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Electronic data interchange and the structure of the UK construction industry

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The UK construction industry is characterized by its fragmented nature. Information technology (IT) has had little effect on the industry, its work practices and structure. Electronic data interchange (EDI) is a standardized technology aimed at reducing the inefficiencies of trading. This paper analyses the possible impact of EDI on the structure of the industry. The main finding of this analysis is that EDI is a technology that has the capability of altering organizational interfaces to such an extent that it will change the structure of the UK construction industry.

Keywords: EDI, industry structure, fragmentation.

Introduction

The technical development of electronic data interchange (EDI) is well advanced and has been widely publicized (Coomber and Chevin, 1990; Langan, 1990; Parfett, 1992). Investigators into this new technology are now turning to consider the effect it might have on the internal structure of individual construction enterprises (Dyer, 1992), but as yet there has been little discussion on how EDI might affect the structure of the construction industry as a whole. This paper argues that by its very nature EDI will produce a significant shift in that industrial structure.

Porter (1980) has provided the most comprehensive set of methods for analysing industry structure; his work on competitive strategy and more recently on competitive advantage (Porter, 1985) has set the tone for most of the industry analysis in the past decade. The analysis performed in this paper utilizes some of Porter's techniques. Our concern is with the possible effect of EDI on the structure of the industry as a whole. Since the analysis is necessarily performed in the real world its results cannot be verified in the same way as a scientific hypothesis; one cannot carry out a controlled experiment on the UK construction industry. Given this restriction the authors have made an attempt to indicate those points of the analysis which are speculative in nature.

This paper draws on a number of previous surveys and studies of the industry. Whilst each of these studies has been useful in their own right the nature of an industry-wide analysis demands that they be brought together. The juxtaposition of otherwise separate data has revealed further information than would be possible if each were to be examined in isolation. This approach is not without dangers, however; the authors at once acknowledge the work of others in the field yet accept sole responsibility for the use of their results.

This paper considers the nature of the construction industry and then performs a brief survey of IT in the industry. EDI is introduced in a general way; of particular importance in the EDI field is the use of standards and this is considered briefly. This paper then considers the use of EDI in the industry and analyses how this new technology can affect the fragmentation in the industry. Finally some simple but far-reaching conclusions are drawn.

Construction industry economics

Economics is concerned with the allocation of resources and more often than not scarce resources. The economics of the construction industry therefore are focused on the allocation of resources for construction projects. The economics of this situation are quite different from other economics, as is well understood by those within that industry. The one-off nature of the work, the

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transient existence of the project teams made up of many diverse actors and the cyclical nature of the wider economic climate, all exist for imperative reasons and mitigate against more permanent economic relationships. The structure of the industry itself is a result of these temporary partnerships with the cost-driven competitive nature of the industry creating the need for low fixed costs. Even the largest contractors are no more than management shells relying on the expertise of their project management staff.

However, the allocation of resources in this industrial structure is not optimal. The industry is fragmented in many dimensions and the boundaries between the various elements represent loss in the allocation and distribution of resources. Whilst the fragmentation has sprung from the economics, it has become so embedded in the industry that it has become formalized in guidelines such as the CIOB Code of Estimating Practice. The treatment of subcontractors by most contractors is another example where the original reasons for some procedures have been lost to time yet have or soon will outlive their usefulness. If an organization or more likely if a partnership of organizations can reduce these cross boundary costs then in the short term they will be able to reap great benefits in either increased profitability or larger market share or some trade-off between the two. However, this cost reduction can be easily reproduced by other partnerships nullifying any advantage it may confer. A cost reduction strategy will only result in temporary competitive advantage, but further alterations to organizational and functional interfaces will produce longer term opportunities and threats.

