SWP 27/90 ELECTRONIC DATA INTERCHANGE - TECHNICAL OPPORTUNITY OF BUSINESS NECESSITY? A REVIEW PAPER

ELECTRONIC DATA INTERCHANGE:
THE LONGER TERM EFFECTS ON INTERNATIONAL TRADE

Introduction:

This series of working papers has been prepared as part of the early work in a new programme of research, based at the Cranfield School of Management. The topic for research is the "Longer term effects of Electronic Data Interchange" on business, in the United Kingdom, Europe, and elsewhere in the world.

Contents:

Seven working papers are available, as follows:

Topic	Date
Glossary of EDI terms and acronyms	18th July 1989
EDI: Technical Opportunity or Business necessity?	18th July 1989
Survey of EDI users and service providers in the UK	October 1989
An update report from the "EDI '89" conference in London	6th November 1990
EDI and advanced information processing - the way ahead	15th September 1989
EDI Standards and the Single European Market	11th September 1989
The effects of EDI on the financial sector	18th December 1989

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Introduction

With the advent of easier communications there are many examples of the application of communications technology. One of the more interesting for business management to ponder is the facility known as "Electronic Data Interchange" where two (or more) computer users agree to co-operate in sending business information over a direct computer-to-computer link. Some examples of what is going on will help to indicate the implications.

- In 1984 General Motors in the USA gave their suppliers an ultimatum: "go online with our ordering and supply management systems or (in effect) get lost!". They *required* their suppliers to go online with EDI.

- Not much later in the UK our own motor industry did a similar thing. As one example, a small company in the North East with 12 years' steady trading experience with the major motor manufacturers (undertaking sub-contract design work - they designed the detail of car door fitments from outline drawings supplied by the manufacturer) were similarly threatened with severance unless they joined the network - but this time it was not business data that was involved but *design and specification information.* The majors wanted them to connect with the CAD systems that were in place, and initially it was by no means certain the the sub-contractor would be able to afford the cost and trauma of acquiring new capital equipment and re-training their staff.

- Recently IBM stated that by 1991 they fully expect that 80% of their business with the largest 2,000 suppliers will be done through EDI: they estimate the savings at $60,000,000 over five years.

- In 1986 alone, 200 oil companies say they saved $40,000,000 on 7,000,000 transactions which were dealt with through EDI rather than the conventional post.

Despite (or is it because of?) computerisation there is still paper in abundance - *at the corporate boundary.* This paper represents more than lost forests: it represents lost time in printing information out, potential errors in the transcription process, time shipping it through the postal system to the recipient, and then waiting for the reverse process when the recipient is able to respond. The above figures for savings may not be large in comparison with the annual turnover of the companies in question but that is not really the point. There *are* savings to be made and many of them are probably not accounted for in the above figures. Direct cost savings are likely to be variable and are estimated to be in the region of 50p to £2.00 per transaction. The *indirect* benefits have been estimated to be two to three times greater than this. The benefits of more effective customer and supplier communication and better management information, perhaps. Most important is the time factor - how do we measure the benefit from the instantaneous nature of the EDI transaction, the possibility of customers checking stock levels before confirming the order, and the ability to clarify queries and problems over an electronic mail link instead of through the more imprecise and un-recorded medium of the telephone?

The immediate and obvious payback is in efficient volume purchasing with a minimum of error, reduced timescales and shared benefits for both the buyer and the supplier. There are more esoteric benefits, though. Messages which are composed of standard elements (not necessarily simple elements) can be sent by someone in English, and received by someone in Japan in Japanese (possibly even in Kanji or Hiragana script), and at the same time by someone in France, in French. The recipient can reconstruct the received information *in any way that suits them.* Unlike the conventional postal system, or telex, or facsimile, the EDI system sends the data as an abstract data structure that can be moulded into whatever form the recipient likes without changing its meaning or significance at all. Standard elements such as "E&OE" - "Errors and omissions excepted", or "Inclusive of Freight and Insurance" - can easily be reduced to compact codes which are re-constituted at the receiving end, in a different language if required.

Where the data is of high volume - orders, invoices, shipping advices, bills of lading, routine communications of all kinds - there is the potential for improved efficiency through the use of EDI. The potential is quite independent of computer size - whether a mainframe, mini or micro is in use it is quite in order to turn to EDI. Interestingly, the medium is equally irrelevant - telecommunications, magnetic tape, electronic mail or even punched cards - EDI is actually conceived as a *structure for data* and does not presume a particular transmission medium. In this way it hopes to find the widest possible application.

The reader might like to note that EDI itself is to become big business. The 1987 United States market for EDI services was estimated (by an Input survey) at $90,000,000; the 1991 figure is expected to be $1.3 *billion* by 1991. This will make it a major slice of the total information technology market place in the 1990s.

