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SWP 5/94 BEYOND THE VALUE CHAIN: A NEW FRAMEWORK FOR BUSINESS MODELLING

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BEYOND THE VALUE CHAIN: A NEW FRAMEWORK FOR BUSINESS MODELLING

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ABSTRACT

The value chain has served well in the late '80s and early '90s as a strategic modelling tool for managers. It has a process orientation which is easy to understand and which is effective in use. However, today this process orientation needs to be balanced by an alternative view which gives an *information* viewpoint.

Recent experience with the strategic use of process and information based modelling techniques is mixed, but the increasing importance of information based modelling is obvious as businesses are pressured to share more information with their partners. It is also clear that information modelling is not so easy as process modelling.

A new framework for business information modelling has been developed and is presented here: the Cranfield Enterprise Model. It is based loosely upon entity modelling techniques[1]. It has seven main domains within which specific entities can be located and related to other entities. The domains are:

- Marketplace
- Product or Service
- Procured input
- Performance
- Corporate resource
- (information about) Supporting activities
- (information about) Value adding activities.

In use the new model provides benefits to management (and the business at large) in different ways:

- helping to develop an inventory of information in use,
- assessing the quality and completeness of information management,
- showing where there is information that has strategic potential, and
- providing a structure for the administration of information in a business.

Specific illustrations based in manufacturing, retailing and information technology services companies show the different ways in which the new model helps in different kinds of organisation. It has been found that the new model helps to provided rapid results in an area which is traditionally steeped in difficulty.

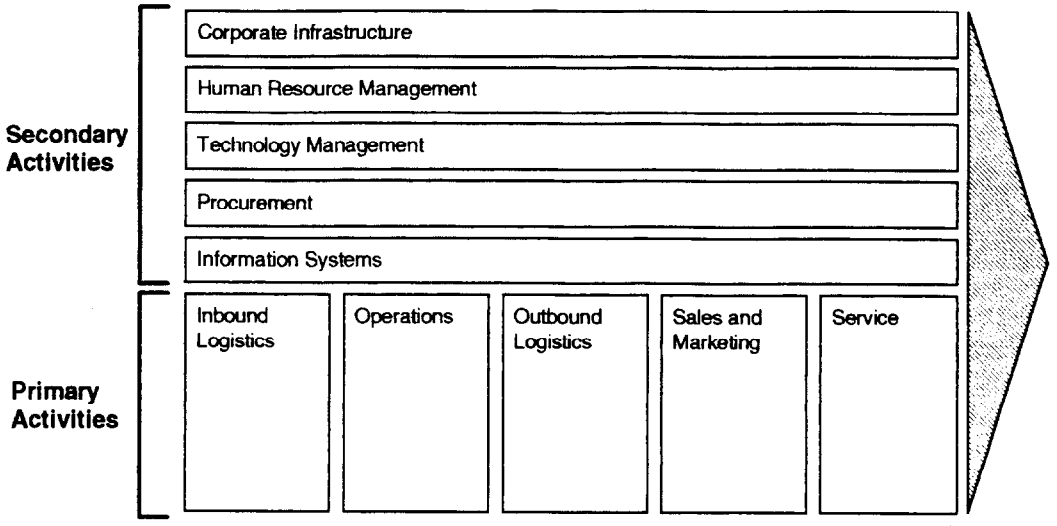
Note: Enlarged versions of the diagrams included in this paper are provided at the end, before the appendix

INTRODUCTION

There can be few people who have not come across the value chain [Porter, 1985], at least in passing. Many have adopted it as a primary tool for thinking about business, because of its simplicity and because it often helps one to take a fresh view of a business. The value chain has made a lasting contribution to the way that business managers and academics think. In particular, because it is essentially a *process*-based view of business, it has contributed to the current interest in *business processes* and how we can manage them through improvement, redesign and redefinition.

The value chain is all about how the primary functional areas of a business - inbound logistics, operations, outbound logistics, sales and marketing, and service - can be seen as adding value within the overall activity of an organisation. It also shows how the secondary supporting functions - for example infrastructure, human resource management, technology management, procurement and information systems - contribute to the efficiency and effectiveness of these primary functions.

Figure 1 - The value chain



At the Cranfield School of Management the value chain is a routine feature of our teaching and our research. In particular, in researching the longer term effects of Electronic Data Interchange (EDI) upon business [Bytheway, Dyer and Braganza, 1993] the value chain played a very important initial role. In the course of this two year project, working with twenty European organisations, we analysed many businesses and used the value chain as a framework to guide more detailed low-level analysis of business activities [Bytheway and Dyer, 1990; Bytheway, 1991]. This helped us to identify possible applications of electronic data interchange. We found that the "location" of an information interchange in the value chain is a good indicator of the kind of benefit that might be expected and the implementation problems that will be faced. For example, automating information exchange on the customer side of the value chain is difficult, whereas automating information exchange on the supplier side is relatively easy.

However, we also found that in order to understand the true potential of EDI - or any other new technology - we not only had to explore the *process structures* within an organisation but the more abstract *information structures* as well. This is because EDI opportunities are not only based in information exchanges which are easily seen through a process model, but also in information *sharing*. If we are to take a longer term view of EDI, we need to understand the information that our business partners have which we could share [Bytheway, 1991(c)]; sharing implies unrestricted access to mutually interesting information rather than prearranged exchange of particular instances of information. To be able to deal with this we need an information model.

In the more general case, we found that process models help to find short term efficiency and effectiveness benefits whereas the information model helps to find more radical evolutionary benefits. The two perspectives lead to different kinds of understanding and different opportunities.

[1] An appendix to the paper provides a brief explanation of the choice of entity modelling as the preferred modelling technique.

- *The process viewpoint*:

  We need to be able to see the processes within a business - at an appropriate level of detail - so that we can understand how they might be improved or redesigned with information technology.

  The value chain works well as a framework for process modelling. By overlaying the detail of business processes and flows on the value chain of a single business it helps to show the movement of *goods* (generally from the left to the right), *money* (generally from the right to the left) and *information* (every which way, but most importantly *demand information* from the right to the left). At the level of the industry value chain, information interchange opportunities can be accurately located and classified according to the different functional areas that comprise the source and destination for the exchange.

  In our research project we found that the volume and detail of process modelling can be difficult. When this happened we used the value chain as a "safety net" because it provided a stable, universal framework to which the detail of process models could be mapped. In a hierarchic decomposition of business processes, the generic functions in the value chain can be seen as the first (highest) level of decomposition.

- *The information viewpoint*:

  We also need to be able to see the information in a business - again at an appropriate level of detail - so that we can put on one side the process viewpoint and see an alternative representation of the business based on the structuring of information.

  Here the value chain is less helpful. It fails to show the underlying information structures although it can be used as a framework for showing information flows moving between processes. An organisation seeking to understand the potential for information sharing (rather than just information exchange) will find only limited help from the value chain model. We need an information model to do this effectively.

  In this situation it is tempting to reach for the corporate data model to find inspiration (for information sharing ideas) but, as with process modelling, we know that the detail of data analysis can present insuperable difficulties in terms of corporate acceptance and understanding. The general experience of corporate data modelling shows that it is more problematical than process modelling. Indeed, how many corporate data models are truly "owned" and understood by the whole company? Where is the high level framework for data modelling which will render the results of data modelling comprehensible and comparable, as the value chain does for the results of process modelling?

  Again, for this we need a different framework, and in our research project at Cranfield we were unable to find one in the literature. We therefore developed a generic framework for business information modelling, and the purpose of this paper is to present it for the first time (although it has been previously published in a specialist context [Bytheway and Braganza, 1992]). It is referred to here as the **Cranfield Enterprise Model**.

The paper first reviews the state of business modelling. The Cranfield Enterprise model is then presented and illustrated using simple examples developed in the course of research at Cranfield. The paper concludes with an appraisal of the model and its potential for further use and development.

BUSINESS MODELLING - A REVIEW OF CURRENT PRACTICE

Contribution to business success

The contribution that business modelling makes to the success of a business seems to be variable. Where the value chain itself has a history of successful use and has undoubtedly contributed to the success of many businesses, it is now being challenged in view of the new and different circumstances of the 1990's. A recent paper from Norman and Ramírez [Normann and Ramírez, 1993] argues that the notion of *actual* value adding is not so important as the need to be able to *invent* it. By quoting from the history of IKEA and other organisations they show quite clearly that we need far more than a simple value adding model - we need to get deeper into what the business is really all about, and to be sure that we exercise *concepts* about the business as well as the functions and processes that it undertakes.

At the same time other basic assumptions about how to succeed in business - all based to some extent upon our ability to model business processes in order to manage them - are being challenged. In areas as diverse as product development, manufacturing (especially computer integrated manufacturing), product design and customisation, logistics, retailing, direct marketing, media and advertising - even in insurance and other information intensive industries - there is evidence that new forms of business and enterprise modelling are a critical factor in dealing with today's challenges [Sheridan, 1993; Takeuchi and Nonaka, 1986; Lopes, 1992; Pine, 1993; Stecher, 1993; Smith, 1991; Stahlman and Brody, 1993; Zahniser, 1993; Novack, Dunn and Young,1993; Cole, 1992].

At the more practical level there is extensive work being undertaken to develop business modelling methods and techniques, and one area of development is the extension of systems modelling techniques into the management and strategic activities of business. Some organisations have had good experiences, and a number of recent papers argue the case for businesses to be able to model using systems thinking at the enterprise level, in order to:

- unify the many aspects of corporate systems,
- find opportunities for innovation,
- manage concurrent operations,
- break out of current barriers - both to thinking and to business itself, and to
- improve the health of the organisation.

[Haeckel and Nolan, 1993; (anonymous), 1991; Li and Juster, 1993; (anonymous), 1988; Aranow, 1991]. We can also find increasing reference to the notion of the *virtual enterprise* in the academic and practitioner literature [Flaig, 1992], and that Japan is also awakening to the potential for more abstract business modelling [Shibata, 1991].

On the other hand, reports of actual experiences suggest that we do not yet agree what we mean by terms such as "virtual enterprise", "enterprise modelling" and "architecture". One report of an "enterprise architecture" is largely based upon the geography and technology of the organisations involved [Richardson, Jackson and Dickson, 1990]. Whilst this is not wrong (the focus in this case was in fact on the technologies of two organisations and how they might be merged) it reflects our long history of always thinking about the physical rather than the abstract. Other evidence provides enthusiastic reports of experiences with the more abstract information resource modelling [Shah and Leja, 1991] and practical experiences with architectural ideas (for systems) in the construction industry [Eastman, Chase and Assal, 1993].

There is a clear trend to explore and develop our ability to model businesses and industries at a high level, for competitive advantage. This may in part be because the value chain familiarised people with new ideas about modelling but it is also because there are many other modelling ideas that merit the attention of management. Certain modelling ideas from the world of systems thinking are particularly important, as information becomes more and more a key determinant of business success.

As the competencies of businesses and business people develop we have to understand what really is the basis for business competition. In the past it has been about organisation, marketing and product management; more recently it has been something to do with the effective use of information technology and the management of business processes. In the not-so-distant future the basis of business competition will have more to do with IT infrastructure, and especially *data* as a key element of infrastructure. This means we must understand the way that data is used within an organisation and

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how it relates to the information that the business needs[2]. We have to find new tools to take better account of data (and information) in our strategic analysis and planning.

