DEVELOPING LEAN AND AGILE SUPPLY CHAINS IN THE UK HOUSEBUILDING INDUSTRY

M. Naim[1], J. Naylor[2], and J. Barlow[3]

ABSTRACT

The paper presents the concept of 'leagility'. Building on lean and agile literature, the paper describes the similarities and differences between these concepts and the application of each paradigm within the context of the total supply chain. Particular attention is paid to the notion of the 'decoupling point', which determines the location within the supply chain at which a product is customised. Using examples from various industries, the potential for the application of 'leagility' in housebuilding is described, as well as the barriers to its introduction in the UK.

KEY WORDS

Supply chain, process orientation, lean thinking, agile construction, housebuilding.

[1] Corresponding author: NaimMM@cardiff.ac.ukTel: +44 (0)1222-874271 Fax: +44 (0)1222-874301Logistics Systems Dynamics Group, Department of Maritime Studies and International Transport, Cardiff University, P.O. Box 907, Cardiff, CF1 3YP.

[2] Formally LSDG, Cardiff, now Unipart UK.

[3] SPRU, University of Sussex, Brighton, BN1 9RF, j.g.barlow@sussex.ac.ukTel: +44 (0)1273-877166 Fax: +44 (0)1273 685865.

INTRODUCTION

There has been considerable interest in the construction industry in the concepts associated with 'lean thinking' (Womack and Jones 1996). As a paradigm, and with its associated tools, methods and techniques, this has generated a 'wake up call' to an industry famous for its lack of innovation and poor performance. More recently, notions of 'agility' have developed in both manufacturing and construction. A number of authors have noted that agility supersedes leanness, as the latter is either insufficient to meet the ever changing requirements of a dynamic market place (Booth 1996, Ward 1994) or is merely just a characteristic of agility (Christopher 1999).

It is often presumed that the introduction of a new paradigm means that previous ones are superseded. The danger with this attitude is that without careful consideration of the benefits of each paradigm, important lessons regarding their successes and failures will be lost. In particular it is important to consider which paradigm is best for a particular business in terms of its supply chain characteristics.

Drawing on research carried out for a major project which is developing and demonstrating customer focused approaches to housing supply[4], and work on lean and agile thinking that originally appeared as separate articles (Naylor et al. 1997, 1999, Barlow 1998, 1999), the paper describes the notion of 'leagility' and the potential for its application in the UK housebuilding industry.

LEAN AND AGILE PARADIGMS

When discussing 'new' paradigms it is important to examine the concepts as given by the definitions and subsequent explanations, rather than the terms themselves. Naylor et al. (1997, 1999) discuss the commonalties and differences between leanness and agility within a supply chain context from a generic perspective and give the following definitions:

- Agility means using market knowledge and a virtual corporation to exploit profitable opportunities in a volatile market place.
- Leanness means developing a value stream to eliminate waste, including time, and to ensure a level schedule.

These definitions were developed from close scrutiny of the literature and must also be read within the context of the *total supply chain*. Only in this way will it be possible not only to differentiate between the two paradigms but also to examine their complementary nature. We therefore need an adequate definition of a supply chain. One that the authors has found most fitting is that by Stevens (1989) as it adopts a systems approach. This implies 'gestalt' – the idea that the whole is greater than the sum of the individual parts as advocated by one of the great UK pioneers in material flow management (Burbidge 1983).

---

[4] 'Meeting Customer Needs Through Standardisation'. The sponsorship of the EPSRC and DETR, and the time and effort made available by the industrial partners is gratefully acknowledged. Thanks are also due to our are research colleagues on the project, David Gann, Severine Hong-Minh, Ralph Barker and Ritsuko Ozaki.

- A supply chain is a system whose constituent parts include material suppliers, production facilities, distribution services and customers linked together via a feedforward flow of materials, a feedback flow of information and flows of cash and resources (Stevens 1987)

The definitions may be expanded to include other constituent flows such as the feedback flow of cash and the two-way flow (in theory) of resources, including human resource and equipment (Naim 1997). To close the loop from the supply chain definition back to the lean and agile paradigm definitions we also need to consider the 'decoupling' point.

