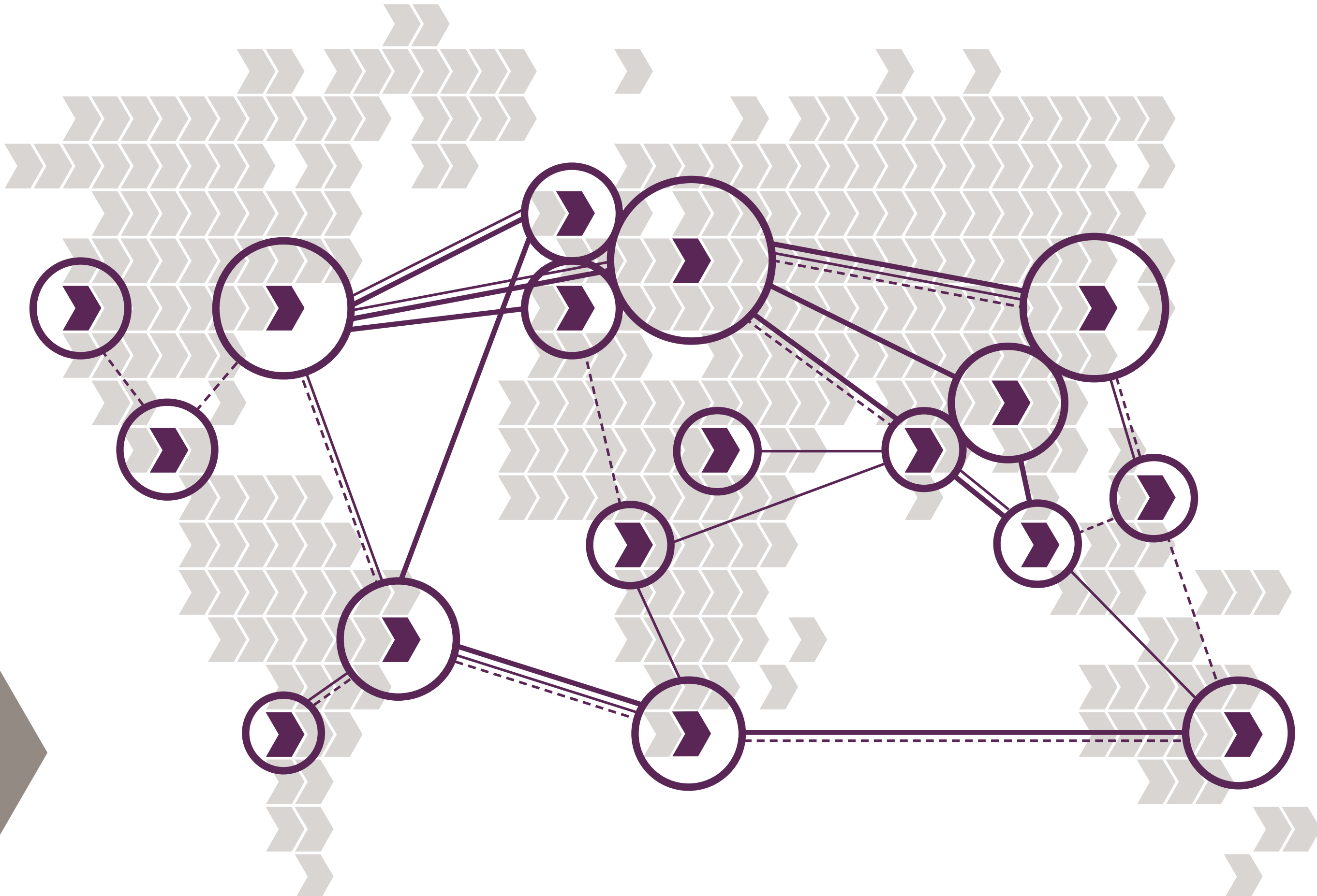
CAPTURING VALUE FROM GLOBAL NETWORKS



Strategic approaches to configuring international production, supply and service operations

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IfM MANAGEMENT TECHNOLOGY POLICY

UNIVERSITY OF CAMBRIDGE

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Capturing value from global networks

Strategic approaches to configuring international production, supply and service operations

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Foreword

For international manufacturers, the effective design and management of global value networks – configuring end-to-end activities internally and externally, distributed across the globe – can be a vital source of competitive advantage. However, in recent years the task has become increasingly complicated, presenting both challenges and opportunities for firms to create and capture value, and, in some cases, to re-invent their business models.

