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AN INNOVATIVE SUPPLY CHAIN STRATEGY FOR CUSTOMISED HOUSING

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ABSTRACT

There has recently been considerable interest in construction research in paradigms developed for the manufacturing sector. Using lean thinking and agile production as examples of innovative organisational and business process design, this paper explores their commonalities and differences. In this way, it is possible to judge which paradigm is the most appropriate for given market conditions. By presenting action research outputs from a project on the UK housebuilding industry, the paper indicates the potential application of both lean and agile construction from a supply chain perspective. The paper concludes that housebuilding supply chains have to be engineered according to whether the market objectives are low cost, flexibility or a combination of the two.

Keywords: customisation, housebuilding, supply chain, lean and agile, process innovation

INTRODUCTION

Britain has an expensive and ageing housing stock. Furthermore, we build less new housing than elsewhere in the developed economies. Pressure on the existing housing stock is substantial because of changes to demography, lifestyles and working practices. These pressures are unevenly distributed, with southern England potentially facing the greatest pressure for additional homes (Barlow et al., 2002).

To what extent can the current system respond to these demands? Britain's housing supply system is overwhelmingly dominated by speculative housebuilding. The sector is, however, relatively poor in responding to short-term changes in demand. This is partly the result of low

levels of technical and organisational innovation – which are now the subject of government and industry initiatives to improve performance – and partly the result of supply-side problems. The latter predominantly relate to the lack of land for development, speed with which the planning process operates and problems in securing skilled labour.

As we have noted, the housebuilding industry is undergoing a sustained effort, largely via the Housing Forum (www.thehousingforum.org.uk), to reduce construction costs and improve delivery times and quality. Government is exhorting the industry to learn lessons from other manufacturing sectors, where ‘lean’ and ‘agile’ manufacturing techniques have become increasingly common during the 1990s. And other countries have seen moves towards manufactured approaches to housing supply, most notably Japan (Gann, 1996).

The aim of this paper is to explore the possible use of lean and agile production in the UK housebuilding industry. First, we discuss the theoretical perspectives relating to lean and agile production. We then examine what housebuilders *should* be doing, drawing on an analysis of current housebuilding supply chains and the lessons from other industries. In the next section, we look at current housebuilding industry progress to more lean and agile approaches, and where the barriers to their more widespread adoption lie. Finally, we draw some conclusions on lean and agile production in relation to wider debates on product and process innovation.

THE LEAN AND AGILE PARADIGMS

Definitions

In the construction management press there has been considerable interest in the concept of lean thinking, to the extent that there is an almost blind leap of faith in its powers to transform

construction. The lean paradigm has largely been transferred from manufacturing, especially the automotive sector, following the publication of *The Machine that Changed the World* (Womack et al., 1990). But if Oliver (1999) is correct, the newer notion of ‘agile production’ may well lead to a rejection of the lean paradigm.

In order to consider the appropriateness and potential effects of the lean and agile paradigms on the housebuilding industry, it is necessary to first explore the definitions and subsequent explanations of ‘lean’ and ‘agile’ production. Naylor et al. (1997; 1999a) give the following definitions, developed from close scrutiny of the literature:

- *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 must be read within the context of the *total supply chain*, as both refer to this via the ‘virtual enterprise’ and the ‘value stream’. Consideration of the supply chain is also necessary in order to examine the differentiating and complementary defining features of both paradigms. The supply chain may be defined as:

- *a system whose constituent parts include material suppliers, production facilities, distribution services and customers, linked together via a feed-forward flow of materials, a feedback flow of [demand] information (Stevens, 1989)*

As well as the feedback flow of demand, there may also be the flow of system state information (such as inventory levels), the flow of resources and the flow of cash (Naim, 1997). Such a

systems perspective implies ‘gestalt’ – the idea that the whole is greater than the sum of the individual parts (Burbridge, 1983). It is important to consider the concept of ‘gestalt’ to ensure that we are not constrained to sub-optimum solutions within the supply chain. In the supply chain context, the notion of ‘customer focus’ – common to many of the management paradigms – represents one property of a wider systems approach. Customer focus may take the form of volume and variety of a particular product in relation to the needs of the end customer. Appropriate metrics include product quality, delivery reliability and timeliness, level of service and price.