Origins

We all know about the early competitive attitudes to data interchange systems in the USA; we might not have thought of them as the early signs of a global trend for standardisation, but that is what they were. American Hospitals and the McKesson Drug Company are frequently quoted as examples of the successful competitive application of information systems. They were also the seeds of future problems because the underlying ad hoc proprietary standard had to be maintained in the face of continuing new communications technology; from the early competitiveness there grew an unexpected interest in co-operation so that the maintenance problem could be shared. In addition, industry pressures for standard solutions became overwhelming and the early players became at risk of isolation. The US chemical and trucking industries in particular have worked towards national standardisation through support for the work of the ANSI (American National Standards Institute) X12 committee and the EDI architecture which is embodied in their work.

The United Kingdom was equally active. Frank Taylor and Ray O'Connor (both of whom are still very active in the UK) were instrumental in starting work in the very early days at the NCC (National Computing Centre) in Manchester. Here in the UK the commercial competitive element was barely evident and there was much more interest in making standards work to everone's benefit. The early proposals for standardisation work were rejected by ISO due to a lack of interest but, when it finally picked up, the competition between the different European standardisation agencies (basically France against the rest of Europe) more than made up for the lack of commercial competition.

The world of finance provides the best established examples of the electronic exchange of information: in some parts of banking it has been normal practice for a very long time. Out of the habit of using the telex for so much financial information exchange grew the SWIFT network; this allows instantaneous transmission of instructions from one bank to another. In addition, there is currently much in development between the credit card companies, the banks and the retail trade. The transmission of transaction information between retailer and credit card company (or bank) at the moment of sale is becoming routine.

The heartland of EDI, however, is data interchange in the general case between *any co-operating businesses*. Whilst there is no reason why purely financial information should be excluded, the main interest is in replacing routine business documents with streams of structured electronic data. Surveys have attributed up to 10% of the costs of imported or exported goods to procedural and documentary overheads and in the freight forwarding industry there have been a number of examples of special purpose systems including Air pak from Freight Computer Services, and Unitel from McGregor Sea and Air Services. Although their functionality was very highly specified and the systems contained much that was admirable their use was limited.

The first widely available example of data interchange in the UK was TDI - a standard for trade data interchange developed (with supporting software known as INTERBRIDGE) by a UK "quango" called SITPRO (Simplification of International Trade Procedures) [2]. This organisation, supported by government and with revenues from sales of software, documentation and consultancy services, had (and still has) the following objectives:

- to clear procedural obstacles concerning imports and exports to the UK
- to achieve efficiency in delivery and payment
- to modernise information systems (both paper and electronic).

TDI has found wider application and is the basis for much work in the Article Numbering Association which is relevant to the retail and distributive trades. We will return to TDI later, and use it to illustrate more carefully how EDI works.

There is a tendency to associate EDI with the technology of information systems. This is entirely wrong, and one of the purposes of this paper is to show how matters of policy and strategy are raised by the introduction of EDI. The problem may be because EDI is so often referenced in the same breath as OSI - the international framework for communications standards. Whilst it is true that a network is usually a main feature of the implementation of EDI facilities can be obtained quite easily from third-party sources and EDI is much more concerned with purchasing policy, customer and supplier relationships, and the awareness of the industry at large. Figure 1 shows how EDI sits right at the top of the seven layers of OSI.

The relationships between EDI and OSI are not yet well formed, but more recent standardisation work (for example the X400 standard for information exchange) is now making firmer connections. The average business need not be too concerned about this: EDI services including networks are easily acquired from third party sources who have the necessary expertise - more of this later.