- The decoupling point separates the part of the supply chain oriented towards customer orders from the part of the supply chain based on planning (Hoekstra and Romme 1992)

As we will see, the decoupling point is the strategic stock that separates the demand side of the supply chain (focused on delivery to the end customer) from the supply side (based on logistics planning). The decoupling point is an important element in designing the supply chain so that we may ensure 'total value' is delivered to the end customer. Total value may be defined as delivering a product of the highest possible quality, with the best possible service, in the shortest possible time and the lowest possible cost (Johansson et al. 1993). Total value may be expanded to include health, safety and the environment (Evans et al. 1997).

Both Naylor et al. (1997, 1999) and Barlow (1998) have indicated the similarities between the lean and agile paradigms. A useful way to relate the lean and agile paradigms is to consider their delivery of total value. Table 1 highlights the difference in *relative emphasis* of each paradigm. This view of value delivery by Naylor et al. concurs with that of Barlow who states that 'agile production introduces an added degree of customer focus'.

A number of key characteristics of the two paradigms have also been identified by Naylor et al. based on a comprehensive review of the available literature[5]. These characteristics are listed in Table 2 and have again been rated according to the emphasis placed on them by each paradigm. The first three characteristics are the cornerstones for both paradigms while the latter four are those that differentiate the two paradigms. Both paradigms pay particular attention to the need to develop an integrated, seamless supply chain, where players act as a virtual enterprise. Thus, the seamless supply chain is focused on delivering value to the end-customer so there is the need to obtain accurate market knowledge and transfer that information to all supply chain members, who are synchronised to meet the customers' needs.

[5] Steven (1989), Womack et al. (1990), Grunwald and Fortuin (1992), Stalk and Weber (1993), Goldman et al. (1994), Hayes and Pisano (1994), Harrison (1995), Kidd (1995), Womack and Jones (1996), Anon (1997), Evans et al. (1997), Mason-Jones and Towill (1997), Towill (1997).

Table 1: Rating the importance of the different metrics for leanness and agility (Naylor et al. 1997, 1999)

❍❍❍ = Key metric, ❍❍ = Secondary metric, ❍ = Arbitrary metric

Metric	Agile	Lean
Lead Time	❍❍❍	❍❍❍
Service	❍❍❍	❍❍
Costs	❍❍	❍❍❍
Quality	❍❍❍	❍❍❍

Table 2: Rating the importance of different characteristics of leanness and agility (Naylor et al. 1997, 1999)

❍❍❍ = Key metric, ❍❍ = Secondary metric, ❍ = Arbitrary metric

Keyword	Lean	Agile
Use of market knowledge	❍❍❍	❍❍❍
Visual Corporation / Value Stream// Integrated Supply Chain	❍❍❍	❍❍❍
Lead Time Compression	❍❍❍	❍❍❍
Eliminate Muda	❍❍❍	❍❍
Rapid Reconfiguration	❍❍	❍❍❍
Robustness	❍	❍❍❍
Smooth Demand / Level Scheduling	❍❍❍	❍

Another important element for both paradigms is time compression, although the motivation behind this differs slightly. Lean production emphasises the need for waste elimination, or *muda* to use the Japanese term. Thus, all activities that do not add value to a product or service are eliminated and even those that do add value are compressed or undertaken in parallel. Agility also calls for time compression in material and information flows, but with the focus on improving the responsiveness (and rapid reconfiguration) of a business process.

The main difference between the two paradigms is the ability to cope with uncertainty, including variations in production volume and the degree of product variety required. Figure 1 indicates the suitability of each paradigm to cope with such uncertainty. The lighter areas indicate that agile production is more suitable as a solution, while the darker areas indicate that lean production is more suitable.

Agile businesses may be seen as more robust, and hence flexible, than lean ones. Such businesses are able to respond to variations and disturbances. This is in direct contrast to the requirements of a lean business for stability. Moreover, by its very nature a lean business ensures that stability is attained by implementing suitably simple and optimum process and procedures (Naim 1997). Stability is achieved by making use of market knowledge and information and long term forward planning.

