From Supply Chains to Total Product Systems

Book Section

1.1

From Supply Chains to Total Product Systems

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Introduction

The evolution of supply chain management and practice has had an integral and expanding role in contemporary global economic and socio-political change over the past 25 years or so. This role is moving closer to centre stage with the emergence of business models equating to 'total product systems'. The impacts of advanced supply chain practice include driving fundamental changes in approach to product design, the concept of 'product', production methods, distribution, marketing, aftermarket support and end-of-life (EOL) reprocessing. Viewed in their full context, methods of supply chain management (SCM) have major influences on societal functioning and on economic development at global, national and local levels. Even the supply chains for simple products can involve several different industries and link many companies, large and small. Those for complex products may span several technological domains and economic sectors, linking hundreds or sometimes thousands of companies.

Complexity is evident, for instance, in the scale and scope of supply chain operation in capital and consumer goods sectors (such as aircraft, cars and apparel) and in services (such as hotel chains, fast-food franchises and financial services). In such cases, elements of the design, production and distribution processes associated with an end-product, together with the associated management and support services, may be carried out in large numbers of organizations in many countries in all continents. This provides the context in which 'a very small firm in one country may be directly linked into a global production network' (Dicken, 2004, p. 253). 'Geographic dispersion has occurred on a massive scale' (Ernst, 2002, p. 504). Supply chain organization has provided the channels through which much of this has occurred. Consumer and other products, together with the methods of production and marketing that underpin them, are projected from the countries of the industrial core into

those of the semi-periphery and periphery, reshaping economies and societies. But this is not one-way traffic. There is also substantial movement in the opposite direction as patterns of specialization and integration are fostered on a global scale. Also, transnational companies have developed in newly industrialized countries (NICs) and in some developing countries (DCs), and become engaged in similar management of supply chains on an international or global scale. At the individual level, developing supply chain practice is directly or indirectly reshaping people's lives, whether as workers (in all categories), subsistence farmers, consumers or owners of small retail and other businesses. Those not affected must now be a dwindling minority of the world's population.

An extensive academic literature is concerned with aspects of these phenomena. Much of it is located in management accountancy, business management, organizational behaviour, and various branches of economics, as well as the supply chain 'mainstream'. Not surprisingly, the mainstream literature is primarily concerned with overall supply chain strategy, with practice in areas such as purchasing and logistics, and with analysing issues of 'lean supply' and other perceived problems. The emphasis of this literature is primarily technicist, presenting supposedly 'neutral' solutions to current managerial preoccupations. There is a focus on what are thought to be the most efficient methods for achieving high standards of performance in target areas that include cost reduction, managing outsourcing, shortening replenishment cycles, minimizing inventory, achieving consistent high standards of product quality, reducing time to market and 'getting close to the customer'.

These are highly significant competitive objectives, although the difficulties confronting those who seek to achieve them are not always adequately explored or are underestimated. Supply chains are highly complex phenomena, and the long term challenges of co-ordinating and developing their functioning are ill matched with managerial cultures where rapid career moves are combined with the influence of successive management fads and fashions (Pascale, 1990; Scarborough and Swan, 2001; MacDonald, 2004). A further problem is that supply chain practice tends to be abstracted from its broader contexts and effects. For example, the pursuit of cost reduction on a global scale takes several routes. Increased outsourcing has been one of the vehicles of change, and the search for suppliers offering ever lower costs can lead to suppliers who exploit lax regulation of labour conditions, environmental protection, and so on. The product flow in such cases has been traced to large retailers and brand owners with highly damaging consequences – a factor that is reshaping approaches to SCM.

It might be expected that these broader socio-economic issues are central to the supply chain literature. Instead (with some exceptions) they are the concern of different bodies of literature including development studies, geography, industrial relations and some branches of economics. For instance, development studies specialists seek to understand the relationships between commodity chain functioning and economic development and associated extreme disparities in the global distribution of economic activity and wealth. Approaches from these fields potentially contribute towards more holistic perspectives of contemporary supply chain functioning and management. However, as Harland points out (Chapter 1.2), the various bodies of

knowledge 'have remained largely unconnected' – although she and colleagues have subsequently taken steps towards establishing such connections (Harland et al., 2004). If there is a shift towards management of total product systems as is suggested here, multi-disciplinary research and analysis are ever more urgent.

Different academic traditions apply a varied terminology to what, broadly, are the same phenomena. Usage includes supply networks, value chains, global commodity chains and product systems. The chain metaphor is probably the most widely used, particularly among practitioners. But it conveys images of rigidities, whereas the multiple connections, the dynamic changes in patterns of sourcing and the varied roles of the actors that are found in practice, are more adequately captured by the metaphors of networks and systems. A further step is needed – I suggest the concept of total product systems – to capture the full implications of current advances in practice. Combinations of factors, including the lead actors' competitive strategies, activism among consumer, union and other groups, and the effects of environmental regulation are reshaping the SCM agenda. This is reflected in evolving approaches to production and product design and organization, and in shifts towards integrated management of the four phases of the 'cradle-to-grave' (C2G) product life cycle:

1 production phase – all stages from raw material generation through intermediate processing stages to completion of end-products;
2 distribution and sale of end-products;
3 product use and support in the aftermarket;
4 end-of-life (EOL) stages.

The rest of this chapter is divided into two main sections. The first establishes some of the main contours and issues evident in supply chain development. The second reviews the concept of total product systems as an extension of SCM.

Mapping the Issues

Supply chain evolution

Major differences in approach, methodologies and patterns of contemporary evolution in supply chains are evident within, across and between industrial sectors, and at the national level. They demonstrate contrasting strategies and varying patterns of practice – differences that, in substantial part, are attributable to the lead companies in chains, also referred to as: key actors (Kaplinsky, Chapter 1.3); focal firms (Harland et al., 2004); original equipment makers (OEMs) or 'primes' (Amesse et al., Chapter 4.4). In general terms, supply chains have been perceived primarily in terms of materials flows through the various stages from processing primary materials to intermediate processing and end-manufacture and on to the delivery of finished products to end-users – as in the example in Figure 1. But service products also have supply chains and, for some types of product, data generation and processing constitute the counterpart of materials flows, for instance in handling applications, cases