Naylor et al. (1999a; 1999b) have shown where the emphasis of the lean and agile paradigms lies in terms of satisfying customer requirements. Both highlight the need to deliver quality products within the shortest and most reliable period of time possible. But while the *lean* paradigm argues for the development of a physically efficient process – that is, waste and cost reduction – the *agile* paradigm stresses the need for effectiveness in terms of high levels of service via flexibility and customisation. Using marketing metaphors (Hill, 1995), the market winner for a lean process is price, while that for an agile process is service (Naylor et al., 1999b). This view of value concurs with that of Barlow (1998), who states that ‘agile production introduces an added degree of customer focus’.

The defining characteristics of lean and agility are indicated in Table 1, following a thorough Review of the literature¹. Both paradigms develop the argument for ‘gestalt’ by arguing the need for integrated supply chain processes, despite using differing language. In both, the total supply chain may be geared up to meeting customer needs after ascertaining their wants by attaining

market knowledge. Both paradigms also put the need for time compression strategies as a central theme: time to market is seen as paramount, with the elimination of non-value added time leading to significant benefits, such as reduced inventory keeping and hence reduced total costs (Towill, 1996).

*** Table 1 near here ***

The two paradigms begin to differentiate themselves when considering the *order winning criteria*. As mentioned previously, lean production focuses on efficiency – minimising resource requirements through the elimination of waste (or ‘muda’²) but ensuring acceptable levels of service. In contrast, agility maximises customer service, and in particular flexibility, while attaining acceptable costs. These factors therefore represent the two main defining characteristics.

The lean process is so *efficiency* orientated that it relies heavily on certainty to ensure cost minimisation. There is a need to engineer-in stability, achieved primarily through level schedules to avoid expensive on-costs, resulting from disturbances occurring in the supply chain (Naim, 1997). With costs minimised, it is therefore possible for a lean producer to offer many features to the customer as standard. While this may limit actual choice, it does give the customer a perception of ‘value for money’.

In contrast, the agile process is focused on *effectiveness* - the ability to give customers exactly what they want, when they want it. That is, to offer a customised product. This requires some ‘slack’ to be built into the process, usually in the form of excess capacity, to enable the supply

¹ See Stevens (1989), Womack, et al. (1990), Grunwald and Fortuin (1992), Stalk and Weber (1993), Goldman et al. (1994), Hayes and Pisano (1994), Harrison (1995), Kidd (1994), Womack and Jones (1996), Evans et al. (1997), Towill (1997a; 1997b).

chain to be robust to both product volume and product variety changes. Cost is not an over-riding concern although it still has to be limited to ensure profitability.

Combining the lean and agile paradigms

This view of lean and agile production is synonymous with the functional product and innovative product strategies developed by Fisher (1997). These have been utilised by Naylor et al. (1999b) to suggest that ‘one size does NOT fit all’. That is, the right solution has to be applied to the right problem. If the market requirements are such that purely functional products suffice, then an efficient, lean process has to be engineered. If the market calls for a high degree of customisation – that is, an innovative product – then the process has to be responsive and hence agile.

These are two clearcut cases. What, however, is the solution when a customised product is required, but cost is still an important issue? Here, we need to close the loop from the total supply chain perspective back to the lean and agile paradigm definitions by considering 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). It represents 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. Various strategies for locating the decoupling point are shown in Figure 1.

*** Figure 1 near here ***

² The Japanese term frequently used within the literature.

At one end of the spectrum, we have the functional product approach involving 'ship to stock / make to stock' strategies (cf. Fisher, 1997). Thus, a standard product with a relatively long and predictable life cycle and assured demand may be stocked and simply picked off the shelf by the consumer with minimal lead-times. The problem with this strategy is that there is still some risk of finished goods stock obsolescence.

At the other extreme, we have the 'buy to order / make to order' supply chains which are potential strategies for the customised product. There is no risk of stock obsolescence as the product is configured to customer requirements from the start of value adding operations undertaken on the raw materials. The major disadvantage is the potentially protracted lead-time before the consumer is in receipt of the finished goods.

A compromise situation is 'assemble to stock', which attempts to trade off stock obsolescence risk with lead time requirements. Such an approach has been utilised since the 1920s (Pagh and Cooper, 1998), and a notable modern case is that of Benetton clothing (Gattorna and Walters, 1996). Assemble to stock strategies have been shown to be particularly effective in the electronics industry (Naylor et al., 1999a; Hoekstra and Romme, 1992; Davies, 1993; Lee and Billington, 1992), where product life cycles are continuously decreasing, there is an ever increasing requirement for customised products, and competition and price wars are driving down prices (Berry and Towill, 1993). The strategy in this case is to postpone or configure the customisation of the product as late as possible. The aim is to deliver standardised or functional products and systems to the decoupling point as sub-assemblies and to configure them as and when the customer order is received.