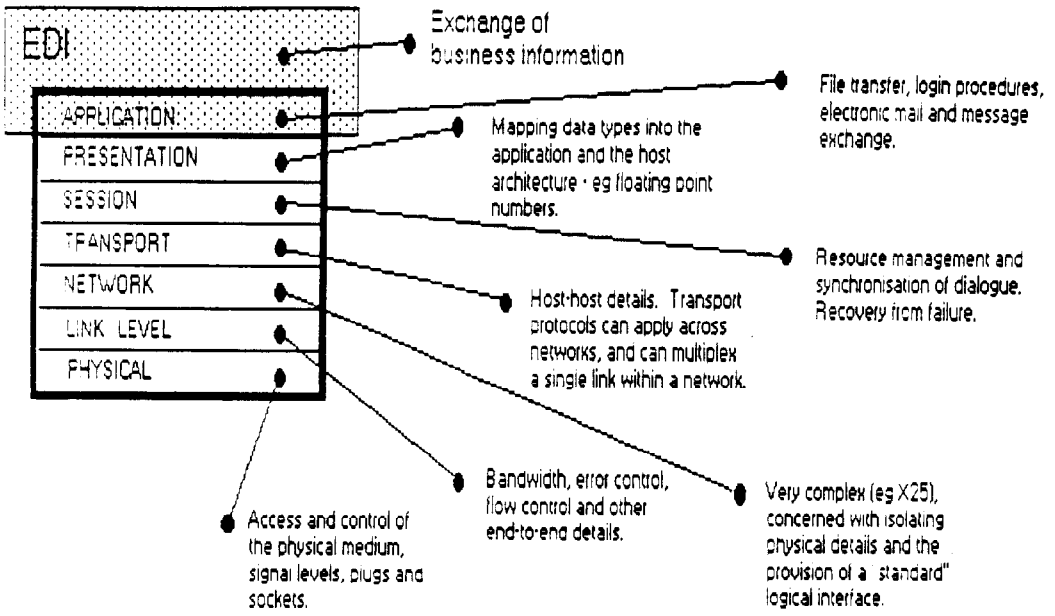

FIGURE 1 - THE OPEN SYSTEMS INTERCONNECT 7-LAYER MODEL AND EDI

Current state of play

The technical aspects, then, are not the most important. Any business contemplating EDI for efficiency reasons should take account of the broader issues. In the beginning it seems that EDI is no more than a standard for *data structures* but in terms of implementation it has an effect upon *business procedures* as well. For example, it makes possible a completely new approach to the invoicing and payment cycle: conventionally we invoice as soon as we possibly can, and delay payment as long as we can. There are often complex relationships between payments received and the individual amounts billed - how much time is wasted in accounting offices trying to allocate payments to invoice details? The introduction of EDI permits a more rigorous approach and can provide clear attribution of payments on the part of the payee. The overhead involved is trivial and the auditability of the accounting function ought to be much more straightforward.

We should regard EDI at three different levels:

- There is the physical connection of the computers, which is a matter for the technicians. It can easily be dealt with by procuring EDI facilities from third party suppliers such as ICL GEISCO or ISTEL, any of whom can provide networking facilities.

- Then there is the amendment of current applications software to facilitiate the transfer. It can be by re-programming the application (sales order processing, goods receivable or whatever) to incorporate the link directly, or by putting a bridge in place which will link existing applications software more economically to procured package software that will interface with the EDI network.

- Finally there is the question of any fundamental changes to existing business practice. Do customer and supplier relationships need review? Does EDI require a distinction between high and low volume suppliers (say)? What about suppliers and customers who do not want to climb on board the EDI bandwagon?

Thus EDI can affect the approach to routine business operations and can lead to a complete re-think. Why have an invoice at all? Could payment be initiated on receipt of the shipping advice? How dramatic will be the effect upon time-scales, lags and responsiveness in the payment cycle? It is not many years since it was routine practice in the North West of England for a corner shop to send a teenager round to the wholesaler with a list of requirements and a *blank cheque*. The wholesaler filled in the figures when the details of the stock that was actually collected was known. Perhaps this degree of trust still pertains in some corner of commerce, but EDI allows the same immediacy with all the accounting and management controls than we would wish to see put in place.

