BUSINESS PROCESS REDESIGN USING EDI: THE BHP STEEL EXPERIENCE

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ABSTRACT

EDI should not be seen as a competitive weapon - it does not offer a sustainable competitive advantage to its users as did the earlier inter-organisational systems (such as the various airline reservation systems). Instead, EDI provides a standardised infrastructure upon which an adopting organisation can reengineer its business processes and thus confers a long-term, strategic and comparative advantage upon such an adopter. The potential for sustained competitive advantage to be derived from EDI arises from its integration with the organisational structure of its implementor, depending upon the implementing organisation's ability to redesign its business processes appropriately.

This paper examines the case of (arguably) the most sophisticated EDI-using company in Australia, BHP Steel, demonstrating the advantages obtainable by an organisation using EDI as a foundation for its re-engineered organisational structure and business processes and concludes that:

- there are real benefits to be obtained from an inter-organisational electronic trading strategy founded on EDI as the enabling mechanism - benefits which are considerably more extensive than EDI's comparatively simple technical nature would appear to offer;
- organisational gateways utilising an Application Generic approach to system integration and isolating the communications issue by insisting on the use of international data communications standards do offer a realistic and successful solution to the problem of internal and external trade for large and sophisticated organisations;
- the majority of these achievements would have been either unlikely or totally impossible without BHP Steel's commitment to organisation-wide Business Process Redesign.

INTRODUCTION

The major problems associated with involvement in EDI are not primarily technical in nature, but may rather be the result of inefficiencies in corporate information systems analysis and design - or, alternatively, might result from a lack of top-level management support (this postulate was first discussed in Swatman and Clarke, 1990; and further developed in Swatman and Swatman, 1991a and Swatman *et al*, 1993). This lack of organisational acceptance, in turn, implies that the broad organisational integration and re-evaluation of structure and function which Wilmot (1988) and Benjamin, De Long and Scott Morton (1990) regard as essential for strategic gains from EDI may require further exploration.

It has now become almost an article of faith within the EDI community to claim that "EDI is 90% business and 10% technology". A wide variety of writers within both the trade and academic sectors provide support for the view that EDI should be regarded as a strategic issue, rather than as a technical problem (see, for example, Sadwani and Sarhan, 1987; Robinson and Stanton, 1987; Patrick, 1988; Lyttle, 1988; Skagen, 1989; Rochester, 1989; Emmelhainz, 1990; Swatman and Swatman, 1991a; 1991b; 1991c; Vogel, 1991).

The failure to validate this view is largely due to the difficulties of separating EDI's technical aspects from the organisational issues of implementation and integration. Prospective users of EDI have tended to view both aspects of the total EDI system as falling within the domain of their own I.S. department. Since the creation of an EDI communications system is unquestionably a complex and difficult task, such a technical difficulty naturally becomes the focus of concern within a technically-oriented department.

The results of multiple case study research reported in Emmelhainz (1987), Benjamin *et al* (1990) and Swatman (1993) provide some support for this view, indicating that larger organisations in the U.S. and Australia are taking an increasingly sophisticated view of EDI's role as an enabler of long-term change. These case studies do not, however, provide a detailed picture of the decisions made by such organisations or of their longer-term, EDI-based strategies. This paper is intended to extend that

picture, describing a single, in-depth case study which complements the earlier research and offers insights into both the potential which EDI holds for business process redesign and into the likely pattern of such EDI integration. The paper is therefore a description of one company's experience of using EDI as an enabling infrastructure for EDI - later research will explore the generality of the conclusions drawn from this exemplar case study.

Clearly, in an environment such as Australia's, where fully-integrated EDI is still in its infancy, any organisation which had consolidated EDI with its business processes would be suitable for such an investigation. My aim was, however, to find an organisation which had:

- reached a level of maturity sufficient to enable successful planning for technical and business process redesign; and
- taken a considered decision to develop an integrated approach to EDI and inter-organisational systems - a serendipitous fall into integrated EDI would not be sufficient.

Identifying an organisation's level of maturity was the more difficult of these two conditions to meet. In defining the MIT90's framework, Scott Morton (1991) describes organisations in terms of five forces which remain in dynamic equilibrium as the organisational context changes. Of these five forces Scott Morton considers *management processes, structure* and *individuals and their roles* to be critical to any organisational transformation. I have already argued (in Swatman and Swatman, 1992) that if organisations are to change as a result of evolving technology, they must focus on the culture of the organisation (as represented by the organisational structure and by the roles and tasks of individuals). It is clear, therefore, that organisations which wish to enter a *considered* transformation (which can be equated with the term "re-engineering", or with the concept of business process redesign), must take a holistic view of these five forces and their interaction. An appropriate candidate for this case study, then, must be aware of the implications which an integrated approach to EDI holds for management processes, organisational structure and individuals within the organisation.

Galliers (1991) points out that IS strategy should be strongly embedded in business strategy, feeding off and into the business strategy process - which in turn feeds off and into the organisation's business environment. Further assistance in identifying an organisation capable of acting as a "critical" case study of EDI integration is provided by Galliers and Sutherland (1989, 1991a, 1991b) in their model of the stages of I.T. growth in organisations, which provides a six-level classification of the stages of organisational maturity. Only those organisations which have reached stage 5 or 6 of the Galliers and Sutherland model could possess a sufficiently mature approach to the MIT90's five forces and have the ability to plan for the use of information technology (and EDI in particular) as an enabler of business process redesign. To find an Australian organisation matching both these *desiderata* I needed an organisation which had achieved a holistic approach to its management processes, organisational structure and individual staff roles - and which had applied this holistic view to long-term planning for an EDI-based approach to business process redesign.

From the group of possible case study candidates (which included, *inter alia*, Coles-Myer, the four automotive manufacturers, Australian Paper Manufacturers (APM) and the Australian Customs Service) I selected the BHP Steel Electronic Trading Project (ETP). BHP is Australia's largest company, with assets of A$22 billion - and the BHP Steel subsidiary itself is larger than the majority of Australian organisations. Long before the commencement of the Electronic Trading Project, BHP was already committed to formal planning for both organisational and technological change. The Electronic Trading Project itself was the result of several years of preliminary analysis and strategic planning and followed a development path based on clearly defined goals.