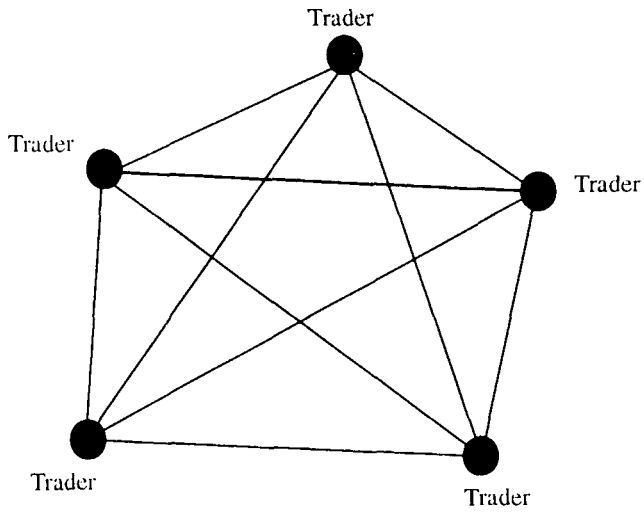

Figure 1 Trading relationships without a market

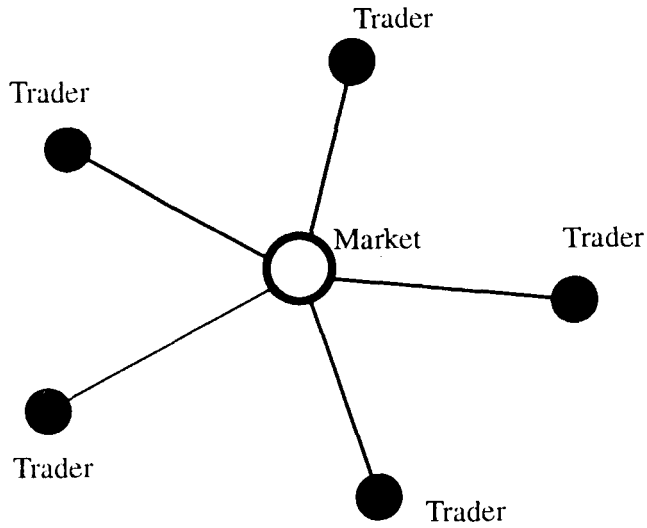

Figure 2 Trading relationships with a market

The internal market of the construction industry

A market consists of a location where an exchange of goods can take place. The theory behind the existence of markets is very simple. Consider n buyers and suppliers each of whom will potentially trade or barter with the other. In the absence of a market each must travel to the other with all their goods to establish whether a trading relationship exists; the number of journeys necessary for complete interaction is Σi where $i = 1, 2 \ldots n\text{-}1$ (Fig. 1). If there exists a single location where all parties agree to appear at the same time then the number of journeys necessary is precisely n (Fig. 2). The savings in travelling costs are large and this was the origin of market days in market towns. Other benefits accrue from this centralized market. Buyers can easily compare the prices of comparable goods from a number of different suppliers and, thus, establish the best deal quickly and easily. In modern times the improvement in communications has meant that the need for a physical market has decreased. It is now more common to view markets as conceptual rather than physical, composed of the multitude of trading exchanges. Potential traders can communicate their needs through postal services or more recently electronic media; it is this last point that is the subject of this paper.

The construction industry (whilst serving a particular market) has its own internal market, with a large number of traders involved in a huge number of interactions. Yet there are a number of factors that still make this internal market and, hence, the industry, non-optimal. First, traders only interact with a small number of pre-selected partners since it is expensive to identify and deal with all possible partners. Second, there is a high cost associated with these interactions. Finally, information asymmetries can exist in the interactions which lead to loss of

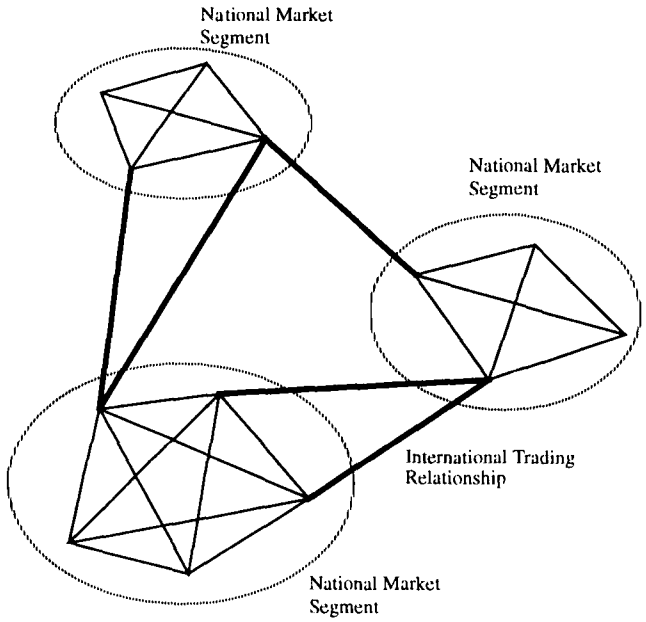

Figure 3 National market segments

value to at least one party involved and ultimately to the client. In terms of the resource allocation model the problems are those of resource identification, resource selection and the actual trading event itself, all of which cause partial segmentation in the market.

On a national scale one might also identify two further dimensions of segmentation: specialization and geographical region. At the moment these are acceptable segments given the diversity of work and the difficulty in transporting the raw materials necessary for construction. Indeed the end-product cannot, in general, be delivered on site; manufacture takes place at the point of use. But even so with the trend towards multiskilled workforces employing flexible manufacturing processes, a trend epitomized by the paradigm of mass customization (Pine, 1993), the breakdown of specialist segments might result. Equally the use of prefabrication might threaten the existence of geographical segmentation to a certain degree.

The international market is massive, being estimated to be £5500 million. In 1991 Bovis Construction Company completed an 18 month study of this international market (Duffy, 1991). This market however is even more segmented on geographical lines with little economic movement across borders (Fig. 3), but the future might be very different. The Bovis study showed that costs abroad were only 70% of the costs in the UK. Whilst there is still little economic leakage from one country to another this situation can continue, yet given more international competition it is clear that UK companies could be challenged on their home ground. Referring to this discrepancy in cost base Chris Spackman, the managing director of Bovis has been quoted as saying that 'if we can't produce buildings at those sort of figures none of us have a future'. But on a more positive note he estimates that design and specification costs could be cut by 10%, construction costs by 17% and organizational costs by 3% (Duffy, 1991).