As Naylor et al. (1999a) have shown, the 'assemble to order' strategy utilises both the lean and agile paradigms and may be termed the 'leagile' supply chain. As indicated in Figure 2, the decoupling point represents the strategic stock of standardised products. The positioning and the magnitude of this stock needs careful engineering, considering product value, product complexity and product demand at each stage of the supply chain (Jones and Riley, 1985). The strategic stock should be kept at a minimum reasonable level to minimise stock and obsolescence costs while maximising service levels (Grunwald and Fortuin, 1992; Towill et al., 1997). Thus, this strategic stock is not 'muda', but actually adds total value to the delivery of the product to the customer.

*** Figure 2 near here ***

Downstream of the decoupling point, we have the agile processes that react to the changing customer requirements. Standardised components are pulled from the decoupling point, assembled and delivered to the customer. Upstream of the decoupling point, there are the lean processes that proactively manage and control the delivery of the standardised components and/or sub-assemblies to the decoupling point. Planning is undertaken to ensure an adequate pipeline of material (push mode) while operationally the material is pulled 'just-in-time'.

LEAN AND AGILE CONCEPTS IN HOUSEBUILDING

Is the 'leagile' concept of potential use in the housebuilding supply chain? There are a number of inherent similarities between housebuilding and PC production. At the most basic level, the PC may 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.

In its simplest terms, a house may also be decomposed into core elements: the foundations, the shell, the roof and the fit-out and services. Each of these elements may comprise 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 these elements by a number of different players in the supply chain, including the developer, the builder, contractors, sub-contractors and suppliers.

Following extensive analysis and documentation of the supply chains of a number of major social and private house builders via action based research, we have developed conceptual models of an 'as is' housebuilding supply chain and an 'as could be' scenario. The data and methods utilised in the diagnostic of the supply chain are presented by Barker et al. (2000). Data sources may be summarised as empirical ('walking the process', process mapping and questionnaires), archival (document analysis), analytical (database mining and analysis) and opinion (interviews and brainstorming sessions). These various sources of data gathering and methods ensure triangulation of the data, aid in the validation process and ensure consensus of findings.

Classical modelling tools, such as process mapping, were utilised by the research team to document current supply chain practices, undertake diagnostics and recommend improvement strategies (Barker et al., 2000). Coupled with these more traditional industrial engineering

modelling media, we found it useful to utilise soft systems tools (Checkland, 1990) to highlight the key strategic and operational supply chain issues. In particular, a rich picture representation was used to present the broad view, so important in helping to understand problems and potential solutions without becoming obscured by minutiae. This preliminary aggregate analysis is commonly found in many management innovations, including business process engineering³, lean thinking (Womack and Jones, 1996) and agile production (Kidd, 1994).

Figure 3 shows the rich picture representation we have developed of a housebuilding supply chain. This model focuses on the major issues related to the planning and control of the supply chain and its associated operational logistics. It is not meant to be comprehensive, but presents the seven critical ‘hot spots’ identified by the supply chain diagnostics and related research activities. It is possible to relate each of the hot spots to the key characteristics of leanness and agility, as presented in Table 1.

- Hot spot #1 (*no use of market knowledge*) – at a regional and site level, loose purchasing agreements are made with manufacturers and builders’ merchants, but these are solely based on price. There are no guaranteed time scales for actually buying and calling off the material. The suppliers have little visibility of long-term market requirements.
- Hot spot #2 (*lack of supply chain integration*) – the site manager has the unenviable task of ‘juggling a number of balls’ at the same time. He or she obtains a considerable amount of information, but, without a clear strategy of how best to utilise the information, it ends up as actually being more of a detriment to the supply chain than a benefit. This concurs with

³ Johansson et al. (1993) emphasise the need to avoid ‘paralysis by analysis’.

theoretical studies about information transfer in the supply chain (Mason-Jones, 1998).

Information transfer to the supply base is merely in terms of call-offs.

