need to structure the company to respond to a changing environment. Thus, instead of seeking to work out what the future will be and develop an optimal plan for that scenario, it is better to consider a range of future scenarios and seek strategies that are robust to future possible developments.

Kay [34] introduced the concept of 'strategic fit' — the matching of an organisation's resources to its external environment. This is a key idea in evolutionary strategy formation. Since the environment is changing continuously, then it follows that the organisation must co-evolve to maintain its strategic fit. But co-evolution, flexibility and adaptability require far more than a robust strategy (itself harking back to the idea of a fixed 'plan'). They have implications for the company structure, its processes and the way people are managed.

In particular, future ICT systems need to deliver what Tapscott et al [13] refer to as 'variability management'. They will need to provide information from an ever-changing variety of sources, customised to the roles and needs of individual users, and support inter-enterprise business processes so that virtual organisations can be created that span manufacturer, supply chain, distribution and customer. Realising this vision will require considerable research and development, given the limitations, discussed above, of the current models of organisations underlying ICT.

5.2 Evolutionary strategy and decision making

As the commercial environment becomes more dynamic and therefore more uncertain, both strategy development and implementation more closely resemble 'wicked problems' in which both 'what needs to be done' and 'how to do it' are unclear and the subject of debate.

The complexity approach favours decentralised decision-making, since those working close to the market-place are more likely than those in headquarters groups to be aware of changes in customer needs and can respond more rapidly to such changes. The view of the manager is as a coach or steward with a role as a market-maker, rather than a controller. The objective is to keep the firm in a 'sweet spot' between chaos and rigidity [36] — a zone of creative adaptability. Two important mechanisms for doing this are:

- encouraging diversity of thought (so the firm has a wider range of ideas and views to consider),
- facilitating the creation of more connections between people — so that ideas can be promulgated, discussed, combined and criticised.

Literature examples of how companies respond to changing circumstances emphasise the need for detailed discussion and debate to explore many options and gain commitment to changes agreed [31, 35, 36]. This would suggest that communications technology, in particular, has a role in strategy formation and decision-making. Experiments comparing face-to-face and computer-mediated communication [37] show computer-mediated communication is good for sharing information, gathering opinions, and debating alternatives. Computer-mediated communication is egalitarian, frank, task-oriented and produces a wider range of alternatives. Thus, ICT systems can support the capture and consideration of diverse opinions that might be lost in face-to-face situations where certain individuals, through their status or behaviour, can dominate the discussion. However, the poverty of 'social cues' (non-verbal communication) in current forms of computer-mediated communication inhibits interpersonal collaboration and trust, especially where communication is anonymous and not within a familiar social context. Thus, people are unable to reach consensus and feel less solidarity with each other. This leads to a sense of 'de-personalisation' and being less satisfied with the group's accomplishments. Computer-based groups are effective in reaching an intellectual understanding of shared problems (less distracted by extraneous social communication?) but live, face-to-face debate is needed to generate the trust and reciprocity necessary to implement that understanding.

Decentralised decision-making requires a common vision of what needs to be done, and possibly a consensus on how this can be achieved. It is not technology *per se* that enables this common viewpoint to be established, but rather time and appropriate tools for thinking [15]. ICT enables information to be gathered and disseminated more widely across the company, providing a basis on which to take autonomous action. However, the capabilities of these systems are increasing and will be greatly enhanced by future ambient intelligence technologies — much greater information on process performance and status will be gathered in real time. If information overload is to be avoided, the systems themselves will not only take over much of the routine information transfer and

recording, but also ensure process information is delivered to individuals in a timely and controlled way.

However, this implies that more attention needs to be paid on what information is required by managers to take effective action. Weick [26] points out that '… managers keep forgetting that it is what they do, not what they plan, that explains their success'. Adaptability changes the way managers view knowledge. Instead of seeing knowledge as an object (information) to be stored and shared, there has to be a shift towards knowing as a process that shapes what people do. As discussed above, more information does not necessarily lead to be more effective management, and can even be counter-productive.

This issue raises a number of questions, largely unresolved, about how the enormous amount of data generated by future management systems is to be processed by those systems and presented to managers throughout the organisation.

- What data is to be collected — is this an adequate representation of the the system being monitored?
- How does the system determine which data to select for further processing, how is that data aggregated, and to what extent does the system interpret (make autonomous decisions based on) this data?
- What data is to be presented to which managers, and how can this best be done to support sense-making?

The answers to these questions depend on what assumptions are made about the company, its employees and the wider environment, and how these assumptions, or models, are embedded in the systems. In order to process data and present it as information, the systems themselves will incorporate implicit models of the organisation and the role of individuals.