An internal BHP document reporting the results of preliminary investigations into the need for such a project stated:

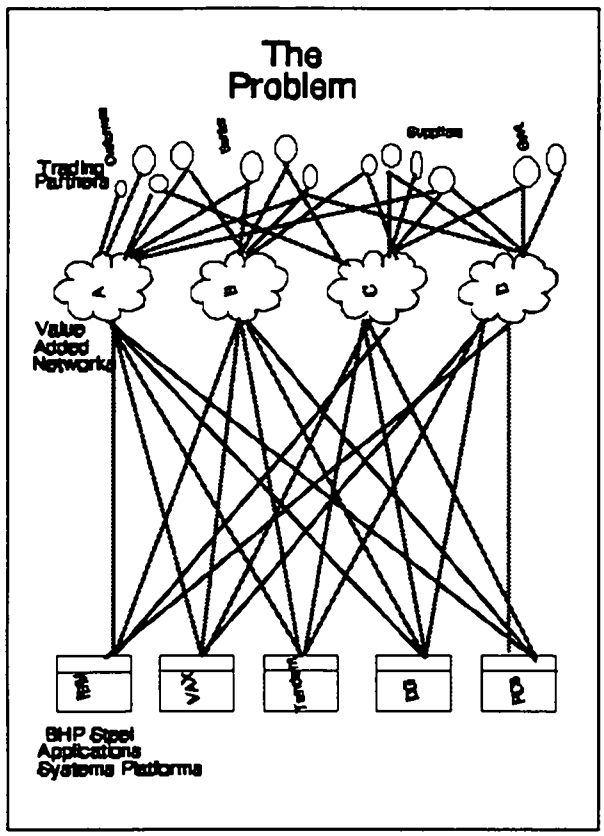
> "Traditionally EDI has been driven by customers down to their suppliers, but BHP Steel has seen a unique opportunity to be pro-active and initiate EDI with our customers. By taking this initiative we can create business benefits to both BHP Steel and our customers (the partnership approach) as well as achieving extensive savings in administrations costs, stock holding, error reduction, manufacturing efficiencies ... flowing from this was the realisation that BHP Steel need to develop an EDI strategy to cover all the elements of electronic links with our customers and how such links could be converted into value-added servicing that can give BHP Steel a competitive edge." (BHP Steel, 1989:4).

A further advantage of the Electronic Trading Project was its development along strictly controlled project management lines, with BHP Information Technology (BHP IT) being contracted as technical

project manager and controller for the project in June 1990 (Hunt, 1992). This approach enabled a separation of the strategic, top-management decisions regarding organisational processes from the tactical decisions regarding implementation issues and the resolution of technical problems.

BACKGROUND TO THE ELECTRONIC TRADING INITIATIVE

The Electronic Trading Project Rationale



Although BHP had been using inter-organisational systems for many years, these tended to be non-standard systems involving very limited groups of users (mostly drawn from BHP subsidiaries) and having widely varying protocols for data, formats and media. Hunt (1992) points out, however, that during the late 1980's a number of BHP Steel's divisions became involved in true, mainstream-standards-based EDI projects, using a variety of value-added network providers (VANs). As the number of these projects increased it became evident that this decentralised approach was likely to lead to longer-term problems - BHP Steel's trading partners would increasingly find it necessary to connect to a variety of VANs, each potentially using either different standards or differing versions of the same standard.

Figure 1 (adapted from an unpublished 1990 BHP IT presentation) illustrates the problem of multiple connectivity as the organisation perceived it at that time. It was apparent that BHP Steel needed a long-term solution to this problem which would provide both inter and intra-organisational connectivity and which would act as a strategic focus for the organisation's business restructuring.

The Electronic Trading Project Solution

In April 1990, following an 18-month study by a Steel group Steering Committee (composed of senior managers from both business and technical areas within BHP Steel Divisions) which assessed the EDI strategies of other companies world-wide, BHP Steel initiated the "Electronic Trading Project" (Fuller, 1990). The result of the study, its analysis, discussion with other EDI implementors overseas and a formal planning process was the following proposal:

"... that BHP Steel introduce international standard EDI with customers via an Electronic Trading Gateway, in order to gain competitive advantage by focusing on customer service. The Gateway approach enables the different divisions of BHP Steel to present a common face to all customers at minimal cost and with minimal duplication of effort, and will be a significant step in making BHP Steel our customers' preferred supplier on a long-term basis" (BHP Steel, 1990a:3).

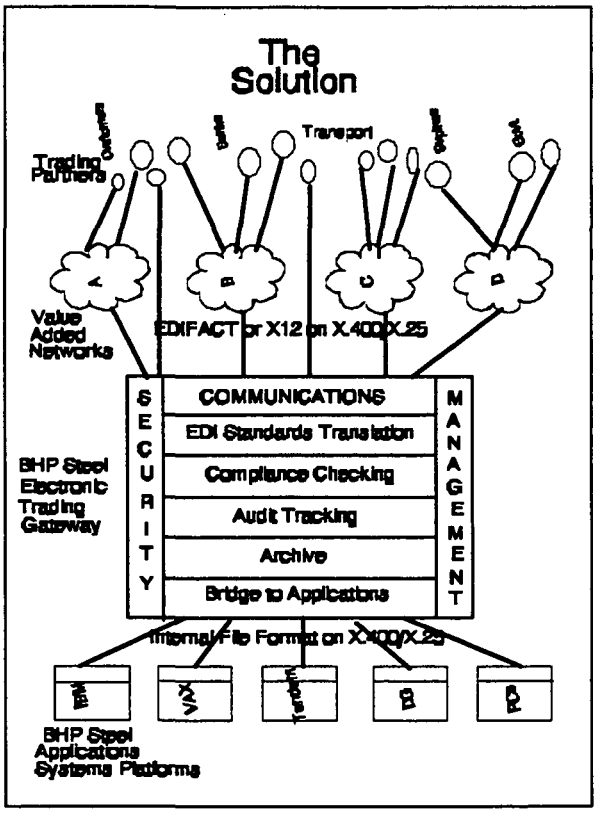


Figure 2 (adapted from a 1991 BHP Steel newsletter) illustrates BHP Steel's gateway solution to its multiple connectivity problem. Despite the lack of widely-accepted texts relating to the subject of "Corporate EDI Gateways", it would be generally agreed that such a gateway comprises a number of modules providing the management and control facilities needed by large and complex corporate EDI systems. These facilities include:

- EDI message construction and translation:-
  - translation between application software package standards and some agreed-upon inhouse "standard"
  - queue management for both in and outbound documents
  - translation between this in-house standard and the various EDI document formats (such as ANSI X12, TDI or EDIFACT)
  - "compliance checking" of arriving messages to ensure correctness;
- transmission between the organisation's internal data communications standards (X.400 or a local area network standard such as IEEE 802.3) and those of the recipient, who may be a value-added network service provider (in which case X.25 would be the most likely standard) or a trading partner (who might very well be using X.400 messaging);
- session management and directory services maintenance (such as X.500);
- full delivery audit facilities;
- security and management features;
- call-logging facilities, designed to enable the operation of a service desk;
- the creation of trading partner relationships and the establishment of trading partner profiles; and

- a variety of optional additional services, such as support for interactive database queries.