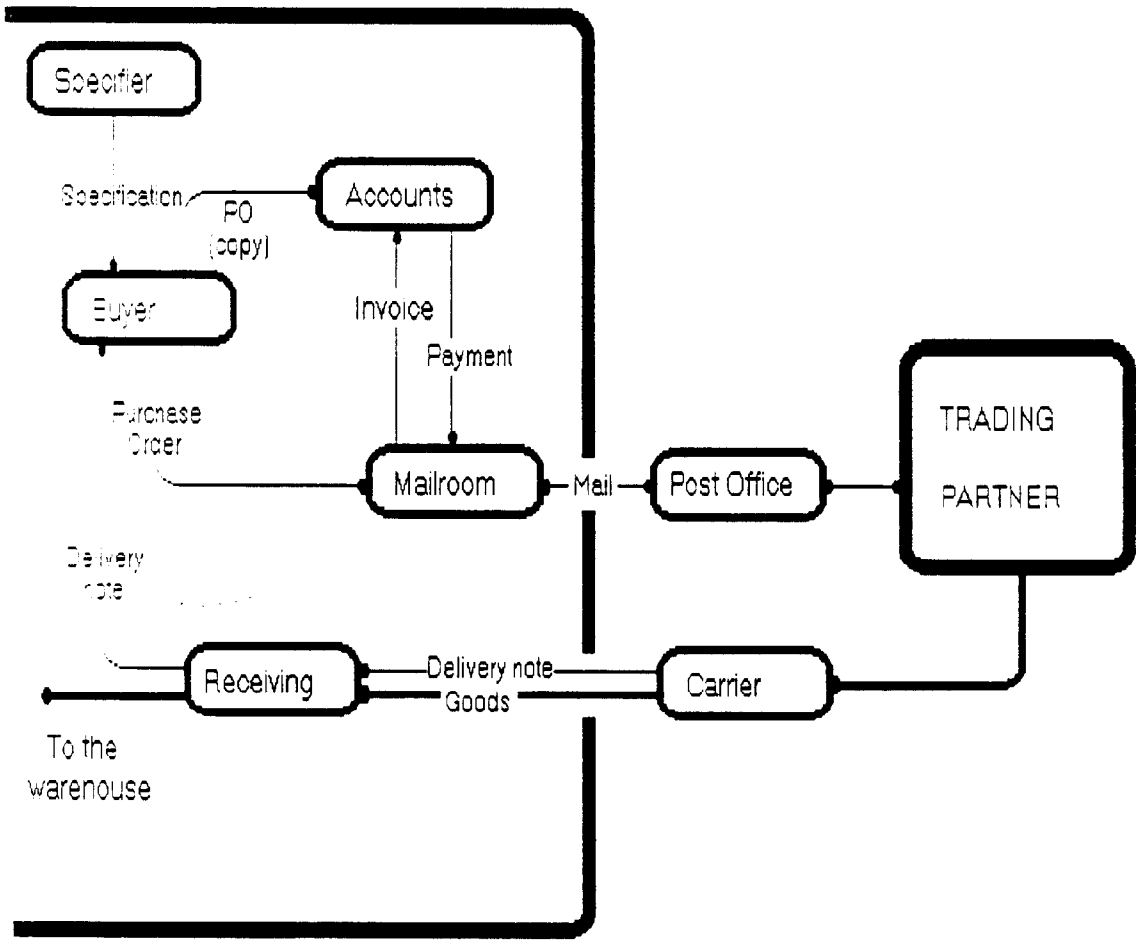

FIGURE 2a - BEFORE ELECTRONIC DATA INTERCHANGE

In practical terms the effect of EDI on the organisation seems to be marked (see Figure 2 for the "before" and "after" views of EDI) and whilst it will clearly effect the routine practices of the accounts, buying and specification functions (and the mailroom!) these are practical issues which good management should be able to deal with very straightforwardly.