- Hot spot #3 (*no time compression strategy*) – manufacture and supply lead-times are protracted. Supplier delivery performance is poor. A lack of supplier development and an environment of confrontation yields a vicious circle of blame. The suppliers get volatile short-term call-off information from the site and no medium term demand requirements. They are therefore unable to respond adequately to site needs. Both the regional purchaser and the site are uncertain about the suppliers' abilities and impose unrealistic requirements. Late changes in site requirements occur and the supplier is unable to rapidly reconfigure, delivering large batches to site. This is a common phenomenon in the supply chain (Houlihan, 1987).
- Hot spot #4 (*inability to rapidly re-configure*) – similar to hot spot #3, sub-contractors are selected by headquarters (again based on price rather than value), but are called as and when required by the site without medium term planning horizons. Due to the associated uncertainty, sub-contractors commit themselves to a number of different sites without actually having capacity available to do so. There is, therefore, poor response from the contractors when they are required on site.
- Hot spots #5 & #6 (*excessive muda, or waste*) – a clear symptom of the uncertainty in the supply chain is 'muda', in the form of waste stock and general wastage of material. It is necessary to build a stockyard of material due to the uncertainties mentioned in the previous hot spots. This is merely a 'comfort' stock and has no strategic value. Sometimes material that is required will not be available from the stockyard. At other times the material available

is not required. As the stockyard is not actually properly engineered into the site layout it becomes merely a dumping ground for material. Losses occur through damage, mislaying or theft and hence waste is high. The picking, sorting and moving of material is ad-hoc and due to poor material identification, leads to wasted time. Material from the stockyard may or may not arrive to the right house, at the right time, in the right quantity. More than likely, it will not be synchronised with resource availability.

- Hot spot #7 (*muda*) – the ultimate symptom of the traditional supply chain is the need for a finishing foreman. His role is simply to chase waste and hence his very task is wasteful. He progress chases contractors and materials. He identifies faults and assigns re-work programmes. He interacts with the new homeowners and attempts to address the snag list; yet all the hot spots indicated previously still exist. The finishing foreman is an indication that total customer value is poor. In particular, quality is at a very low level and lead-times are long. These should be qualifiers for applying both lean and agile principles.

Rather than getting the best of both worlds, the housebuilding supply chain is actually making the worst of all worlds. There is a focus on cost, but everything that is undertaken is actually shown to be contrary to the need to be efficient. There is constant change in requirements and demand and hence the lean principle of *smooth or level scheduling does not exist*. Yet even with the uncertainties, the supply chain is *not robust* enough to change, as capacity is not engineered into the process. As indicated in Figure 3, the customer is not even in the picture. The supply chain is essentially working in a *make/supply to stock environment* and if the demand is not there for a product, then price cuts or incentives occur to stimulate the market place.

Part of the research undertaken involves developing a ‘dream’ supply chain. This involves the design of conceptual models and the development of associated principles and rules to guide the housebuilding participants in engineering efficient and responsive supply chains. In order to address the issue of ‘leagility’, Figure 4 has been developed. This indicates one possible scenario for specific housebuilding conditions. Early in a supply chain engineering programme, the type of product has to be identified in order to determine the right supply chain type. The scenario indicated in Figure 4 is for the sub-assemblies and components feeding into a house type that may be considered innovative, requiring a degree of customisation and where both lead-time and price have to be considered.

The principles of lean and agile production, as given in Table 1, are embodied in the rich picture model. As with Figure 3, the model elaborates on the issues concerning planning, control and execution. Strategic requirements are translated into build plans and materials requirements. Long-term capacity requirements are issued to first and second tier suppliers. The first tier suppliers (in this case builders’ merchants), have capacity designated to the housebuilder to ensure adequate supply of both material and human resources. In this scenario, the builders’ merchants have a new pivotal role as they reside on the supply chain decoupling point and offer a supply and fit service. This mode of operation has been cited as the future role of builders’ merchants (Agapiou et al., 1998).

As the supply chain now has a push planning mechanism in place, it is possible to ensure adequate pipeline fulfilment of materials to the decoupling point. The builders’ merchant is tasked with assembling consolidated kits ‘just-in-time’ from stocks of standardised components and/or sub-assemblies that are the decoupling point. Such stock may be replenished via ‘just-in-time’ pull signals or actually managed by the suppliers themselves.

The builders' merchant consolidates the kit after receiving a pull signal from the site manager and delivers the material with the appropriate contract personnel to actually fit the product into the house. The consolidation is the point at which configuration of the product takes place and is based on a call-off that has been developed following customer requirements capture from the site. It is not envisaged that the customer will have an infinite choice, but will select his or her personal requirements based on a menu that shows the viable choices from a combination of the standardised components. A typical level of choice – highlighted by Towill (1997a; 1997b) and based on the example the US housebuilder Doyle Wilson – indicates that customers have considerable product variety, including 40 brick finishes, 3000 wallpapers, 4 study styles, a wide range of carpets and individual wiring schemes. This implies a high degree of customisation, coupled with the lean physical efficiency emphasised in the case study.