The BHP Steel Electronic Trading Gateway (ETG) was based upon an existing commercial product (Digital Equipment Corporation's DEC/EDI™ package), but the company has been extending the DEC/EDI concept to include the additional features mentioned above and has now completed most of these features. An important feature of the BHP Steel initiative is the decision to use exclusively universal standards for both data communications (OSI/X.400/X.25) and document translation (ANSI X12 and UN-EDIFACT). Hunt (1992) explains that this decision was the result of BHP Steel's earlier experiences with a variety of more or less proprietary inter-organisational systems and value-added networks. The ETG's developers hope to obviate the need for constant re-development as value-added network providers and trading partners become more sophisticated and more focused on international markets. Davenport and Short (1990) point out that IT is continuing to evolve and that new technologies will have a substantial impact on the processes used throughout the 1990's. They suggest that the IT infrastructure be sufficiently robust to support newly emerging applications appropriate to a particular process.

A significant decision by the original Electronic Trading Project committee was to appoint a full-time Marketing EDI Project Manager for a period of at least two years (later extended for another two years), who would take responsibility for the project and become the "EDI Champion" within both BHP Steel and BHP IT (BHP Steel, 1989; 1990a). The importance of the EDI Champion and senior management support for EDI implementation and senior management commitment was found to be a crucial factor in effective business process redesign by Davenport and Short (1990), who point out that strong, visible commitment from the highest levels of management convinced staff that redesign was critical to the organisation and that IT would play an important role in this redesign.

This decision is very similar to those made by Levi Strauss in the United States, or Tesco in Britain - both organisations which are cited widely (see, for example, Rochester, 1989; Dubois, 1990; Baker, 1991; INS, 1991; Harris et al, 1992) as ideal examples of how to implement EDI.

BHP Steel sees the Electronic Trading Project as the first measurable step in achieving a fundamental change in the way it conducts business. The project is expected to bring long-term benefits to the organisation and to its trading partners in the areas of:-

- closer trading relationships
- increased sales and service
- competitive advantage
- more efficient business practices
- reduced order cycle time
- lower inventories
- reduced clerical errors and invoicing disputes
- freeing staff from traditional roles.

STRUCTURE OF THE ELECTRONIC TRADING PROJECT (ETP)[13]

The overall plan, envisaged in the original proposal (BHP Steel, 1990a) was to implement the Electronic Trading Gateway at BHP IT in Wollongong and to start trading an initial set of documents (purchase orders, purchase order amendments, order status and despatch advices) with the major Steel Institute of Australia distributors (that group of customers common to the majority of the BHP Steel business units). The complexity of BHP Steel's divisional structure provided a real advantage to the project's developers - before starting "live" operations with these customers, the system would be fully tested internally by creating links between selected BHP Steel business units having customer-supplier relationships.

Beyond these short-term goals, the Gateway was intended to serve as an EDI translation and communications hub for *all* documents with *all* trading partners (including customers, suppliers,

[13] The following brief description of the Electronic Trading Project has been derived from a number of sources (BHP Steel, 1990b; BHP Steel 1991a; BHP IT, 1992; Hunt, 1992; BHP Steel newsletters on the Gateway project; and interviews with senior personnel at BHP Steel and BHP IT directly involved in the project).

banks, the Australian Customs Service and transport companies) of both BHP Steel and other BHP groups. Longer-term plans anticipated the extension of the Gateway to provide additional electronic services such as email and interactive database access. Above all, the Gateway was seen as a key element of BHP's communications strategy.

Another major objective of the project, identified in the original proposal, was the establishment of a Steel Industry Working Party (SIWP) associated with the EDI Council of Australia (EDICA) and involving BHP Steel, BHP IT, EDICA, major customers and value-added network providers. The Working Party's mission was to develop a set of agreed standards for the initial EDI document set in the form of an industry-wide Implementation Guide for EDI document standards - and to involve as many other industry groups as possible.

In view of its size and complexity, the Electronic Trading Project was divided into three development stages, which are briefly described below:

Stage 1 - Initial Pilot

This stage had a strong marketing focus - initial business documents were selected with the intention of improving ordering efficiency and materials management. Activities included:

- the development and testing of the Electronic Trading Gateway
- initial application link testing by means of inter-Divisional pilots (S&CP ordering from SPPD and LBI ordering from S&CP) and
- a successful EDI connection between one Steel Division and its major customers (Tubemakers of Australia Merchandising Division and Email Metals Distribution Group).

Fuller (1990) points out that the strongly market-oriented focus of this stage necessitated the development of a generic Trading Partner Agreement to highlight the rights and responsibilities of each party when adopting electronic trading.

Two successful cross-industry initiatives have emerged from this work:

- because BHP trades with companies in industries as diverse as Automotive, Heavy Engineering, Mining, Hardware and Retail there was a clear need for consistent document sub-sets across all these industry groups. To this end, the SIWP and the existing Heavy Engineering, Mining and Minerals Working Party (HEMMP) cooperated to produce a common Implementation Guide for cross-sectoral users, particularly members of the Steel Services Centres of Australia who both purchase from and supply to BHP Divisions. The SIWP has recently changed its name to become the Australian Metals Industry Working Party (AMIWP) - a name which better reflects the wider scope of the group;
- the Construction Industry Working Party - comprising developers, architects, builders, fabricators and manufacturers - decided to target a specific development project (the Darling Park Building in Sydney's Darling Harbour), both to examine the potential benefits of EDI and to seek the involvement of other industries, such as the Steel Re-inforcement Industry.