A key question in many business managers' minds today concerns the future for strategic management, and how it can further enhance our ability to plan strategically with systems thinking as the driving force. This is clearly very important indeed when we are dealing with the information intensive industries, and when we are looking for new systems in support of customer service improvement [Holtzblatt and Beyer, 1993]. Some reports of experience with modelling for strategic analysis are cautious but show clearly the need for generalised reusable business models [Goodhue, Kirsch, Quillard and Wybo,1992]; when there are generalised business models (possibly on an industry by industry basis) it will be far easier and quicker for businesses to adopt and benefit from new systems ideas. There is evidence of the need for modelling in the general management literature [Greenwood and Hinings, 1993] and in specific cases where an organisation is trying to reposition a key function like technical development in the overall scheme of things [Fleetwood and Molleryd, 1992]. In general however the contribution that business modelling makes to strategic management seems still to be limited and the work of Goodhue et al [Goodhue, Kirsch, Quillard and Wybo,1992] is important in helping us to understand how it can be more effective.

The world of business is still interested in ideas for systems based modelling, but there is a long way to go before we will have adequately bridged the gap between the business and systems viewpoints.

Business modelling and the systems world

On the other side of this gap, the world of information systems continues to develop and promote ideas about systems modelling for the general benefit of the business. Work by Zachman is often quoted [Zachman, 1987 and Burgetz, 1992] and the theme of linking the business and technical levels through the medium of models is recurring [Robotham, 1993 and Radding, 1991]. Some suppliers (for example IBM and D&B Software) are nailing their flags clearly to the business and enterprise modelling mast [Eckerson, 1992 and Cusack, 1991; also Vizard, 1993]. The modelling stimulus that derives from the increasing use and capability of Computer Aided Systems Engineering tools is also evident [Gibson and Snyder, 1991; Scholz-Reiter, 1992].

The world of information technology standards making is also increasingly dependent upon its modelling capability[3] and today the area of automated manufacturing standardisation is particularly active in this area [Kosanke, 1991]. Business modelling ideas are also widely used in papers circulated to international and national standards making committees (but not generally available). Despite this, there are no published standards for enterprise modelling although they are beginning to be sorely needed (see the ISO technical report on conceptual modelling [ISO, 1987] for an important discussion of conceptual modelling, which provides a baseline for current work in ISO and IEC standards making).

There are other moves in the world of information technology to promote business modelling in different ways and at different levels. One of the most visible areas of activity is the world of object orientation: it is clear that many of its devotees are determined to extend the use of the object paradigm to work at the highest levels of business thinking as well as at the technical level. Some papers explore the impact of object models on application development [Cockburn, 1993] and others offer the object paradigm as a way of dealing with complexity [Mujtaba, 1992]. The bulk of the literature simply reviews the potential for object oriented thinking or reports on methods, tools and experiences [Gu Junzhong, 1993; Mertins, Sussenguth and Jochem, 1991; Mertins, Sussenguth and Jochem, 1992(a); Mertins, Sussenguth and Jochem, 1992(b); Nelson, 1992; Dobson, Blyth, Chudge and Strens, 1992]; one paper reports on success with the object orientation in the San Jose police department [Kehler, 1992] and another documents the difficulties involved in making the ideas work [Ling and Teo, 1993].

The object orientation is important because it brings together some of the ideas of process and data modelling, but it is not yet widely understood and it is too early to make judgement about it based on the early experiences. Process modelling and information modelling are well understood, however, and this paper concerns itself primarily with these two approaches and their variants (function decomposition, data modelling, entity modelling, and so on)[4].

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2 We have always said in our EDI research at Cranfield that *data* - when it is interpreted - becomes *information*. Information - when it is understood - becomes *knowledge*. Knowledge - when it is deployed - becomes *wisdom* - the ultimate basis for competitive advantage?

3 Consider for example the Open Systems Interconnect (OSI) seven-layer reference model and the way that it has shaped thousands of man years of standards making effort.

4 We will here refer consistently to *process modelling* and *information modelling* unless there is good reason to do otherwise.

The Computer aided Acquisition and Logistics Support initiative (CALS)

Before concluding this brief review of the state of play, we should note one special area of activity which is contributing greatly to our understanding of high level business modelling: the CALS initiative. This originated within the US Department of Defense but now affects thinking in many other sectors, especially through standardisation work (on document and product standards). Through this work we are able to see very clearly how the potential for increased information sharing between business partners can be facilitated by standards.

Proper information management is at the heart of the CALS initiative. CALS will evolve into the electronic age the way that defence procurement is handled, by the increasing use of electronic forms of engineering and commercial information. The first phase of CALS introduces standards for information exchange, and subsequent phases will develop our ability to share information in this very complex and information intensive sector.

We must expect that the early experiences in the defence sector will lead to a new confidence in business generally [DeLauche and Reeves, 1992; Endrijonas, 1992; Palmer, 1991; Ross, 1992; Endrijonas, 1993; Mitchelmore, 1992; Chapin, 1990; Freeman, 1991]. In the United Kingdom a whole industry initiative is based on the STEP standard for product information which was promoted within CALS: the Process Industries STEP Consortium is mobilising efforts to introduce and promulgate the use of STEP on a very wide basis in the UK, with some success [Springtape, 1993].

We should expect that further experience with CALS will bring new benefits to a far wider audience. Also, we should expect that it will highlight some of the organisational and management problems associated with this radical new way of approaching business.

THE USE OF PROCESS AND INFORMATION MODELLING

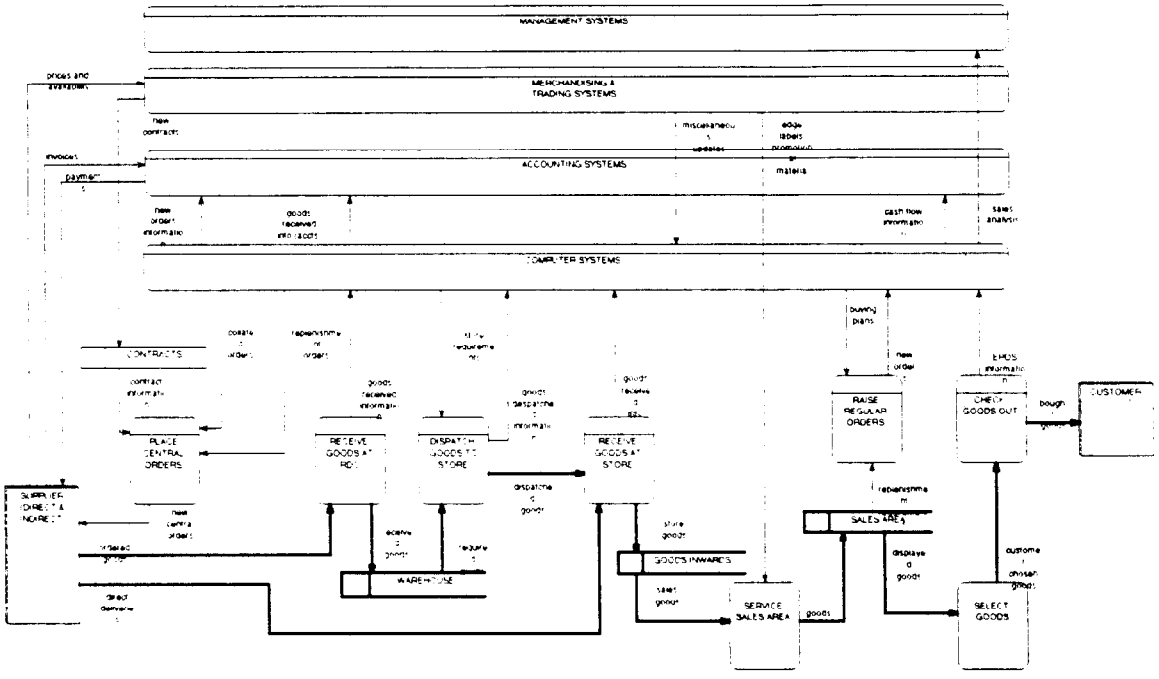
Process modelling

Modelling business processes is a very natural thing to do, although to do it well requires some understanding of the basic rules and techniques in order to avoid problems. The success of the value chain in the late 1980s and early 1990s indicates how welcome it was (for many at least) as a means to get away from the organisation chart (as the dominant view of a business), and to replace it with a functional or process-oriented viewpoint. The value chain is useful because it is simple, because it provides a home for all business activities within a well understood and widely accepted framework, and (because it is widely used) it provides a basis for discussion and negotiation of business boundaries when we are looking for new ideas. The topology of the value chain can be developed to show how information and material flows through the business more explicitly, by laying out specific business processes in the form of the value chain and adding flows indicating the movement of information and goods (see Figure 2 below).

At the more mundane level of systems specification and development we now have more than ten years' experience with structured analysis methods and we know that process modelling is often an effective tool in the hands of a competent business systems analyst. Whether seen through the relatively simple device of a process decomposition model or through a more complex hierarchy of data flow diagrams, many people in business accept these models readily and have become used to using them to articulate their ideas about systems.

In our research at Cranfield we found in some cases that *business* managers produced data flow diagrams without prompting, as the obvious way to convey precisely what their department did and with whom they interfaced. This was the exception and not the rule, however! We naturally used process modelling in order to communicate our ideas with them, and we used the value chain successfully to help lay out the topology of high level process models.

Figure 2 - Retailing business process model in the form of a value chain



In the more general case, the use of process modelling is quite widespread: in the redesign and re-engineering of manufacturing systems [Manley, 1993], quality management in the aerospace industry [Bradshaw, Holm, Kipersztok, Nguyen, 1992; Bradshaw, Holm, Kipersztok, Nguyen, Covington, 1991], performance improvement in the health sector in the US, where 66% of hospitals are involved in process improvement initiatives [Mahlen, 1993], and in the software engineering industry where the international community is taking up the process improvement idea based on a process

based model of capability and maturity [Baumert, McWhinney, 1992]. The viability and acceptability of process modelling seems to be well established.

This is not so true of information modelling.

Information modelling

Information modelling is more difficult to do and has a more difficult history. For example, in a class of mature MBA students at Cranfield most will have come across data modelling but only a few will have favourable memories of it. Most likely, the work will have been done badly, by analysts who had no finesse and no vision (or whatever other capabilities are required) to successfully complete the task. The history of difficulty with information modelling has led to continuing efforts to improve our understanding and abilities.

Perhaps some of the difficulty is because the result - a data or entity model - can be derived by two completely different procedures: bottom up data analysis (in which case the result would probably be termed a *data model*) or more intuitive top down analysis (which for most people would produce an *entity model* or sometimes a *logical data structure diagram*). The confused terminology is to be regretted. However, if we are to get the best from the results of data or entity analysis (which we will refer to here simply as an *information model*) we need to keep an open mind and not be too preoccupied with proprietary analysis techniques and the associated procedures.

What is more important is to note the degree to which organisations are succeeding with information modelling. There is evidence of activity, whether to simply assert the need for good information modelling and to develop the technique [Bainey, 1983; Allen and Boynton, 1991; Beynon-Davies, 1992; Cesarini, Grazzini, Pippolini, Soda, 1990; Ichiko, Takeuchi and Nango, 1989; Robinson, 1993; Potter, Kochut, Miller, Gandham and Polamraju, 1993; Parker, 1993; Armitage, McCarthy, 1987] or to analyse the benefits of modelling at the level of data integration [Goodhue, Wybo, Kirsch, 1992]. There is also work on improving the effectiveness of database design and implementation using knowledge-based techniques [Storey and Goldstein, 1993].