Construction industry fragmentation

The description of the construction industry in terms of an internal market is too simplistic to capture the fine but essential detail that determines the full picture. Furthermore, as a predictive tool it is unable to identify any future directions that the structure of the construction industry might take. It is predicated on a simple resource allocation model in which availability and price are the determining factors. As many authors point out, price is just one competitive dimension. It continues to be the dominant dimension in construction with its use of competitive tendering, commodity suppliers and subcontractors but this might not continue to be the case as the industry develops.

Fragmentation is the key characteristic of the industry. It is a characteristic that permeates every aspect of the industry (O'Brien, 1991; Krippaehne *et al.*, 1992). The work of Porter (1980) considers fragmented industries in general and these general findings are worth summarizing before dealing with the fragmentation of the construction industry in particular.

A fragmented industry is one in which no firm has a significant market share such that it can influence the market. Such industries are populated by large numbers of small and medium sized companies, many of them privately owned. There are a number of reasons for fragmentation. Among these are economic factors. For example, the number, size and nature of the products demanded by the customers are such that the demand can only be satisfied by a large number of small suppliers. Another factor in any fragmented industry is geography. Often there are high transport costs associated with the products and more particularly it might be difficult to export the products. Yet again there are functional factors with the need for many organizations each of which can only satisfy a small part of the initial demand.

Porter says that industries that exhibit these characteristics are 'stuck'. In general he notes that it is difficult to consolidate such industries, primarily because of the industry economics which cannot be easily overcome. One major effect of these economics and the resultant fragmentation is that not only are they characterized by many competitors but also by generally weak bargaining positions. Marginal profitability is frequently a result (Porter, 1980). For any particular firm in a fragmented

industry it is therefore necessary to adopt a strategy that will either increase productivity or reduce costs.

Some of these general observations are directly applicable to the construction industry, however, we can make more specific observations. Most obviously one can note the fragmentation inherent in the project nature of construction work. Each product is essentially unique and whilst there may be some commonality between different projects there is sufficient differentiation to mean that each must be treated on its merits.

Since the work is non-repetitive in nature and because of the financial structure of the industry, the group of individuals brought together to complete a project exist as a team only for the lifetime of that project. After the project is completed they split up, which is itself a cause of fragmentation. This temporary and fragmented group structure means that there is poor knowledge transfer from one project to another; again one notes the fragmentation.

Porter (1980) has described how production processes can be viewed in terms of a value chain. Each time a product is operated on in some way or another then not only are resources consumed in that operation but value is added to the product. These processes include not only the direct processes which cause a physical alteration of the product but also such processes as moving the product from one place to another (bricks have more value to a contractor on site close to their point of use than in a warehouse) and inspection (which can be used to verify quality to some standard). The value chain of the construction process is fragmented. One merely has to note the use of architects, consultants, contractors, subcontractors and materials suppliers to observe this fragmentation.

This fragmentation is based upon the various organizations involved, but even within the same organization there will be functional fragmentation. In a contracting firm the quantity surveyors, estimators, planners, site managers, etc., will each have a quite different 'world view'. The advent of design and build enterprises has shown however some firms trying to come to grips with this fragmentation in an attempt to optimize value to the client. Part of this functional fragmentation exists because of the specialist nature of those functions but some of it is embedded in the culture of an organization with no economic value whatsoever.

Finally this functional fragmentation is exacerbated by the fragmentation of the data and information needs of each separate function. Some of the functional boundaries exist precisely because of the specialization necessary in handling data and information in the management of the construction value chain. These boundaries in turn require exchanges of data which in some cases manifest themselves as formal trading exchanges.

Data flow in construction

It is probably impossible to establish whether specific boundaries have been caused by the nature of data interchange or whether the data interchange has arisen because of the existence of boundaries; all that can be said is that the boundaries exist and that data interchange takes place across those boundaries. Any future change to the data exchange will, however, affect the nature of the boundaries, but before considering in detail the imminent change in the nature of the technology supporting this data exchange we should briefly consider the relationship of data flow and fragmentation in the industry. As we have seen a crucial element in all this fragmentation is the movement of data and information between the trading partners and across functional boundaries. Our general description of resource allocation and industry fragmentation can be framed in terms of this flow. Ndekurgi and McCaffer (1988) have identified a typical data flow problem in the construction industry. Data which are provided by one value-adding process is rarely in a format suitable for subsequent downstream processes. In fact the processes are so separate that they rarely acknowledge the needs of each other. In some cases the data is so incompatible that the next process must re-extract the raw data (i.e. the input to the original process) or construct their own. One of the authors has witnessed this personally where a project planner admitted that they threw the results of the estimating process into the bin and started again from the bill. The sole function of the estimators was to win the work, if they were successful then that was of little concern to those who planned the work. Ndekurgi and McCaffer (1988) see that the solution to this problem is through integration in the sense that any data created by one process should be suitable and available for use in any other process. If data flows become automated than the very idea of data flows (which stress the exchange across boundaries) will be replaced by one of data sharing (which stresses the nature of integration). The technology that supports this automation of data flows, and, hence, introduces the idea of data sharing is EDI.