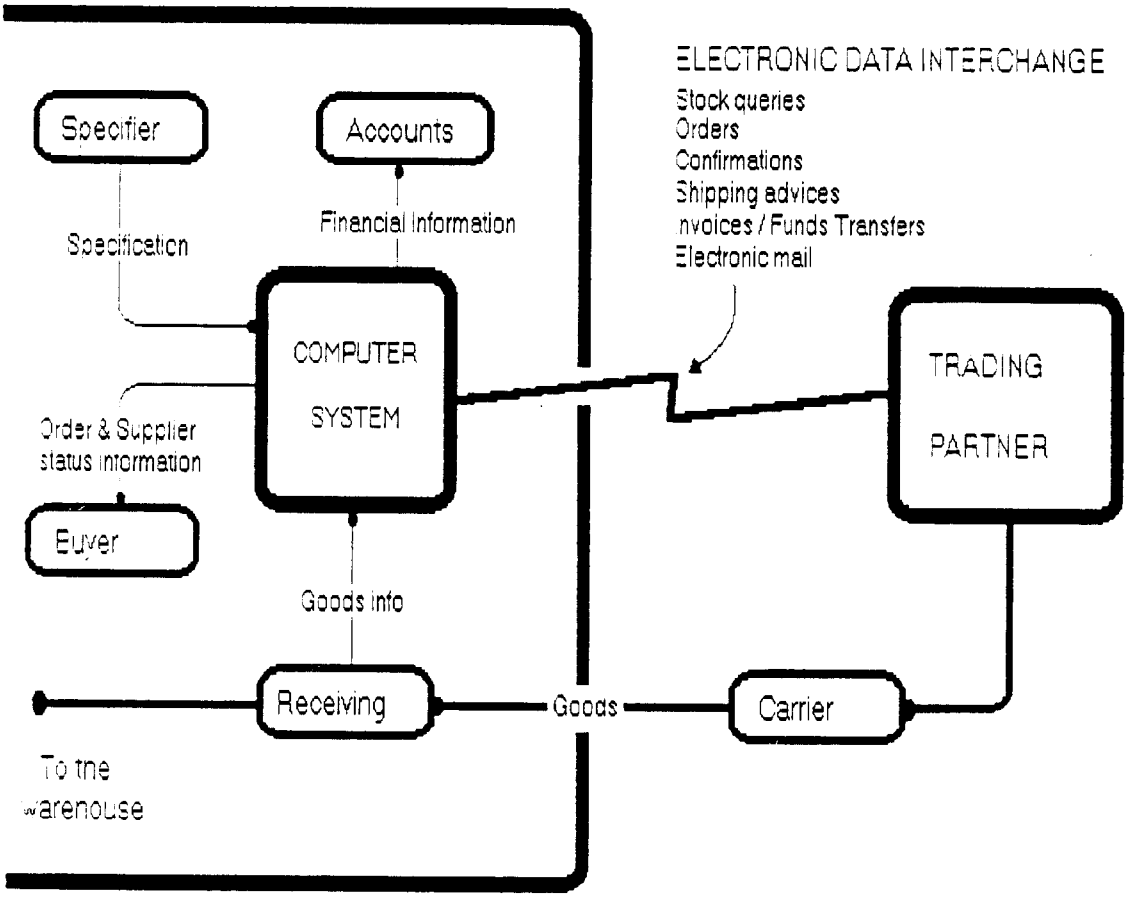

FIGURE 2b - AFTER IMPLEMENTATION OF ELECTRONIC DATA INTERCHANGE

EDI is still at the stage of requiring a distinct partnership between participants rather than providing a basis for "open" business activity. The next main development will be to throw EDI open to all comers, and provide a facility which does not require prior negotiation. Clearly, the effects of a new *open* market based upon networks and instant buy/sell decisions could well compare with the introduction of "Big Bang" in the city.

It follows that there is a deep need for education. In a "follow the leader" situation the initiating partner may find that it has a struggle on its hands to explain and encourage the commitment of the "following" partner - hence the role of the third party expert. It is easier to turn to an expert source of supply than to re-invent all the arguements from scratch. Otherwise the participants have to bear the full cost of development and this is

only viable in the case of the larger companies which have the funds to hand and the motivation to strive for the multi-million pound savings that are evidently possible. Further information on the state of play is available from the expert suppliers. For example General Electric Information Services provide introductory literature for the USA [1], and SITPRO can provide all the information that one might require in regard to Europe [2].

Implementation

So how does the typical business go about evaluating and implementing electronic data interchange? One must recognise the fact that it is still early days and that the industry has not yet begun to mature. This is the time for strategic advantage: the company that ignores EDI will find that its trading partners move ahead and take tactical advantage and now is the time to decide on the strategic approach. The following notes discuss strategy and other issues concerning implementation.

Strategic issues:

- A company could strive for differentiation and customer/supplier leverage through the medium of EDI. It is a form of vertical integration, in that the company taking the intiative can call some of the shots across the boundaries of the industry value chain and exercise control at those boundaries. In this way the initiating partner can engineer things to their own advantage.

- Alternatively the strategy could be one which aims for sharing, on the grounds that any short term advantages will be quickly eroded and the real long term benefits come from sharing, not from competing. This is the more mature view which might pay off better in the long run.

- Third, the initiating partner could consider working entirely through trade associations or professional bodies. The Article Numbering Association is one example where the association has been very pro-active in getting things organised, but there are more subtle ones: the trade association can play an important role in providing a forum for discussions and a vehicle for intra-industry standards if it wishes.

Exploration:

Any company considering EDI needs to explore the EDI options and check out industry attitudes. Within the company the right people need to be involved - senior management should be briefed and should be asked for strategic guidance to indicate the best way forward. Operational management will have their own viewpoints and it is not only the buying dept that is involved; accounts, marketing, engineering and production may all be able to see advantages within their own domain and should have an opportunity to contribute at the earliest stages.

A major issue for senior management is the assessment of the implications for business systems and the risks that might be introduced. For example:

- Data integrity: how is the accuracy of incoming data to be checked out, and how will incoming orders be vetted to make sure that they are not from delinquent or undesirable sources?

- What will be the risk that the network introduces additional sources of insecurity? Some networks which are truely open are in use by people who may have only frivolous or mischievous intention.

- Is there any risk of a loss of management control? There ought to be the opportunity to improve control, but it needs to be *planned in* otherwise it might result in a net loss of control.

- What external dependencies might be introduced that are undesirable, or a source of risk? The third party network solves the difficulty that we would face providing an in-house network but it leaves us somewhat vulnerable in the event of industrial action over which we have little or no control.

- What potential instability derives from rapid communications in the business context with which we are concerned? (Again, remember the "Big Bang" in the City of London and October 19th 1987 ...).

Risk evaluation:

The risks from the "open network" are very relevant today. Blind faith in the ability of the network supplier to ensure security and integrity is not enough. One of the IBM world-wide networks supports a facility called BITNET which is very much used by the international community of business schools. In the run-up to Christmas 1987 Christmas Trees appeared on the screens of users of this network over five continents. It was not an expression of the seasonal greetings felt by the management, it was initiated by a graduate hacker on BITNET in West Germany. It was an example of what has become known as the software "virus", an extraneous software routine that self-replicates across different systems when disks are copied from one to another or (as in the BITNET case) which self-propel themselves around a network as the users log on and off. To date there are no guaranteed ways of protecting against the software virus.

