DOMAIN: Dynamic Operations Management Across the Internet

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Abstract

This paper will introduce some of the fundamental elements of the proposed DOMAIN research project. It is argued that if full advantage is to be made of the emerging Internet technologies a paradigm shift is required in the way in which manufacturing companies plan and control their operations. The current and future capabilities of the Internet mean that it is possible for demand data and supply capacity data to be visible to all companies within a manufacturing supply chain. In conjunction with developments with respect to communication and information technologies, an alternative to the traditional linear transfer of information within supply chains is possible; the development of supply webs and a more interactive approach to supply chain partnering provides an enhanced alternative.

Keywords

**Manufacturing planning & control, supply chain enhancement, Internet,
manufacturing information systems**

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1 INTRODUCTION

The objective of the DOMAIN research project is to investigate the role of the Internet within the manufacturing supply chain and, in particular, focus on its impact on the manufacturing planning and control operation. It is well established that planning and control systems make significant contributions to the successful operations of any manufacturing organisation both internally and across its supply chain. However, the role of such systems needs to be re-evaluated in the light of developments in communication and information technologies. The current and future technological capabilities of the Internet mean that it is possible for demand data as well as supply capacity data to be visible to all companies within a manufacturing supply chain. It is perceived that manufacturing supply chains will change from an order-driven-lot-sizing approach to one more akin to a capacity-availability-booking approach supported by appropriate search engines. Furthermore, using Internet based information transfer, supply webs will replace the traditional linear movement of information within supply chains and thereby facilitating a more interactive approach to supply chain partnering.

Recognition of the importance of the supply chain and effective supply chain management has grown over recent years. Companies have reduced their core manufacturing capabilities and placed a greater reliance on both new and existing suppliers. In the exacting global economy organisations need to be able to respond to the demands of their customers and, as a consequence, the effective management of supply chains is a critical factor differentiating the successful organisations from those which are less successful. One of the key parameters affecting the operational success of a supply chain is the speed of information flow through the supply chain. Although organisations are breaking down functional barriers in an attempt to allow a smooth and timely flow of information, it is the Internet and in particular the use of extranets which offers the opportunity to make step change improvements in this area.

Although current Internet attention is naturally focused on the role of electronic commerce or e-commerce, research is being undertaken addressing alternative issues; examples include design-to-manufacture tools (Smith & Wright, 1996), concurrent manufacturing (Lapsley *et al.*, 1996) and virtual supply chain management (Baxter *et al.*, 1997). In the context outlined here, the UK manufacturing research community and key (strategic) industrial supply chains need to investigate and understand the implications of web based manufacturing control and to develop the alternative methods and strategies necessary support this new manufacturing paradigm. This research opportunity represents a key challenge to developing a UK manufacturing infrastructure for the millennium.

2 UK MANUFACTURING PLANNING AND CONTROL

In May 1997 the EPSRC undertook a review of the research and training support provided by the Design and Integrated Production (DIP) programme for the period 1992 to 1997 (EPSRC, 1997). With reference to 'operations and production

planning' it was commented that most of the research focused upon methodologies for more effective implementation of existing production planning and control systems or upon improved scheduling or modelling algorithms as illustrated in Table 1. As a result the research base in the UK has been somewhat retrospective and provided limited 'vision' in terms of the next generation of systems. The quality of the research has not been questioned, however, there needs to be an activity determining the structural and operational characteristics of the manufacturing planning and control systems which are likely to be part of the 'factories of the future'.

EPSRC Operations and Production Planning Research - Topic Breakdown		
Generic Area	Number of Projects	% of Projects
Implementation and Audit Methodologies	10	28%
Scheduling Algorithms and Modelling/Systems Specification	14	39%
Other Topics	12	33%
EPSRC Operations and Production Planning Research - Performance		
Research Factor	Average	Variation
Research Quality (1-World Class, 2-Competitive, 3-Useful, 4-Limited)	2.4	0.56
Research Dispersion (Groups attracting 3 or more grants)	26% (OPPR)	40% (DIP)

Table 1 EPSRC Operations and Production Planning Research 1992-1997

For whatever reasons, little of this research has examined alternative manufacturing planning and control paradigms and the current industrial progression from MRPII to ERP through products such as SAP, Baan and Oracle has dominated the research mindset. The importance of the supply chain and effective supply chain management has grown over recent years and, importantly the role of planning and control systems is pivotal in this context. The above report identified opportunities for collaborative work between these areas. However, not only is there opportunity to investigate these important relationships but, using the developing Internet based technologies, radically different designs or approaches

can be explored and a Supply-Chain Resource Planning (SRP) mindset can emerge.