There is other evidence of the need to manage information more effectively in the wider sense. A recent survey shows that data related issues now occupy the top two slots in senior management concerns [Niederman, Brancheau, Wetherbe, 1991] and some current work is aimed specifically at extending data modelling to encompass the whole enterprise [Scheer and Hars, 1992; Moody, 1991; Marcus, 1993]. Industries are striving to create industry wide information models [Tippee, 1993], and just in case we need further evidence, there are even reports of how useful data modelling has been in managing historical archives [Busch, 1992] and in the horse racing world [Wexler, 1993].

Needless to say, in the background the methodology specialists work on to provide ever more capable and standardised support environments and supporting software systems [Davis, 1992] but not everything is straightforward. There are implementation difficulties at the practical level [Tannenbaum, 1991; Hazzah, 1991] and at the architectural level [Narayan, 1992]. In different sectors we even find that cultural attitudes are a major factor; as one example, the banking community still seems to suffer from extreme conservatism and reports indicate that information modelling is not part of their repertoire of business analysis tools [Gandy, 1993].

Business modelling: the wider viewpoint

With this caution about culture in mind, we must remind ourselves that systems based modelling is not going to solve all our problems. Clearly, there are many aspects to success with information systems, and our ability to model processes and information are only two of these aspects. Every organisation has its culture [Johnson and Scholes, 1989] within which we have to deal with politics [Davenport, Eccles and Prusak, 1992]. We do not pretend that more and better systems thinking will solve all the problems of business, but we do submit that there is a long way to go yet before we have explored and understood all the potential. In particular, we believe that the potential for information modelling is still not yet fully realised, for want of a high level framework with which to introduce and then explore the detail of information in business.

THE NEED FOR AN INFORMATION MODELLING FRAMEWORK

Information is one of the most important assets an organisation has. Everything an organisation does involves using information in some way. The volume of information can be vast and the different types of information are numerous, but it does have a value which - when it is recognised - may be critical to the success of an organisation.

The nature of information

Organisations function by means of human and automated systems communicating with each other, either internally or externally, but always by means of information. Internal communication takes place between automated information systems, individuals and between groups of people or departments, within the same organisation. External communication takes place between organisations, which may be members of the same group of companies, and between other trading partners, their suppliers and customers. Increasingly, *external* communications are critical in assuring the future success of an organisation [Dyer, 1991(a)]. This is partly because of the widespread availability of the right technologies (EDI and communications networks) but also because of the strategic advantages of sharing information across whole supply chains, in order to reduce inventory and to accelerate the movement and availability of demand information.

In the same way that the value chain divides business function into two categories, one could argue that information can be divided into two broad categories, namely, *supporting* and *value adding*.

Information: supporting or value adding?

Supporting information is that which relates to *facilitating* activities such as personnel management and financial management. In a manufacturing business it might be termed "commercial" information. It can be seen as something which we have to have - a "necessary evil" perhaps - but which does not directly contribute to the value added by the business, as seen by a customer. Consider the simple examples of orders and invoices, of contracts and personnel records. Clearly, without this information the business would not be able to operate but we must be aware of the cost of maintaining it and the risks of not having it when we need it. We need to minimise these costs if at all possible, and there are many ideas which help us to do this. Self billing, for example, is a way in which customers can raise invoices on themselves. This can dramatically reduce the amount of "paperwork" involved in doing business, and lead to operational benefits such as far easier invoice matching. Equally, some businesses are exploring the way in which suppliers can automatically raise purchase orders on behalf of their customers, with the same kind of benefit. In the food retailing business both of these ideas are current and the benefits in terms of reduced administration are significant. Essential to both is the idea of information *sharing*. In the first case the customer needs to share information with the supplier about deliveries, and in the second the supplier needs access to the customer's stock files.

Value adding information is that which is directly relevant to value adding as seen by the customer: product specifications and designs, operating handbooks, technical help services, and of course key information services in the service sector. It more important to success than supporting information; whereas supporting commercial information merely facilitates business (and could be seen as a source of cost) value adding information is directly associated with the capability of the organisation to service customers' requirements (and needs to be seen as an asset). Benefits come firstly from recognising its existence, and then capitalising on its value to business partners (whether they are customers, suppliers, agents or whatever).

Information: dynamic or static?

The idea of value adding and supporting information only gets us so far. There are problems with the idea, for example the context in which the information is being used. What is valuable to one participant may not be to another, and we must remind ourselves that it is really *processes* which generate value in business, not the information that feeds them.

There is another way to look at information: it can be seen in one sense as being dynamic - information on the move from one process to another - and in another sense as static - information at rest, in corporate files and databases. An organisation is made up of personnel who may perform their duties as individuals, as members of a team, department or division or as members of the board of directors who control and manage the business. For the organisation to thrive they all must communicate with one another by passing information throughout the entire organisation, the information being transferred up and down as well as across the hierarchy. It is helpful if personnel share a proper view of what the

information is: what it means, how they can use it, and how they must sustain it. This is difficult to achieve and, as we have noted, there is no generalised information model that can be used to convey this understanding.

We were pleased to find in our research that some organisations with whom we worked do place great emphasis on the importance of information models, notwithstanding the difficulties in creating and working with them. Conversations with food retailers, electrical goods retailers, transportation companies and software package suppliers have helped to reinforce our belief that a well-developed and well-accepted information model is a source of great actual (or potential) commercial advantage. What was particularly interesting was the way in which this advantage is realised over a much longer time scale than with process modelling - many years in some cases. Experience indicates that a good corporate information model can take a long time to develop but is far more enduring than any process model.

Information: a basis for business process analysis?

The world of business is (at the time of writing) going through a period of intense interest in business process management. "Business process redesign" and "Business process re-engineering" are two terms widely used to describe current thinking. What is rarely mentioned is that a good information model is a basis for *business process invention*. If we do not wish to continue with existing business processes but to define new ones, the information model (in the form of an entity relationship diagram) provides a basis for doing this. Each entity in a business - CUSTOMER, PRODUCT and EMPLOYEE are examples at the high level; SALES ORDER, ASSIGNMENT and QUERY are examples at the lower level - has a life cycle through which it must be managed. New customers have to be brought into our care and their needs have to be understood; Products have to be conceived, engineered, produced and maintained. Customers and products both have to be disposed of when we are done with them (or they are done with us). At the lower level even the transitory entities such as queries and assignments have to be initiated, processed and concluded. In this way, a well understood and agreed entity relationship model provides a means of restating the process needs of an enterprise, and the life cycle requirements of every entity can be fed into a consolidated statement of the process needs of the whole organisation. This is a feature of some methods of business analysis, such as SSADM[5] but it is not often well done because it id done by the wrong people without proper management involvement. With the involvement of senior management, and used to create a high level statement of enterprise requirements, entity life cycle analysis has been found to be a very powerful and effective technique [Bytheway, 1991 (d)].

The need for a generic model of information in business

Today we are as much concerned with information in whole industries as we are with individual companies. If there is to be any chance of co-ordinating or aggregating the information held by different participants in a partnership, a supply chain or a whole industry, it is necessary to provide a framework for reviewing the information that might be shared. As noted, we know of no generally available model which allows us to see the essential structure of information in a business in the same way that the value chain lets us see the essential structure of the function of a business. It was for this reason that we developed the Cranfield Enterprise Model.

[5] SSADM: Structured Systems Analysis and Design Method - the public sector standard for systems analysis in the United Kingdom.

THE CRANFIELD ENTERPRISE MODEL

Introduction to the model

The Cranfield Enterprise Model was evolved during the EDI research project to provide a means of exercising some of these ideas about information, and in order to assess the benefits of information sharing in business [Dyer, 1991(b)]. The requirements of a high level framework for information modelling are:

1. It must be generic, and able to deal with quite different kinds of business.
2. It must represent all aspects of an organisation's business.
3. It must help to separate supporting information from value adding information.
4. It must provide a foundation for high-level database design
5. It should be easily understood
6. It should be able to incorporate information about business processes.

The last point is perhaps the most difficult aspect of the model but it is important. The model addresses the requirement by dividing business into seven domains, five of which are recognisable as traditional areas for database implementation and two of which are not (the last two in the list below):

Information about the *marketplace*
Information about *product*
Information about *procured input*
Information about *corporate Resource*
Information about *corporate performance*
Information about *supporting processes*
Information about *value adding processes*.

The last two domains address the sixth requirement (information about processes) and need a word of explanation. As well as having supporting and value adding processes in a business (as seen through value chain analysis) we also need to have *information about those processes*.

Information about a business process is not the same thing as the process itself. Consider the financial manual in a typical organisation, for example. It tells the workforce how it is to deal with financial procedures such as claiming expenses and invoicing customers. The content of the financial manual is information *about* the supporting processes of the business. Equally, the commercial manual can be seen as information about how contracts are to be dealt with and who has the authority to do what. Again, this is important information about how the business operates.

We also need information about the value adding processes of a business. Consider the contents of an advanced manufacturing planning system, which includes not only bill of materials information but also information about the routing of work from one point on the factory floor to another. Consider the information about the procedures whereby product is specified and designed - the technical standards in an engineering company of some kind. In a different industry such as pharmaceuticals the written statement of procedure is absolute - nothing may happen without it being done correctly to the approved procedure, otherwise the new drug will never be approved for use, or the new batch in manufacturing will have to be destroyed, or whatever. Again, this is all information *about* business processes, but this time it is about the value adding operations.

Here we divide information about processes according to the categories *supporting* and *value adding*. This is reflects the separation of processes into the same categories in the value chain model, and it served us well in the course of our research work into electronic data interchange. Other categorisations are possible, of course. Information about all processes could be treated within a single category. There are other schemes, such as:

- strategic versus tactical processes;
- operational versus infrastructural processes;
- high priority and low priority processes;

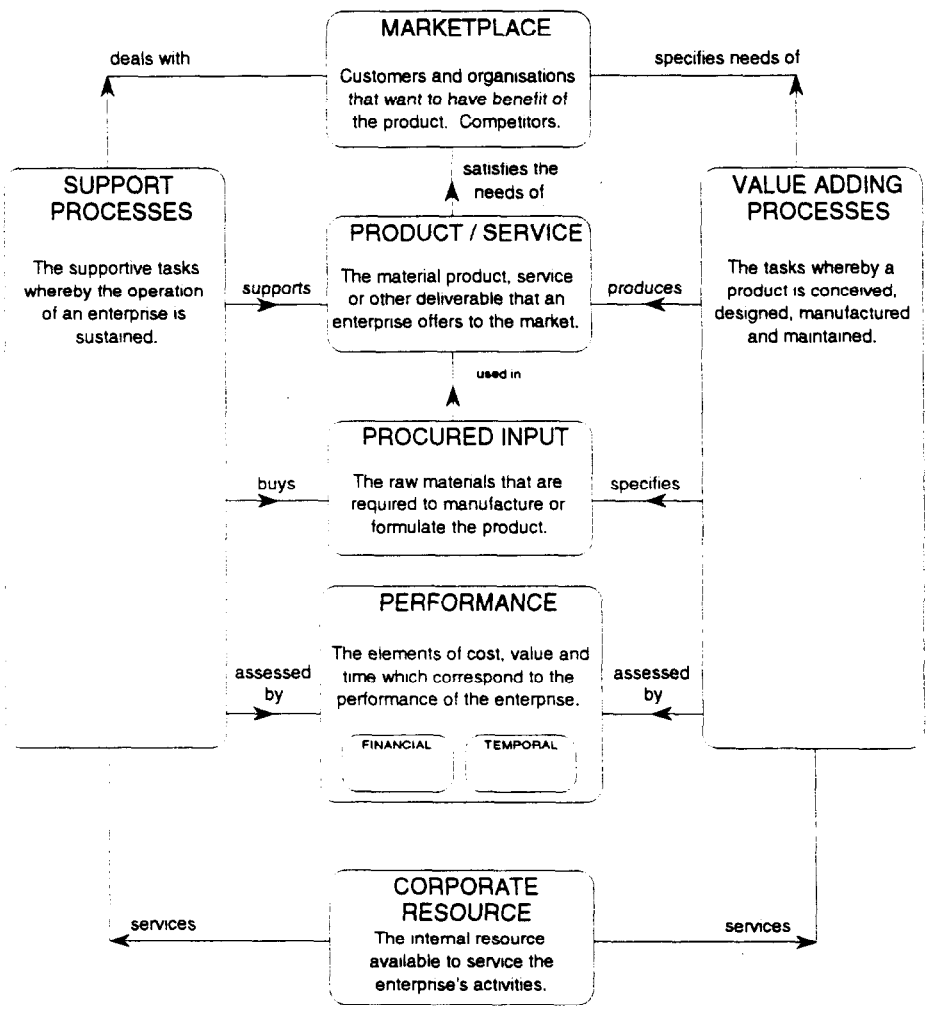
or some combination of these different schemes. This does not change the general approach to enterprise modelling presented here, although with more than two categories of process it becomes more difficult to represent the model on a single sheet of two-dimensional paper.