CURRENT HOUSEBUILDING INDUSTRY PROGRESS TOWARDS LEAN AND AGILE PRODUCTION

It appears that the findings from the supply chain analysis described above are replicated across the housebuilding industry, but it is by no means clear that firms have begun to move towards the lean construction paradigm (Barlow, 1998; 1999). To recap, the key business processes required for the adoption of a 'leagile' approach to housebuilding are the minimisation of resource requirements through the elimination of waste in the supply chain and the maximisation of customer service, especially flexibility, at an acceptable cost.

Supply chain management

Barlow (1998; 1999) suggests that while housebuilders were making efforts to reorganise their supplier relationships, many of the key features of lean thinking had barely penetrated the

industry. The perception amongst housebuilders was that the logistics of housebuilding make it hard to organise just-in-time delivery of materials and its impact on profitability was unclear. Furthermore, the transfer of risk down the production chain to subcontractors reduced the incentive to introduce leaner supply models for housebuilding. Housebuilders tended to rely on subcontractors to act to reduce waste. In this respect, then, hot spots 1-4 (see above) all featured – to a greater or lesser extent – in the firms examined in this research.

‘Partnering’ with suppliers is one way in which many of these hot spots can be overcome. However, although supply chain reorganisation – in the form of reduction in the number of preferred suppliers – is a primary objective of many housebuilders, progress towards partnering, as understood in other construction sectors, has been slow. While some firms are now turning to longer term supply agreements which include key partnering features such as gain sharing and workload guarantees, there are barriers which hinder the emergence of partnering. On the one hand, there is intense competition between small suppliers of some housebuilding inputs, while on the other hand, many housebuilders perceive there to be an imbalance in power between a relatively weak housebuilding industry and large oligopolistic suppliers for other inputs. Moreover, the relative simplicity and repetitiveness of much housing development may also obviate the need for close collaboration between client (i.e. developer) and suppliers to improve buildability, unlike in major building or civil engineering projects. And in the social housing sector, Housing Corporation procurement guidelines have prevented the adoption of longer-term supply relationships until recently. However, the concept of partnering has now been endorsed and in order to secure grants, housing associations will need to be ‘Egan compliant’ from 2004; this includes a commitment to the adoption of partnering.

As well as government exhortation in the social housing sector, there are three factors which may drive the industry towards increased use of partnering. First, problems in securing an adequate supply of skilled labour in many areas are leading some housebuilders to develop longer term relationships with subcontractors, either on a labour only or supply-and-fix basis. So far, this has proved difficult because of the level of competition for labour in certain areas and the limited number of subcontractors which are of a sufficient size to provide a suitably wide geographical coverage. It is possible, however, that the need to ensure their loyalty will force housebuilders into adopting 'true' partnering relationships.

Second, as hot spots 5-7 indicated (see above), excessive waste is a critical problem in housebuilding supply chains and its minimisation potentially provides benefits in terms of improved profitability for both housebuilder and subcontractor.

Third, an increasing amount of housing development is of a 'non-standard' form. Already about half of all new homes are built on brownfield (recycled) sites. These are frequently more complex in spatial configuration or ground conditions and often require a one-off design solution. Additionally, a growing proportion of total housebuilding comprises one-off mixed-use development or conversion from existing buildings (DETR, 2000). These require a wider range of development skills than is found within typical housebuilders. As other parts of the construction industry have found, partnering is particularly beneficial in technically or financially complex one-off projects, where the key participants can be brought together early in the planning process (Barlow et al., 1997).

Customer focus

The second aspect of 'leagility' is the maximisation of customer service – a greatly improved ability to capture customer requirements and more responsive production systems to provide a more customised product. This requires the adoption of business processes which integrate production and sales functions, and the introduction of customer-centred performance measures.

So far, efforts to maximise customer service have been limited to improvements to market research and after-care. Even though there is a widespread perception that buyers have become more astute and aspirations have grown, this has not been translated into moves towards increased customisation. Most firms have tried to pre-empt purchaser choice by ensuring they have as wide a portfolio of house types as possible (Nicol and Hooper, 1999), citing as barriers to increased customisation such factors as building and planning regulations, current construction lead times, and the perceptions of valuers and mortgage lenders (Barlow, 1998; 1999). Another commonly expressed view is that customers do not necessarily know what they want.