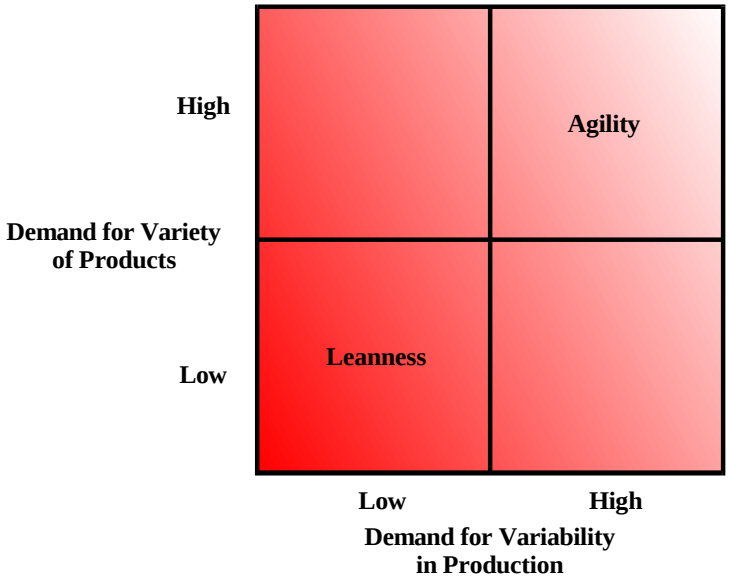

Figure 1: Applications of leanness and agility (Naylor et al. 1997, 1999)

HOUSEBUILDING, LEANNESS, AND AGILITY

The UK suffers from both a quantitative and qualitative gap in new housing supply. Not only is insufficient new housing built annually for current and future housing needs, but there is widespread public dissatisfaction with the performance of housebuilders in providing products which customers want to buy (Barlow and Gann 1999).

Most house builders have a keen sense of costs but an under-developed understanding of value. In speculative housing development, the selling price is derived from what the market

will bear, based on the cost of production and land, together with expected profits. In contrast, producers in other highly competitive consumer goods industries are forced to innovate to reduce production costs below selling prices in order to achieve profitability. They also develop new products in order to differentiate themselves in the market place. Speculative housebuilders usually build to stock, designing properties before customers are found. They generally use standard housing types which can be modified to provide cosmetic choices for customers. There is little differentiation between these producers other than their ability to access land more effectively than their competitors. Nevertheless, research suggests that more than 83% of homebuyers would like to be offered greater choice over the initial design of their homes[6].

Unlike other sectors of the construction industry which have sought to capture customer requirements more effectively (Anumba et al. 1996, Dulami et al. 1996), housebuilders have made little effort in this direction. One view commonly expressed by housebuilders is that customers do not necessarily know what they want. Their perception is that the majority of customers prefer to purchase new housing which they believe will be easy to sell later, rather than making customised choices which may detract from the perceived value of their investment.

Another problem is that in the case of *social* housing provision, the immediate customer – the social housing landlord – is not the same as the end-user, the tenant. Social housing landlords may aim to fulfil the functional needs of tenants as closely as possible, if only to minimise complaints. However, as the provider *and* owner of the dwelling they also have requirements, which may be at variance to their tenants' immediate needs. Concern over the immediate cost of production, given the limited availability of government funding for this type of housing, may impact on building and space standards. Increasingly, though, social housing landlords are considering the lifetime costs of the dwelling when preparing a new project, which implies a different set of construction criteria primarily relating to maintenance and energy costs.

Despite these 'generic' problems, to some extent faced by housebuilding industries in all countries, there have been a number of attempts to introduce lessons from lean production. Generally, business process modelling has been a precursor to the elimination of non-value added activities and supply chain management programmes which are designed to lead to time compression and reduced total costs (Evans et al. 1997, Melles and Welling 1996, Horman et al 1997, Birke 1998). The Japanese approach has been extensively documented (Gann 1996). An oft-cited example from the USA is that of Doyle Wilson (Womack and Jones 1996).