This idea, that we need information about processes (as well as about other things) is fundamental. To anyone who has undertaken quality improvement initiatives based on process analysis, the idea will quickly make sense. However, to someone who is stuck in a business where things "have always been done this way" the idea will be difficult to understand, because the information about business processes is lost in the heads of the people who have been doing the different jobs - no doubt in the same way for years and years. If we are to change the processes within a business, it behoves us to understand and take stock of the "inventory" of information *about* those processes, whether it is written down or simply within the working knowledge of those employed in the business. Until we do this we will never know what we are trying to deal with.

The idea that we need information about our customers, products and employees is far more obvious and needs no discussion here. We might remind ourselves finally about the need for management information in the form of performance information - how much revenue was achieved last month, and what was the cost of production last week, for example.

Overview of the Cranfield Enterprise Model

Figure 3 - The Cranfield Enterprise Model



The figure following provides an initial view of the Cranfield Enterprise Model; it is the beginnings of an information model which mirrors the products and processes of an enterprise and it gives an insight into the primary areas for information analysis at the level of the whole enterprise. It covers the whole of a business, and yet it provides a means of locating any specific item of interest and it provides a generic starting point for the development of more detailed models. It also helps to classify the component parts of the information coming into or going out of the business into different kinds, such as commercial, financial, technical, and so on. The model is loosely conceived as a high level entity model, which provides a standard shape and layout for more detailed entity models (which would otherwise be difficult to understand and use).

The enterprise modelling framework in the Figure is not a finished model of a business, it is just a starting point. In order for it to be useful (just as with the value chain) it has to be developed to include all the words that are in familiar use in a business. It has to be supported by detail within the areas of particular interest: information about the people who make up the organisation, the market place within which the business operates, and the supply side information about what has to be bought and where it comes from. Only then will it start to work for its audience. Nevertheless, for the present purpose it is a sufficient starting point and we will show how it is developed to understand particular businesses by the use of examples.

- Marketplace

  Information about the marketplace typically includes details of customers, people and organisations that want to have benefit of the product. Also, about competitors and the way that their presence impacts on success.

  Customers
  Customer needs
  Market segmentation
  Market regions and territories
  Competitors
  Suppliers
  ... and even ...
  Economic factors
  Political factors
  Social factors

- Product

  The material product, service or other "deliverable" that an enterprise offers to the market; its specification, capability, configuration and operational needs. In the case of service operations, the nature of the service and its speed of response; its information content and the timeliness of the information provided.

  Price
  Discount arrangements
  Inventory levels
  General product availability
  Packaging requirements
  Product specification
  Product make-up and Bill of Materials
  Product documentation
  Applicability
  Functional and performance specification
  Product standards

- Procured input

  The raw materials and inputs that are required to manufacture or formulate the product or service; their sources and the suppliers offering them. Their characteristics, such as availability, lead time and cost. In the case of service operations, much of the procured input might be external data, taken into the organisation and used to deliver service of some kind to the customer.

  Procured raw material
  Components and subassemblies
  Material classification
  Specification information
  Sourcing of material and components

Compatibility and allowable substitutions
Availability

- Corporate Resource

The available standing corporate resource in terms of people, capital equipment and other assets. Also, buildings and property, but not unused inventory (that is better seen as procured input).

Organisational structure
Employee information
Skills and disciplines
Job descriptions
Assignment of employees to jobs and tasks
Training courses
Capital equipment and corporate assets
Allocation of capital equipment to jobs and tasks

- Corporate performance

Management information. Probably (as indicated in the figure) information about the financial performance of the business and also information about the temporal performance - how quickly and how productively product and service is delivered. Here we would find the raw input to an executive information system.

Period results
Group profitability
Product profitability
Corporate performance
Average time to ship
Volume of production
General accounting information

- Supporting processes

Information about the supportive tasks whereby the operation of an enterprise is sustained: management, financial and contractual information; also information about the selling and other ancillary processes.

Sales order processing
Purchase ordering
Making payments
Receiving receipts
Commercial approvals
Contract management
Cash management
Personnel management
Corporate management
External commercial procedures

- Value adding processes

Information about the tasks whereby a product (or service) is conceived, designed, engineered, manufactured and maintained. Information about any aspect of operations which is perceived by the customer as useful.

Product specification
Product development
Production engineering
Quality control
Distribution
Installation and commissioning.

Use of the Cranfield Enterprise Model

General comments

We must be careful to understand what we can and can not do with such a framework. We can not show the movement of information - that is best done with a high level process model which could be based upon the value chain. We can however show the overall structure of information and the way that it all fits together. Most importantly, we are able to relate information about processes to the product, service, customer or supplier which depend on them. This is done horizontally on the model, for example by showing how:

- a VALUE ADDING PROCESS *is responsible for* specifying or producing a PRODUCT,
- a SUPPORTING PROCESS *is the responsibility of* a certain PERSON and *occupies* certain items of EQUIPMENT or PROPERTY for a PERIOD OF TIME,
- the VALUE *created by* an EMPLOYEE *is dependent on* their CONTRIBUTION to value adding activities,

and so on. The italicised words indicate the relationships one would expect to find in the model; the capitalised nouns indicate the entities one would expect to find.

Note how the entities include people (EMPLOYEE), concepts (VALUE), material things (PRODUCT), abstractions (CONTRIBUTION), and time (PERIOD OF TIME). This is one of the most challenging aspects of entity modelling - it demands that we consider as equivalent (entities) things which we have for a lifetime considered utterly different (people, objects, concepts and abstractions). On the other hand, once we can get this idea into our heads we can begin to manage information on a far more balanced and effective basis.

The new model is helpful because it provides a framework within which judgements may be made about a business based on the information used by the business, without particular bias towards people, products or concepts. When dealing with business strategy and general business development we need to know that we have considered all possible areas; just as the value chain provides an overall framework for thinking about process, so the Cranfield Enterprise Model provides an overall framework for thinking about information:

- How much information is actually kept and how well?
- How complete is the approach to information management?
- What information could benefit business partners (especially suppliers and customers) in order to improve overall supply chain performance?
- Should information be exchanged with business partners or should it be shared in a more literal sense?
- What information is sensitive and requires special security and management, and what can be freely given away?

ILLUSTRATIONS OF THE CRANFIELD ENTERPRISE MODEL IN USE

The latter part of the EDI research project at Cranfield used a business opportunity analysis method [Bytheway, 1991(d)] to explore the potential for EDI in different kinds of businesses. An important stage in this analysis method is the development and analysis of an enterprise model according to the framework described here. From this work it is possible to illustrate the use of the framework with three different businesses: a manufacturing company (based on Heenan Drives in Worcester, UK), a large superstore and retailing operator (based on ASDA, headquartered in Leeds, UK) and an information systems services company (Norwich Systems and Accounting, in Norwich, UK).

The illustrations which follow are indicative of the vision of each of these businesses as seen by *management* within the business. They are not the product of data modelling or any strict form of systems analysis - they are the result of working sessions with operational managers in which their thoughts about the deeper aspects of their businesses were recorded within the enterprise modelling framework. They are therefore not to be seen as a basis for database design: that would require far more detail than given here, just as systems design would require far more detail than is typically provided within the value chain.

A manufacturing company

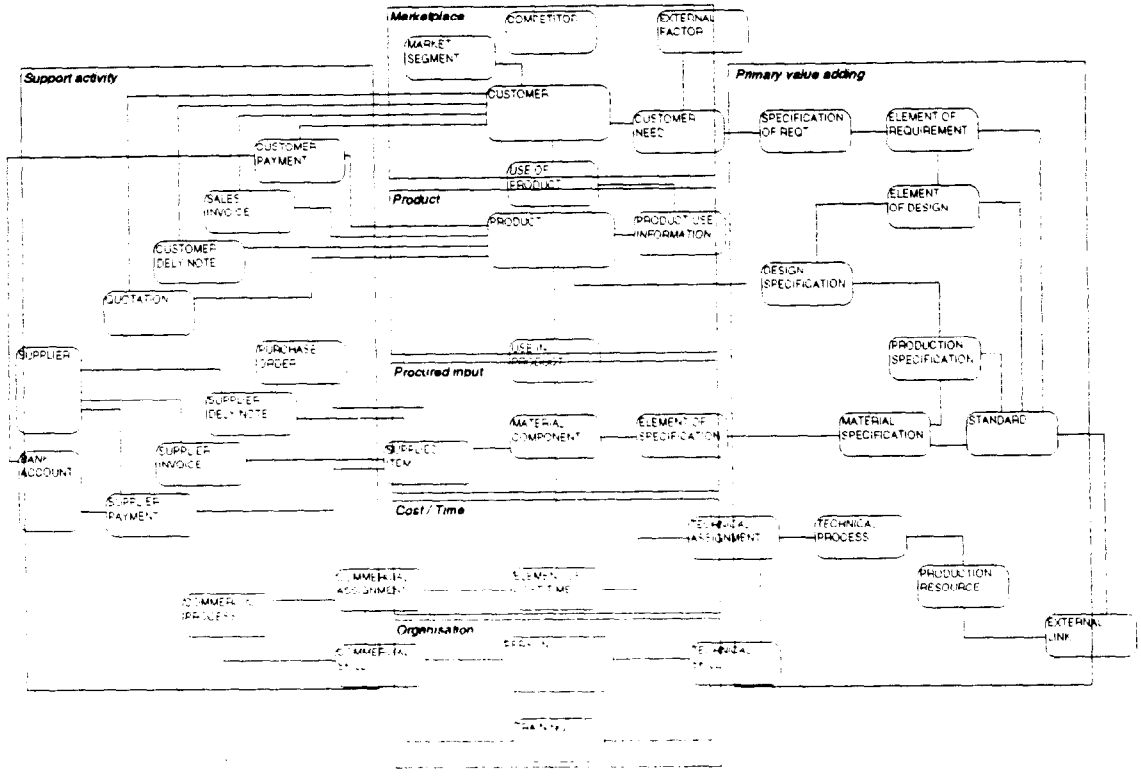


Figure 4 - A simplified manufacturing enterprise model

This model shows about 40 entities, seen as critical by the management of a small manufacturing enterprise producing variable speed drives and automated control systems, such as are needed in factories to drive production lines and in coal mines to operate large conveyor systems. The business had been a make-for-stock business operating with agents and distributors but the new managing director Brian Morgan had a vision of more direct contact with the customer, and a clear understanding of the customers' needs and the way that product capability contributed to it. He also worked extensively to reorganise the company (laying much emphasis on team work and the proper understanding of the skills and roles of each employee) and to redefine the technical processes that specified and produced the product. He reorganised the stores operation and personally led the project which successfully implemented a new MRP II system.