IT and the construction industry

Whilst the construction industry constitutes 10% of the UK's gross national product its investment in IT falls far below the mean for other industries. It has been claimed that major contractors spend only 0.5% of their turnover on IT whilst consultants spend 1.5% of their fees (Building Centre Trust, 1991). In all likelihood therefore there is still much that IT can do for the construction industry in general and contractors in particular.

Beneficiary / Benefits	Individual	Function	Organization
Efficiency	Task Mechanisation	Process Automation	Boundary Extension
Effectiveness	Work Improvement	Functional Enhancement	Service Enhancement
Transformation	Role Expansion	Functional Redefinition	Product Innovation

Source : Gibsa and Hanner (1985)

Figure 4 The benefit/beneficiary matrix

The strong national segmentation suggested by Fig. 3 indicates that the UK construction industry has not yet faced strong international competition, but as suggested above the future may be bleak unless it can find ways of reducing construction costs and improving productivity. Information technology can contribute to this drive for competitiveness. The contribution of IT to an organization can be analysed in a number of ways. A typical approach involves the benefit/beneficiary matrix introduced by Gibson and Hammer (1985), shown in Fig. 4. There are three classifications of benefit, these being efficiency, effectiveness and transformation whilst there are three types of beneficiary, namely the individual, the function and the organization. The matrix is used to establish the effect of IT within the organization. For example, one can identify the use of word processors for clerical staff as belonging to the upper left corner of the matrix; in no way is business affected except through the improved personal productivity of the employee involved (although extra facilities such as spell checkers can improve effectiveness). The most fundamental changes occur in the bottom right corner; here IT drives the process of business re-engineering. The effects at this level are not only strategic for the organization but they also begin to alter the industry structure through the introduction of new dimensions to competition.

Whilst the massive volumes of data needed in each project might suggest an ideal application area for IT it is nevertheless the case that each project is essentially unique with particular problems that need to be overcome as and when they arise. IT is ideal in situations where work is repetitive and standardized; in construction and even more particularly in construction management this is not the case. This has acted as a brake on the adoption of IT.

A further restraining factor is the necessity to reduce fixed costs. Organizations currently cannot afford to take a longer view because of the cost- and time-driven nature of the work. As noted above this is a contributory cause to the current fragmented industry structure. Indeed it is still the case that many firms in the industry have still not yet taken the first steps towards the adoption of IT. It is still possible for firms to exist and compete without this technology. Even quite large firms have managed to avoid the use of word processors and spreadsheets.

A further major reason why the industry is moving with careful consideration is the lack of good industry-specific systems. There is a double movement at work here. On the one hand, we have already noted the reluctance of the industry especially with respect to technologies that might be speculative in nature; nobody wishes to be the first to jump. On the other hand, the software suppliers sensing this reluctance have produced systems which have a highly restricted functionality and address only specific tasks or problem areas. CAD software is freely available, as is estimating software, project planning software, accounting software and so on, yet each of these systems is essentially isolated and reflects the fragmentation in the value chain of the industry. The problem is that IT nearly always changes the nature of work whereas the systems produced to date have been built and marketed on the basis that they replicate faithfully the practices of the various specialists and professions. As Zuboff (1988) has shown IT not only automates it also *informates*, that is, it creates new data structures and information which allow new techniques of working. The word informate was coined by Zuboff to describe the more fundamental effects of IT in an organization. Whilst automating a process merely involves an improvement in efficiency – how well you do something – informating is concerned with effectiveness – it actually changes what you do. In terms of the benefit/beneficiary matrix informating is reflected in the bottom rows where effectiveness causes changes which eventually result in the transformation of roles, functions and businesses.

Zuboff (1988) has also shown that whilst automation is usually well planned and understood, the informating capability (which is built upon the automating capability) usually occurs in an unplanned and essentially unpredictable fashion. It nevertheless opens up the possibility of great benefits. In the realm of construction software the deliberate attempt by the developers to create pure automation systems has hamstrung those systems and failed to deliver the great changes experienced in other industries where IT has not only automated but also informated. Much software development effort is still being devoted to fine tuning the systems to suit the needs of the specialists; adopting a wider perspective, which looks beyond the functional boundaries, could result in massive competitive advantage as it has for some firms in other industries. EDI by

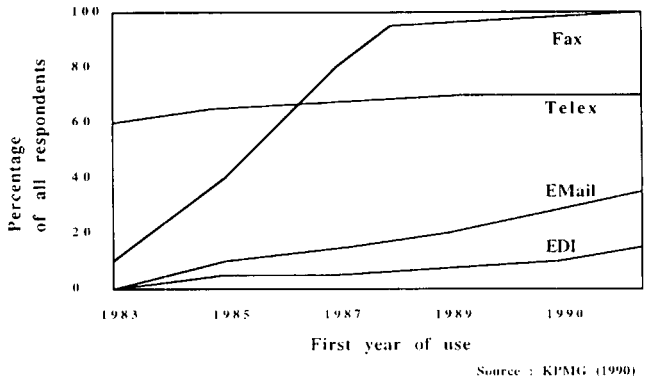

Figure 5 Growth in communication technologies

its very nature crosses such boundaries and may become the engine for these changes. IT always causes fundamental shifts in industry structure when it assumes a dominant role.