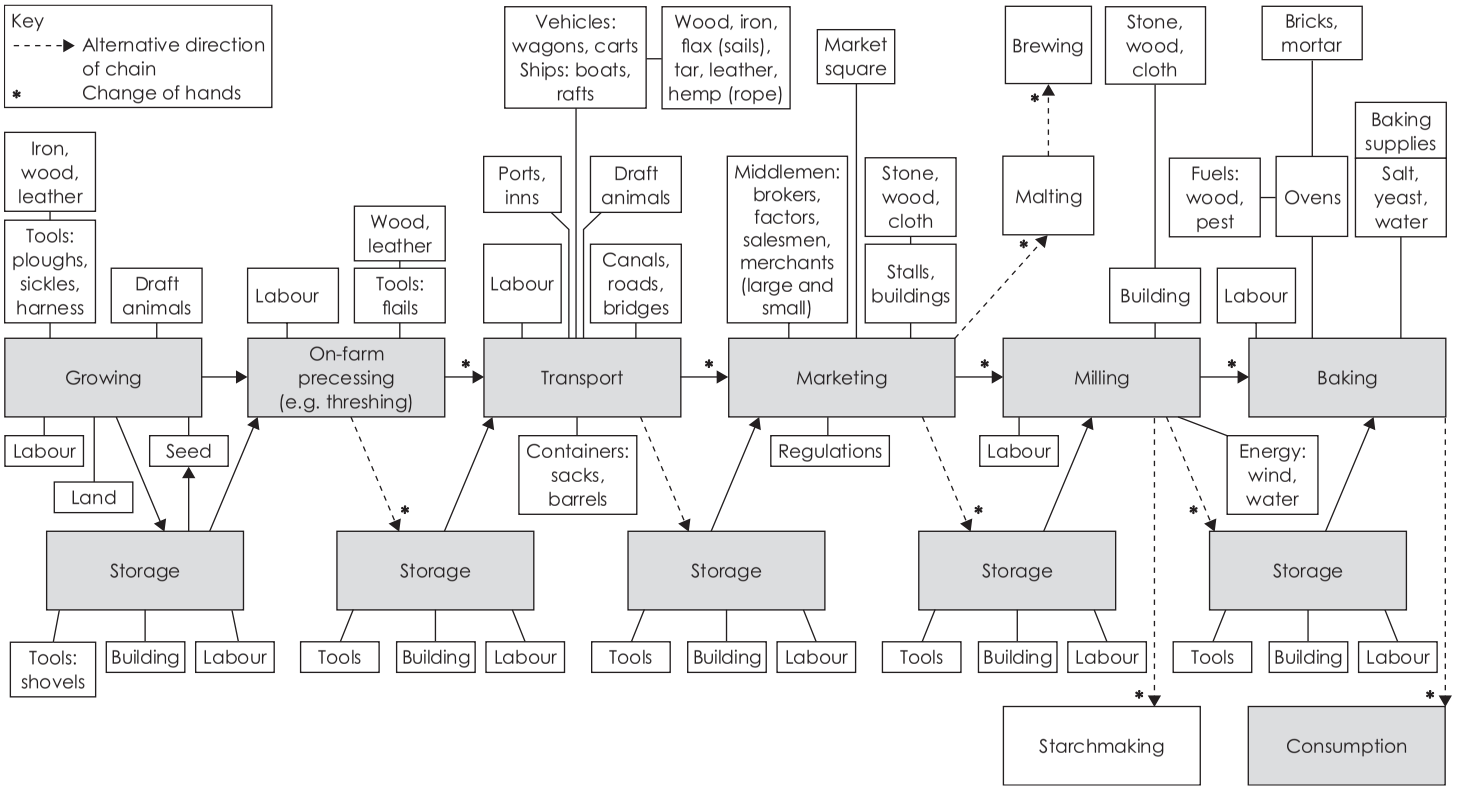

Figure 1 Grain flour supply chain: material flows from primary processing to delivery (Pelizzon, 1994, p. 35)

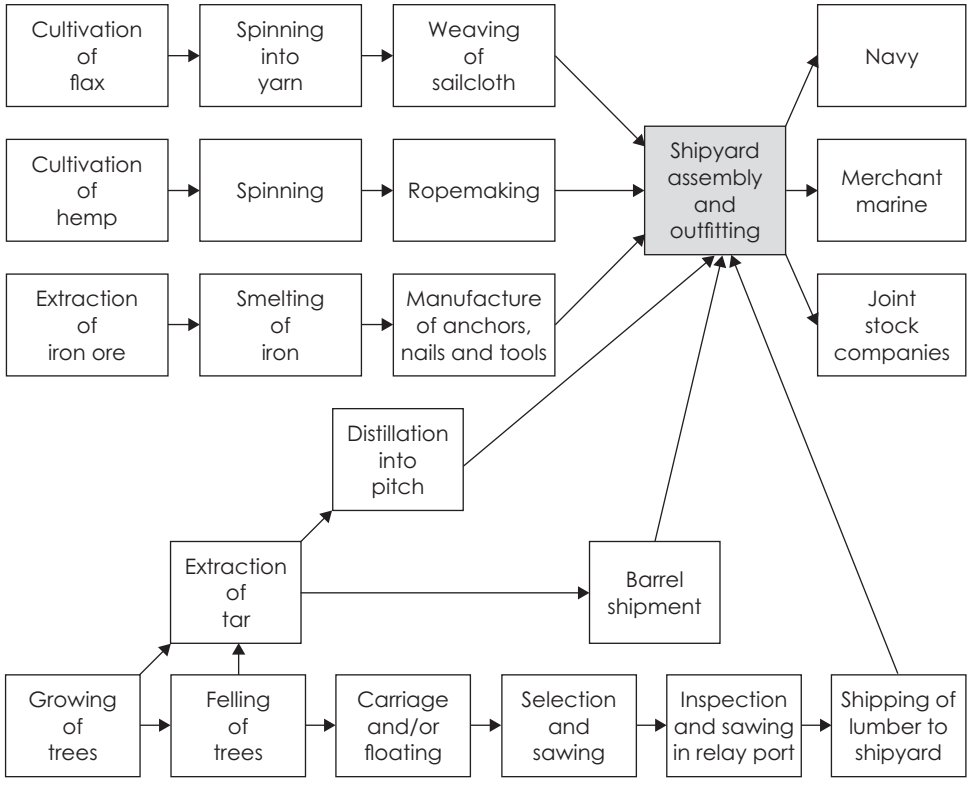

Figure 2 Shipbuilding supply chain: convergence of intermediate products (Özveren, 1994, p. 22)

and claims in public services and in the financial sector. Figure 2 illustrates a further general characteristic in the downstream flow towards the final assembly of end-products. There is a progressive convergence of intermediate products (components, subsystems etc.) that derive from different sectors with distinct materials technologies and process technologies. Such convergence from different technological domains adds to the challenges that face attempts to co-ordinate on a chain-wide basis.[1]

The seventeenth- and eighteenth-century 'commodity chains' in Figures 1 and 2 establish the long standing antecedents of some of the issues encountered in contemporary practice. They are summarized by Hopkins and Wallerstein (1994) as chains that 'were geographically extensive, complex, and in constant recomposition' with, in the grain flour example, a 'constant geographical reshuffling of the links in the chain'. Concern with 'flows and stocks' of materials, components and so on reflects the influence of logistics and procurement as core functions within SCM. The 'management of physical distribution' appears to have provided initial steps towards SCM in the 1960s and early 1970s (Gattorna and Walters, 1996), while Harland (Chapter 1.2) suggests that the actual term SCM dates from 1982. This shift in terminology and associated changes in practice relate to a number of developments.

Purposive SCM Hopkins and Wallerstein suggest that, in the above examples, 'it would be imprudent to assume that production decisions were made by anyone without some awareness of the existence of such chains, at least to the degree of appreciating that there were alternative possible sources of inputs and alternative possible outlets for outputs' (1994, pp. 48–9). In contemporary practice, 'awareness' has developed into highly purposive approaches to SCM in which the lead actors aim to intervene across all the stages of a chain, determining their spatial distribution by co-ordinating production, marketing and distribution on a global scale. For consumer products in particular, co-ordination aims at progressive integration across the total production flow from raw material processing through to the sale of end-products. Most recently, integration has moved towards product support in the aftermarket and, tentatively, to processing EOL products. This represents a clear movement towards management of 'product systems'.

Service inputs At each supply chain stage, inputs from outside the core processing flow are essential to chain functioning. Many of these are service activities, including energy supplies, logistics services, the design and operation of information and communications systems, hardware and software supply, maintenance services, 'consumables', and product design and development. Thus Palpacuer and Parisotto (Chapter 4.2) refer to views of 'the new role of services, or intangible activities, as superior sources of value creation'. Their significance is indicated by estimates by Quinn (1988) and Quinn et al. (1990) that 'within manufacturing, 75 to 85% of all value added, and a similar percentage of costs, are due to service activities' (quoted in den Hertog et al., Chapter 1.7: see further discussion in that chapter). The role of service inputs in overall chain activity is also related to the changing character of intermediate products and end-products, many of which are marketed as 'product offers' that include a variety of support and other value-adding services.

SCM as organizational capability Organizational competencies have become 'primary sources of competitive advantage' (Palpacuer and Parisotto, Chapter 4.2). SCM capabilities are among these, particularly when focused both outwards and inwards – on the internal supply chain. For lead actors, the external focus is most likely to include chain-wide co-ordination. In other organizations, the proximal supply chain – immediate buyers and suppliers – is likely to be the main concern, although there may be some positioning by proactive upstream firms in relation to specific lead companies and chains. Either way, the focus has tended to intensify under the umbrella of SCM, drawing disparate functional areas such as purchasing, production management, quality and logistics into closer co-ordination – in the more successful cases. Lund and Wright (Chapter 1.6) suggest that the concept of SCM 'has grown rapidly in popularity in North American industry over the last five years'. Increased popularity, in the US as elsewhere, has been reflected in supply chain strategies of varying coherence – among which lean concepts have been influential (but see various chapters in this volume).