All of these factors, and others, can be found in the enterprise model. It shows that each of the seven domains within the framework is addressed to some degree or another, and there are no areas where there were major omissions. What is very helpful is that it helps us to see the very important information that relates one main area to another, and which we have to manage carefully if we are to sustain our control of the business:

- the assignment of individuals to their tasks,
- the use of components in products,
- the use of products by customers,
- the way that design features address customers' needs,
- the way that standards bind together the different layers of technical information, and
- the way that payments and invoices relate to supplies and sales.

Each of these effectively joins the information in one domain to the information in another. The entities in question - ASSIGNMENT, USE OF PRODUCT and so on - are sometimes referred to as associative entities because they associate the important entities in one domain with other important entities in another. The detailed business information that attaches to these entities may be high volume and is often seen as mundane, but it is essential to successful management. We must have high quality, reliable data which shows how our customers derive benefit from our products and how our people are assigned to their tasks if we are to have any chance of seeing the benefits of strategic developments. The organisation that fails to manage this critical information will never know whether its strategy has achieved anything, except by a difficult subjective process of observation and assessment "after the fact". The organisation that does have this information will be able to see - quickly from its operational data - that management decisions and actions are having the intended effect.

Brian Morgan when he was at Heenan Drives summarised this in a straightforward and effective way. "If it moves on the factory floor," he was given to saying, "then I will see the effects moments later in the general ledger". How many manufacturing companies could say this with their hand on their hearts? The information in the general ledger will only ever make sense when it is properly associated with other operational information about the processes and people that comprise the cost drivers.

A retailing company

This is a simpler model, but then some would argue that retailing is a simpler business. There are only 20 entities, fitted to only four of the seven domains in the enterprise modelling framework. There are no references to entities within the domains of procured input, corporate performance and value adding processes.

This leads to a quite different kind of discussion than with the manufacturing company. Why is there such a preponderance of information about supply (orders, deliveries, invoices and the rest), and none whatsoever about value adding? Why do we have so little evidence of management information based on corporate performance? Why does this retailer seem to be unconcerned about the properties and characteristics of the procured inputs? The answer is that retailing is a different kind of business. The information may indeed be less complex that is found in a manufacturing business but the processes are likely to be just as complex.

What was found in reviewing this model with the EDI management team at ASDA was that there is indeed a preponderance of information based in the supply side of the business and that the future success of the business does depend more on the information available about customers and their buying habits. Although customer is shown in the retailing enterprise model the business actually had no information within its systems about customers. It is one thing to summarise many thousands of sales details and to analyse them by store and by the day of the week, but until retailers can associate sales details with individual customers retailing will always be an approximate business. Herein begins the justification for affinity club schemes and the idea that charge and debit card data can be used to start maintaining information about customers. These ideas which in the past were often intuitive can now be assessed through the framework in the light of all the information that the business actually works with.

We can also launch a discussion about the true value adding that goes on in retailing. One analysis argues that it is just bulk breaking. Volume deliveries get into customers' shopping bags by processes that include regional distribution centres, trunking and local distribution arrangements and in-store operations. Nothing actually happens to the product, and many customers would as readily buy from the original manufacturer if appropriate packaging quantities were available. As it happens, they are not and so we have to go to the retail store.

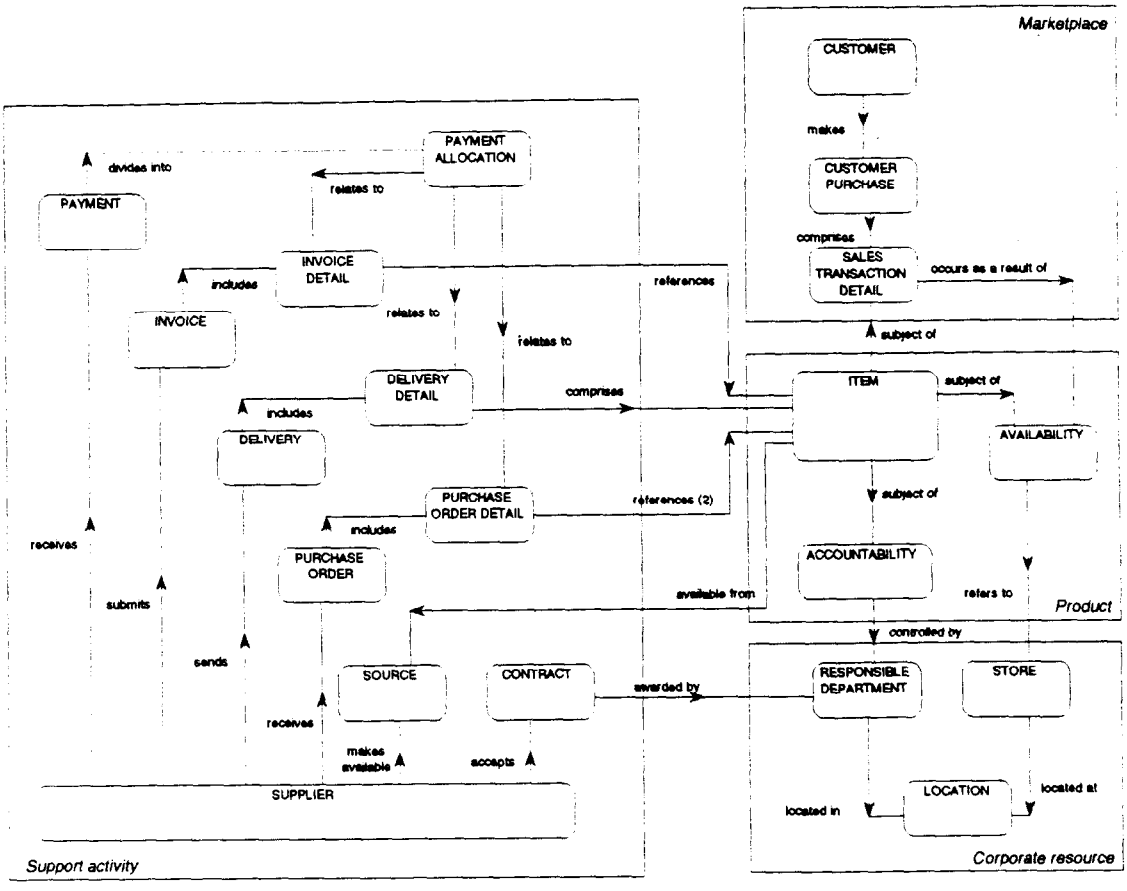


Figure 5 - A simplified retailing enterprise model

But then we note that there is a trend to warehouse clubs which do acknowledge that bulk-breaking is the only real value adding, and it is interesting to note the readiness of the buying public to go to these alternative outlets. But what about the "shopping experience" which the retailers argue is the real contribution of the retailer. If this is truly so, then we must find processes in the value chain that deliver the shopping experience, and also entities in the enterprise model that reflect this experience. Without this, the notion of a good "shopping experience" will remain an arguable and possibly unmanageable aspect of the business.

At a more practical level, retail outlets such as ASDA in the UK are introducing real value adding. The availability of freshly baked bread is one illustration, where a part of the store is given over to an in-store bakery. This has the benefit that the bread is delivered in component form (far more compact than the finished loaf) and the customer gets a totally fresh product, but it needs some additional information - about the process of baking and the batches that are produced. Also the quality control requirements, which are quite different than for bought in product.

In the same way, the number of lines sold and the kinds of lines are being extended to provide more completely for the customers' total needs. This is all good for business, but if we are to succeed with it we must have a clear vision of the entities that reflect the customers' needs. For example, who is the customer and what are the typical buying patterns? What are today's special needs, and what is the particular condition of the customer and the local circumstances on this occasion? In the UK, if there is a local soccer match the pattern of demand is significantly changed. If the weather changes, then as would be so anywhere in the world the demand changes yet again. All of this hints at information which we need in order to be able to access and manage if we are to further develop and improve the business.

The enterprise model shows that most of this is absent in the simple view of this retailer, but it also provides a shape and structure that we can use to speed up the process of analysis and development. Equally important, it provides a structure

around which we can negotiate with our business partners in order to share more information. What does the delivery company know that we would like to get our hands on? What does the customer know that we could usefully capture in order to more effectively manage the business?

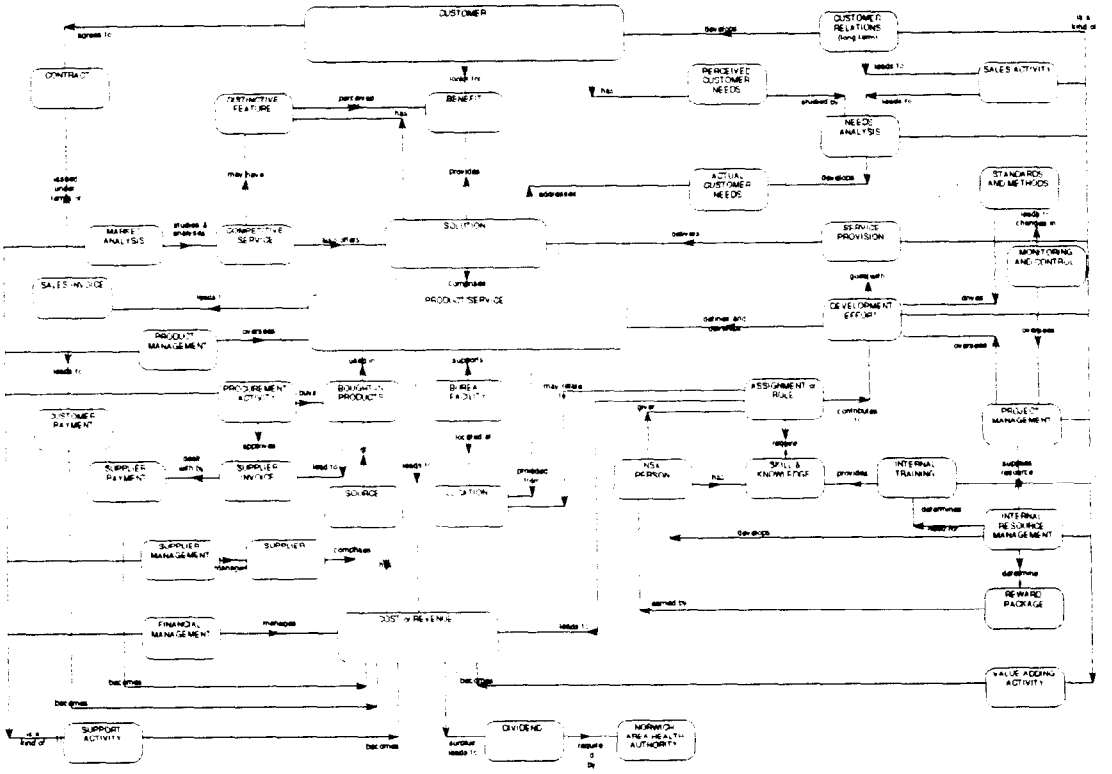
There are two ways to summarise the information-based opportunities that present themselves to a retailer today. One is to argue that good information management allows the retailer to become "smarter". By knowing more about product availability and customer's needs, the retailer can provide a more satisfactory service to customers. The other way to express the opportunity is to use information management to enable a large operation to present the aspect of a small one. By having rapid access to customer information a more personalised service can be provided, just like it used to be in the old days with the corner store or the family grocer. (Equally, a small company can use information management and information technology to present the aspect of a large company: easy access from any location, rapid response, and wide coverage of products and services).