Many housebuilders are, however, rationalising their product portfolios and increasing the frequency of redesign. This follows the introduction of more sophisticated approaches to market research and the use of information systems to record customer experiences. Some firms have begun to integrate their marketing, design and production functions more closely.

There are features present in the UK housing system which offer the potential to both stimulate and hinder increased customer focus. In the *speculative housing* sector, inhibitors relate partly to the development process itself and partly to the lack of competition from alternative suppliers. Speculative housebuilders usually build to stock, designing properties before customers are found and using standard housing types which can be modified to provide a degree of cosmetic

choice for customers. Securing access to land, and buying and developing it at the right point in the market cycle, is critical. 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, and also to develop new products to differentiate themselves in the market.

Clearly, one important driver towards radical change would be a rejection by potential customers of the new products currently on offer. Arguably, there is dissatisfaction on the part of consumers and government over the industry's performance, especially in terms of its ability to meet the quality standards expected of modern industry. The substantial growth in the amount of self-built housing, despite the considerable difficulties in this procurement route, may be a reflection of this consumer dissatisfaction⁴. There has, however, been a long-term undersupply of new housing in much of the UK compared to other developed countries (Barlow et al., 2002).

Acquiring the right new home, in the right location, is frequently not a viable option for purchasers. The housebuilding industry's prime competitor is therefore the existing housing market, which arguably helps to stifle the quality and innovation expectations of housing consumers. In short, a lack of product competition has sustained a generally conservative housebuilding industry.

Moves towards greater customer focus in the *social housing* sector are hindered by other problems. Apart from high demand, limited supply and the lack of a market within which households can exercise choice between suppliers, the funding arrangements create additional

⁴ The number of new homes built in this way is estimated to have risen from about 8,000 to 15,000 units since 1988, while the new homes market has contracted (Barlow et al., 2001).

problems. Housing Corporation (the principal funder) rules mean you need to predict the rent levels of each flat at the start of the project planning process, but it is generally not possible to identify the tenants for the property or even the scheme. Housing associations therefore try to anticipate users' needs, based on their experience of tenant feedback on previous schemes. However, generally views are expressed via 'quasi end-users', i.e. housing estate managers, which may reflect their own prejudices. Housing associations may well 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 that may be at variance to their tenants' immediate needs.

There are two factors that may drive housing associations towards increased customer focus. First, housing associations increasingly need to consider the lifetime costs of their property when preparing a new project. This means that a different set of construction criteria, relating to maintenance, flexibility and energy costs, will need to be considered. Building in flexibility and future adaptability will therefore rise in importance, especially as the turnover of households in the social housing stock is very low.

CONCLUSIONS

The lean and agile paradigms may be classified as innovations in management thinking. They highlight key strategic needs that must be put into place in order to make an organisation competitive. These paradigms focus on the introduction of new processes (Livesey, 1983). We have suggested that while lean production emphasises the *technical efficiency* of processes, agility focuses on *process responsiveness*.

A danger of any new management innovation is that it is often presented as a radical innovation since it is commonly associated with a new textbook on the subject (or rather, an easy-to-read management book). In fact, management process innovation frequently relies more on faith than practical, rational choice and often leads to an unequivocal renunciation of all previous paradigms (Oliver, 1999). Such a dogmatic approach can result in the belief that single solutions can solve several distinct problems. We have advocated that while each new paradigm has distinct features, it should be seen within its context of previous innovations and the ensuing rational choices that have been made. The best characteristic of various paradigms can actually lead to an optimum solution.

There is a tradition in the UK housebuilding sector of focusing primarily on cost, rather than total value. As we have indicated through cross-sector case studies and a housebuilding supply chain conceptual model, combining lean and agile principles can deliver total value to the customer, without incurring a severe cost penalty. We believe it is critical to have a conceptual 'leagile' supply chain model in place for housebuilding companies to fully appreciate the opportunities available to them. From such a conceptual model, detailed supply chain designs may be developed. While there is still considerable complacency in the sector, it is those companies that use appropriate management innovations in a coherent and rational manner that will provide the total value that customers are demanding and hence beat the competition. To modernise to meet the Egan agenda, it will be vital for UK housebuilders to exploit these management innovations.