SUPPLY CHAINS AND THE DECOUPLING POINT

The potential for applying lean and agile production in housebuilding should not involve the implementation of one approach at the expense of the other. There is a need for a careful consideration and application of *both* paradigms within the total housebuilding supply chain. Figure 2 shows various potential strategies that may be applied to the supply chain. By

[6] The survey of 1000 people was carried out by *2000 Homes* at the 1998 Evening Standard Home Buyers Show.

viewing the supply chain as a whole it is possible to determine the most suitable paradigm for a particular business and to develop a 'leagile' supply chain (Naylor et al. 1997, 1999).

The decoupling point plays an important role in defining the leagile supply chain. In manufacturing it is commonly associated with the strategic stock that buffers the supply chain from changes in customer demand, in terms of both volume and variety. Associated with the decoupling point is the issue of postponement and late configuration. As seen in Figure 2, there are two extreme positions. The first is the 'buy to order' supply chain in which the product is configured from the outset, that is, from raw materials. In this supply chain all businesses are agile and all respond to changing customer requirements. This supply chain works well as long as the customer is willing to accept long lead-times. The other extreme is the 'ship to stock' structure in which a standard product is provided from a defined range. Although lead-times are very short (or 'off the shelf'), the danger of obsolescence has to be considered.

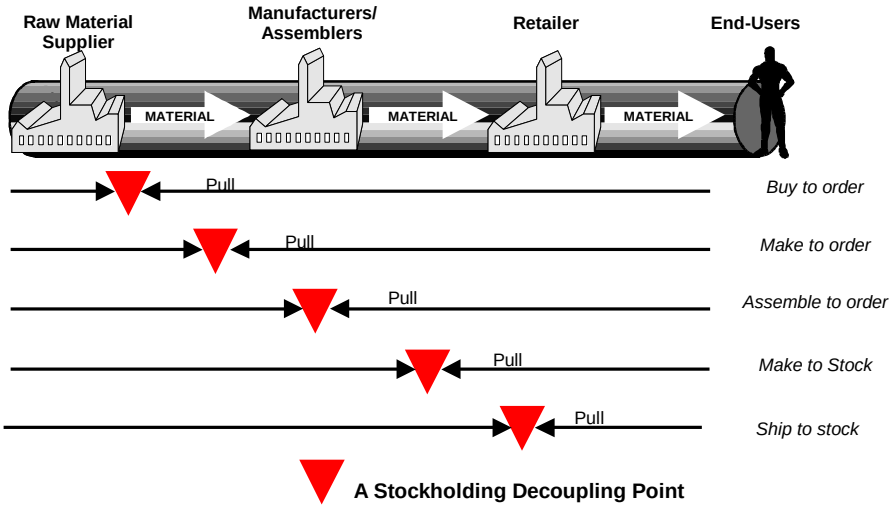

Figure 2: Family of supply chain structures (Hoekstra and Romme 1992)

The issue then arises as to whether or not it is possible to have the best of both worlds—short customer delivery lead-times and low obsolescence risk. The aim is to configure the product as late as possible to allow a considerable element of flexibility and hence customer choice (or customisation) while making the best use of standardised components. As may be seen in Figure 3, on the downstream side of the decoupling point the supply chain copes with both variability in demand volume and high product variety. Upstream from the decoupling point the supply chain is working to a stable demand with relatively low variety.

From Figure 3 it is possible to determine which paradigm is most appropriate by considering where in relation to the decoupling point a business is situated. Downstream from the decoupling point a business needs to be agile. Each value stream has a number of different products flowing through it. The lean paradigm is applied to upstream businesses that 'push plan' and 'pull execute' standardised products down a number of different value streams.