An IT services company

The enterprise model for this IT services company is probably the best developed example, in that it was the focus of management's attention for very important strategic reasons, and it provided important input for the development of their corporate strategy at a critical stage in the development of their enterprise. In presenting the details, this model has put aside the background image of the seven domains, but they do of course underpin the model, guiding its structure and balance, as can be seen by inspecting the results.

The business situation here was based in one of the UK regional Area Health Authorities, where there is a high degree of change and where there are great pressures to privatise those parts of the overall "public-owned" health industry which are not central to the care of patients. This includes computer services. In Norwich, it was decided to launch the computer department within the Norwich Area Health Authority as a free trading operation. This required that the new management team discarded all previous business processes (as being appropriate only to a public body) and found new models for how the operation could work. This involved definitions of markets, products and services, job titles and job descriptions, and all the other stuff of a complete new business.

Figure 6 - A services industry enterprise model



The enterprise model was used to achieve this. The results of an early brainstorming session with the management team were sifted and organised through application to the Cranfield Enterprise Model, and then reviewed again with the audience. Many areas were found where no plans were being laid down, including both commercial and technical activities that needed to be put into place, and also the relationship between the delivered solution and its component parts. Each of the components of this enterprise model - the entities of the business - was then analysed for its process requirements and the resulting requirement for process capability was mapped into an "empty" value chain. This led to the first statement of the business process requirements of the new enterprise.

At a time when the efforts and energy of the management team could easily have disappeared in short term operational issues and management by crisis, the model provided a means of standing back and reviewing the context and deep structure of the business without getting bogged down in details. Most importantly, it permitted a completely fresh statement of the business processes that were needed, by inspection of each of the entities in the final enterprise model, and an analysis of their life cycles. This is a key feature of the business analysis method developed within the Cranfield EDI project [Bytheway, 1991(d)], as already explained.

The challenge of information in the supply chain

Other work in the Cranfield EDI project included a study of a supply chain, including BP Chemicals, Proctor & Gamble and ASDA. Although primarily based upon process modelling the conclusion of the study included the development of a new kind of enterprise model, based on an analysis of all the entities relevant to the joint activities which (in this case) delivered a domestic floor cleaner based on BP chemicals, manufactured by Proctor & Gamble, and sold by ASDA.

This work can not be reported here, partly because it is confidential to the participants but also because it is incomplete. However, it showed that the enterprise modelling idea can be used to define what is meant by a "virtual enterprise". In this case, the virtual enterprise is the sum of all the activities undertaken by these three major corporations in delivering one simple class of products to the consumer - a floor cleaner. It is important in the future that management takes advantage of any opportunity to manage the supply chain more completely, and finds every opportunity for efficiency and effectiveness benefits within the supply chain.

This kind of problem can be dealt with by means of process modelling. Almost all of the literature we have come across uses the process modelling paradigm. The challenge to find new process models for supply chains will depend partly upon a clear vision of the information needed within them, and we can now argue (based on our experiences) that to *start* with information models, using an enterprise modelling framework, is the best way to find new process structures in business.

The Cranfield Enterprise Model presented here is just a start and has only been completely used in the analysis on one business. In the next stage of our work we will be developing it to analyse multi-business situations and we expect to find new ideas for supply chain management by redefining the processes of the supply chain in this way. One of the greatest challenges is that there is actually no such thing as a supply *chain*. Every supply chain is really a subset of a *network* and the complexity of network analysis presents enormous challenges without some guiding framework to clarify and assist. The technique of enterprise modelling based on the information modelling approach holds the promise of helping greatly, and we have already launched (in our research projects) a new conceptual model for supply network analysis which takes the enterprise modelling idea and moves it forwards. At the same time, the application of the framework to single company scenarios continues and is proving to be very helpful.

CONCLUSIONS

In general, although the general approach to entity modelling continued to be difficult for some of the people we worked with, the new model was extremely helpful. In different studies it helped a major retailer to see the information that they had (and the additional information that the needed) in a completely new way. It showed how a manufacturing company can base a major part of its business strategy on the development of new information competencies, based on a deeper understanding of their customers and the use that they made of the manufactured product. It allowed a new start-up service company to devise a complete strategy for change by allowing previous practices (the old way of running that kind of business) to be discarded and a new, more abstract foundation to be put into place based on the Cranfield Enterprise Model. This then allowed the derivation of new process definitions which were used to populate the evolving value chain.

It is useful to note some general observations and conclusions from this early use of the model.

1. It provides a good companion model for use with the value chain. Where the value chain provides a common framework for process (or function) analysis, the Cranfield Enterprise Model provides a common framework for information (or entity) analysis. It helps to identify the underlying structure of information in any business.
2. It provides an easy-to-understand (and easy-to-remember) topology for mapping corporate data models, where several of these need to be seen by a wide audience, or where they need to be compared one with another. This is particularly important in cases such as logistics and supply chain operations, where the sharing of information is critical to success.
3. It provides a vehicle for a "stock taking" of the information that is used by an organisation, and allows analysis of the potential for information sharing and exchange between different organisations (or within larger organisations comprising many business units where information needs to be integrated).
4. It provides a structure for organising the results of fact finding and interviewing; references to information in the business can be accumulated within the structure of the enterprise model in order to make a judgement about the balance and coherency of information as it is perceived by those working in an organisation.
5. It provides an important classification scheme for information in an organisation, which is an extremely useful vehicle in preparing for strategic analysis. Applications can be mapped to it and common data areas can be identified.
6. It has the potential to contribute in other areas. For example, in the clarification and refinement of accounting practices: the way that it rigorously maps activities to the resource that is consumed allows a fresh interpretation (or definition?) of what is meant by "Activity Based Costing". In marketing: it prepares the ground for a more complete understanding of how products and services really meet customers needs, and for storing this information in a way that can be accessed and used by those who need it. In engineering: it shows how all of the many stages in design, specification and production engineering need to use the same information, and it provides sound foundations for the development of new integrated engineering operations.

It is in this last area that there is more work to be done. Consider the world of academia, which suffers the same problems as business: too much reliance upon functional specialism. For the purposes of research and teaching we need models which transcend the different management and functional disciplines and provide common ground for comparative studies. We believe that the Cranfield Enterprise Model is an important contribution to this need, and we will continue to work with it.

At the same time that there is a rapidly developing interest in business process redesign (and re-engineering), there is evidence of comparable interest in a business information. Just as business process redesign can take the value chain as the starting point for high-level analysis so does any analysis of business information need a high level framework. Work at Cranfield has evolved such a framework and tested its usefulness in a related research project, with positive and useful results.

This experience provides the basis for further research and developmental work on virtual enterprises and supply chain management. It provides a tool for managers to use in developing and negotiating future strategic business partnerships, which will increasingly be based upon business *information* as a key infrastructural element rather than (or even instead of) business processes.

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For the last four years he has been chairman of the UK committee for software engineering standards and has contributed for eight years to international standards making in the general area of information systems engineering.

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Ashley Braganza is the third member of the EDI Research team and is from the banking industry. He has an MBA from Strathclyde and is currently researching for his PhD at Cranfield. He has substantial experience of international and domestic banking, and specialised in the strategic financial application of EDI before joining Cranfield as a Research Fellow. Since then he has worked on several research projects and successfully launched a new research project into Business Process Redesign. Ashley has written widely and has just concluded a book on EDI and the law.