Internationalization Supply chain co-ordination and strategic focus have increasingly been applied on an international, if not a global, scale to the point where 'final products, almost without exception, involve substantial inputs across the value chain that are produced in diverse locations across the globe . . . For instance, the supply chain of a computer company typically spans different time zones and continents, and integrates a multitude of transactions and local clusters' (Ernst, 2002, p. 504). Ernst terms such examples 'global production networks', but many of them are part of more extensive global distribution and retailing networks which may be co-ordinated by the same key actors on both the production and the distribution sides. In many cases, these key actors are either long standing transnational companies or large companies that have moved to transnational operation through outsourcing. This makes efficient SCM mandatory for survival, emphasizing the co-ordination of activities 'through a diverse array of intra-firm and inter-firm arrangements' (Palpacuer and Parisotto, Chapter 4.2).

Deepening inter-organizational relationships (IORs) Efficient organization of the process flows emphasized by Figures 1 and 2 is only one of several categories of activity that, in contemporary economic conditions, potentially strengthen links between supply chain participants and the overall competitiveness of a chain. Several types of inter-organizational link may develop, extending an organization's critical resources beyond its boundaries (Dyer and Singh, 1998). Potentially, these links draw on a comprehensive cross-section of an organization's intangible resources involving a wide range of occupational groups, and may involve working across organizational boundaries. However, this range of connections: (1) does not invariably develop, but follows from shifts towards collaborative relationships between actors; and (2) is generally confined to a limited number of key players in a chain.

As is illustrated at the dyadic level in Figure 3, these links include:

1 Emphasis on upgrading existing products and on designing and developing new ones as collaborative ventures, often as part of outsourcing. In sectors as diverse as aerospace, automotive, textiles and food products, product development has become a collaborative, supply-chain-based process that is critical to competitive performance (Bidault et al., 1998; Fraser et al., 2003).
2 Collaborative innovation driven by pressures for process and/or product improvements. Both radical and incremental innovation have the potential to reshape activities of all types in all stages in a chain, including production processes, logistics and information systems design. The role of supply chain relationships in this respect is emphasized by Dyer and Singh who summarize earlier studies as suggesting 'that a firm's alliance partners are, in many cases, the most important source of new ideas and information that result in performance-enhancing technology and innovation' (1998, p. 665).
3 The development of new capabilities, knowledge and ideas in significant parts of a chain which may be fostered by lead companies. This places distinct demands on the actors, although 'knowledge sharing routines can create inter-organizational competitive advantage' (Dyer and Singh, 1998).

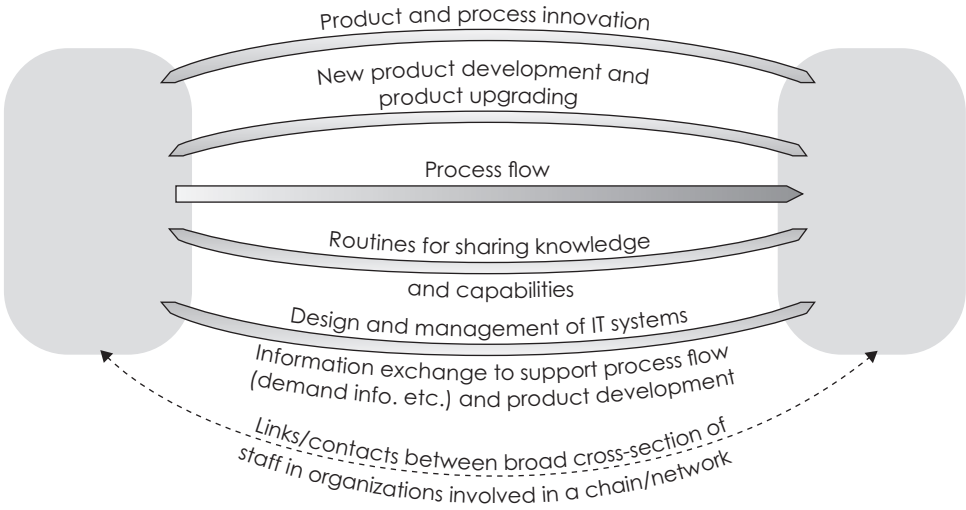

Figure 3 Inter-organizational relationships

4 The design and management of intra-chain systems using advanced information and communication technologies (ICTs) has become central to the development and co-ordination of other types of activity, including linking operations across the total chain to demand conditions at the point of sale and in the aftermarket. There is a 'potential for "real-time" information transfer . . . across enterprises and industries'; this supposedly offers 'unparalleled opportunities for customer responsiveness, and cost and productivity improvement' (Lund and Wright, Chapter 1.6), but can go seriously wrong (see below).
5 The application of standardized – and long established – methods of production analysis and organization to improve inter-company or chain-wide process performance, much of which has aimed at achieving demand-driven production. For instance, this emphasizes the use of 'lean' methods and techniques derived from the Toyota production system, such as JIT and continuous improvement (see Pilkington, Chapter 3.1). The overall objective is to identify, improve and co-ordinate value-adding processes 'across functional and company boundaries in both the design and delivery of the appropriate product–service bundle . . . [in which the] focus of attention should not be on the company or functional department but instead on the complete value stream' (Hines et al., 2000, p. 5).

The advantages of IORs such as these are compelling, as is reflected in the well publicized experience of companies such as Toyota, Rolls-Royce, Dell Computers and Tesco. For all of them, supply chain strategies have been a central (but far from the sole) element in sustained growth and expansion and in competitive success against seemingly dominant rivals. Performance in this respect reflects the transition from a focus on 'point efficiency' towards a sustained focus on systemic efficiency

(Kaplinsky, Chapter 1.3), The potential gains from effective long term systemic efficiency are indicated by the proportions of organizational activity – 60 to 70 per cent or more – now commonly accounted for by purchased inputs. The targets extend beyond reductions in total costs across a chain to consistent high standards of quality, high levels of product availability, speed of response to short and longer term market changes, and rapid introduction of innovative new products. Hence, competition has come to be viewed as 'not company against company but rather supply chain against supply chain' (Christopher, 1992). Dyer similarly identifies the need for a shift of emphasis in analysis 'from the competitive advantage of firms to the competitive advantage of value chains/networks' (1996, p. 663). This involves the development of sophisticated supply chain strategies and their consistent, long term application to all areas of a chain.

In aggregate, the developments in practice outlined above fit an ideal-type model that is reflected in much of the management literature. But substantial constraints stand in the path of the model's realization, and make intra-chain integration hard to achieve and slow. Many constraints are evident in the highly diverse national, cultural, legal, economic and social conditions across which most supply chains operate. Others are inter-organizational, and are evident in contrasting organizational objectives, cultures and systems. Organizations linked in a supply chain tend to have different priorities and ways of doing things. These reflect intra-organizational factors such as rivalries between functional groups, differences in occupational and learning cultures, organizational inertia and so on. Further constraints relate to the emphasis on ICT applications in many supply chain programmes. There are many striking examples of technical achievements in B2B (business-to-business) e-commerce, including the real-time use of point-of-sale data by retailers' head offices and suppliers, and simultaneous use of design data between buyers and suppliers. But technical possibilities need to be set beside failures in supply chain applications as part of the more widely observed 'discrepancy between IT investment and IT performance' (Macdonald, 2004). Allowing for achievements in some lead companies, it seems doubtful that SCM in general has been significantly more immune from the 'IT productivity paradox' than other areas of management – as is indicated by UK examples of costly, IT-centred supply chain failures such as Mothercare (Politi, 2002) and Sainsbury (Macalister, 2005).

Networks – routes and roles

A growing preference in the literature for the looser concept of networks and a corresponding emphasis on network management may partly reflect the challenges of co-ordination and integration across a supply chain. As a metaphor, 'network' captures variations in conditions more effectively – such as those associated with differing supplier roles, resources, capabilities and depth of involvement. Links between buyers and suppliers change for many reasons, including the introduction of upgraded or new products that require different materials, processes, components, support services, and so on. In fashion apparel, designs, fibre types, colouring methods,

fabric types, garment construction and accessories change continually – as do the suppliers. In other cases, new knowledge and/or skills are sought for innovatory or modified products. Changes also follow from buyers' pursuit of lower cost materials or components. Similarly, suppliers such as design consultancies, equipment manufacturers and software houses may have only intermittent involvements but nonetheless provide powerful contributions to the competitive and innovatory capabilities of a product network.