Stage 2 - Full-Scale Implementation

This stage was planned to involve the development of further documents and application links, together with a controlled "roll-out" of the Gateway services to trading partners (pilot testing of at least one document with each participating Division and at least one of that Division's major customers). It was also intended that this Stage would include the extension of the project to support any other BHP Steel initiatives wishing to use the Gateway. Four such initiatives were undertaken during Stage 2 (each of which is discussed in more detail in later sections of this paper):

- the integration of externally-sourced and corporate business data
- the development of the EDIFACT QALITY Test Certificate
- the incorporation of bar coding and product numbering technologies
- the Asia Pacific Economic Cooperation (APEC) EDI Pilot

Stage 3 - Project Extension

This stage of the project, which commenced in mid-1992, includes further development of other Electronic Trading Services such as electronic mail, electronic funds transfer and remote database access, in addition to continued "roll-out" to other major customers. The project was completed in mid 1993, although the Steering Committee later agreed that a central management role would be required for a further two years to ensure that the existing implementation momentum continued at its current level.

The remainder of this paper provides a more detailed explanation of the Electronic Trading Project, covering:

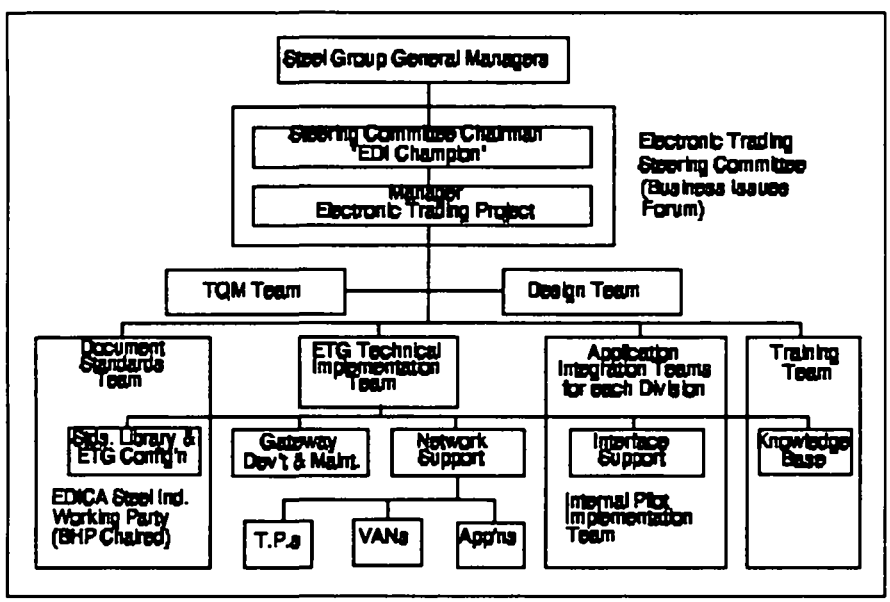
- the organisational structure of the project
- the Electronic Trading Gateway
- in-house integration software - the Customer Trading Management System
- the development of the EDIFACT Electronic Test Certificate
- the APEC multi-lateral pilot scheme
- the bar coding and product numbering pilot scheme.

While there are clear conclusions to be drawn from this single case study, it is also important to note that wider research is required before any conclusive judgments can be obtained.

The Structure of the ET Project Team

BHP Steel recognised that to accomplish the short- and long-term objectives of such an ambitious project would require a development strategy which:

- had enthusiastic senior management support
- took a "staged" approach to development
- had realistic development milestones for installation, implementation and integration.



The selection of BHP IT as technical project manager and controller provided a consistent approach to project planning and control. In addition to strong management commitment, however, the project planners found that all parts of the organisation must be involved in the planning and implementation of a project which will impinge upon the activities of all Divisions. Figure 3 (BHP Steel, 1991a:121) illustrates the organisational structure of the ETG project:

Fuller (1992) explains that two organisational strategies, in particular, proved effective in educating and involving participants:

1. the *Cross-Organisation Steering Committee*, which sets EDI policy and directs the EDI project team through a Project Manager. The group comprises legal and audit representatives

as well as Marketing, Information Systems, Supply and, more recently, International and Finance Division representatives. The group meets bi-monthly and provides the essential EDI champion in each key area of the company;

2. the *Cross-Organisation Functional Teams*, which are the real implementation "engine-room" and are integral to achieving the project's objectives. Functions include application integration, communication, Total Quality Management, mapping of document standards and system design. The project team has also recommended that BHP Business Units join EDICA as subsidiaries and become involved with the relevant EDICA industry working parties.

These strategies are exactly those articulated by writers on business process redesign (see, for example, Davenport and Short, 1990; Hammer, 1990; Morrow and Hazell, 1992) who advocate the formation of just such cross-functional teams and viewpoints.

Internal/External Document Integration - the Electronic Trading Gateway (ETG)

The overall strategy of the Gateway is defined in a BHP Steel Evaluation Report as

> "... the ability to offer a variety of value-added Electronic Trading services on an international standard communications basis to customers, suppliers and other trading partners ... the Electronic Trading Gateway is viewed as an "enabling" service. It will provide the communications and standards infrastructure on which BHP Steel's business units can build their inter-enterprise application systems to the mutual advantage of BHP Steel and its trading partners" (BHP Steel, 1990b:9_10).

The Report identifies the key elements of that strategy as including:

- a single Gateway (a network of both centralised and decentralised multiple nodes) for all electronic transmissions - whether via VAN or directly from individual trading partners, government agencies, etc.
- the use of international standards for data communications (ISO/CCITT), document translation (ANSI X12 and UN-EDIFACT), office communications (ODA/ODIF) and messaging (X.400 on X.25)
- the provision of OSI data communications between the Gateway and all appropriate BHP application platforms (DG, Digital, HP, IBM, PC's, PC LANs, Tandem)
  the provision of X.500 directory interface when available
- the ability for BHP Steel business applications to support international EDI standards for data elements directly
- the provision of remote data base access, enabling trading partners to access BHP Steel data bases (either stored on the Gateway host itself, or via the Gateway to BHP Steel host systems)
- support for encryption and authentication codes for added security (if required).

The Electronic Trading Gateway is responsible for translation between the single internal document standard and the multiple external standards used by each application's trading partners - each of BHP Steel's applications exchanges files of document data with the ETG, using X.400 and a single internal format defined by BHP. The Gateway provides a true integration facility, enabling not only the association of internal business data with externally-sourced EDI documents, but also the synthesis of data across internal applications.