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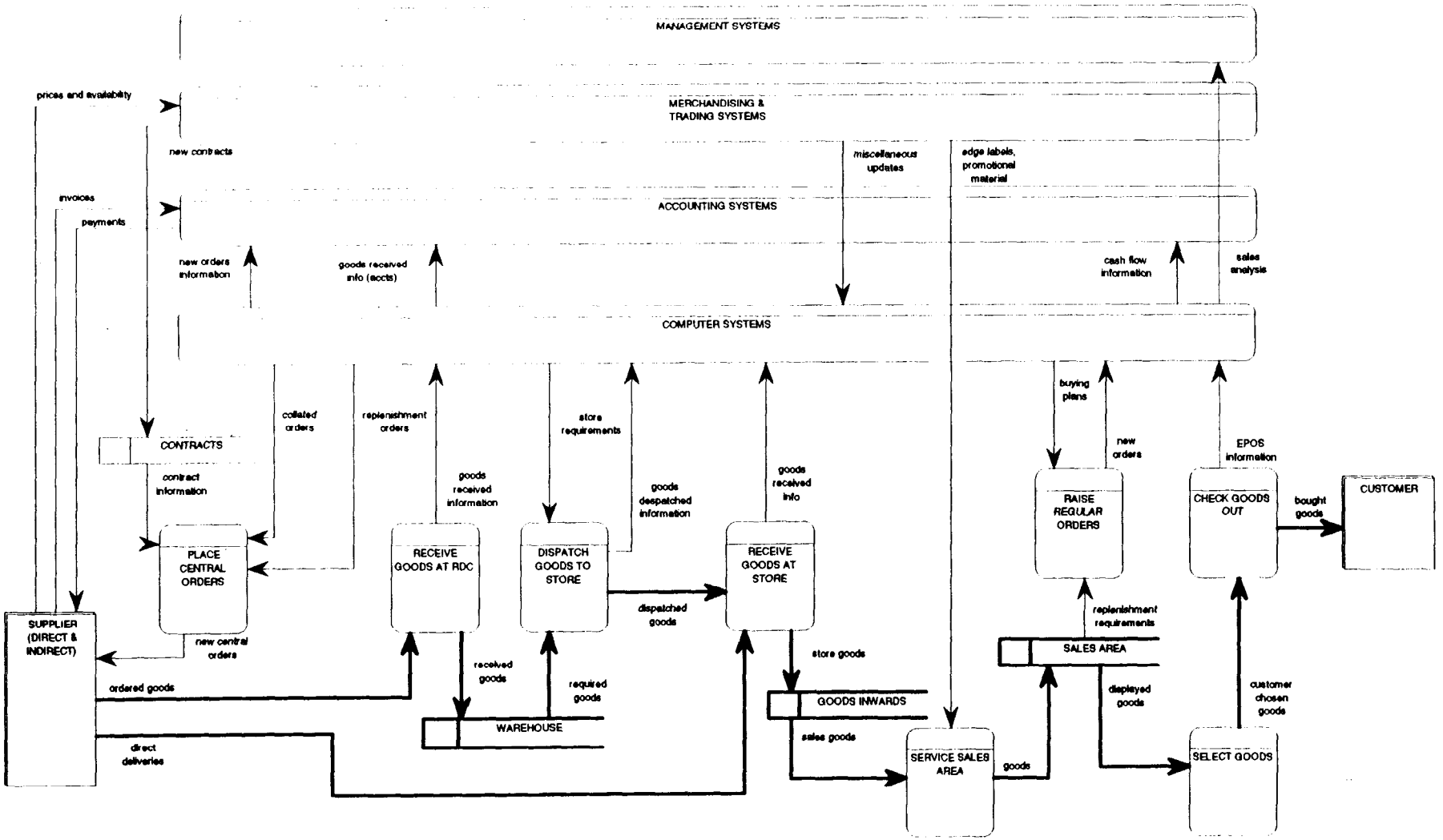
MANAGEMENT SYSTEMS
MERCHANDISING & TRADING SYSTEMS
ACCOUNTING SYSTEMS
COMPUTER SYSTEMS
prices and availability
new contracts
invoices
payments
new orders information
goods received info (accts)
miscellaneous updates
edge labels, promotional material
cash flow information
sales analysis
buying plans
new orders
EPOS information
CONTRACTS
contract information
collated orders
replenishment orders
goods received information
store requirements
goods despatched information
goods received info
PLACE CENTRAL ORDERS
RECEIVE GOODS AT RDC
DISPATCH GOODS TO STORE
RECEIVE GOODS AT STORE
RAISE REGULAR ORDERS
CHECK GOODS OUT
bought goods
CUSTOMER
SUPPLIER (DIRECT & INDIRECT)
new central orders
ordered goods
received goods
required goods
dispatched goods
WAREHOUSE
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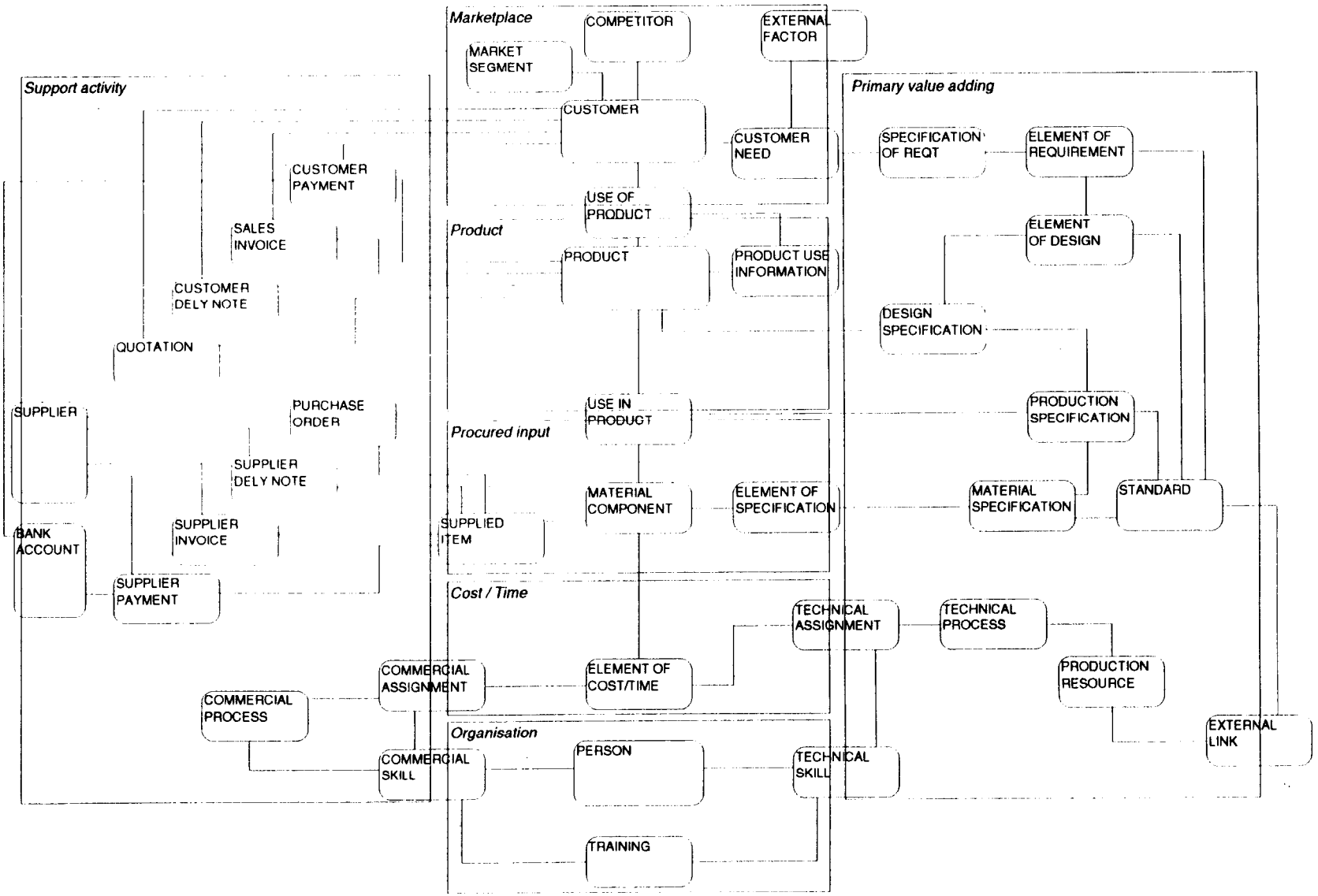
Marketplace
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EXTERNAL FACTOR
MARKET SEGMENT
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CUSTOMER NEED
SPECIFICATION OF REQT
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CUSTOMER PAYMENT
USE OF PRODUCT
ELEMENT OF DESIGN
SALES INVOICE
Product
PRODUCT
PRODUCT USE INFORMATION
CUSTOMER DELY NOTE
DESIGN SPECIFICATION
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MATERIAL COMPONENT
ELEMENT OF SPECIFICATION
MATERIAL SPECIFICATION
STANDARD
BANK ACCOUNT
SUPPLIER INVOICE
SUPPLIED ITEM
SUPPLIER PAYMENT
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COMMERCIAL ASSIGNMENT
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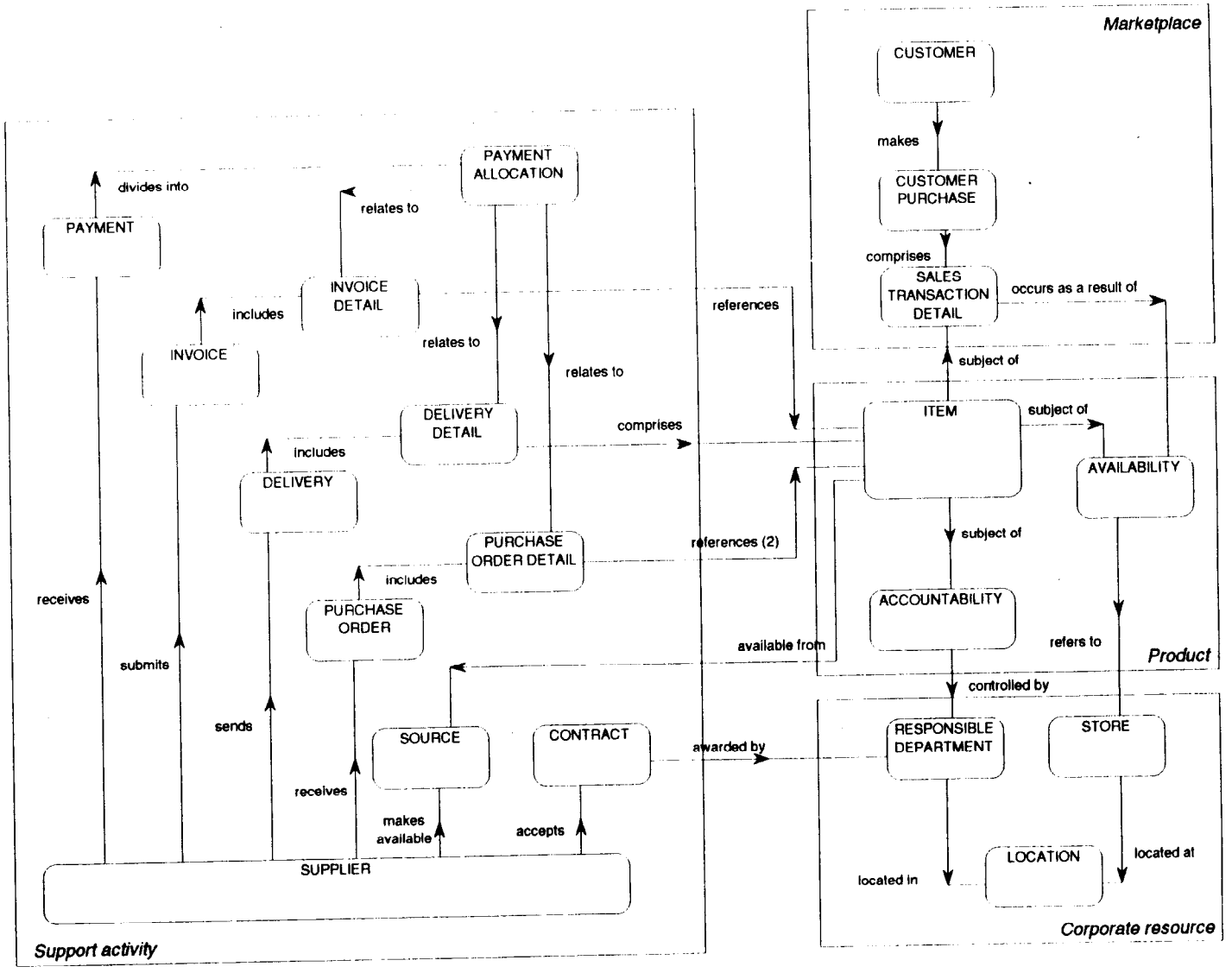
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PURCHASE ORDER
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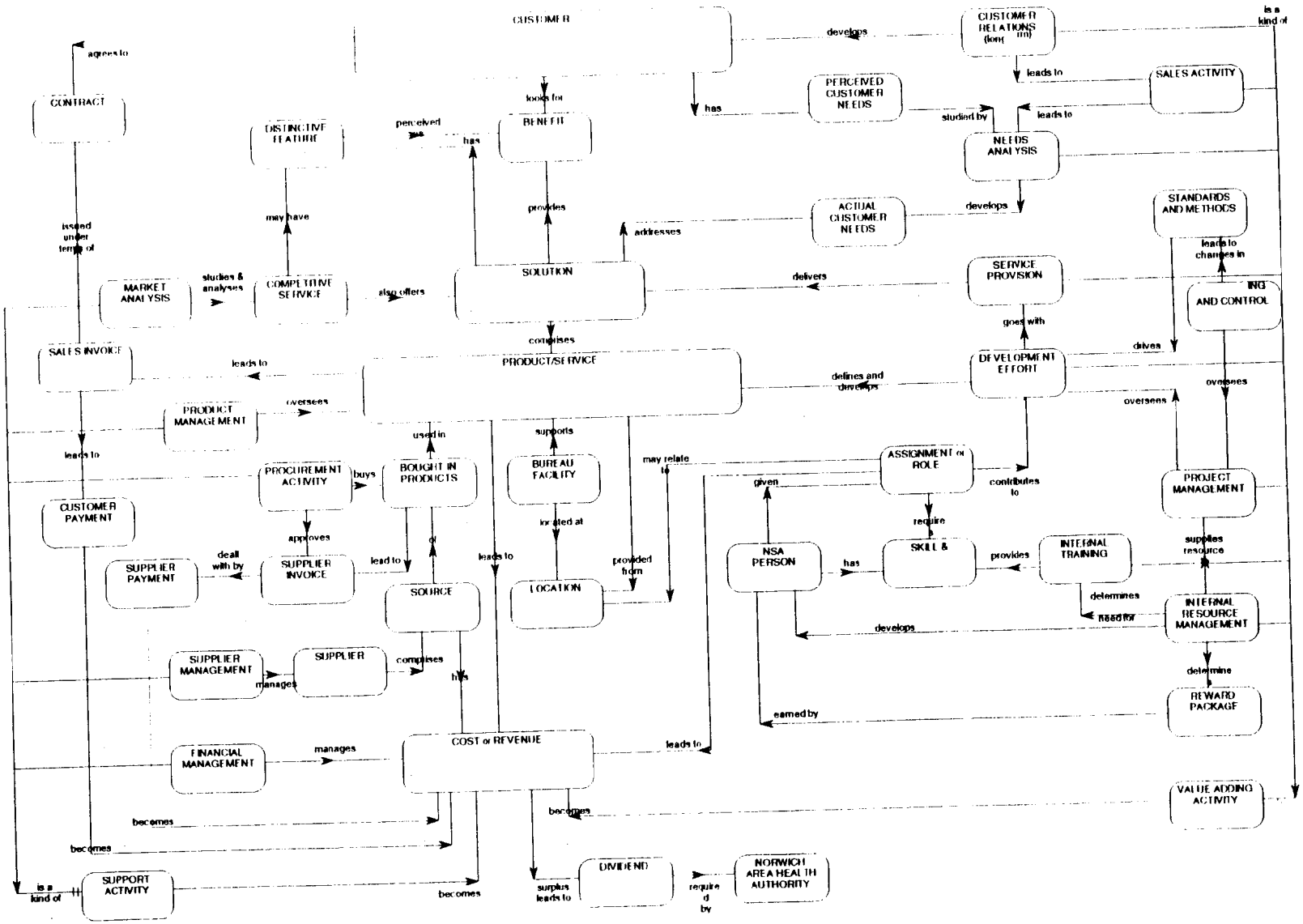
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studied by
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has
BENEFIT
NEEDS ANALYSIS
may have
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develops
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leads to changes in
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required by
NORWICH AREA HEALTH AUTHORITY