The research challenge is therefore:

- To identify the requirements of future SRP systems,
- To establish business effectiveness of an SRP approach,
- To define the appropriate business context.

3 CONTROL SYSTEMS CONFIGURATION CLASSIFICATION

Recent research at Liverpool has identified the important relationship between the business classification of a manufacturing company and the information systems requirements in terms of the contingent variables of complexity and uncertainty. The research (Kehoe, 1997) indicated the need to map the business unit classification (assessed in terms of the Puttick-style grid) onto the information system configuration (assessed in terms contingency theory) as shown in Figure 1.

Significantly the research indicated the need for 'appropriate' manufacturing information systems and that for particular business sectors the requirement is for simple, supply-chain based systems rather than complex within-enterprise configured 'solutions'. Although there are some developments within commercial planning and control systems to encompass supply chain requirements, reports suggest some way to go before such systems become mainstream. Moreover, developments are such that systems are intended to work in conjunction with conventional MRPII and ERP systems (Newing, 1997).

The system research issues are therefore:

- How to configure and present supply chain based manufacturing planning and control information,
- To what extent changes in operations management practices are required to utilise the alternative systems strategies,
- To what extent reductions in systems complexity and uncertainty will support manufacturing objectives such as flexibility and responsiveness.

4 E-COMMERCE AND THE SUPPLY CHAIN

The enveloping presence of the Internet within business has been phenomenal and growth is set to continue; US analysts Killen and Associates estimate that by 2003 the global Internet market for consumer goods will be over 600 billion dollars. In response, organisations will be required to fundamentally change the way they do business (Manchester, 1997). Recent commentary suggests that the barriers do not lie with the technology but the business processes (Taylor, 1998). This raises an interesting point. As organisations break down their functional barriers in an attempt to enhance the flow of information, it is the Internet that provides the opportunity to make further, step change improvements in this area.

Although business-to-business electronic trading has been around for more than 20 years using electronic data interchange (EDI) networks, the complexity of early EDI packages, rival standards and relatively high costs have traditionally excluded

many smaller suppliers. The consequence of this is an estimated 2% use of EDI by UK companies (Moran, 1998). Because most organisations have a telephone and a PC and are thereby Internet enabled, initial access is unlikely to be an issue.

Figure 1 Information Systems Contingency Map.

Current Internet attention is naturally focused on the role of electronic commerce or e-commerce. However, it is important to recognise that e-commerce extends beyond the business-to-consumer relations to include the business-to-business relations which naturally extend over supply chains. It is within this sector where the volume of activity is expected to be the greatest. Businesses are adopting inter-company trade over the Internet in order to cut costs, reduce order-processing time and improve information flow.

Through the use of extranet applications, for example, organisations can be in a position to gain access to information such as product data, order status and inventory levels. Alternatively, and perhaps more conventionally, using less vulnerable technologies customers have access to browse product catalogues and place orders across the Internet. In both the described cases a *static* application has been adopted; it is the premise of this paper that the opportunity now exists to explore more *dynamic* applications of Internet technologies within the area of manufacturing planning and control across the supply chain.

To fully utilise the potential offered by the Internet to manufacturing supply chains a number of research issues again need to be addressed:

- Identification of appropriate search engines and search strategies,
- Establishing manufacturing planning and control presentation formats using HTML,

- Evaluation of the processing relationships between HTTP and the manufacturing information data model.

5 DOMAIN: ONE WAY FORWARD

The role of the DOMAIN project is to investigate the role of the Internet within the manufacturing supply chain and, in particular, focus on its impact on the planning and control operation. This research will build upon existing work in the analysis of manufacturing information systems (Kehoe, 1993), supply chain modelling (Towill, 1996) and supply chain management (for example, Naim *et al.*, 1997) and manufacturing planning and control system modelling (Boughton, 1995). Additionally, the interdisciplinary nature of this proposal will see active co-operation between the CONNECT Internet application centre (Charlton *et al.*, 1997), within the Computer Science Department at Liverpool University, and the Manufacturing Systems Research Group, within the Department of Engineering.