The Electronic Trading Gateway offers BHP Steel a level of integration equivalent to that of stage 3 in the model of EDI integration presented in Swatman and Swatman (1991c) - "seamless integration". The ability to link internal application systems to one another through the Gateway, however, offers the possibility of stage 4 integration - "business process redesign". The following Section of this Working Paper discusses the process of integration between the Gateway and BHP Steel's various application systems, not only supporting the view that the ETG provides a seamless approach to integrating applications (both internal and external), but also considering the potential for redesigned business processes. The effects of such integration upon organisational structure and implications for business process redesign are then considered a little later in the paper.

Internal Application Integration - the Customer Trading Management System[14]

The Customer Trading Management System (CTMS) was designed to manage the electronic transmission of corporate business data from any of the organisation's IBM mainframe application systems to its recipients (either external trading partners, or other internal application systems) through the Electronic Trading Gateway - and back again.

A universal design for CTMS was initially stated in the Application Interface Requirements of the Electronic Trading Project Design document (BHP Steel, 1991a) which has since been tailored to suit the requirements of the Sales and Marketing Systems - culminating in the CTMS as it is today. This design required applications wishing to send documents to a trading partner (incoming documents from trading partners were to be treated in an analogous fashion) to:

- read the application databases and create records in the appropriate BHP internal file format for that document type (e.g. purchase order), converting internal data values to the single external standard
- combine these document records into a Mail File (multiple documents of differing document types for multiple trading partners could be accumulated into the same Mail File)

write an image of the Mail File to an Audit database to enable tracking and error recovery

- transmit the Mail File to the ETG using the Mail Agent appropriate to that particular application platform.

CTMS was originally developed to link only a single system to the Gateway, but currently links three applications within the Steel Group, with a future extension to the Slab and Plate Products Division Test Certificate Systems anticipated:

- the Sales Administration and Order Management System (SAMS), which handles product sales to customers
- the Steel Group Invoicing System (SGIS) and
- the Sales Reporting and Debtors Management system (SRDM).

Although these are separate applications, the same group of systems developers handles the mapping of outbound application-specific formats to CTMS' consistent BHP-wide internal format (and *vice versa* for inbound documents) - ensuring a consistent approach to the document conversion process for all application systems. BHP Steel have therefore decided to implement the more maintainable "application-generic" approach, ensuring a minimum of later integration problems as further applications, databases, external trading partners and documents are added to the system.

At first sight, this integration between external documents and applications (e.g. customer purchase orders and the generation of actual orders within BHP Steel's manufacturing facilities) merely appears to replace a physical paper trail with its electronic equivalent. The BHP Steel initiative, however, is intended to do much more than this - the Gateway and the CTMS pilot are the foundation for business process redesign which will effectively revolutionise the organisation's manufacturing and administrative structures, linking internal and external business information in the most effective and timely manner. The organisation's long-term approach to Information Systems - and its EDI and Electronic Trading infrastructures - is based upon the view that it is *information*, not paper-based documents, which provides the life-blood of the organisation.

The following sections of this Working Paper describe three specific, Gateway-related projects which were designed to link corporate business information and telecommunications in an effective manner:

- the first two projects relate to BHP Steel internal initiatives (although both these projects have substantial inter-organisational components)
- the third project (the Asia Pacific Economic Cooperation (APEC) EDI pilot) differs from the other BHP initiatives reported since, in this case, BHP Steel is merely one member of a multi-organisational group.

The APEC project is included in this Chapter for two reasons:

- this is a significant BHP Steel Electronic Trading Gateway project and thus throws further light on the Electronic Trading Gateway initiative; and

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[14] The following brief summary of the Gateway's activities is drawn from a number of sources - BHP Steel 1991a; BHP Steel 1991b; internal BHP Steel and BHP IT documentation; and interviews with BHP IT and BHP Steel personnel involved in the CTMS and Gateway development projects.

- the multi-lateral integration involved in this project is directly related to the subject of this Working Paper - the integration of EDI into internal applications and organisational structure.

GATEWAY-RELATED PROJECTS

Business Data Integration - Electronic Test Certificates[15]

Test Certificates are formal documents which certify the attributes of steel products (for example, their chemical and mechanical properties). BHP generates around 200,000 of such Test Certificates annually - ranging in content from simple, 1,000-character documents to reports having as many as 8,000 characters for special steel products.

Certificates are usually needed by BHP customers for one of three major reasons:

- to accompany re-sale of products by BHP Steel Merchants
- to set up manufacturing processes
- to re-use data (such as chemical analyses) in the generation of Test Certificates produced by customers themselves.

Production and management of BHP Steel's Test Certificates was formerly confined to a number of stand-alone Test Laboratories and computer applications within the organisation. Over recent years, the Steel and derivative industries have increasingly adopted Quality Assurance systems, which have made Test Certificates even more necessary to steel distributors and their customers. Simultaneously, however, the costs of paper-based document storage and retrieval have increased substantially - the cost of administering a paper-based Test Certificate system has been estimated collectively by customers at well over $500,000 *per annum.*

This problem was exacerbated by two further considerations:

- only 12%-15% of all Certificates in storage ever need to be retrieved and
- Certificates (designed individually at different times) were produced in a wide variety of formats and with a variety of headings and layouts.

Clearly, a more efficient and less costly method of issuing Test Certificates was needed.

The proposal to issue Test Certificates by means of EDI document transfer resulted from the findings of a cross-organisational review group. The group completely re-engineered the test certification process, recommending a two-stage implementation strategy:

- in Stage 1, certificates were received by trading partners in conjunction with steel deliveries (the pre-EDI arrangement). Manufacturers and fabricators gained benefits, however, from selective access to the information contained in the BHP Test Certificates - and to complete certificates at need. In the case of manufacturers who undertake additional processing and require only a portion of the information contained in the certificate, electronic receipt enables the more efficient production of their own certificates - avoiding the errors which can be introduced by manual data rekeying, as well as allowing faster data handling and the elimination of paper document copies
- in Stage 2, additional benefits accrue to trading partners from the establishment of a central database on BHP's Electronic Trading Gateway, from which customers can request certificates "on demand". This service is particularly useful to those customers having only occasional need for physical certificates.

The proposal offers overall benefits to users which include:

- more rapid Test Certificate availability
  reduced handling requirements
  reduced storage requirements and need for retrieval as a result of "on demand" certificates
- significant cost reductions - costs to complete both Stages of the project come to $100,000 for customers and $350,000 for BHP; potential on-going savings are estimated to be approximately $500,000 p.a. for customers and $100,000 p.a. for

[15] The following brief summary of the Electronic Test Certificate project is drawn from a number of sources - Fuller, 1992; BHP Steel, 1992a; 1992b; Harvey, 1992; internal BHP Steel and BHP IT documentation; and interviews with BHP IT and BHP Steel personnel involved in the Test Certificate project.