Communications technology in construction

Clearly the nature of the cross-boundary communications are important in a highly fragmented industry. The technology used to support these communications is not a neutral or passive medium, but rather it has a profound effect on the nature of the boundaries. With a stable environment based upon paper and voice exchanges this effect has been largely unregarded but with a shift to electronic application to application communications this intrusive characteristic of the media (rather than the message) will disturb this stability. In its simplest form the technology will in itself add value (VANGUARD, 1989).

In 1983 10% of all the respondents of an industry survey (KPMG, 1987) used FAX, by 1989 this had grown to an almost 95%. Figure 5 shows how this increase has occurred. A typical result of the survey was that 87% of contractors used FAX to communicate with subcontractors. FAX has therefore taken over from TELEX as the dominant method for technological data transfer yet it is still essentially a paper-based medium of exchange. It is used as a supplement to, and direct replacement of the slower postal-based communications. It has been noted that sophisticated IT products are frequently used to produce technical drawings and invoices and these are subsequently put in the post or faxed (Baker, 1991).

The KPMG Peat Marwick McLintock and CICA report (KPMG, 1987) is the baseline for much of the discussion on IT in construction in the UK and this is true for EDI. The original survey (with information gathered up to 1987) had no mention of EDI in it at all (KPMG, 1987), it was only the follow-up survey published in 1990 that showed 6% of contractors used EDI (KPMG, 1990). The prediction made in the follow-up survey was that this figure would double over the next 2 years. The report stated that EDI was still very much on trial, the suggestion being that the industry still held reservations about the technology. This is not surprising given that EDI is not a direct substitute for another form of communication. It demands new ways of working and good existing IT applications.

The industry survey suggests that EDI will 'show the same pattern of growth as FAX when the Integrated Services Digital Network becomes more widely available. ISDN is not well known yet.' On the contrary we do not believe this to be the case. ISDN is not well known but even if it becomes well known EDI will not see the same pattern of growth. FAX and TELEX are cheap tools which can be operated independently of other technologies, they are general purpose in nature and they can be used for communication independent of any particular organizational structure. EDI is quite different in nature. It relies upon the existence of IT applications which are used to send and receive the communications. Many of the benefits of EDI will not accrue if an organization does not have a substantial IT infrastructure in place; the messages which can be passed are restricted in nature and the use of EDI implies a change in working practices. Finally, the adoption of EDI implies the beginning of a breakdown in the fragmentation that currently exists in the industry. Each of these factors will act to restrain the growth in usage.

EDI – background and benefits

Much of business and commerce is a paper chase. Whilst paper has certain tactile advantages it is nevertheless expensive to handle and process. A survey performed by ISTEL (1989) estimated that 3.2 billion documents were sent in the UK associated with the order/invoice cycle. Each document cost on average of £10 to process. More than £24 billion of the total cost of processing was associated with people and paper handling. Even paper money is being replaced by electronic impulses for cash transfers. In a mixed media environment where paper and computers co-exist it has been found that 70% of computer output needs to be re-entered as input into further computers and that this re-entry of data can represent up to 25% of the cost of a commercial transaction. The loss occurs not because the two systems are fundamentally incompatible but rather because they are simply not connected electronically. Further if they are linked in some fashion they have different format requirements, the output format of one being different

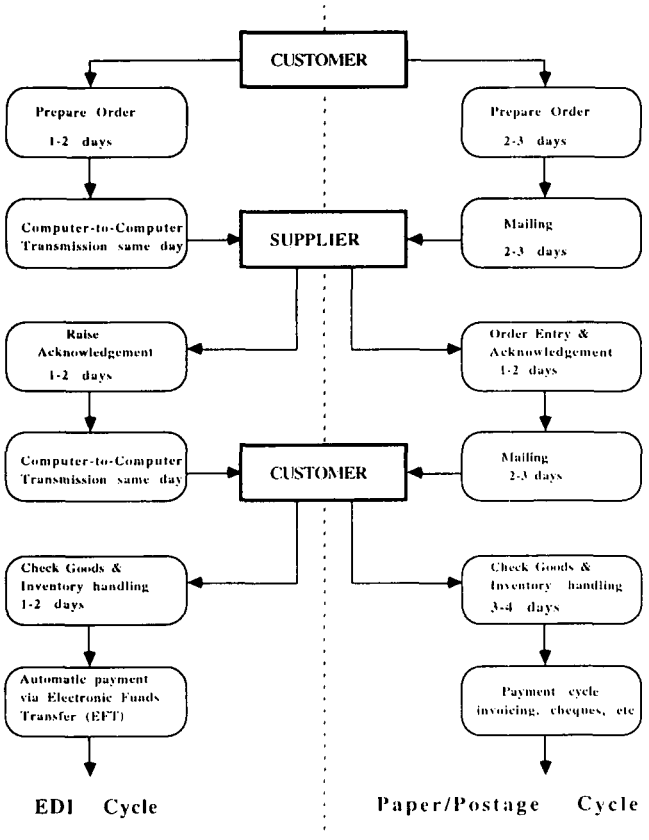

Figure 6 Typical trading cycles

to the input format of the other. EDI is a development that aims to overcome these problems.