Advances in process and information technologies, and the emergence of new specialised companies fulfilling key research, production or service roles, often located in new international centres of capability, have changed the traditional value creation model. This, together with the development of new markets in the emerging economies, has meant that many industries have witnessed the progressive 'disaggregation' of their value networks. The fundamental design challenge for firms is how to focus on their internal advantages and exploit these rapidly changing external capabilities, whilst leveraging their global reach and scale.

Early research into production and operations management focused on individual factories. More recently, the discipline has focused on continuous improvement practices in individual factories and the dynamics of increasingly fragmented and complex supply chains. New research at the Institute for Manufacturing's (IfM) Centre for International Manufacturing demonstrates that, in this age of rapid and escalating change, it is only by understanding a company's overall global value network – and the industrial ecosystem in which it resides – that it is possible to appreciate fully the opportunities that can emerge from the most appropriate configuration of assets and capabilities.

In practice, this can be a significant challenge for many organisations. Research and development, supply, production, logistics and service are usually managed by separate teams, making it difficult for companies to gain an understanding of their network as a whole. It typically requires a significant change in network design and operations capability when aligning a company's internal network with the external networks of strategic partners. Companies need a new set of strategic frameworks that can support this kind of 'whole system' perspective while maintaining focus on each of the major sub-systems.

A research and practice model

The research we undertake at the IfM is wholly grounded in industrial experience. In addition, through our dissemination arm, IfM Education and Consultancy Services (IfM ECS), we work with leading companies across a wide range of sectors to apply and further develop our research in industrial settings. We have now worked with more than 50 companies on network projects and have developed a set of structured approaches that support companies through strategic and operational change. We also work on collaborative projects involving both companies and government institutions, particularly where there is a common interest in configuring new value networks to support, for example, emerging or disruptive technologies.

Our intention here is to share our latest research and practice with our unique practitioner-policy-academic community who actively help shape our forward research agenda. For those who have yet to engage with us, I hope you find the concepts stimulating and relevant, and that the outputs provide useful contributions to the international manufacturing debate.

Jagjit Singh Srai
Head, Centre for International Manufacturing
Institute for Manufacturing
University of Cambridge