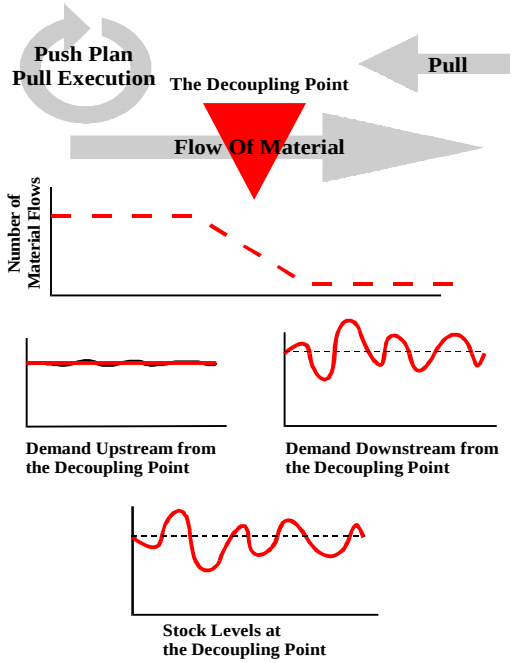

Figure 3: The role of the decoupling point in the supply chain

APPLICATIONS OF LEAGILITY AND IMPLICATIONS FOR HOUSEBUILDING

There are a number of well-documented examples of the 'leagile' concept in industry:

- Benetton, who delay the dyeing of their jumpers until the very end of the supply process. Thus, with standardised jumpers, customised as late as possible, a degree of customer choice is achieved without long lead-times and the risk of obsolescence (Gattorna and Walters 1996).
- Originally Hewlett-Packard produced printers for a global aggregate demand and customised them for local markets prior to their shipment to regional distribution centres. Unfortunately, demand forecasts were seldom accurate, so obsolescence risks were high. The solution was to postpone the decoupling point as late as possible and customise the printers in the regional distribution centres when the order was 'pulled' by the customers (Davies 1993, Lee and Billington 1992).
- A European personal computer (PC) producer has moved from a mass production system to a leagile one (Berry et al. 1995, Berry and Naim 1996). This involved the implementation of just-in-time (JIT) systems that reduced total lead-times by 46%, the development of a holistic approach to supply chain management via the utilisation of a global material logistics systems and finally the integration of its suppliers into its total supply chain concept. The final supply chain structure adopted an 'assemble to order' structure and a leagile strategy as shown in Figure 3.

There are a number of potential similarities between housebuilding and PC production. In its simplest terms a house may be decomposed into four main elements: the foundations, the shell, the roof, and the fit-out. Each of these elements may be made up of one or more components. The house is thus a system consisting of elements and the components that interconnect to create the whole. Housebuilding requires the integration of a number of different players in the supply chain, including the developer, the builder, contractors, sub-contractors, and suppliers.

At the most basic level the PC may also be broken down into simple elements: the keyboard, the screen, the box, and the internal sub-systems. All PCs are practically the same and there is very little to differentiate products, but it is still necessary to customise the product to meet particular customer needs. In well-engineered supply chains this will be achieved by delivering standardised components up to the decoupling point and then assembling the relevant components to deliver the customised product. This may be in terms of the right hard-disk size, the right screen size, the right processor types, and so on.

How far can this approach be applied to housebuilding? While there is a perception that customer demands have grown, there have been few attempts in the UK to introduce lean and agile production processes which aim to improve the level of customer focus (Barlow 1998, 1999). The response to more demanding customers has been limited to offering slightly greater choice over fixtures and fittings, and better systems for dealing with complaints. Housebuilders have also been updating their product ranges faster and more frequently. In addition, supply chain reorganisation—as a tool for reducing input costs—has been practiced for several years. Firms have sought to establish longer-term relationships with smaller numbers of preferred suppliers, but this cannot be seen as holistic supply chain reorganisation. In general housebuilders simply aim to exert pressure on suppliers to reduce their prices by using bulk buying power. There have been few—if any—attempts to encourage local distribution merchants to 'kit' together all the components and materials for a specific building site as and when required—i.e., the right amount, at the right time, at the right place, of the right quality, and at the right cost.

What are the barriers that prevent the introduction of a leagile approach to housebuilding in the UK? Increasing the level of customisation is felt by housebuilders to be constrained by institutional factors, notably a perception that planning authorities will not allow house types that vary from those that have already been approved, as well as a feeling that there is no real demand from customers. There is also concern about the implications of increased customisation for internal business processes, supply chain management, and logistics.