Future ICT systems offer the possibility of providing appropriate information to individuals, to support decentralised decision-taking in response to changing demands (the adaptive company model). But these same systems also offer the potential for greater control of both processes and service, involving the monitoring and storage of far larger amounts of information about individuals than is currently possible. Used inappropriately they could result in unacceptable levels of monitoring of both consumers and employees resulting in suspicion on the part of consumers and causing stress in employees [38]. If system design emphasises efficiency, then the result may be counter-productive with high levels of monitoring and control inhibiting the innovation essential for survival in an increasingly competitive environment.

5.3 Adaptive business processes

Nelson and Winter [39] described the regular and predictable behaviour patterns observed in a company as 'routines'. They recognised that the knowledge and experience of the organisation were embedded in these 'routines'. Significantly, Nelson and Winter saw the routine as the organisational equivalent of a gene — evolution of companies proceeded by the variation, selection and propagation of routines. If a firm's routines embody corporate knowledge, then adaptability requires companies to find ways to change routines rapidly so as to accommodate new knowledge. Yet, it is the routines that determine the ability of an organisation to absorb, develop and respond to new knowledge.

The advance of ICT means that routines (business processes) are increasingly embedded in software and that evolution of the company means evolution of its software infrastructure. Breaking integrated systems into components such as Web Services, provides one way to enable systems to evolve to meet changing needs. Individual Web Services can be reconfigured, new ones developed, and the various components combined in different ways. However, routines not only include formal processes, but the structures, traditions and behavioural norms of the organisations. Both explicit and tacit knowledge are embedded in the routines, although only explicit knowledge will be embedded in software processes. Because these routines interact with each other, the introduction of new processes into an existing system is not straightforward.

Organisational forms, and the associated practices and routines, reflect their evolutionary history [40—43]. A 'cladistic diagram' (a diagram showing evolutionary history) can be developed for an economic sector. These show how successive new practices and innovations have been introduced, resulting in a range of organisational forms. For example, McCarthy et al [43] studied the automobile industry and identified 53 characteristic practices (such as standardisation of parts, job rotation, TQM sourcing, manufacturing cells, etc). They also identified 16 distinct organisational forms:

- ancient craft system,
- standardised craft system,
- modern craft system,
- neocraft system,

- flexible manufacturing system,
- Toyota production system,
- lean producer,
- agile producer,
- just in time system,
- intensive mass producer,
- European mass producer,
- modern mass producer,
- pseudo lean producer,
- Fordist mass producer,
- large scale producer,
- skilled large scale producer.

An evolutionary tree (Fig 6) can be derived from cladistic theory and shows the probable sequence of events leading to the development of different organisational forms. Each form has used a different selection from the 53 characteristic processes. What is clear from this type of diagram is that changing from one organisational form to another not only involves adopting new practices, but also abandoning old ones.

A well-established company, especially if it has experienced a relatively stable commercial environment, will have developed a system of processes or routines that are mutually consistent and reinforcing. Such a system is highly stable, but this stability makes it resistant to change [44]. It is well known that changes are frequently resisted by those affected within an organisation. Some of this may be the result of individual interests being threatened, but it could also arise from people with more detailed knowledge who can see problems not apparent to the strategy and policy makers driving change [45]. Even when all are agreed with the overall aim, the systemic nature of most enterprises means that change must be co-ordinated [31]. An holistic view of a company's operations is needed if evolution via new Web Services is to be effective. In some cases, the existing routines may be so closely coupled that some changes are impossible, and the only option may be to build a new greenfield plant [44].

6. Conclusions

This paper outlines some of the key drivers for change in corporate IT systems.

On the demand-side, new IT systems routinely claim to offer significant cost reductions through better control and the more efficient use of resources. They