BHP for the foreseeable future, in addition to a saving of $0.30 per Test Certificate (on average) for BHP.

The new aproach, however, necessitated changes to existing BHP systems and procedures in terms of:

- the need for a BHP Functional Team to coordinate Test Certificate issue
- the creation of an EDICA Steel Industry Working Party to coordinate and consolidate work on document standards (the development/amendment of relevant EDIFACT/X12 messages)
- necessary changes to Test Certificate print formats (Test Certificates are now standardised on a single A4 page format)
- new and amended control/audit procedures
- education - both within BHP Steel and of trading partners.

Maintenance of Quality Assurance standards in the new system is now achieved by means of:

- the existence and application of formal and documented systems for certificate generation at both BHP and customer sites
- auditing of customers' certificate generation systems prior to the receipt of BHP approval to produce BHP Test Certificates
- periodic system audits at both BHP and customer sites to ensure adherence to and maintenance of the system.

Another major achievement of this programme has been the development of the EDIFACT QALITY Test Certificate document as a result of the work of the SIWP. The Test Certificate programme (a senior management, rather than IT, initiative) has brought together all the parties involved in the production and use of Test Certificates across organisational boundary lines. The flow of information involved in the Test Certificate process has taken precedence over the previous paper flow, modifying work practices in both BHP and customer operations. Further substantial changes are expected both in the use made of Test Certificate data and in the application systems geared around this data - a clear indication of the organisation's move towards stage 4 organisational integration "business process redesign".

Business Process Integration - Bar Coding and Product Numbering Initiatives[16]

Product numbering is an internationally compatible system for identifying products and services by allocating a unique number to each item or service which may be traded worldwide. By identifying products unambiguously, these numbers provide a means for manufacturers, exporters, importers, wholesalers and retailers to communicate regarding the goods they trade. Product numbers are represented by barcodes which can be scanned and thus entered directly into a computer.

Article numbering associations exist in almost all countries - in Australia, for example, the relevant organisation is the Australian Product Numbering Association (APNA), in North America the Uniform Code Council (UCC) provides services to both the U.S. and Canada, while the British equivalent is the Article Numbering Association (ANA). These organisations exist to allocate codes based upon consistent International Article Numbering standards, provide technical assistance and education to companies, support retailers in introducing scanning technology and to offer information and research services (Palazzolo, 1992a).

De Vries (1992) discusses the early use of product numbering, which began in the 1970's, when barcodes were placed on individual consumer articles to enable detailed recording of the flow of goods leaving the shop via the cash register. These original initiatives became considerably more sophisticated with the advent of EDI - and suppliers/customers now optimise communications which relate to business transactions by linking their automated barcoding systems.

These more advanced systems were made possible by a significant extension to the international product numbering system - the UCC/EAN Application Identifier (AI) standard. Palazzolo (1992b) explains that the basic tools of the existing system (the EAN/APN 13 or 8 digit consumer unit number and the ITF 14 digit trade unit number) merely serve to identify products. The AI standard enables companies to add additional variable information to individual products or packs at the time of production or shipping - ranging from customer purchase order numbers to serial shipping container

[16] The following extremely brief summary of product numbering and bar coding is drawn from Palazzolo (1992a; 1992b) and Brown (1992), while the information concerning BHP Steel's product numbering and barcoding initiatives is based upon Meakins (1992) and internal BHP Steel memoranda and documents - and upon discussions with BHP Steel personnel involved in these activities.

codes, batch numbers, use-by dates, or product weight/length information. Email's Service Variant Numbers differentiate products which are identical as sales items (and therefore have common Product Identifiers), but which use different and non-interchangeable spare parts. The Service Variant number tells the service technician which non-interchangeable spare parts must be used for that particular appliance (Brown, 1992).

Meakins (1992) suggests that in an EDI environment, product codes are adopted primarily as a means of communication across disparate application systems, each of which may identify products differently. Steel manufacturers and distributors presently use non-standard, in-house product codes - often structured and worded in such a manner as to indicate the product itself. Although such codes may be exchanged directly by using translation tables, the increase in EDI traffic will increasingly favour conversion to codes based upon international standards. Four of BHP Steel's major Divisions have adopted the APNA 13-digit Consumer Unit product numbers and there are currently more than 800 numbers in use for EDI trading. Products are being allocated numbers continuously and the list is expected to grow into the 10's of thousands. Product numbers are incorporated into EDI messages as a pair of data elements which comprise both a qualifier (such as Buyer's or Vendor's Part Number) and the product code itself.

BHP Steel's involvement with the EDICA-based Steel Industry Working Party is crucial to the acceptance of international product number standards. The SIWP advocates the use of APNA standards, although it has not yet agreed upon a set of Steel Industry bar code data elements for use within the APNA's AI standard for supplementary information. The SIWP and the APNA are currently evaluating a range of options to match Steel Industry data elements to APNA numbering systems and symbologies. The integration of bar coding with EDI handling is complex, since document data must also either be transferred and mapped to produce bar code labels at the time of despatch, or be read and mapped from bar code labels at the time of receipt or inventory. Agreement on the designation of data elements and their position within bar code fields in the EDI environment is now underway within the SIWP.

More advanced and integrated use of bar codes will come from the development of evaluated receipt settlement to automate the link between product receipt and payment for goods. This requires the extraction of data elements from individual Despatch Advice bar codes and the reconciliation of product and quantity with either Purchase Orders or period contract information, followed by the automatic generation of either a Payment Order and Remittance Advice or, at the very least, a Pre-payment Advice. Such systems will enable the elimination of invoices and back-end document matching, lead to improved cash-flow forecasting and enable an interactive approach to contracts and sales/price catalogues. The initial BHP Steel initiative involved an EDI-EFT pilot with major suppliers in early 1993 and EFT pilots with customers are continuing.

The entire project will take a considerable amount of time - BHP Steel anticipates that the flow-on of EFT to customers beyond the most immediate group could take as long as 7-8 years. Meakins (1992) points out that EDI, barcoding and EFT schemes compete for the same capital pool as general computing facilities and may take many years to be accepted by smaller organisations who see fewer benefits in such integration. It is clear, however, that BHP Steel's longer-term ambitions will add another level of business process redesign to present system innovations - the use of barcoding and EFT will not only eliminate a number of existing documents and improve efficiency, but will also increase the organisation's move towards *information-based*, rather than document-based operations.