The overall increased risk will also be found in more mundane things such as new external dependencies, additional equipment failures and a failure to pick the right standards where there is no agreement. An assessment of all risks is a necessary part of en EDI evaluation.

Experimentation:

Experimentation is an important part of the early investigation. Despite all the assistance that is brought in, there will be lessons to be learnt within a single business that are not to be seen elsewhere. Some initial difficulties solved in "prototyping" mode will save enormous difficulty and embarrasment later on. It must be remembered that external parties are involved and it is worth getting the final implementation right first time.

Experimentation will also help to determine who is interested and who is not. After all, not every supplier and customer will necessarily want to go online and the business might have to adapt to live with both. As was learnt at the start, IBM are going for their top 2,000 suppliers and the oil industry closed ranks and did it internally within the industry. What did they do with all the others with whom they do business? Equally the EDI approach might not suit all products. Perhaps some simply can not be sold without conventional negotiation or specification.

Direct or indirect?

An important tactical question is the extent to which existing applications should be changed. The basic option is to build bridges - hopefully with standard bridging software like INTERBRIDGE which minimises the effort involved - or to integrate so that EDI related processes benefit from the EDI facility in a more immediate and direct way. A basic guideline is that existing batch systems can be easily dealt with by bridges; real time systems provide a clearer opportunity to go direct to the EDI link but will involve a good deal more work, of course.

Testing procedures:

EDI has a tendency not to sit still. Something is always changing, and installed EDI-related systems will need re-testing whenever they are updated. This testing will involve all of the partners, and it is necessary to establish testing procedures which will ensure the correctness of any new versions of the related systems. Because all of the partners will be involved getting these tests specified, agreed and implemented is a larger task than the testing of internal systems.

Networking:

Providing the network might be the easiest part. The third party solution eliminates all of the difficulties and much of the technical risk, but it is not always the best way to go. It will cost money. If EDI is a facility that is to be used mostly during the day, it might be that in-company networks are available and not heavily used during the day because their primary purpose is for overnight transmission of bulk data between head office and branches. It might already offer a gateway into public networks which ultimately link through to a majority of the partners involved.

At this early stage in the EDI business every situation will be different and there are no general rules. A major sticking point might be the question of who is to pay for the additional costs of all of the required networking. A self-centred organisation might try to put the costs onto the customer (and risk losing them when another supplier chooses to share the benefits of EDI), whereas a more aggressively competitive organisation might offer the networking completely free of charge if it is determined to increase its share of the overall market. It is a good idea to analyse trading volumes by trading partner. By the 80-20 rule it will often be found that a minority of customers (or suppliers) account for the majority of the business, and the cost-benefit equation can be optimised in some way.

Education:

Critically important to success is education. After any piloting exercises, when the pros and cons are better understood and the ground rules have been established it will be necessary to educate all of those involved. Where there is a "follow the leader" effect the leader, inevitably, carries most of the educational load. Cummins in the USA make diesel engines and wanted to go EDI. They adopted the policy of sharing rather than dominating and their chosen tactic was to remove all the *barriers* that might have prevented suppliers going the chosen route - EDI on the CDC (Control Data Corporation) network. This involved a lot of education, but was confined to a few partners: on their sales side only ten customers represented 90% of all sales volumes and they are now all on EDI.

Education does not finish at the conclusion of implementation. An energetic programme of follow-up activity will ensure that teething problems are dealt with and that all of the benefits are exposed, understood, and shared by all the participants.

Standardisation

Standards are, inevitably, a key issue. Internationally there is still some jockeying for position, but we should expect that over the next few years there will be some stabilisation. The EDI phenomenon will mature and settle down in time. The way to incorporate EDI into standard business practice will be much more obvious, and we might even find that start-up businesses are able to take the EDI option as a single simple step which eliminates many of their administrative problems. At this point EDI will no longer be a strategic issue, or course.

The nature of an EDI standard:

What is an EDI standard? By what specific means are we able to define how data is transferred? Is it all technical jargon, or can anyone understand what is going on?

EDI standards are not difficult to understand. The main feature is the concept of generality in data structures and the definition of an overall structure for data exchange that defines precisely how to start an EDI session, how to identify data as opposed to control information, how to ensure there are no errors, and how to "tag" or label standard data elements and non-standard ones.

The TDI standard is an example of a standard approach to the packaging and identification of business data structures based upon:

- a restricted dictionary of all of the data elements that might occur
- a degree of prior negotiation between the co-operating partners, and
- implicit rather than explicit semantics (through the dictionary references, which indicate to some extent how the data should be interpreted).

Each of these features can be seen as a restriction or disadvantage. We would wish to replace the restricted dictionary with one that is open and able to expand dynamically to incorporate new structures (each equivalent to a document). It would be preferable to start with no need to negotiate between partners, and explicit semantics would help to create this more open approach to data interchange.