Network concepts have become fashionable through visions of the ICT-centred 'new economy' – including the flamboyant version of Evans and Wurster who predict the defenestration of older organizational forms, including supply chains, by new, Internet-based methods of organizing collective activity that 'allow buyers who want the best product to find suppliers who offer the best product – worldwide' (2000, p. 189). Perhaps in response to this style of approach, Dicken et al. (2001) describe networks as 'a much abused concept, "more of a chaotic conception" than a rational abstraction'. It has been co-opted by the management fashion industry: 'the business and management literature now bulges with books and articles that eulogize the new network paradigm as the prescription for business success' (ibid.). Their view of networks is as 'neither purely organizational forms nor structures . . . [they] are essentially relational processes'.

Emphasis on the dynamics of network relationships and processes captures the constant shifts in the cast of actors that are usually associated with product supply, and their varied roles, shifting with continuous evolution in product ranges and the behind the scenes effort to sustain, for consumer products, what retailers sometimes refer to as 'the theatre of shopping'. It also reflects more closely the realities of management roles that involve juggling and sustaining buyer–supplier relationships, in contrast to the static, linear imagery of chains. The network metaphor accommodates the typically wide variations in buyer–supplier relationships within a product flow, for instance in levels of participation and dependency among the actors. It allows for the overlaps in patterns of supply where firms sell in competing networks. But the looser framework implied by the network concept is misleading if it is taken to imply a rough equality among the participants. In network governance and in the distribution of rewards among the participants, the lead actors' roles are central.

Lead actors

The lead actors are generally large organizations that, in supply chain terms, are located close to, or at, the interface with end-customers, whether these are other organizations or consumers. In both service and industrial sectors, 'competition between supply chains' is primarily defined by the lead companies in particular sectors and product categories. Competitive success is shaped by their strategies, their objectives, their selection of key partners, their approaches to the management of relationships with these partners and other actors further upstream or downstream, and their success or failure in shaping performance across the chain.

Gereffi (1994) distinguishes between lead companies in two commodity chain categories: 'producer-driven' chains in which large transnational industrial organizations are dominant, and 'buyer-driven' chains dominated by 'large retailers, brand-named merchandisers and trading companies' (see also Kaplinsky, Chapter 1.3). The most critical distinction he makes between the two categories is greater centralized power over production organization in supplier-driven chains compared with buyer-driven chains. But, in this and other respects, the contrasts emphasized by Gereffi have been eroded. The divisions between supplying and buying at the retailer–producer juncture have become highly blurred, not least by changes in relative size where retailers have grown to become larger than most of their suppliers, and have developed large-scale international retail operations. Some retail franchise operations in the food sector and in apparel exert a tight hold on production organization and supply to their franchisees whose operations are also kept under control, as is illustrated in the fast-food sector (Schlosser, 2001) and by Benetton (Camuffo et al., 2001). The point is reinforced by the significance of retailers' 'own brands' or 'private labels' in Western Europe, particularly in the UK. Where own brands are used aggressively, retailers are drawn into proactive roles in marketing and in product development. Retailers' brands often compete directly with those of manufacturers, and can be highly innovative – as in the example of cook-chill meals. In such cases, retailers enter the direct organization of supplier activities by developing product designs and/or specifications and by monitoring suppliers' production methods, standards and performance. In other cases, retailers collaborate with suppliers in product development. Thus, reviewing survey evidence at much the same time as Gereffi's work, Fernie concluded that 'the initiative for forging relationships has come from the retailers as they have become more responsive to their domestic markets, and take responsibility for elements of the value-added chain which were once the sole prerogative of the manufacturer' (1995, p. 143). Since that time, the proactive roles of retailers have been reinforced by increasingly intensive application of ICTs – in some cases, with high levels of success.

Two other categories of key actors need to be considered in the UK context. First, changing government policies have pushed public sector organizations towards more co-ordinated approaches to product supply. These have necessarily evolved in a distinctive way. For example, purchasing agencies act on behalf of large numbers of end-users in the defence and healthcare sectors. The challenges include keeping within the constraints on public sector tendering and other sourcing processes set by national and transnational regulatory bodies. These inhibit the development of collaborative buyer–supplier relationships comparable to those common in the private sector. Second, many private sector service organizations, including large financial companies, energy suppliers, engineering and other consultancies, and software and computing businesses, have developed significant supply chain roles. Many of these organizations now operate transnationally. To a significant extent, they rely on outsourcing and franchising within their product networks, such as in the design and operation of IT services, in accounts processing and other back office functions, and in processing customer enquiries in call centres. In both public and service

sector categories, distinct patterns of operation, product supply and business development are evolving.

However, the roles of lead companies are limited in several respects. One constraint is the influence of 'external governance' (see below) on the policies and practices fostered by lead firms. Another is the sheer difficulty of exerting consistent influence across networks of disparate, far flung suppliers with divergent interests. The roles and position of network participants vary widely in their criticality to the final 'product package'. Suppliers producing commodity components or services are vulnerable to price pressure and short term decisions from buyers. Those supplying products that embody specialized intangible assets such as hard-to-replicate skills and knowledge are in stronger positions. Others are large companies which control strong consumer brands that the large retailers have to stock or which produce major subsystems or components for which there are few alternatives. Examples include some types of microprocessors, electrical and electronic subsystems. Products like these give their producers significant power and autonomy in relation to lead actors, and signify a further type of constraint. In such cases, the distribution of knowledge and competencies among buyers and suppliers, together with rising levels of investment and risk associated with major process innovation and new products, can present a compelling case for inter-firm partnerships. These may extend to multi-firm collaboration: 'in some cases, strategy will be formulated at the network level by a group of firms that explicitly take into account the resources and capabilities that reside within the network in formulating strategy. Individual firm strategy will be constrained and shaped by the network – meaning the strategies and resources of other firms in the network' (Dyer and Singh, 1999, p. 185).

Governance

If the overall direction of a chain or network is shaped by lead actors, one critical question is how this is accomplished. Significant sections of the literature focus on issues of supply chain governance but, broadly, deal with these issues in two very different ways. One set of approaches, primarily linked to the development literature, focuses on the macro level – the chain or the network. They include concerns with the influences that shape the behaviour of the various actors, the distribution of activities among them, and their comparative rewards. The second (considered in the following section) focuses on the cost-effective organization of production at the micro level, primarily in terms of dyadic make or buy decisions.

The means by which lead companies exert their influence across diverse sectors and organizations linked within a product network are captured by Gereffi's description of governance structures as 'authority and power relationships that determine how financial, material and human resources are allocated and flow within a chain' (1994, p. 97). Kaplinsky (Chapter 1.3) distinguishes between intra-chain ('internal') governance and external governance. External governance primarily derives from national and international state entities, shaping supply chain practice through regulatory controls and other forms of influence. As an example of the latter, Solis

(2001) refers to US government pressure on US-based Japanese automakers to weaken ties with their *keiretsu* suppliers (i.e. Japanese suppliers with which the automakers had close ties, including cross-shareholdings) with the aim of increasing opportunities for US suppliers. This contributed to changes in buyer–supplier relationships among formerly closely linked companies.[2] External governance also derives from the influence of some types of NGO, including trade unions and environmental and consumer groups.

The influence of external governance is mostly sectoral, or wider, in its effects. The distinct identities and coherence of specific product networks are primarily shaped by internal governance, particularly by large lead companies. But there are widely divergent approaches. Some largely rely on market power, others on more formalized assertion of influence across a chain to establish comprehensive governance regimes that combine a strategic overview with operational rules. Strategic level action takes two main paths.

First, many large companies have outsourced substantial elements of their supply chain management to trusted core suppliers, often as an extension of outsourcing production and other activities. Tactics vary, but they tend to involve fostering long term relationships with the core suppliers, some of whom are pressed to take responsibility – as lead or 'tier 1' suppliers – for the lines of supply associated with main components, sub-assemblies, complete product modules or specific product lines, such as lettuce suppliers to a grocery chain. This includes dealing with, and managing on guidelines established by the lead company, suppliers in the lower tiers (2, 3, 4 etc.) who are involved in that line of supply. Examples are found in sectors as diverse as apparel manufacture, retailing, automotive manufacture and aerospace. A lead company may thus deal directly with far fewer suppliers while retaining a strong indirect influence over other actors in the supply chain.