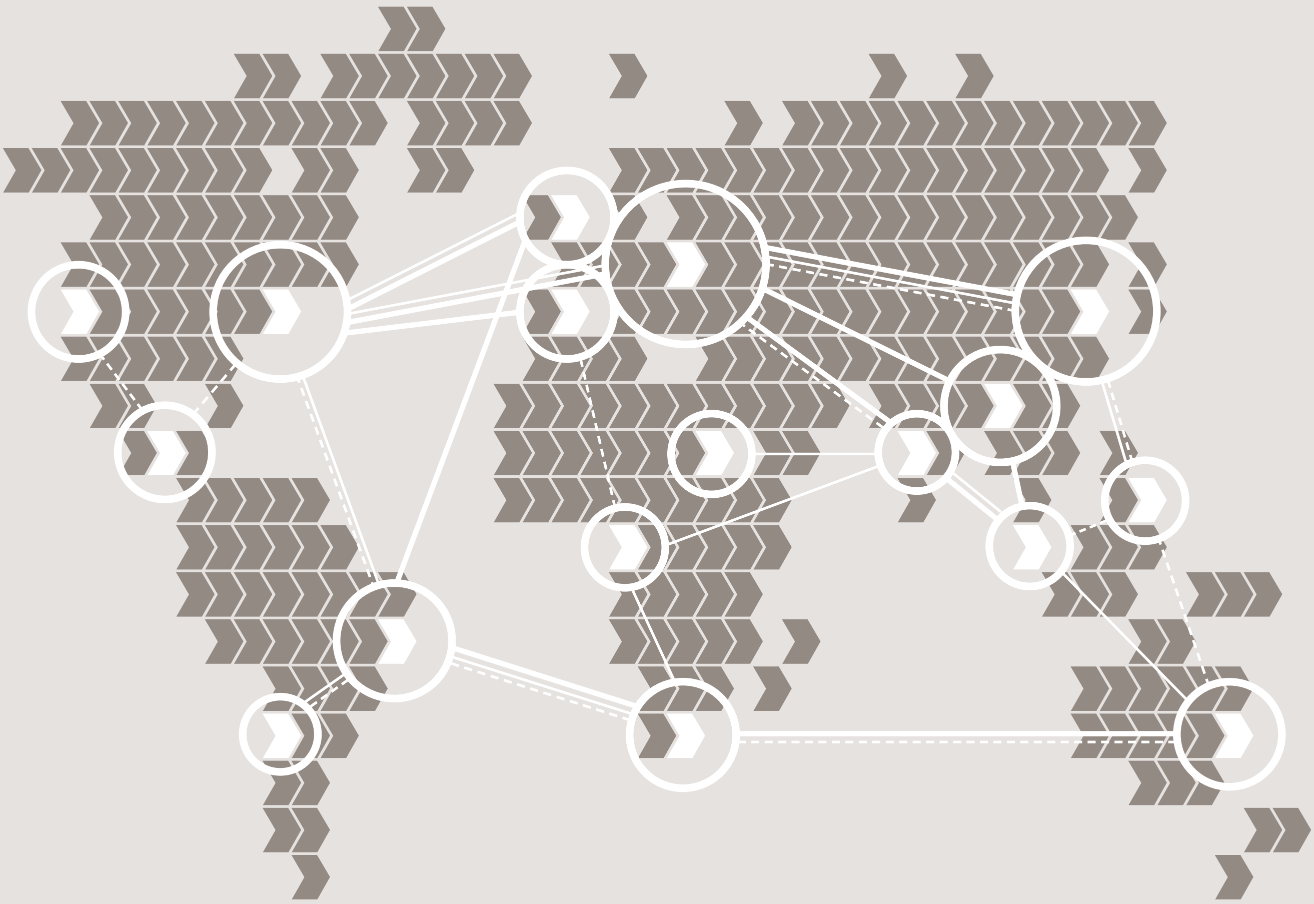
INTRODUCTION

Jagjit Singh Srai and Paul Christodoulou

Capturing value from global value networks

A ‘global value network’ consists of all the value-adding firms involved in the supply of products and services to end users. Managing these networks has become increasingly challenging as firms specialise within the value chain and become more globally dispersed. This report describes the research and real-world application of innovative approaches for guiding strategy and policy in this rapidly changing field.

- The imperative
- Integrated research and practice
- Strategic network design
- Emerging themes



Global value networks – complex systems of specialised, geographically dispersed firms delivering value to end customers

Key

Material flows

Information flows

'Value' flows

The imperative

The vertically integrated business of the twentieth century has become the 'global value network' of today. Organisations that are able to align these complex value networks with their strategic aims have an opportunity to achieve clear differentiation from their competitors.

Global value networks may be defined as 'the total chain of activities that adds value in delivering products and services, including all contributing players, distributed around the world'. As recently as 30 years ago, many of these activities were usually contained within a vertically integrated firm. Within little more than a generation, the traditional model has exploded to form a complex interaction of activities dispersed across more narrowly focused companies, distributed across mature and emerging economies.