A simple view of the stucture of the TDI syntax is given in Figure 3. The structure is given in the form of a structure diagram, the nature of which will be familiar to anyone who has learnt the disciplines of structured programming. For those who have not, a few simple words of explanation:

- The diagram is a hierarchy where any individual box represents the sum of all that comes below it: it is therefore a data decomposition diagram.

- An asterisk "*" indicates repetition, ie a box annotated thus can occur many times.

- A letter "O" indicates optionality, ie from a set marked thus one must be chosen.

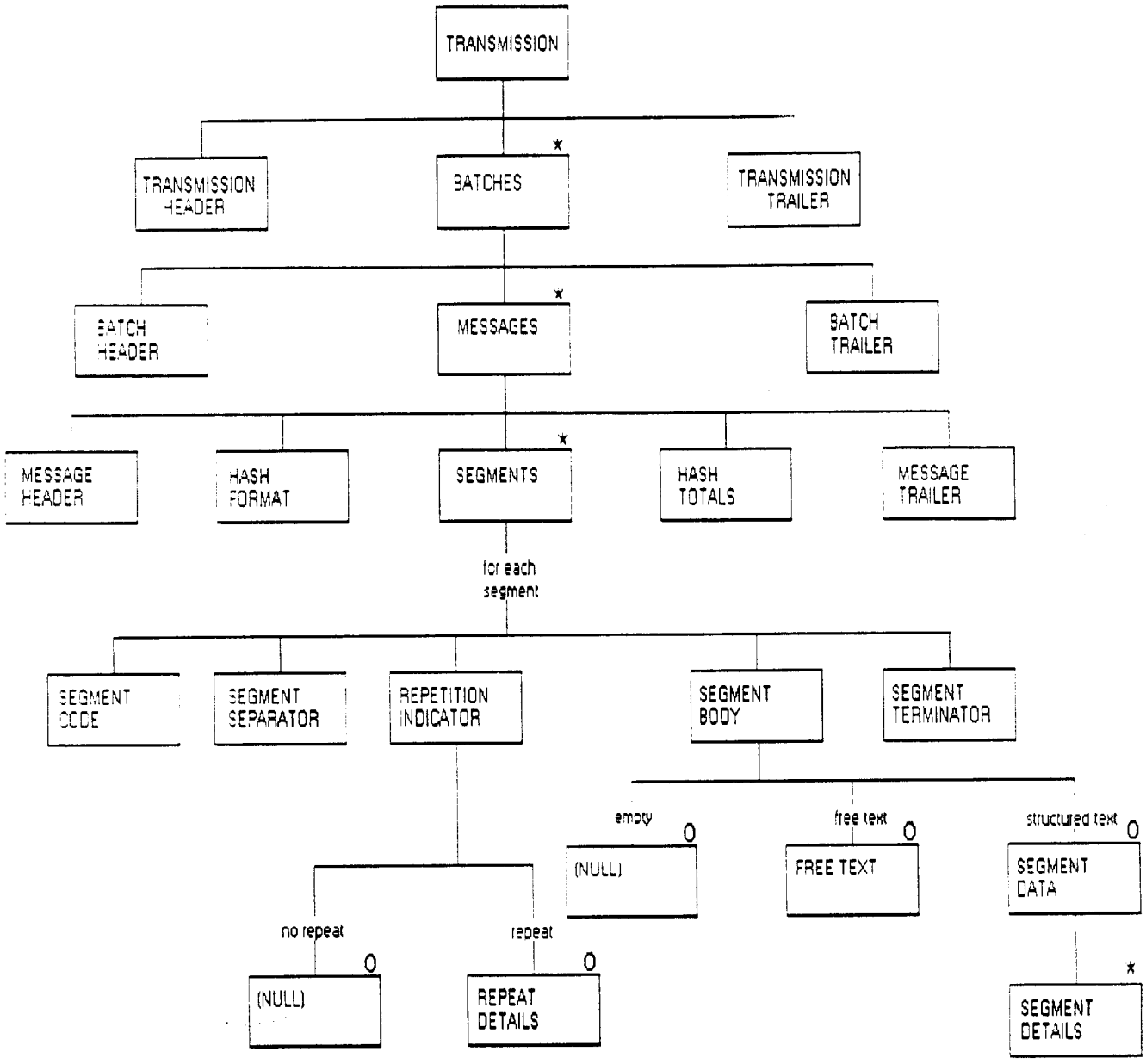

FIGURE 3 - THE STRUCTURE OF TDI SYNTAX

Thus (by inspection of the diagram) a **transmission** is made up of a transmission header, followed by one or more batches of data, followed by a transmission trailer record which terminates the exchange in an orderly, controlled way. Each **batch** is composed of a header and trailer between which are one or more messages. The structure of a **message** is a little more complex, because as well as a header, trailer and the substance of the message - the segments - there are elements which determine the hash total format and (after the message segments) the hash control totals. This hash totalling mechanism is used to verify that there has been no loss or corruption of the data.