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

○○○ = Key metric, ○○ = Secondary metric, ○ = Arbitrary metric

Table 1: Rating the importance of different characteristics of leanness & agility
Source: Naylor et al. (1999)

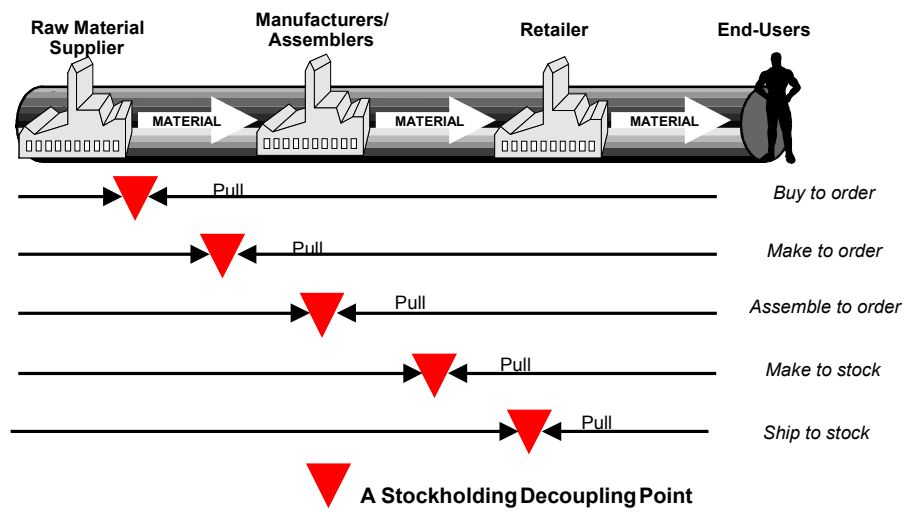


Figure 1: Family of supply chain structures
Source: Hoekstra and Romme (1992)