The causal trends

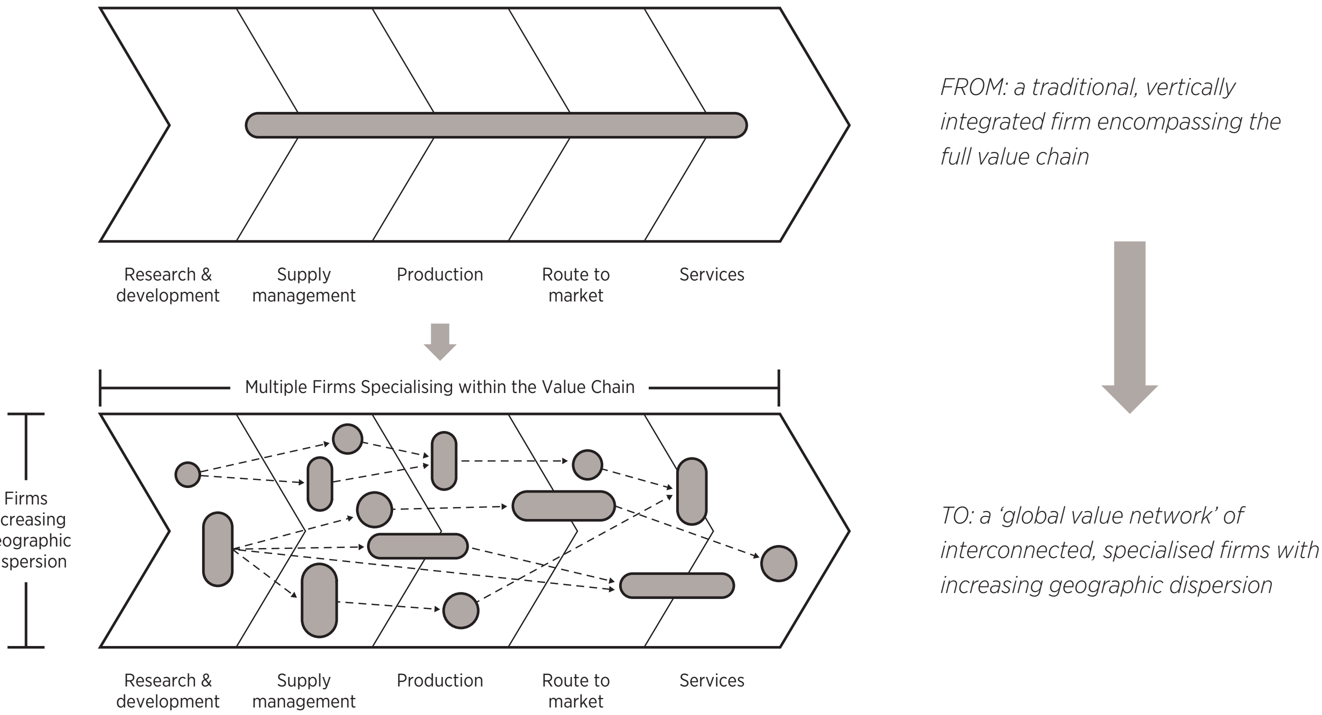
The simplified diagram below illustrates this radical transformation, and highlights the two key causal trends. The first is the increasing geographic dispersion of firms as they extend their global reach to access new markets and cheaper resources. The second trend is the increasing specialisation of firms within the value chain, driven chiefly by the need to master increasingly complex technologies within a narrower field. The typical global value network for industry sectors such as consumer goods, pharmaceuticals or aerospace involves hundreds – if not thousands – of independent specialised firms, often distributed across many countries.

Why this is challenging

Configuring such complex networks requires strategic alignment of the different activities in the value chain and the independent firms which execute them, each with potentially different objectives and business models. This new reality demands radically new strategic approaches to design the appropriate configuration of assets and business processes within and across organisations.

Extracting value from global value networks

The potential benefits associated with getting this right are very high. Well configured networks can deliver more innovative products and services at lower cost by harnessing synergies across collaborative players, by accessing the best talents and by being responsive to diverse customer needs. They have the potential to secure access to scarce resources, be responsive to volatile market dynamics and be resilient to economic, political and environmental shocks. The companies that embrace advanced configurations and new capabilities can expect to extract higher value from these ever-changing complex networks.



Integrated research and practice

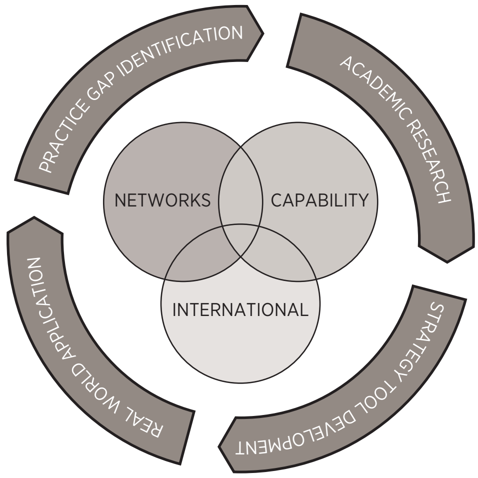
The IfM's Centre for International Manufacturing pursues an extensive programme of research and real-world application of new approaches for the strategic configuration of global value networks, working closely with a community of industrialists, policymakers and academics.