Overall, such supplier hierarchies reflect practice in some Japanese companies, providing lead companies with a 'clustered control structure' (Solis, 2001). But there are important and potentially critical differences when western supplier hierarchies are compared with the pioneering Toyota production system (TPS) on which western interpretations have tended to be based (see various chapters in this volume). The TPS developed organically over many years in participation with main suppliers (Ohno, 1988; Shingo, 1989), and is still evolving through continuous innovation, learning and adaptation. This approach also involved cross-shareholdings between Toyota and key suppliers. In contrast, shifts by some western companies towards aspects of the TPS model appear to have been largely formulaic, 'top down' (in a rather different way to Toyota) and attempted within short timescales that are not best suited to the operational changes, learning and acculturation required of internal workforces, suppliers and customers. Such approaches are also vulnerable to changes in key personnel and to shifting management fashions.

Second, again reflecting the TPS model, some lead companies have outsourced other areas of responsibility to main suppliers along the lines identified in Figure 3. This potentially involves the design and development of key subsystems, components etc., ICT applications, knowledge sharing and so on. These forms of outsourcing – or collaboration – further extend the governmental reach of lead companies across a

chain or network, partly by shaping what core suppliers require from their own suppliers.

These strategic relationships are underpinned by actions that, in the main, are operational in character. In 'ideal-type' cases, these include the following.

1 Lead companies continually seek new sources of advantage across a chain. These are found across a spectrum that, at one end, extends to large, primary materials suppliers. The objectives may be innovatory (e.g. developing new or improved materials) and/or may focus on economies of scale by requiring intermediate suppliers to source from core primary suppliers. Examples include steel and specialist metals producers (vehicles and aerospace) and textiles (apparel retailers, brand owners). The other end of the spectrum encompasses core subsystem suppliers, equipment and software producers and others close to a chain's main technological domains – such as university departments. Lead companies thus stay close to emerging developments and their innovative and organizational possibilities.
2 Lead companies and tier 1 suppliers set terms of supply that extend beyond price to a range of performance standards. These typically include: tight quality requirements; supply on a just-in-time (JIT) basis, sometimes linked to insistence on a supplier's adoption of 'lean' practices; and conformance to the lead company's ICT standards. Standards are also set for product specifications, product cost profiles (schedules for cost reduction that allow for the learning curve), delivery methods and schedules. Uniform application of these standards aims to maximize competitive advantages across the whole network – although there are substantial obstacles in the path of such standardization.
3 Operational standards are sometimes supplemented by codes of conduct for suppliers which extend to standards of environmental, ethical and employment practice.
4 Large companies continually monitor supplier performance, reflected in emphasis on using metrics that provide clear data on operational performance in areas such as quality and delivery (see Åhlström and Karlsson, Chapter 3.6). Ideally, these standards extend through all lines of supply.
5 Performance monitoring may be supplemented by periodic assessment of suppliers by lead companies or their agents. These range from production methods and procedures through to training standards and capabilities relevant to design and innovation. Processes of measurement and review build up a continually evolving picture of suppliers' strengths and weaknesses, and their contributions to overall chain competitiveness.
6 'Best practice' as defined by lead actors and main suppliers is cascaded to upstream and downstream companies in a network. Some lead companies (reflecting the TPS model) establish supplier associations to support supplier development and to encourage knowledge sharing. Support may include the secondment of staff between buyers and suppliers for joint problem solving, and may facilitate training to standardize process methods and techniques or product development methods between companies. Similarly, the use of *kaizen* (continuous improvement) approaches may be encouraged.

These examples emphasize the scope and sophistication of internal governance extending across parts, at least, of the more developed networks. In such cases, governance permeates a wide range of practice and thinking within the organizations involved. These 'regimes of practice', and the associated intra-chain culture that may develop, extend across national boundaries. However, reiterating an earlier point, there are substantial differences in approach, by lead companies and others, to managing buyer–supplier relationships.

Buyer–supplier relationships

Divergences in approaches to SCM can, up to a point, be compressed within the three-part typology associated with the transaction cost (TC) model. Briefly, the model emphasizes firms' capacities for separating or integrating process activities at their boundaries. 'Technologically separable interfaces' (TSIs) provide critical locations in a process flow, hinge points at which firms have 'make or buy' choices. These choices are mapped onto three categories of supply relationship. One is 'hierarchical governance' (i.e. production within a vertically integrated organization) in which, to a degree, the instruments of managerial control such as fiat, monitoring and sanctions integrate and control operations across adjacent TSIs. Until the 1980s, shifts towards high levels of vertical integration appeared to be 'the dominant trend in the west' (Dore, 1983 p. 463). This was overtaken by a progressive shift towards the international relocation of production, increased use of outsourcing and related changes in modes of governance. For instance, 'older hierarchical forms' are seen as giving way 'to the flatter network architectures of global production systems . . . [which are] characterized by a multiplicity of inter-firm relationships and a blurring of organizational boundaries' (Murray and Trudeau, 2004, p. 17). A wide range of factors has contributed to this shift, including improvements in international transport systems, ICT applications, and the influence of management fashions such as lean production.

In the TC model, sourcing from external suppliers ('market governance') is the direct alternative to vertically integrated production. Choices between markets and hierarchies are viewed in terms of trade-offs, principally between production costs and transaction costs. Attention has focused on transaction costs, partly because of assumptions about their role but also because they are a significant business cost. North (1990) and Butler et al. (1997) suggest that transaction costs may account for a third or more of the costs associated with economic activity (quoted by Dyer and Chu, 2003, p. 59). These estimates may reflect the prevailing, low trust US business culture which emphasizes a continuous search for lower cost suppliers. Large numbers of staff in purchasing, sales and legal departments and areas such as inbound inspection are required to negotiate and draft contracts, and to monitor and enforce them. By contrast, management controls where there is hierarchical governance are held, generally, to keep comparable costs down.

The model predicts that where search processes are efficient, production costs are likely to be lower in market relationships, but to be outweighed by high transaction costs. This becomes more probable where buyers have highly specific needs and

suppliers need specialized assets such as skills and equipment to meet them. In such cases of high asset specificity, each party is regarded as vulnerable to 'opportunistic' behaviour by the other. For example, a buyer may seek to force a supplier's prices downwards where assets are too specialized to be used to supply other customers. Equally, customers who are dependent on specialized suppliers may encounter upward pressure on prices if those suppliers exploit the difficulties the customer faces in finding alternative sources. The need to guard against such behaviour incurs high transaction costs.

These issues are reflected in the wider supply chain literature, and in practice. For example, 'market governance' equates to what are characterized as 'traditional' buyer relationships with suppliers. Purchasing staff are given incentives to search continually for lower price sources, and relationships with suppliers are generally arm's-length, adversarial, short term and, in the US at least, heavily dependent on lengthy, very detailed contract documents.[3] Kaplan and Cooper mention how 'the major US automobile companies would not enter into long term relationships with their suppliers. Every six months, they would put their steel demand out for bid and all the steel companies would compete to win the business by offering the lowest price for the next six months' (1998, p. 203). They relate this to confusion between prices and costs. The seeming gains for buyers from lower supplier prices can be negated by high transaction costs (such as from inspection and other supplier monitoring) and by costs such as transport from distant 'low price' locations which contribute to high 'total costs of ownership'. These additional costs may be hidden within multiple budget heads, a consequence of poorly designed management accounting systems (for example, see Åhlström and Karlsson, Chapter 3.6). Traditional approaches may also be reinforced by employment practice. The UK Competition Commission's (2000) enquiry into grocery retailing refers to the periodic rotation of retail multiples' purchasing staff as a part of career development, sometimes every 12 months. This practice contrasted with the Commission's observation that 'Continuity is an important element in maintaining a good multiple/supplier relationship' (§11.46). As one of the suppliers' organizations pointed out, routine changes at short notice make 'it extremely difficult to maintain stability within the industry' (§11.26).

Both parties incur cost and other penalties because of corresponding 'traditional' supplier behaviour. For example, total transaction costs are increased where traditional buying practices necessitate a continuous search by suppliers for new customers. There are potential long term adverse effects on suppliers' technological capabilities where they 'have little incentive to invest their own capital in product innovations' (Dertouzos et al., 1989, p. 100). This seems particularly likely in relation to investment in specialized human and other assets, as in the example of suppliers to the US automotive industry who 'rationally refused to make relation-specific investments with a payback period longer than the length of the contract' (Dyer, 1997, p. 550).