APPENDIX: A NOTE ON THE CHOICE OF MODELLING TECHNIQUES

In understanding the context for conceptual models and before presenting the detail of the Cranfield Enterprise Model, it is helpful to review carefully but briefly the recent history of modelling in the information and systems analysis disciplines. We need be able to see where the potential for new technologies may be, within and between different businesses, and therefore we need a business systems models to help us. We can divide the different approaches in use into three categories: *structured modelling techniques, soft systems techniques* and *formal methods.*

Structured modelling techniques

For at least 10 years those who use modelling techniques to define business systems have been experimenting and committing to the use of structured techniques for business and systems analysis [1][2]. This has been helpful in that we now have a way of looking at business systems which is rigorous and which helps to ensure completeness and correctness. Generally speaking almost all the different variations on structured business analysis methods employ:

- *Function analysis* to find out and define what is done in a business. This is a very natural way of looking at a business, illustrated in a simple way by the value chain and leading to models rather like that presented here based on food retailing.
- *Data analysis* to find out what underlying data structures are used in a business. This is a time-consuming but meticulous technique for analysing a business from the bottom upwards, using the detailed data used in the business as a starting point. The results are data models - less easy to understand than function models but useful in their own way.
- Additionally, some methods use *Entity analysis* to dig deeper into the ideas behind the business, including the use of entity life history analysis to establish the key events that must be recognised and supported by a business system. This is the least easy technique to use and for many people entity models are the least easy to understand.

We might expect that these modelling techniques would be helpful in modelling business operations. At Cranfield this has been found to be so.

Soft systems techniques

In the background (and with much lower visibility amongst practitioners) is the soft approach to systems modelling[3]. Here the rules are more relaxed and a richer diagramming notation is used to develop a view of systems in business. Much of the focus is on the activities in a business, however, and the objective is still ostensibly to create an information system rather than to understand a domain of interest. Interest in soft systems is still limited amongst practitioners although it is quite widely referenced and taught within higher education in the UK.

Formal methods

Almost as if a counter or a directly opposite response to the soft systems modelling approach there has enthusiastic interest in formal representation techniques. One justification for this is that, if the behaviour and performance of a system is to be provable, we must reduce the definition of the system and its capabilities to a mathematical representation that can be manipulated mathematically. By invoking rules of one kind or another we can demonstrate that the logic of a design is complete and that the performance of the system in all conditions will be predictable and as required; formal methods of modelling could be characterised as "harder" than structured or soft systems techniques.

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1 For an early view of structured techniques see "**Structured analysis and systems specification**", Tom de Marco, Yourdon 1978

2 A more recent text devoted to SSADM (a method widely used in the public sector in the UK) is "**SSADM - a practical approach**' C. Ashworth and M Goodland, McGraw Hill, 1990

3 A good review of recent experience with soft systems techniques can be found in "**Soft systems methodology in action**", Peter Checkland and Jim Scholes, John Wiley 1990

As with soft systems the interest in formal methods may be enthusiastic but it is still limited. One obvious barrier to adoption is the need to study and learn abstract mathematical representations of otherwise familiar things, for example the rules by which we might give a discount to a customer or the way that the functionality of a system is made up.

The need for easy-to-understand models is evident when we consider how important information systems are to us today. We can set about automating information systems as they exist, but we may lose the benefits of more radical improvements to our business: for example the automation of poor logistics practices produces automated poor logistics practices, the automation of chaos produces automated chaos. We need to do better: we should seek to improve a business with new ideas and new information systems to go with them. The more successful examples of innovation and improvement were not achieved by automating current practices.

REQUIREMENTS OF A MODEL

If we are to succeed, there are therefore four prerequisites to success:

- We must understand what the technology is.
- We must understand the business: its processes and the information that it uses.
- We must understand the broader context for the use of information technology in business, for example: standards and business law.
- We must provide ourselves with a means to break the mould of current thinking and to create new ideas.

All four of these prerequisites to success will be aided by modelling tools that let us see the concepts behind a business and the concepts that together make technology what it is. The business is not just its processes nor its data: it is much more. Information technology is not just about hardware and standards: it too is much more. We need a way of accommodating ideas about a business without constraint. This can be achieved by adopting a modelling discipline pitched at a high level but with enough rigour to structure our ideas.

CHOICE OF ENTITY MODELLING AS THE PREFERRED TECHNIQUE

The model developed at the Cranfield School of Management is based on the entity modelling idea. The reasons for this are five fold:

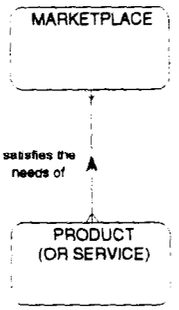
- Soft systems methods and formal methods are not in wide use and have shortcomings. In the former case the soft systems method provides too many degrees of freedom and could be said to lack rigour; in the second case formal methods are not widely understood and the presentation is a barrier to easy understanding. In a sense, each falls to either side of the desired level of freedom and rigour. Structured methods have a better balance and are far more widely used.
- Within structured analysis techniques, entity modelling is probably the least used and yet seems to have the most potential in the area of concept modelling. It has proved its worth as a means of structuring concepts and organising ideas many times over in informal sessions with management and other specialist groups attending Cranfield courses.
- The definition of an entity as "any concrete or abstract thing of interest, including associations among things" (taken from the ISO Technical Report [ISO, 1987]) is perfectly suited to the encapsulation of ideas and concepts concerning information. It allows that animate and inanimate objects as well as abstract notions are rendered equivalent and it therefore liberates us from the usual constraints of thinking only about one type of thing at a time.
- The relationships between entities allow an indirect reference to function, without being explicit. This allows us to liberate ourselves from simple process models which mask the underlying concepts. Process models are natural and comfortable for people to work with, but they tend to reinforce current practice and mask the more enduring ideas behind a business.
- If we wish to work with specific data about a business, the entity model gives us definitive "hooks" to which to attach data without requiring us exhaustively to analyse it. Data analysis is a time consuming task riddled with difficulties at the level of detailed definition and agreement about usage.

MODELLING CONVENTIONS ADOPTED

Before presenting the model it is useful to identify the conventions adopted so that it may more easily be understood.

Notation

The notions or concepts embodied in the model are presented as round cornered rectangles:



Concepts are named using a noun. The contents of such a notion may be anything of interest: people, organisations, abstract ideas, information and data structures, and so on. The relationships between concepts are shown as lines between the concepts (see the figure to the left).

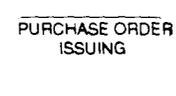
As with regular entity modelling, the relationship can be shown to have cardinality, shown here by the "crow's foot"; further, the relationship is named (generally with a verb or a verb-phrase) and the direction of interpretation is indicated by a small arrow in the relationship line. Thus, the example above is to be read "PRODUCT ... satisfies the needs of ... MARKETPLACE". The arrow does *not* indicate flow. Those familiar with entity modelling should have no problem with this but it is often a problem for the casual reader: most people are more familiarly with process models and they are more natural to use.

Treatment of process concepts

It is often required to show, within a concept model, a process. Not as a process with explicit input and output flows such as would be found in a dataflow diagram, but a process as a concept which we wish to relate to other concepts. An example would be to show a process related to the people who have responsibility for the process, or the security classification of the process.

These processes need to be treated carefully if the coherency of a concept model (developed in the way described here) is to be preserved. For example, if we were working on EDI in a purchasing context we might find ourselves thinking about the actual business process that issues purchase orders and how it might be interfaced to an EDI facility. On a dataflow diagram this process would probably be named "ISSUE PURCHASE ORDER" and it would be natural to include this in the concept model thus ...

... and then to relate the symbol to others using relationships. Anyone practised in entity modelling will know the rule that an entity is named using the singular form of a noun; it follows that in this example we need to find a noun because "ISSUE PURCHASE ORDERS" is a verb-phrase appropriate to a process model but not to a higher level concept model based on entity modelling conventions. We do this by using the gerundive form of the verb[4]. Thus our example becomes ...



... thereby referring to the act of PURCHASE ORDER ISSUING as the subject (or object) of our meaning. To derive the gerundive form of a verb before putting it into a concept model is helpful because it avoids a network of ideas and relationships becoming a simple process or flow model. Most importantly, it renders processes equivalent to dissimilar objects such as data structures, people and organisations, whereas in other models these things are treated distinctly differently. The power of a concept model comes from its ability to render different things equivalent. It allows us to leave behind the conventional separation of process, data, resource and material and work with them as equivalents. By this means we find deeper meaning and provide ourselves the opportunity to discover and develop more radical redesign ideas, which may ultimately produce far greater and more enduring benefits. We believe this is the case with the Cranfield Enterprise Model. While it is still in the earlier stages of its development and use, it has been immensely useful in the Cranfield EDI research project as a reference point and communications vehicle for the team members. It has contributed to case study work, to student projects in different but related areas (such as the study of corporate gateway strategy and implementation) and it provides an "inventory" of issues for EDI management to consider and deal with.

[4] The following definition is taken from the Hamlyn Encyclopaedic World Dictionary: **Gerund**: 1. A derived noun form of verbs. 2. The *-ing* form of a verb when in nominal function ... as in "writing is easy".

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