Message **segments** are still more complex. The diagram is self evident and having shown how it is to be interpreted (above) there is no need to go through in detail. Features of message segments, though, are that they have codes which identify them in the dictionary (for example a code might identify a customer name, address or post code, the detail of one line of an invoice, or a VAT total). At this detailed level every component part of a typical business document is specifiable. Some segments will repeat many times (such as the lines in an invoice), and there is a flexible mechanism to deal with this; the content of a segment may be free text, or it may be delimited in some way (as would be a currency amount, a percentage or a total). A segment might be omitted in which case we need to be able to say so, hence the idea of the "null" segment - the equivalent of the technical manual which has pages labelled "This page intentionally left blank"! At least this avoids the confusion of having to wonder whether a mistake has been made or not.

The TDI standard goes much further into a great deal of detail. The content of all of the headers and trailers is specified, and the specification for the content of segments continues to several levels of additional detail. In all there is probably 10-15 times as much detail as given in Figure 3, but none of it is incomprehensible and *nowhere is there mention of computers, communications mechanisms or programming*. It is possible to package up a message according to the req uirements of the standard and then simply write it down on paper - or write it to a disk, or a tape, or send it down a telephone line. To the TDI standard, it simply does not matter what medium is used.

Given a standard such as this, the reader can possibly imagine how much more straightforward it is to "bridge" out of one's own computer systems into the world of EDI. All the structure and control is given and it is only necessary to take the existing business information in the computer and plug it into the appropriate slots. It might be necessary to convert the data in some way, for example to divide an address down into its component parts or to separate product codes and descriptions, but this can be easily done if existing systems are properly documented and still used in accordance with the original specifications. (Regrettably there are too many instances of computer systems which have not been used consistently: a spare character position in the product code field is "hi-jacked" to be used for identification of product status, or a code originally intended to show the geographic location of a supplier is used to also indicate his credit status. In evolving old systems to meet changing needs it is all too easy to take this approach, and it can lead to chaos later on when the data is let loose outside the boundaries originally envisioned for the system.)

With third party software such as INTERBRIDGE the problem of extracting of exisiting data is minimised. The functions of this kind of bridging software include:

- message construction (insertion of syntax characters, suppression of extraneous data, numbering messages and segments, construction of controlling hash totals), and

- message disassembly (separation of transmission and data segments, validation against tables and controlling hash totals, character conversion to internal formats (if required), writing of output data records).

To quote an authority in the USA, technical standards for EDI have reached something equivalent to "puberty". This is a useful way of putting it: it is great fun growing up but at the age of puberty there is a great deal of false confidence and mistaken judgement. It is quite astonishing, for example that a recent review article in Datamation [3] analysed the world of EDI but failed to make any explicit mention of the international dimension, possibly the most important feature of all. It is true that there is no single standard in

place, but there can be no doubt that EDI will further the shrinking of the globe, and lead to new markets and new business alliances such as would never have been imagined even five years ago.

Future implications

The implications of EDI are wide ranging. What, for example, might be the implication for funds transfer and cheque clearing systems? Will there be any role for the banks to perform in support of commercial transactions in the future? Will the banks recognise that they could (should?) be getting into the front line EDI business themselves?

In the interim, and in the general case, business might be drawn into EDI in different ways. A business might be:

- forced into EDI by a more powerful partner
- tempted into EDI by potential cost savings
- improved by finding better business practice through EDI
- expanded by finding new trading partners through EDI markets.

Each of these is a challenge for management to think about.

In looking to the future, the role of the regulatory bodies could be crucial. What would be the effect of a radical and restrictive government that wanted to regulate (or even tax?) EDI activity? Today there are already some problems internationally. At the last time of checking it was still illegal in West Germany to move data across the national boundary without authority. For example, to run a demonstration of the UK Prestel system in West Germany using the international telephone system is to break German law.

On the other hand, the regulatory bodies might find a constructive role by adopting clearly specified standards themselves and thereby sweeping away some of the commercial confusion. Within the National Health Service there has been agreement on basic data structures which are recognised and will be implemented in all NHS and regional health systems (the Koerner proposal). The purpose is greater than EDI alone - it is intended to provide a standard basis for hospital and community health care data files and also for management, analysis and reporting. Although it is easy to critisise the Koerner proposals on the grounds of incompleteness and (in some small degree) inconsistency, this is to deny the importance of the idea and the fact that pressures to adopt such proposals as these will become irrepressible in the future.

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