Multi-lateral EDI Integration - the APEC Project[17]

The Asia Pacific Economic Cooperation (APEC) work programme supports ten separate work projects, of which the Telecommunications Working Group (TWG) is one. The TWG held its first meeting in Singapore in July 1990 and agreed to undertake a short-term project to compile telecommunications profiles for APEC members, together with three longer-term projects: EDI, Teleports and Human Resource Development. The mission for the EDI project was defined in the following terms:

[17] The brief summary of the APEC EDI project which follows is derived from two internal EDICA documents and supported by interviews with BHP IT and EDICA representatives of the EDICA Telecommunications Working Group involved in the project.

To implement a live, EDI-based, exchange of trade data which facilitates the movement of goods purchased by a New Zealand customer from an Australian manufacturer, meeting regulatory obligations required to support international trading relationships (EDICA, 1992c:25).

The EDI Council of Australia proposed a multi-lateral, industry-based pilot EDI project with two major components - the *commercial* and the *regulatory* transactions involved in international trade. EDICA proposed BHP as the initiating company, due to the company's:

- recognised commitment to EDI
- demonstrated in-house expertise
- substantially wider experience in EDI than any other Australian organisation
- prime trading position in the APEC trading region
- established business relationships with many APEC countries.

1. In terms of the *commercial* relationship, the importer and exporter were to exchange the following documents:
    - Purchase Order (initiating the transaction)
    - Purchase Order Acknowledgement
    - Invoice
    - Quality Report (Test Certificate)
    - Despatch Advice (Shipping Note)
2. The relevant *regulatory* requirements are that:
    - BHP Steel (Australia) will send commercial information regarding the goods via the EXIT I system to the Australian Customs Service (ACS) in order to obtain a customs clearance number;
    - Seatrans/Sydney (the shipping company) will lodge the manifest (details of the movement of the steel products) with the ACS via the EXIT II system. This electronic manifest may go directly to New Zealand Customs;
    - To meet mandatory legislative requirements, New Zealand Customs requires documentation (a copy of the EXIT document and/or an invoice) directly from the importer (or from a broker commissioned by the importer), prior to clearing the goods for entry.

Inter-national trade is an inherently complex process and, even in the form of a pilot project which has been deliberately restricted in scope, the exchange of documents required is rather involved. This project is still in its early stages and, due to both the technical and diplomatic complexity of the relationships involved development is proving a little slower than the original projections.

The EDI project is largely intended to demonstrate to other APEC member nations the effectiveness of EDI as a means of expediting international trade flows. The APEC project is also an ideal illustration of integrated EDI, demonstrating:

- the basic, physical benefits of EDI as replacement for paper-based document flows. International trade is particularly dependent on the movement of huge quantities of paper - which frequently arrive *after* the goods themselves have reached their destination. (BHP Steel have actually noted occasions when it was cheaper to fly one of their own staff members over to New Zealand with the paper-work relating to a particular shipment than to pay the fees which would result from holding goods in storage until the documentation had arrived.) Although the restriction appears to be more crucial to exporters making substantial use of air freight, this case study shows that even companies solely reliant on sea freight (it is not cost-effective to air-freight steel products) can gain substantial advantages from the electronic replacement of paper document flows
- the still more substantial benefits possible from integrating these basic paper trail replacements into the application systems of the organisations involved in international trade. Almost every organisation taking part in this pilot scheme (exporter, shipper, importer, customs and forwarding agents, and regulatory bodies such as port authorities and Customs) has its own internal application systems dedicated to a particular part of the trade cycle. Linking these systems together adds a further dimension of effectiveness/efficiency to the trading process
- the longer-term strategic benefits of thinking in terms of **information** flow, rather than document flow. Each of the organisations taking part in the pilot scheme has

begun to rethink and redesign the processes which form their own contribution to the trade cycle (for example, re-read the descriptions of the manifest information flows above).

This project provides an illustration of large-scale business process redesign across organisational boundaries. The movement of international trade goods is an archetypal example of this problem - many autonomous processes, which were created in the days before computerisation, being improved and redesigned by individual organisations with little, if any, improvement in overall efficiency and timeliness.

The APEC project has tackled this group (or at least a sub-set of this group) of autonomous processes across a wide variety of organisation types (both public and private sector) in an attempt to come to terms with the "second-order" or meta-processes which are needed by the international trading operation. There is, as yet, no term to describe the application of business process redesign across inter-organisational boundaries - but it is clear that the need for such an approach will continue to grow. The APEC project, like other such visionary projects (the European ODETTE or COST 320 projects, for example - see van Maaren, 1993) is endeavouring to develop tools, technologies and organisational structures which will enable organisations to work together for greater overall effectiveness - while retaining their individuality and competitive ability.

IMPLICATIONS FOR BHP INTERNAL PROCESSES AND STRUCTURE

The implications of integrated EDI for re-engineered business processes are critical to the long-term use and effectiveness of this technology. Unfortunately, however, changes to organisational practices and structures tend to occur far more slowly than do computer-based applications - and the organisational impacts may not emerge until quite some time after the technical changes have been put into place. In the case of BHP Steel, for example, the Electronic Trading Project has had a significant effect on both internal and inter-organisational information systems over the past eighteen months, but changes to organisational practice are only just becoming apparent.

This section of the paper describes these early procedural changes, as they affect two separate order management operations:

- customer orders, handled by the Order Entry sub-system of the Sales Administration and Order Management System (SAMS)
- supplier orders and consequent inventory management approaches.

The SAMS Order Entry sub-system was the first internal application system to be targetted for integration with the Electronic Trading Project. Documents involved in this process are of two types:

- incoming - Purchase Orders (PO) and Purchase Order Changes (POC);
- outgoing - Purchase Order Acknowledgements (in practice Purchase Order Change Acknowledgements (POCA), since a single document type is used for both purposes).

1. *Incoming documents.* Prior to the implementation of the Electronic Trading Project, the Inside Sales Representative (ISR) would review each Purchase Order with the customer prior to processing - although there was really no need for such review, save in the case of one-off production (which is a rare occurrence) or where there had to be changes to production or requirements.

   The first stage of integrating in-coming Purchase Orders with internal systems and processes still requires the active participation of the Inside Sales Representative, but has limited the time involved. Purchase Orders are now received in the form of EDI documents through the Electronic Trading Gateway and appear on the Inside Sales Rep's terminal for review with the customer where necessary. Once past this stage, however, PO's released by the ISR are sent for automatic review within the Order Entry system.