EDI is essentially a method for exchanging documents between the computers of trading partners. Unlike electronic mail or FAX, EDI is data exchange between two applications. The data are transmitted by one application to the other in a structured computer processable format without the need for rekeying it (Canright, 1987). EDI has been specifically aimed at automating trading data such as purchasing orders, acknowledgements, material releases, requests for quotations, etc. In the past such trading has been typified by an exchange of paper; Fig. 6 shows such a paper exchange cycle when compared with an EDI cycle. This figure suggests that there is a significant reduction in time and, hence, cost in the EDI cycle as compared to the paper cycle. The 60% cost reduction suggested by this simple trading cycle analysis is in line with the survey conducted by ISTEL (1989) which showed that two-thirds of the cost of paper processing was associated with the human effort involved in paper handling. It is important to stress the application to application nature of this communication technology. An organization can only use EDI if it has IT applications in place; applications, furthermore, that have been built to utilize EDI.

In its simplest form EDI is tactical in nature and the short-term benefits of EDI are obvious. There is a reduction in processing time for interparty transactions and the accuracy of the data is improved. The human effort involved in processing transactions is reduced and overall there is a reduction in cost. The benefits at this level nevertheless improve in proportion to the number of trading partners who mutually adopt EDI. Industry estimates from EDICON show that, excluding direct trading between large manufacturers and construction companies, there are 38 million purchase enquiries and 217 million invoices a year involving trade with some 250 000 customers. It cost more than £300 million to process this paper mountain (Construction Computing, 1989). In the financial world it is estimated that if EDI were adopted internationally business could save in excess of £10 billion (Sanders, 1988). But such benefits are purely tactical and are based on the automation of existing practices; on the benefits/beneficiary we are operating on the level of the first two rows – improving efficiency and effectiveness. At this level it is relatively easy for an organization to avoid the use of EDI. It is in its strategic role that EDI becomes important with far-reaching benefits and implications.

EDI standards

EDI relies upon the adoption of standards. Since it is based on the transfer of data between several organizations with different types of computer systems and applications running on those systems it is necessary that a standard format for each EDI message is agreed upon and adopted by the various parties. The earliest standard was X12 on Electronic Business Data Exchange set by the American National Standards Institute, ANSI (DISA, 1991). Initially it had standards for five different types of document but this number now exceeds 100. Several other standards have been developed notably ODETTE for the European automotive trade and Electronic Trade Data Interchange, TEDIS (Moore, 1987).

The International Standards Organization (ISO) has recently developed most of an EDI standard called EDIFACT – EDI for administration, commerce and transport (UN/EDIFACT, 1991). This standard is being further developed by the United Nations Economic Commission for Europe (UNECE) in cooperation with ANSI X12 (Genilloud, 1990). This work covers syntax rules, the data elements and their formats, the message components and the message itself.

The significance of these standards should not be underestimated; as we have seen the medium is just as much part of a data exchange as the message itself. The technicalities of EDI demand cooperation and partnership; as a technology it begins to draw organizations

together. The implications for such a fragmented industry as construction start to become obvious with this demand for standards. The interfaces that exist between functions and organizations begin to become blurred, a greater degree of integration occurs. It is certain the standards will not in and of themselves overcome the industry fragmentation, rather the standards are a way of breaking down the distant trading relationships that currently exist. The industry structure will however be altered by the use to which this technology is put; to understand this more clearly a specific example from manufacturing industry will help.

EDI and JIT

Just-in-time (JIT) is a philosophy and a way of working that is having profound effects despite its apparent simplicity. JIT is a method of manufacturing in which materials that are necessary for production purposes arrive exactly at the time they are required, they must be neither early nor late. The benefits stem from the elimination of waste. As a way of working JIT demands close cooperation between manufacturers and suppliers. Key to this close involvement is a flexibility and responsiveness which allows ordering and delivery lead times to be reduced as far as possible. EDI contributes to this reduction in a major way.

A major effect of JIT has been that the boundaries and interfaces between different value-adding processes have become blurred through a process of streamlining; to a large extent this streamlining has been enabled by EDI. The importance of inventory has been reduced by tying manufacturers and suppliers together with EDI. Yet whilst EDI has acted as an enabling technology it is not the only factor that has made JIT a success. There has been a change in the organization and behaviour of the manufacturers and suppliers. JIT demands that the manufacturer trusts the supplier to provide the goods at a sufficient level of quality such they they can be used immediately. Defects which mitigate against immediate use are not allowable in the JIT philosophy. Thus, the manufacturer must come to trust the supplier, and this cannot happen through intermittent use of that supplier. Where before manufacturers would seek out the lowest quotes from a set of approved suppliers they are now prepared to link themselves to one supplier (Annis, 1986). (There is much more to JIT than suggested here, we are merely concerned with the contribution of EDI and the manner in which trading relationships have altered.)