The TC model's third category – 'hybrid forms of organization' – encompasses joint ventures, partnerships and other collaborative arrangements between buyers and suppliers. These combine elements of market governance (since they include contractual components and are open to market comparison and termination, at

least in the medium to longer term) with elements of hierarchical governance (see earlier). As with market governance, reliance on highly specialized assets, or co-specialized assets (i.e. where the parties share site, physical or human assets, such as at Smartville[4]), the TC model predicts high transaction costs for the same reasons – i.e. to guard against opportunistic behaviour by the other party.

Several issues stand out in relation to this category. Much of the retreat from vertical integration discussed above has been towards various forms of partnership, both within the context of general supply chain practice, and with more specific objectives such as innovation-centred collaboration. But the three types of approach in the TC model are complementary rather than alternative. Firms generally have to source from substantial numbers of suppliers to meet different types of needs. Large firms, at least, are likely to use a mix of approaches to governance, retaining vertical integration in core areas, relying on market focused sourcing for relatively standardized commodity products for which there are many suppliers, and entering into partnerships with organizations that can provide specialized inputs. These include technological expertise, organizational capabilities and occupation of critical points in the total supply flow – for example, manufacturers of critical proprietary subsystems. Rather than the partnership model, such mixed approaches to supply may reflect practice in Japan where 'enterprises developed complex supply mechanisms that combined vertical integration, arm's-length purchases and commissioned production' (Solis, 2001).

The opportunism attributed to individual and organizational motivation in the TC model is criticized as founded in narrow, 'atomistic' interpretations of behaviour that do not take account of the 'embeddedness' of economic behaviour in social structure and interaction (Dore, 1983; Granovetter, 1985; Uzzi, 1997). Factors in the social structure can impose constraints on opportunistic behaviour by firms and emphasize gains from collaborative behaviour. For example, firms may prefer to do business with customers or suppliers who have a proven track record of reliability and avoid those known to be over-opportunistic (Rooks et al., 2000). The TC model is thus said to underestimate the potential for trust between the parties and 'for leveraging the human ability to take initiative, co-operate and to learn' (Ghosal and Moran, 1996, p. 42). In practice, long standing, seemingly high trust, collaborative relationships between buyers and supplier are not unknown – confounding the 'traditional' model's nomenclature. Examples include Marks and Spencer's relationship with its manufacturing suppliers from the 1920s to the 1990s (Tse, 1985; Bevan 2001),[5] the Swedish printing industry between 1880 and 1990 (Ottosson and Lundgren, 1996), weaving mills in Blackburn (Dore, 1983) and manufacturers in Wisconsin (Macaulay, 1963).

Overall, collaboration depends on high levels of trust, particularly when buyer–supplier relationships develop beyond the limited process flow relationships that the TC model focuses on, and extend into product development and other elements of inter-organizational co-operation. Dyer and Chu (2003) suggest that high levels of trust can be an effective governance mechanism, such as where trust contributes to low transaction costs through supplier self-monitoring and self-enforcement which uphold the agreed terms of supply to a customer. They found evidence of this in

relationships between Japanese automotive OEMs and their suppliers, whereas the lower trust relationships of their US counterparts were reflected in substantially higher transaction costs. But costs are only part of the equation. Dyer and Chu argue that the focus of the TC model 'is almost entirely on *cost minimizing* rather than on *value-creation*' (2003, emphasis in the original). This limited focus lags well behind changes in supply chain relationships. For example, Dicken (2004) observes that moves to subcontracting on an international scale were initially driven by cost minimization, but suggests that this may have changed with the spread of JIT production. The competitive effectiveness of JIT systems depends on commitment across a supply chain to uniform high standards of product quality within tight delivery schedules, and collaboration on aspects of product development. However, customer expectations increasingly go beyond the performance demands associated with JIT. Large firms evaluate their suppliers' performance across multiple indicators. Dyer and Singh (1998, p. 864) also emphasize the importance of innovative capabilities, drawing from von Hippel's (1988) conclusion 'that a production network with superior knowledge-transfer mechanisms among users, suppliers and manufacturers will be able to "out-innovate" production networks with less effective knowledge sharing routines'.

Innovative capabilities are particularly critical with the emergence of two interlinked developments: (1) the growing scope and mounting influence of external governance on activities within product networks; and (2) increasingly systematic management of performance across the full C2G life cycle. Both extend beyond the direct product flows associated with production and distribution since they place other types of input and output firmly on the management agenda, and they raise the issue of the management of materials and other flows that move in the reverse, upstream, direction. This agenda is being vigorously pursued by some trailblazing companies where it draws other groups of managers into the 'supply chain arena'. In aggregate, these developments are best viewed as shifts towards management of total product systems.

Towards Total Product Systems

Supply chains span the total production process and, in many cases, are closely linked – if not integrated – with product distribution and retailing. Co-ordination is underpinned by varied, often sophisticated, systems of governance. Recent developments reach far outside the traditional preoccupations of SCM to the point where activities such as supplier selection are shaped by criteria that extend well beyond concerns with, say, cost, quality and delivery. For instance, sourcing decisions may have to weigh the social and economic implications of different choices. The adverse consequences of ignoring these issues can far outweigh apparent short term gains. Similarly, product design and development can be shaped by product supply considerations – for instance, to take account of the environmental impacts and resource consequences of different options. This emphasis on intra-chain interdependencies reinforces pressures for inter-functional co-ordination and shifts attention towards the total product system.

The potential adverse effects emanate from a variety of external factors, including the growing body of environmental, consumer and other regulation that is reshaping external governance and forcing changes in practice across all four phases of the C2G life cycle. These pressures are reinforced by action from consumer, union, environmental and other groups. These external forces, in combination with competitive pressures, are reflected in actions by lead actors that move them, in effect, towards management of their total product systems – a development that can offer competitive advantages. This is evident in more systematic and vigorous aftermarket activity and in involvement in the EOL phase of the C2G life cycle, both of which strengthen feedback loops to the prior life cycle stages.

Aftermarket integration

The aftermarket has long been an important source of revenue for OEMs such as manufacturers of civil aircraft engines and cars. In the latter case, poor profits from car manufacture associated with excess production capacity in the industry contrast with aftermarket activity 'which generates significant profits for vehicle manufacturers and their retail network' (Seitz and Peattie, 2004). Aftermarket involvement is significant in many other sectors, including office equipment (e.g. desktop printing and copying), transport equipment, buildings infrastructure (lifts, escalators, climate control and so on), and various types of household equipment and services. Partly as a consequence of regulatory pressures, aftermarket support has high priority in the financial services sector where it is associated with the development of extensive SCM roles by lead companies, such as where customer support services are outsourced. The overall significance of aftermarket activity is indicated by Gallagher et al.'s (2005) estimate of aftermarket sales of parts in the USA at more than $400 billion. They also suggest that aftermarket revenues account for some 40 per cent of profits for a wide range of companies.

Integration of aftermarket activity with the earlier life cycle stages reflects the influence of several factors. Some firms have recognized that gains from improved efficiency in the main production flows are also applicable to aftermarket supply: for instance in the systematic organization of 'reverse logistics' to handle product returns from retailers or individual purchasers requiring warranty or other servicing. Generally, however, management of aftermarket supply appears to have been poorly co-ordinated with main product flows, and is often 'a mere afterthought', the operational and financial ramifications of which are poorly understood by managers, with consequences that can include 'value destroying behaviour' (Gallagher et al., 2005). The same authors suggest that while some manufacturers accept low margins on an initial product sale in order to secure future income streams, others sacrifice the latter by:

- the offer of future discounts on parts sales as incentives to secure initial product sales;

- poor co-ordination of manufacture of new products with production for the aftermarket;
- poor organization of the transition to aftermarket support alone when a product is discontinued;
- neglect of the overall dynamics of aftermarket supply.

The revenue potential and the opportunities for more cost-efficient, customer-oriented aftermarket services emphasize the importance of integrating aftermarket strategy within the overall organization of all the phases of the supply or product system. A further factor is regulatory intervention, for instance where consumer protection rules place continuing aftermarket responsibilities on end-manufacturers and on service providers such as the financial services sector. These responsibilities necessarily extend upstream in such respects as the reliability and traceability of product components and materials, and of selling methods for services. Another factor is evolving competitive and marketing practice in which, particularly in relation to consumer durables, firms seek to strengthen and lengthen relationships with end-users through expanded 'product packages' and extended product warranties.