   The next stage of integration involves the separation of Purchase Orders into:

   - automatic orders, where the PO is passed directly into the Order Entry system's automatic review process which merely identifies syntactic errors; and
   - manual orders, where the Inside Sales Rep. must review the PO with the customer prior to Order Entry processing.

At the completion of this stage the Inside Sales Rep, freed from what is presently a very time-consuming and largely unnecessary task, is able to devote considerably more time to what is the true purpose of the position - sales of BHP Steel products to customers.

2. *Outgoing documents.* Out-going Purchase Order Change Acknowledgements, although more substantial than a purely functional acknowledgement, contain only minimal information (such as confirmed delivery date and price) except in exceptional cases where more detail is needed. The first stage of automating outgoing PO Change Acknowledgements is to replace the current printed acknowlegement document which is mailed to customers with an EDI message (the ANSI X12 865 message). This stage is already running "live" with several trading partners and is either in test or in the final planning stages across all BHP Steel Divisions and almost all trading partners taking part in the pilot ETP.

   The second stage of automating the outgoing document process will involve modification of the Order Entry system itself to enable integration of the EDI message at all stages of the outward process. One step has already been taken towards streamlining the process, however, by eliminating the manual reconciliation of Purchase Orders and PO Change Acknowledgements - resulting in significant savings.

   It is apparent that changes to the SAMS Order Entry sub-system processes are in the early stages of redesign - although the cross-sectional coordination between the various Departments affected by the receipt of Purchase Order modifications suggests that an organisational view of the problem is being taken.

Supplier Order processes have undergone significant changes since the introduction of the Electronic Trading Gateway. The structural effect of system-based changes in the order management process has been to change the overall organisational approach from what might be termed a "central store" to a Just-in-Time approach (JIT is a philosophy based on a number of other technologies - EDI, material requirements planning and distribution requirements planning - which combines distribution with manufacturing to get the correct products to the correct people at the correct time):

- the Slab and Plate Products Division believes it has saved one week's worth of inventory as a result of stage 1 order entry automation;
- the Division is now running the plant with 25%-30% of the previously-held inventory of spares;
- Divisional departments are now ordering directly from trading partners, rather than through BHP Steel's own Central Stores;
- the Central Stores themselves have now been able to reduce their holdings to requirements for 24-48 hours:-
  - where electronic orders are placed before 11.00 a.m., deliveries are guaranteed before 5.00 p.m.
  - where orders are placed between 11.00 a.m. and 3.00 p.m., deliveries are guaranteed before 11.00 a.m. the next day;
- larger trading partners are now pushing this just-in-time philosophy out to their own suppliers. A case in point is Bisalloy, which, while using exclusively PC-based systems, has decreased data handling errors, improved timeliness of inventory information (reducing inward goods delays from 36 to 12 hours) and substantially improved the productivity of both supplier and customer order processing by integrating EDI messages with internal system information (Croll, 1992) - suggesting that even comparatively small companies can take advantage of the benefits available from EDI-based business process redesign.

These changes in philosophy and organisational practice are, in turn, generating further and possibly more far-reaching changes. Personnel involved in the supply process are now looking at the potential which electronic trading holds for the despatch of goods. Despatch information passed through the Electronic Trading Gateway offers the possibility of "evaluated receipts settlement", the replacement of invoices by regular payment upon receipt. This involves a purchaser issuing an electronic order and a supplier responding by shipping the goods and sending an electronic ship notice. Payment is triggered either by electronically matching these two documents, or by matching them automatically to a third document - a receipt from the receiving point.

The process is made possible by the fact that supply is on the basis of period contracts, so that amounts and prices are agreed in advance. Electronic linking of payments with despatch information by means of bar-coding and product numbering would significantly accelerate the payment process - and could offer further savings in terms of both Electronic Funds Transfer efficiences and the greater total buying power generated by the elimination of data rekeying.

CONCLUSIONS

This paper has summarised the activities of BHP Steel's electronic trading initiative, with the aim of investigating the successful integration of EDI into internal application systems and organisational structure within an Australian organisation. The length of the case study is due to the complexity of the subject - BHP Steel's strategic approach to the use of electronic trading (both internally and externally) has required the rethinking of many of the organisation's existing methods of doing business - and has led to the creation and development of a number of entirely new internal and external trading initiatives.

The analysis of BHP Steel's Electronic Trading Project provides a number of conclusions:

- that there truly are benefits to be obtained from an inter-organisational electronic trading strategy founded on EDI as the enabling mechanism - benefits which are considerably more extensive than EDI's comparatively simple technical nature would appear to offer;
- that organisational gateways utilising an Application Generic approach to system integration and isolating the communications issue by insisting on the use of international data communications standards do offer a realistic and successful solution to the problem of internal and external trade for large and sophisticated organisations;
- that a top-down, organisational and strategic perception of EDI has led to a fast, effective take-up of EDI at a number of levels:-
  - the development of the Electronic Trading Gateway as an Application Generic facilitator of internal and external sources of information, with a design which encourages continuing modification and enhancement
  - the active involvement of all sections of the BHP Steel organisation in planning and implementation - including production, trading and support groups
  - the successful involvement of trading partners and the spread of electronic trading to what Svinicki (1988) described as the `second supplier tier' - those suppliers who themselves must obtain production materials from other suppliers and who can therefore link another level of organisations into the electronic trading hierarchy and
  - the involvement of related industry sector representatives into EDICA Working Parties to develop accepted document sub-sets in terms of EDICA Implementation Guidelines and the subsequent amalgamation of the SIWP and HEMMP Working Parties which ensures greater currency for the guidelines developed and, hence, greater inter-sectoral trading opportunities;
- that many of these achievements would have been either unlikely to succeed or totally impossible without BHP Steel's commitment to organisation-wide Business Process Redesign, which has led to:-
  - the decision to use an overall project manager and controller for the project to ensure consistency at all stages of development
  - the cross-organisation Steering Committee which sets EDI policy and directs the project team through the Project Manager
  - the cross-organisation Functional Teams which handle application integration, communication, Total Quality Management, mapping of document standards and system design.

Although this paper has concentrated on a single exemplar case study, the highly successful of outcome of BHP Steel's EDI initiatives suggests that further case research, using a wider group of examples, might well offer conclusive evidence of EDI's ability to provide a suitable infrastructure for business process redesign.

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