It is suggested that through the adoption of the emerging Internet-based manufacturing supply chains will be able to change from an order-driven-lot-sizing approach to a capacity-booking-availability approach, supported by appropriate search engines. Defining the information requirements and modelling the effectiveness of operation of the *presentation layer* illustrated in Figure 2 represents one of the core issues for the DOMAIN research programme.

The research implications of what has been termed Internet-based Interactive partnering, or I-BIP, are immense both in terms of the technological and the organisational challenges. A key part of the aims of the DOMAIN project is to develop the UK research community in this area in order to examine these issues. Interestingly, a clear opportunity exists whereby the supporting technologies can be exploited to disseminate and discuss ideas and developments.

There are essentially four stages to the DOMAIN project. The first stage of the work will examine the current usage and operation of the Internet within manufacturing supply chains. Specifically three sectors, i.e. car, electronics and food manufacture, will be examined having well developed although operationally different characteristics. The survey research during Stage 1 will define the conventional production planning and control information flows within the supply chains and build a web orientated model based upon the client/server supply net shown in Figure 2. The work will build upon the existing UK supply chain research base including that at Cardiff (Towill, 1997), Bradford (Webster *et al.*, 1997) and Bath (Harland, 1997).

The research work during the second stage of the programme will take the requirements defined in stage 1 and build a dynamic model of the web based supply chains in each of the collaborative industrial sectors. The research tools to be used during this stage of the work will include industrial dynamics modelling tools such as *ithink* (Dynamic Performance Systems, 1997). The modelling of the dynamic performance of I-BIP will assist manufacturing companies in evaluating alternative strategies in terms of supply chain parameters such as the number of partners, supply capability indices or inventory distribution as well as the typical

manufacturing metrics: for example lead time, throughput and delivery performance. The subsequent results will provide an important stimulus to the implementation stage of the research.

Figure 2 DOMAIN: A Model for Supply Chain Manufacturing Planning and Control using Internet Technologies.

The third stage of the research will bring together the findings from stages 1 and 2 and will illustrate the I-BIP approach through the development of an HTML prototype. A supply-web model will be created providing the information requirements defined in stage 1 and the optimised manufacturing control strategies generated in stage 2. The DOMAIN prototype will provide server-based access to manufacturing capacity and transaction management and a client interface using standard web presentation formats. The emphasis will be to provide a demonstration facility, rather than to attempt to create commercial standard software. This can be used as an on line research tool to focus user evaluation of the I-BIP concepts.

The final stage of the research will formalise the sector-based models and prototypes of I-BIP working and establish a web based newsgroup to co-ordinate the UK research in this area. Although the Internet readily lends itself to the generalised dissemination of the DOMAIN research output, the research group will hold sector-based workshops to demonstrate and evaluate the prototype I-BIP facility developed during stage 3. The research dissemination workshops will assist in the evaluation of the concepts of I-BIP and will refine the strategies developed in stage 2.

Clearly within the work outlined here there are many challenging research questions and implications that need to be addressed; for example operational stability, planning approaches and mechanisms and the positioning relative to

existing systems and infrastructures as well as those relating to access and security. The novelty of the research is illustrated in the comparison between the traditional manufacturing planning and control approach and the I-BIP philosophy shown in Table 2.

Comparisons	Traditional Manufacturing Planning and Control	I-BIP
Planning Approach	ERP (Oracle)	SRP (DOMAIN)
Data Management	Data Warehouse	Data Retailer
Organisational Basis	Enterprise Based	Supply Chain Based
Business Focus	Multi-Site	Multi-Business
Technology Base	SQL Technology	HTTP Technology

Table 2 Differentiating the Research Approach

6 SUMMARY

This paper has introduced the DOMAIN research project, which seeks to exploit the emerging Internet technologies within the areas of manufacturing planning and control and the management of the manufacturing supply chain. The work outlined has been placed in context both of earlier research work and relevant recent developments. Although there has been considerable growth in Internet activity, in particular e-commerce, there is considerable scope for a more *dynamic* application across the supply chain. What is suggested is a radical overhaul of the current planning and control mechanisms, practices and systems in order for genuine improvements to be realised. The DOMAIN project offers one alternative way forward.

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7 BIOGRAPHY

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