Development of the aftermarket is also linked to high – and rising – standards of product reliability which, in some cases, have changed patterns of aftermarket revenues and activity, confronting producers with some critical dilemmas. The significance of aftermarket profits for car manufacturers has been referred to, but these revenues have been eroded by increased product reliability and extended warranty periods, both of which have become essential components of competitive product packages. Similarly, a competitive focus on the performance of civil aircraft engines has increased 'time on the wing' between major engine servicing and reduced demand for replacement parts. In both cases, the responses of lead actors have included reducing costs by improving efficiency in the 'aftermarket supply chain', a challenge that presents different problems to those encountered in the organization of the main supply chain. For instance, demand for replacement parts is very difficult to predict, so that 'lean solutions' are not a realistic option; high levels of inventory are needed to bridge potential gaps between the supply of units for reprocessing and the demand for reprocessed parts (Seitz and Peattie, 2004; Guide and Pentico, 2003). Within the organization, supply to the aftermarket has to be fitted within – and compete with – mainstream production resources and activities. In effect, aftermarket supply has to be sustained as a separate venture, particularly once sale of a main product has been discontinued and the associated production chain has been closed down. Yet aftermarket support may be needed for long afterwards – for instance, 15 years or more in the case of cars and some financial products, and over 30 years for aircraft, aircraft engines, generating and transport equipment.

Lead companies have responded by pursuing new aftermarket opportunities. For example, by 2003, 44 per cent of Rolls-Royce's turnover derived from its aftermarket activities (Done, 2003). To sustain and develop this revenue, the company has extended its range of aftermarket services to provide customers with data from real-time monitoring of the performance of individual engines, contributing to reduced aircraft maintenance costs. It has set up joint ventures with airline customers and

maintenance specialists to build a new network of maintenance facilities for the current generation of large engines such as its Trent series. This ties in with a drive by airlines to outsource non-core activities which, in the case of engine maintenance, received impetus from the need for facilities able to handle the new generation of very large engines. Similarly, some car manufacturers have sought to develop new revenue streams from in-car information systems. Some have expanded their presence in the markets for 'premium' second-hand cars and for car parts. In such cases, adaptation of product supply to accommodate the aftermarket is essential to viability.

The end-of-life phase

The importance of aftermarket integration is increased by emerging responsibilities for, and management of, the EOL phase. This is evident in the EU countries through Directives which regulate EOL processing of electrical and electronic products and cars.[6] Two central provisions in the EU regulation are: (1) the requirement for what Seitz and Peattie (2004) term 'extended producer responsibility' in which producers have to take responsibility for recovering and reprocessing EOL products; and (2) setting targets for the volume of materials, components and substances that must be recovered for reuse. For instance, there are targets of 90 per cent by weight for large electrical and electronic appliances and 85 per cent by weight for cars. But it is the top of the recycling hierarchy – the remanufacture of products or parts – that is the most significant in terms of resource conservation and in economic terms, primarily in relation to aftermarket supply. The potential is indicated in the automotive aftermarket where, in the EU, some 30 per cent of sales of steering racks and air-conditioning compressors were of remanufactured products in 2003. This share is forecast to increase to 80 per cent by 2008 as the EU moves towards the American pattern of greater use of remanufactured products (Seitz and Peattie, 2004, p. 77).

Reprocessing to extend the life of products or parts is viewed as movement towards 'closed-loop industrial systems' (Guide et al., Chapter 3.8). However, progress in this direction presents some formidable challenges. These include matching demand for components or parts from EOL sources to supply, and the organization of reprocessing. Seitz and Peattie (2004) demonstrate that, for car engines, the challenges of an unpredictable supply of engines suitable for refurbishment contrast with the much higher predictability of manufacturing new engines. The challenges multiply with the proliferation of product variants associated with product customization. Meeting these challenges requires dedicated organizational facilities and management. Similarly, separate logistic networks are needed to recover EOL products, to distribute them to reprocessing centres,[7] and to route remanufactured products to purchasers.

Logistic and reprocessing arrangements are organizationally distinct from mainstream product supply and distribution, but they are part of wider and increasing interdependencies that extend across the product life cycle. This is reflected in pressures on product designers to reduce the scale and costs of product variation and, more generally, to reduce materials and energy use by improving product manufacturability. Product designers also have to take account of issues in the

aftermarket and EOL phases. For example, Seitz and Peattie (2004) suggest that design engineers need to include aftermarket considerations within design briefs – for instance through more disciplined product customization that reduces the 'inventory bloat' that can blight remanufacturing. Similarly, in materials selection, designers need to avoid compound materials that cannot be recovered cost-effectively in EOL reprocessing. Likewise, 'design for disassembly' aims to maximize recovery levels and to contain recovery costs. Nevertheless, in current management thinking and practice, the aftermarket and EOL phases seem, at best, to be only loosely connected to mainstream production, the distribution of new products, and other elements of supply chain organization – which is why the integrated management of total product systems is needed and can offer competitive advantages to those who pursue the opportunities at an early stage.

Interaction between external and intra-chain factors

The case for extending the management of supply chains or product networks towards the total product system is reinforced by the impacts of external factors that are linked to growing concerns about the environmental impacts and damage associated with global economic activity and lifestyles. Where these concerns are reflected in regulation, they interact with functioning at the process and other levels within a system by modifying the cost and dynamics of product system functioning. Their significance is illustrated by the emphasis on identifying and eradicating all cost bearing forms of waste in the TPS[8] and in comparable emphasis on lean-type intra-chain approaches. The potential rigour and cost advantages are underlined by Shingo: 'The Toyota production system is said to be so powerful that it could squeeze water from a dry towel . . . at Toyota, we search for the waste that usually escapes notice because it has become accepted as a natural part of everyday work' (1989, p. 76).

The changing context of supply chain organization relates to the issues that have developed around other forms of waste from production processes and other activity – specifically, to the liquid, solid and gaseous wastes that result from energy use and materials processing in *every* stage and activity across the C2G life cycle. These externalized wastes (*muda*) have hardly figured in the cost-conscious equations and concerns with efficiency in lean production and other methods of production organization.[9] The various natural environmental systems (atmospheric, hydrological etc.) could be relied on for their disposal because they were, in effect, 'free goods', largely free of charge to the disposer – or polluter – with few constraints on their use. This is changing rapidly as a growing body of regulation attaches direct costs to the polluting effects of production, distribution and product use.[10] For instance, regulation now prohibits or limits the use of certain types of materials; levies taxes on or prohibits the use of landfill; controls gaseous and liquid emissions; promotes the recycling of packaging and other materials; and, as mentioned above, requires the EOL reprocessing of some durable products.[11]

Such intervention impinges directly on individual firms but particularly on lead actors and on inter-chain competitiveness. Once costs are attached to environmental

impacts, Shingo's 'dry towel' becomes both larger and distinctly damp. The compelling logic of competitive advantage that favours those who are the most successful in eliminating internal wastes, then applies to reducing the costs attributable to environmental regulation – and seeking compliance across a whole network. Where environmental regulation is extended, these costs rise further, contributing to an ever more compelling case for comprehensive intra-chain action to reduce costs by:

- standardizing methods for reducing the total product system costs that are attributable to emissions and other externalized wastes;
- improving intra-firm recycling and reprocessing across all stages in a process flow;
- responsible management of processing unavoidable wastes and their safe, non-polluting disposal;
- achieving high standards of efficiency in all other energy consuming and emission generating aspects of supply chain activity. Katayama and Bennett (Chapter 1.5) provide the example of controversies over JIT deliveries in a number of Japanese cities; Leiper et al. (Chapter 1.8) refer to management of the built environment.

In some cases, the cost pressures linked to environmental impacts on OEMs and their product networks are reinforced by action such as consumer boycotts, as in the case of highly publicized environmental failures like the *Exxon Valdez* oil spill. A wide array of impacts on product networks is attributable to campaigning action by activist groups and other NGOs. Leiper et al. (Chapter 1.8) relate Carillion's development of environmentally sensitive sourcing practices to the 'trigger event' of an activist group invading the company's AGM. The cost pressures in such cases extend to intangible costs such as damage to a firm's or a brand's reputation. In combination, the costs associated with environmental accidents, environmental regulation and activism by environmentalist groups are contributing to a reshaping of supply chain policy and practice – as in moves by some lead companies towards 'sustainable sourcing'.