EDICON

EDI in the Construction Industry (EDICON) is a non-profit making organization concerned with coordinating the application of EDI in the construction industry. It has working groups concerned with various technical issues, an example being bills of quantities (Knowles, 1990). Quite properly EDICON's policy is to adopt, wherever possible, those standards developed by other EDI committees and ratified by UNECE and EDIFACT. Existing standards, however, may not be suitable or applicable to the construction industry and it is in such areas that EDICON is concentrating its efforts. EDICON has released standards for bills of quantities and materials descriptions (Sanders, 1988).

Whilst EDICON is developing into a successful standards body and pressure group it is also taking the first tentative steps towards a real consideration of what will happen to the industry. Dyer (1992) has performed an analysis of a business using the value chain model with a view to investigating the longer term effects upon a business. His basis for analysis was the level of the business unit itself and was primarily concerned with the internal restructuring of a business. His analysis is correct in that he points out that we must not be 'obsessed with current business practice'. The level of our concern is at an industry level, however, since it is clear that the boundaries between businesses will change as a result of EDI.

EDICON as a body is quick to point out the tactical advantages of EDI, some of which have been referred to above, yet it does not advertise the possible shifts in industry structure. The EDICON Membership Prospectus states that the objective of EDICON is 'to bring the benefits of EDI to the UK Construction Industry, the twist, however, is that the real benefits of EDI will only become obvious when that industry undergoes some degree of structural change. This will be a painful process for some. As stated above, perhaps the most dominant structural feature of the industry, besides its size, is its fragmentation.

EDI and the construction industry

Given the above data and preliminary analysis we would like finally to draw out some of the salient issues for the construction industry. But before doing so one issue must be considered – will EDI be adopted by the industry as a whole? The existing economics, industry structure and individual organizational behaviour can all act as restraints. These restraints may be so great that they effectively stop the technology reaching a sufficient critical mass for universal adoption. The Building Centre Trust report (1990) starkly makes the same point when it maps out two possible futures – EDI will either come of age or fail. Our analysis is predicated on the former alternative, although it is as well to acknowledge the possibility of the latter.

A surprising result of this analysis is that the necessary conditions for successful widespread adoption are

closely linked with the effects of that adoption. It becomes almost impossible to separate conditions and effects, as the industry shifts to accommodate EDI then EDI will cause further shifts. Given that the technology will eventually be successful it is clear that once a certain point is reached it will be adopted at an extremely rapid rate. In effect the existence of EDI will become a necessary prerequisite for trading purposes and those companies without it will face pressure to adopt the technology.

In particular those firms without the technology will not be able to match the flexibility, responsiveness and lower costs of those with EDI. Yet it will not be a comfortable ride even for those organizations which embrace EDI wholeheartedly, since there will be a greater squeeze on their own cost base competing with organizations who also use EDI. This can be seen most clearly by using the economic and internal market analysis outlined above and applying it to a construction industry with widespread EDI. First of all in a purely price-based competitive environment it will become extremely easy to identify the lowest cost suppliers and subcontractors. On the part of the contractor there is no substantial extra cost in requesting six quotes or 60. Equally for a supplier with EDI the number of responses can be dealt with semi-automatically by the receiving computer application; there will be little effort involved in dealing with the increased number of enquiries. Indeed for commodity goods the entire process of request, quote, order and invoicing could become completely automated. This situation is analogous to the recent changes in the financial markets with the subsequent shake out – many firms have had simply to abandon share dealing because of the reduction in margins. Second an embracing EDI system allows efficient data flows, this in turn will reduce information asymmetries and again reduce the opportunities for profit making. Finally, the costs of trading will be reduced. Those firms which have, in the past, been able to operate profitably through efficient trading operations will see this particular advantage eroded by the advent of EDI.

All of this is, however, predicated on the continuation of a price-based competitive environment. The reduction in margins will largely render such an environment untenable for the majority of traders – there can only be one lowest cost supplier or subcontractor in any particular trade. Without EDI it is difficult to identify this unique firm; with EDI it becomes easy. Yet is the assumption of price-based competition valid?

Analysis results

The principal result of this analysis is that the widespread introduction of EDI will fundamentally alter the structure of the UK construction industry. EDI will do little to reduce the geographic basis of fragmentation; it will, however, reduce the barriers due to function and specialization. Finally, it will remove almost completely the economic cause of fragmentation. The development of the industry thereafter, however, is indeterminate. In some cases the use of integrated IT systems has essentially broken down traditional barriers in vertically integrated value chains (Konsynski and McFarlan, 1990). These authors give examples where comprehensive IT networks have allowed different enterprises to form information partnerships. The adoption of EDI is the start of the process whereby such partnerships are formed. Once they are in existence partnerships shift the grounds for competition.

These authors also point out that partnerships need not be based on ownership. One might conjecture that estimators could become independent consultants providing a service to contractors on the basis of their expert knowledge of cost data, suppliers, subcontractors and productivity. This would of course need a major shift in attitude in senior management to allow such a crucial function to move outside of their control, yet if the primary competitive dimension is no longer price it might not seem so outrageous. A key unresolved question therefore is how will EDI alter economic integration of the enterprises in the industry. On the one hand, it will facilitate the existence of multiple and separate organizations working in a close cooperative union and, on the other, it will allow large organizations to improve their efficiency and responsiveness. Whether there is economic integration or otherwise the relationships between the players will change, especially between those who have direct interfaces in the value chain.