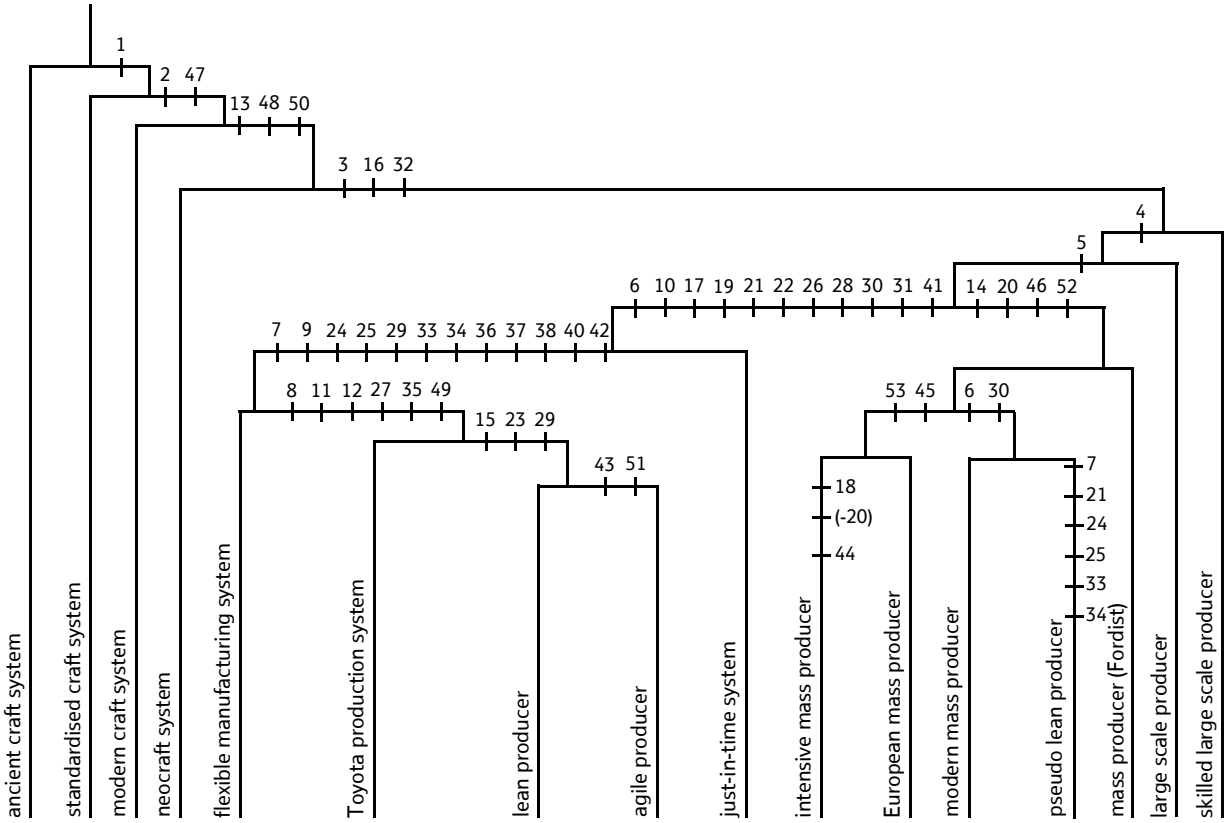

Fig 6 The cladistic diagram for automobile manufacturing organisational forms [43]. Numbers refer to one of the 53 characteristic processes.

can also enable new business models and organisational structures, giving companies greater flexibility and responsiveness in the face of an increasingly dynamic commercial environment. However, despite these objectives, IT has now become a significant cost in its own right, and has not always delivered the promised benefits. Therefore there is a now far greater emphasis on controlling IT costs, making sure the benefits are delivered and that flexibility is not impaired [1].

On the supply side, the success of a few major suppliers, such as SAP and Oracle, has led to the replacement of bespoke and/or proprietary systems with COTS modules and to a shift from separate functional systems to company-wide integrated systems. At the same time, the ready availability of advanced IT systems means these are becoming commoditised, with the result that suppliers are seeking new ways to add value by offering additional services (consultancy, systems integration, outsourcing). At the same time, their customers are facing a world where the use of IT systems has become so widespread that they deliver little or no competitive advantage. IT is in the process of becoming a utility.

The dominant vision for ICT is of a single integrated system, linked to a company's strategic plan, that enables senior managers to see, in real time and at any level of detail, how the company is performing in relation to its strategic targets. This vision makes a number of assumptions about the way companies operate and favours a centralised, control model of management that is best suited to stable commercial environments where the strategic priorities are focused on process optimisation and cost reduction.

However, companies are increasingly facing a dynamic, rapidly changing commercial environment in which innovation and adaptivity are the key to competitive advantage. There is increasing interest in next generation enterprises that will operate on a 24×7 basis in a rapidly changing market environment, characterised by shorter and shorter cycle times for product development and delivery. NGEs will gain competitive edge through constant innovation and rapid adaptation. Such companies require a very different approach to the management infrastructures that support their operations. Centralised approaches tend to focus on efficiency, whereas flexibility and adaptivity thrive in a more decentralised environment. Future ICT systems will need to be capable of rapid evolution, to accommodate changing organisational requirements and ensure the co-ordination of decentralised global operations including operations across organisational boundaries.

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