Social and labour conditions

The economic and social consequences associated with global supply chain activities are subject to highly divergent interpretations. Concerns about the general impacts of global product systems, combined with action directed at specific instances of exploitative or damaging behaviour, have contributed to pressures that are moving lead companies towards total product system approaches. These concerns are diverse, extending from the use of child labour, dire working conditions and lack of protection of worker health and safety through to the effects of sourcing practices and the scale of product distribution on society and economy, particularly in developing countries, They also extend to conditions in the industrialized countries. Hampson (Chapter 1.4) relates 'stress-driven production' in intensive lean approaches to longer term damage to workers' health which has wider social effects: 'such problems may be paid for by the host country's health system'.

Issues like these contribute to what Murray and Trudeau refer to as 'alarmist scenarios', in which lack of global regulation is viewed as likely 'to precipitate a downward spiral in terms and conditions of employment' (2004, p. 18). Other perspectives view the potential outcomes less pessimistically. *Laissez-faire* perspectives anticipate resolution of the issues by long term market functioning whereas social regulation perspectives emphasize the scope for state and non-state actors to influence the behaviour of global firms. But Murray and Trudeau point out that social regulation is highly fragmented in the global context. Globally organized firms and product systems are able to exploit differences in national fiscal, regulatory and other regimes. They suggest that the way forward in this perspective lies in diversified approaches, including working 'through supply chains to ensure that these new standards are widely diffused to sub-contracting firms' (2004, p. 24).

This begs the question of how powerful lead companies might be induced to apply such standards, particularly since employment conditions contrast with environmental standards which are advanced by the external regulation that, in some cases, is applied internationally. One possible answer that might be viewed as a form of 'social regulation' lies in the vulnerability of many lead companies in terms of their images, market positions and brands. They are at risk to consumer, union and other pressure groups that are able to generate adverse publicity, initiate boycotts or take industrial action. This is illustrated by Lund and Wright's example (Chapter 1.6) of the Teamsters Union's carefully co-ordinated – and ultimately successful – combination of industrial action, media advertising and mass leafleting that initiated a consumer boycott. Lund and Wright observe that, in the area of industrial relations, 'Supply chain integration poses a distinct set of challenges and opportunities for employers and unions alike.' Different types of example are provided by Winstanley et al. (Chapter 2.7), including that of a prolonged student campaign against Nike's association with their suppliers' use of child labour and poor labour practices. This led to what is said to be 'the biggest student protest in the US since the opposition to the Vietnam War'. The effectiveness of this campaign may be indicated by changes in Nike's approach. These include terminating the outsourcing of monitoring the company's supplier code of conduct in order to establish more active supervision and, most recently, public disclosure of the names and addresses of all their suppliers. The most significant development in the wider context may be the company's active campaigning for common standards for the global apparel, footwear and sports equipment industries (nikebiz.com, 2005).

As in these examples, action by consumer and other pressure groups appears to be primarily targeted at lead companies. Their strength in relation to their suppliers and the other actors in a product system can also be a potential source of vulnerability. Large-scale market presence raises the profile of their sourcing and marketing policies, exposing them to the risks of continuing adverse publicity and mass action. They are vulnerable to the practices of distant suppliers, such as the use of child labour and other forms of labour exploitation, even where they claim to be unaware of it. One response for lead companies has been to develop extensive supplier codes of practice covering issues of employment practice, the prohibition of child labour and environmental standards. The practical significance of such codes depends on the flow of

information combined with active monitoring and policing. Where this takes place, *and* where activism by consumer, union and other groups is effective, there appears to be a substantial enlargement of the scope of governance regimes that fits the social regulation perspective. It is an approach that national governments and inter-governmental bodies should examine for its potential to advance standards in environmental and employment practice, and to support more balanced global economic development.

For companies, the interdependencies and responsibilities that span the full cradle-to-grave product cycle point to the need to co-ordinate design, production, accounting and other functions across the full product cycle, and among the full range of actors within the broad network or system that is linked to the C2G life cycle. Needs for co-ordination on this scale are compounded at the macro product system level by the increasing globalization of supply chain functioning. These developments underline the need for co-ordinated management of the 'total product system' which, very gradually, is being fulfilled. Thus, beyond the view of contemporary competition as being between supply chains or value chains, factors such as those explored in the final two sections suggest that there is a transition towards competition between total product systems. Competitive success in this context becomes heavily dependent on the ability of key players, both large and small, to relate to the total product system and to derive the maximum advantages from tackling 'external *muda*', the various issues associated with product EOL and the other challenges that have been discussed here. However, these are challenges that large, lead companies are most attuned to. For most small and medium enterprises, these same challenges indicate the evolving context in which they have to seek to survive and to grow.

NOTES

This chapter derives from research in retail, apparel, aerospace, healthcare and automotive product systems. It develops from a paper first presented to EIASM's 2nd European Forum on Market Driven Supply Chains: From Supply Chains to Demand Chains, Milan, Italy, 5–6 April 2005. Support and suggestions from my colleague and co-researcher, Ruth Carter, have made important contributions to this chapter. Thanks also to Stuart MacDonald for some very constructive comments on the initial draft.

1 Technological domain is used here to refer to the different types of knowledge that are required to produce and support end-products. It also includes economic and operational factors that contribute to differences in priorities, time horizons, cost constraints and so on.
2 Solis also points out that changes in ownership, as western companies gained controlling interests in all the Japanese auto manufacturers except Toyota and Honda, also led to changes in supply chain organization. For instance, Renault's control of Nissan led to a 40 per cent reduction in supplier numbers, disinvestment in suppliers and increased reliance on global sourcing.
3 The examples tend to be drawn from the US literature and from practice influenced by US transnational companies. But different patterns may prevail in other countries and legal systems. For example, the UK's Competition Commission (2000) found that, in the grocery industry, 'full written agreements between the main parties and their suppliers

were unusual' (vol. 2, §11.56). Yet multiple retailers and their suppliers 'gave very different views on their interdependence' (§11.11). While descriptions of relationships were often couched in terms of partnership – at least by retailer representatives – many suppliers described relationships that were, in many respects, 'traditional' in character (e.g. see §11.26).

4 'Smartville' is the purpose-built site shared by MCC (a Daimler–Chrysler subsidiary, assemblers of the Smart Car) with the company's system partners (main suppliers) in a series of closely linked, dedicated, facilities – i.e. co-specialized assets.

5 Bevan links M&S's decline to, among other things, the jettisoning by senior management of the company's long standing collaborative relationships with suppliers.

6 Guide and Pentico (2003) emphasize alternative approaches to this issue, contrasting the EU's 'waste stream approach' with the 'market-driven approach' favoured in the USA.

7 Seitz and Peattie (2004) contrast those run by the OEMs with those of specialist independent remanufacturers, highlighting contrasts in knowledge and experience between these two groups, and the potential conflicts between them.

8 For example, Ohno (1988) refers to the TPS's emphasis on the seven wastes of overproduction; waiting; transporting; overprocessing; inventories; moving; making defective parts and products. But this concept of 'waste' is grounded in the manufacturing shopfloor and concepts of 'direct labour costs'. Subsequent approaches have encompassed service activities, in the manufacturing and service sectors, applying broader definitions of waste.

9 Lean-type approaches may contribute to reduced use of energy and materials and decreased environmental impacts – but note Katayama and Bennett's example (Chapter 1.5) of adverse reactions in Japanese cities to the pollution and other impacts associated with JIT delivery.

10 The list of such interventions is a long one but, to illustrate, range from action to remove lead additives in petrol – essentially national initiatives, so that coverage is far from universal; to European Union action to regulate waste streams such as through the End-of-Life Vehicle Directive; to, at the international level, the Montreal Protocol concerned with compounds that deplete the ozone layer.

11 Use of other types of resources, particularly non-renewables, forms part of the overall picture. But these are generally left to solution by the market through supply–demand relationships and the competitive advantages associated with efficient resource use.

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