At present such relationships are loosely coupled. Such loosely coupled relationships are characterized by arms-length price-driven dealings; there is low added-value and buyers can easily switch from one supplier to another (ICL (a), no date). Information technology can make this competitive environment more intense through the use of that technology to reduce prices and as the above analysis suggests EDI in particular can make things particularly uncomfortable if it is used in this fashion.

This is to see EDI, however, merely placed into the existing industry structure and used as a tactical tool to improve the efficiency of existing operations. There are additional benefits which begin to accrue through the use of EDI such as the provision of better service to customers. A supplier can use EDI to enhance its basic product line and add value. Customers frequently seek such quality in services and are prepared to pay a premium. This one single idea can radically transform an industry. Sir John Harvey Jones realized that ICI

would fail if it continued to be merely a manufacturer and supplier of commodity chemicals and he re-engineered the business so that it added value to its products (albeit not using EDI).

But much higher level advantages can accrue if these concepts are taken further and firms move towards long-term trading partnerships. Organizations will become more tightly coupled. In this scenario buyer and supplier have a much closer and biased relationship. In these types of market the number of trading participants is cut down dramatically and trade is largely on the basis of added value. Finally the market becomes price insensitive and it is only with difficulty that buyers can switch between suppliers (whether or not such suppliers are in-house or independent). The focus on added value may become the basis for competition in construction. One manifestation might be the emergence of one-stop enterprises offering a total construction package from design and construction right through to maintenance and eventual decommissioning. The financing arrangements of buildings might become more integrated such that the cost of construction becomes linked to the income flow generated by the final product.

A further example of the changing relationships between suppliers and their customers can be seen in the growth of supplier accreditation programmes in other industries (British Rail, no date; ICL (b) no date). Such programmes are used by manufacturers to ensure that their suppliers meet some minimum specified standards; typically these standards involve the specification of quality levels. Those suppliers which become accredited are accorded preferential treatment by the manufacturer, this preference usually manifests itself in the form of long-term agreements. The point is that the manufacturers will commit themselves to a specific trading relationship provided the supplier maintains the required standards. Supplier accreditation programmes are an example of the new closer working relationships needed between trading partners to survive in modern competitive environments; they are relationships not based on price.

Using the work and terminology of Zuboff (1988) the construction industry will become informated through the adoption of EDI. No longer will it be appropriate or even desirable merely to automate existing business methods; the extensive availability of high quality data through a low-cost medium will open up new methods of working. The challenge to management will be to identify and utilize the opportunities opened up through the change in trading relationships.

Now it is quite obvious that the UK construction industry is a long way from such a scenario yet other industries have undergone substantial structural shifts of this nature. It is beyond the scope of this paper to go into these general issues in any great detail but the shift to some degree is dependent on suppliers moving away from selling generic products on a price basis to selling unique services on a quality basis. As Porter (1980) points out there are two basic mechanisms for competition, lowest cost and differentiation; whilst there can only be one lowest cost supplier there are many dimensions to differentiation. The major result of EDI and changes in the structure of the industry may mean that the shift is from cost to differentiation. Even further down the road the use of partnerships themselves will 'provide a new basis for differentiation' (Konsynski and McFarlan, 1990).

Conclusions

The full implications of EDI are yet to be realized by the construction industry. Individual organizations are beginning to experiment with this new technology and it is beginning to spread. The effect and benefits as perceived by the industry are largely tactical. Primarily, these are seen to be:

1. lower costs;
2. higher productivity;
3. less waste due to increased data accuracy;
4. hence improved profits and/or market share.

But all this is based on the current price-based competition which in turn exists because of the highly fragmented nature of the industry. With EDI this state becomes unsustainable; once it becomes widespread the squeeze on prices will be greater than before its introduction. There will indeed be lower costs, higher productivity and less waste but the conclusion of improved profits will be a false one. Indeed exactly the opposite will occur since resource allocation will become more efficient. It is our view that a comprehensive EDI infrastructure will fundamentally alter the nature of the construction industry. The more fundamental effects of EDI will be:

1. reduced industry fragmentation;
2. integration of functions through data partnerships;
3. biased long-term relationships;
4. competition based on differentiation;
5. better value to clients through differentiation;
6. improved profits for groups of firms involved in differentiation.

If these final speculations seem somewhat remote then it is perhaps just as well to remind ourselves that everything described above has already happened in one industry or another. Industry structure is changed by IT and the structure of the UK construction industry will be changed by IT. This paper has considered a

technology that could well act as the driver of the changes.

The ideas underlying EDI are simple. It solves the problem of incompatible communication protocols amongst companies. Once a company has adopted those standards and established a link with the communications network it can freely exchange information with any other company using the network. In the short term there are simple gains to be made. In the long term there are opportunities and threats. The implications are far reaching.

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