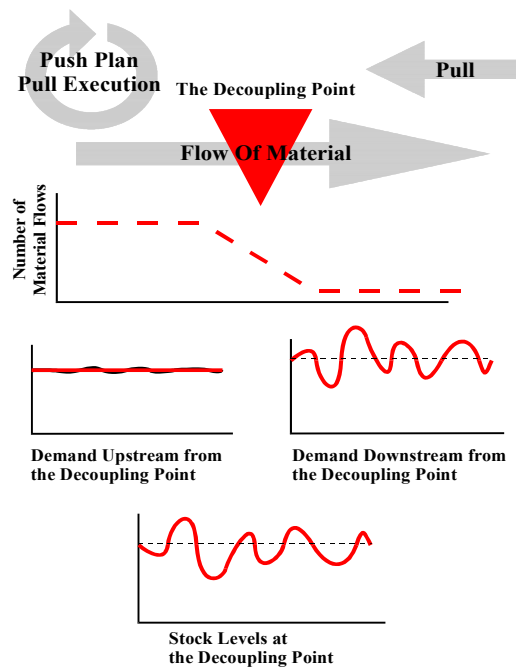


Figure 2: The role of the decoupling point in the supply chain

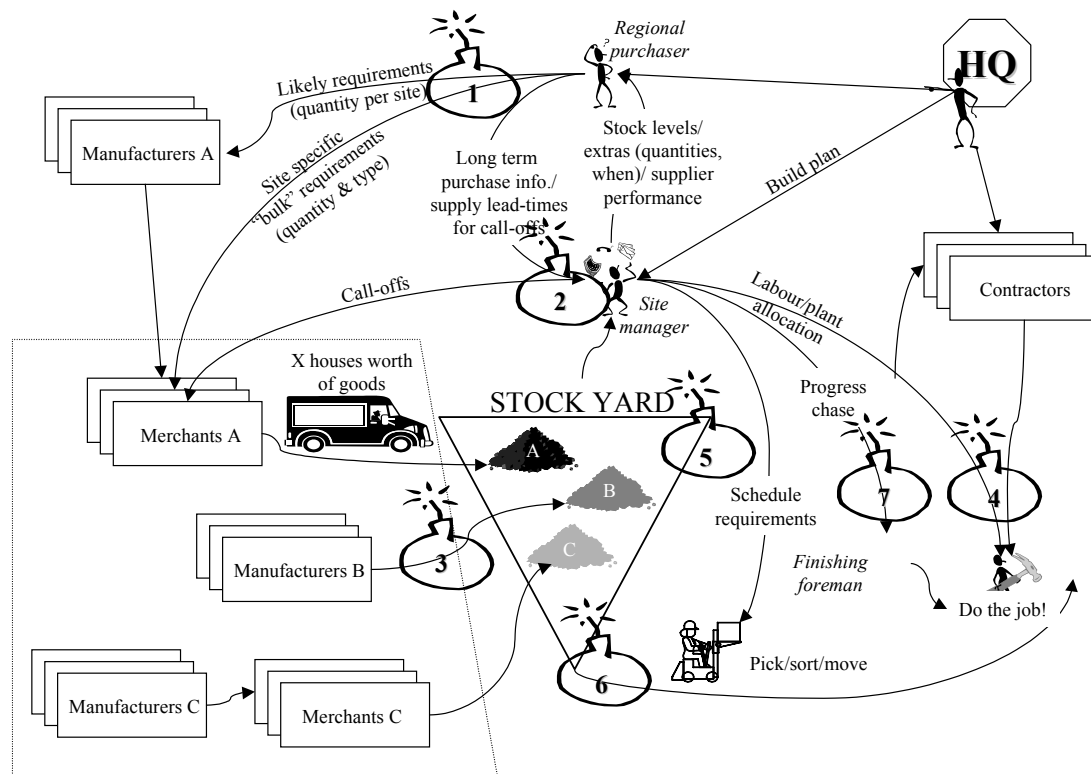


Figure 3: Rich picture representation of the ‘traditional’ supply chain

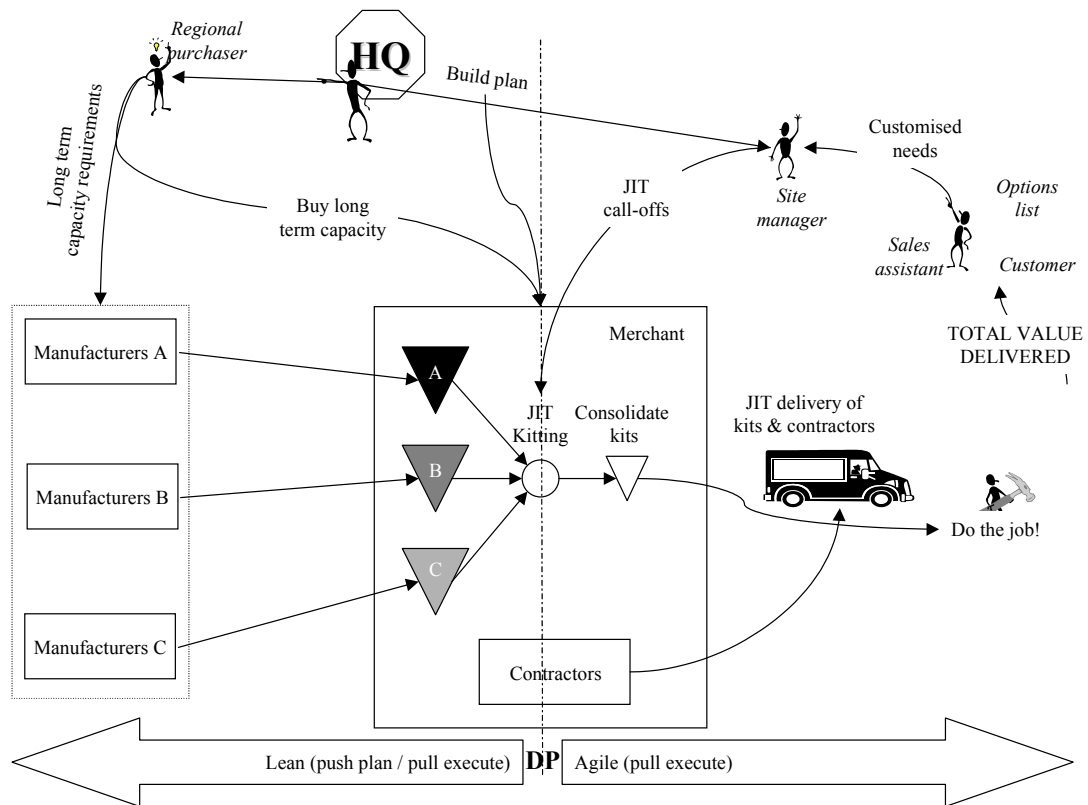


Figure 4: Rich picture representation of the 'engineered' supply chain using the decoupling point as a strategic tool