There are also a number of structural barriers to change. First, housebuilding is generally organised in sequential stages, bringing together a large number of firms that rely heavily on subcontractors. This means that the various interests in the industry operate disjointedly and have different economic characteristics and capacities to innovate. It is potentially difficult to keep any innovation proprietary and make early monopoly returns. Furthermore, the amount of feedback from the industry's workforce and markets is lowered, and the industry's organisational learning capacity reduced. Second, there is arguably an undersupply of new housing. This means that speculative housebuilders face limited competition, as there are few alternative sources of new supply—the social housing sector is targeted at specific population groups and self-build sector is hardly a viable alternative because of problems in obtaining

suitable land. Third, because housebuilders perceive they face an environment of constant 'feast or famine' (cf. Ball 1999), their approach emphasises the achievement of short-term financial results. Houses are therefore completed to suit the requirements of the financial period rather than customers' needs. Finally, previous attempts at production process innovation, notably the introduction of standardised systems building during the 1960s and timber frame housing in the 1980s, have left a perception that 'the public' does not want new approaches to housebuilding. This has been reinforced by the fact that traditional competitive strategies served housebuilders well for much of the past three decades.

CONCLUSION

The concept of 'leagility' is well established, although the terminology practitioners and academics have used in the past has differed. Examples of its successful application may be seen in different market sectors, most notably in clothing and electronics manufacture. By drawing the analogy between housebuilding and PC production we wish to highlight the potential for a standardised component approach that not only requires a careful consideration of the technology but also an assessment of the best supply chain strategy. The challenge is to determine the practical requirements that distinguish different housebuilding supply chain structures.

Although there is a conservative mind set in the housebuilding industry, as highlighted above, it should be remembered that many UK industries have gone through the same hurdles. It was not uncommon for many practitioners in the UK motorcycle industry to underestimate the potential of foreign competition. The UK housebuilding industry at the moment has a major advantage. It can learn from the mistakes and the successes of other industries that have had to go through the trauma of playing 'catch-up'. But it is important to realise that time is running out – already a major US player is busy acquiring British housebuilders.

REFERENCES

Alarcon, L. (ed.)(1997). *Lean Construction*. A.A. Balkema, Rotterdam, The Netherlands, 497 pp.

Anumba, C., Kamara, J., and Evbuomwan, N. (1996). "Encapsulating the 'voice of the customer' in construction projects." Proc. of the 12th Annual Arcom Conference, 11-13 Sept., 1.

Ball, M. (1999) "Chasing a snail: innovation and housebuilding firms' strategies." *Housing Studies*, 14 (1).

Barlow, J. (1998). "From craft production to mass customisation? Customer focused approaches to housebuilding." *Proc. 6th Ann. Conf. Intl. Group for Lean Constr.*, IGLC-6, 13-15 August held in Guaruja, Brazil.

Barlow, J. (1999). "From craft production to mass customisation? Innovation requirements for the UK housebuilding industry." *Housing Studies*, 14 (1).

Barlow, J. and Gann, D. (1999). "Searching for customer focus in UK housebuilding." CIB Conference on 'Customer Satisfaction: A Focus for Research', Cape Town, Sept. 1999.

Berry, D. and Naim, M.M. (1996). "Quantifying the relative improvements of redesign strategies in a PC supply chain." *Int. J. of Production Economics*, Vol. 46-47, 181-196.

Berry, D., Naim, M.M., and Towill, D. R. (1995). "Business process reengineering an electronic product supply chain." *IEE Proceedings on Science, Measurement and Technology*, 142 (5), 395-403.

Birke, H. (1998). "Lean construction: strategisk samverkan med kunder och levrantörer." Paper presented at the Partnering in Construction seminar, Byggforskningsrådet, Stockholm, 13 May 1998.

Booth, R. (1996). "Agile Manufacturing." *Engineering Management Journal*, 6 (2), 105-112.

Burbidge, J. (1983). "Five golden rules to avoid bankruptcy." *Production Engineer*, 62 (10).

Christopher, M. (1999). "The agile supply chain and how to create it." March, 9-12.

Davies, T. (1993). "Effective supply chain management." *Sloan Management Review*, Summer, 35-45.

Dulami, M., Baxendale, A., and Jewell, M. (1996). "Refocusing construction to meet customers' requirements." In Langford, D. and Retik, A. (eds.) *The Organization and Management of Construction: Shaping theory and Practice (Vol. 1)*. UK, E and FN Spon.

Evans, G., Naim, M., and Towill, D. (1997). "Process costing - the route to construction re-engineering." Proceedings of the Mouchel Centenary Conference *Innovation in Civil Engineering and Construction Engineering*, Cambridge, 153-162.

Gann, D. (1996). "Construction as a manufacturing process? Similarities and differences between industrialised housing and car production in Japan." *Constr. Mgt. and Econ.*, 14, 437-450.

Gattorna, J.L. and Walters, D. W. (1996). *Managing the supply chain: a strategic perspective*. MacMillan, London.

Goldman, S.L., Nagel, R.N., and Preiss, K. (1994). *Agile competitors and virtual organisations: strategies for enriching*. Van Nostrand Reinhold, UK.

Grunwald, H.J. and Fortuin, L. (1992). "Many steps towards zero inventory." *European Journal of Operational Research*, 59, 359-369.

Harrison, A. (1995). "The impact of schedule stability on supplier responsiveness: a comparative study." *Sec. Int. Symp. on Logistics*, 11-12 July, Nottingham, UK, 217-224.

Harrison, A. (1997). "Investigating the sources and causes of schedule instability." Third Int. Symposium on Logistics, 9-11 July, Padua, Italy, 155-164.

Hayes, R. H. and Pisano, G. P. (1994). "Beyond world class: the new manufacturing strategy." *Harvard Business Review*, Jan.-Feb., 77-86.

Hoekstra, S. and Romme, J. (1992). *Integral logistics structures: developing customer oriented goods flow*. McGraw-Hill, London.

Horman, M., Kenley, R., and Jennings, V. (1997). "A lean approach to construction: an historical case study." In Alarcon, L. (ed.)

Johansson, H.J., McHugh, P., Pendlebury, A.J., and Wheeler, W.A. (1993). *Business Process Reengineering*. Wiley, Chichester.

Kidd, P. T. (1995). "Agile manufacturing: a strategy for the 21st Century." *IEE Agile Manufacturing Colloquium*, 11-16.

Lee, H.L. and Billington, C. (1992). "Managing supply chain inventory: pitfalls and opportunities." *Sloan Management Review*, Spring, 65-73.

Mason-Jones, R. and Towill, D. R. (1997). "Information enrichment: designing the supply chain for competitive advantage." *Supply Chain Management*, 2 (4), 137-148.

Melles, B. and Welling, D. (1996). "Towards a different view of production control in construction." *Proc. of the Fourth Annual Conference of the International Group for Lean Construction.* University of Birmingham, Department of Civil Engineering.

Miles, J. (1996). "Where is the Henry Ford of Future Housing Systems?" Lecture to the Royal Academy of Engineering, London.

Naim, M. M. (1997). "The book that changed the world." *Mfrg. Engineer*, Feb., 13-16.

Naylor, J. Ben, Naim, Mohamed M., and Berry, D. (1997). "Leagility: integrating the lean and agile manufacturing paradigms in the total supply chain." Occasional Paper #47, December, Dept. of Maritime Studies and International Transport, Cardiff University.

Naylor, J. Ben, Naim, Mohamed M., and Berry, D. (1999). "Leagility: integrating the lean and agile manufacturing paradigms in the total supply chain." Special Issue of *International Journal of Production Economics*, *Design and Implementation of Agile Manufacturing Systems* (forthcoming).

Stalk, G. and Hout, T.M. (1990). *How time based competition reshaping global markets.* The Free Press, New York.

Stalk, G. and Webber, A.M. (1993). "Japan's dark side of time." *Harvard Business Review*, July-August, 93-102.

Stevens, J., (1989). "Integrating the supply chain." *International Journal of Physical Distribution and Materials Management*, 19 (8), 3-8.

Towill, D.R. (1997). "The seamless supply chain – the predator's strategic advantage." *International Journal of Technology Management*, 13 (1), 37-56.

Ward, C. (1994). "What is agility?" *Industrial Engineering*, November, 14-16.

Womack, J. P. and Jones, D. (1996). *Lean thinking*. Simon and Schuster, New York.

Womack, J.P., Jones, D.T., and Roos, D. (1990). *The machine that changed the world.* Rawson Associates, New York.