Centre for International Manufacturing
The Centre for International Manufacturing (CIM) is one of the IfM's major research centres. The Centre's research focuses on three major themes: 'networks', 'capability' and 'international'.

The 'networks' research theme involves the close study of the characteristics of complex networks in terms of their intrinsic properties and behaviours, leading to a deeper understanding of configuration needs, especially regarding strategic design and the integration of sub-systems and partners. The 'capability' research theme focuses on the advanced business processes and organisational routines that are required for the successful operation of complex value networks within multinational companies, across functions, and between the collaborative players making up the total network. The 'international' research theme tackles the challenges associated with the crossing of national borders, whether in the search for new markets, vital resources and technologies, or global resilience.

Research across these three themes leads to a rich understanding of the structure and dynamics of global value networks and to the development of innovative concepts and frameworks.

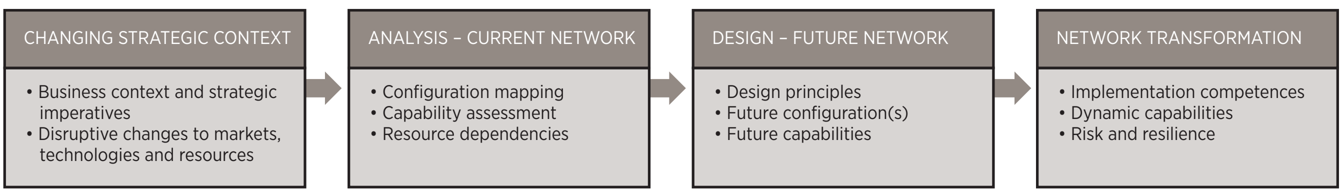
A virtuous circle
CIM also aspires to create a virtuous circle encompassing the development of new theory and concepts, the translation of these into a set of structured approaches and practical design tools, and the application of these approaches with partner companies – all informed by continuous feedback from the companies themselves. This collaborative approach involves CIM researchers and IfM ECS practitioners working closely with a wide range of multinational companies. The aim of each project is to leave the company with a set of strategic approaches, tailored to their specific needs and context, which they can adopt and continue to apply after the project has been completed. This approach has led to significant business benefits achieved through network reconfiguration and capability development. From a research perspective, the approach seeks to develop generalisable insights on network structure and dynamics and related operational capabilities. These insights can then inform the analysis, design and effectiveness of operations within different international and industrial contexts.



CIM research integrates theory-building and practical application

A common process for configuring global operations
The application of the full range of CIM's frameworks follows a structured approach to creating and implementing innovative network strategy. The approach has four steps:

Step 1 involves deep analysis of the changing strategic context – typically covering the business and technology drivers relating to the scope of the challenge – and resulting in clear articulation of the strategic imperatives. **Step 2** aims to develop a deep understanding of the current network in terms of its configuration and capabilities. **Step 3** is the key creative activity that designs the future network. This requires distillation of the fundamental network design principles and the evaluation of a range of future configuration options leading to an agreed vision. **Step 4** involves network transformation – not just defining the executable projects but, crucially, identifying the organisational competences required for implementation. This overarching approach is common to the four key areas of network analysis and design (i.e. production, end-to-end supply, service and global value networks) and deploys tailored tools specific to each area. This provides a powerful vehicle for delivering a range of strategies to meet business challenges, all aimed at maximising value capture from global value networks.



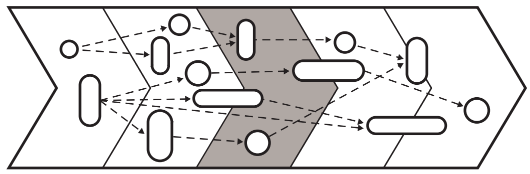
Four-step process for strategic design of global networks

Strategic network design

The Centre for International Manufacturing has developed a set of structured approaches, based on research, for the strategic design of global value networks. The first part of this report describes how these common approaches are used to address different elements within the value chain and shows how they have been applied in a number of multinational companies to achieve significant business benefits.

Designing a production footprint to reduce cost and increase responsiveness

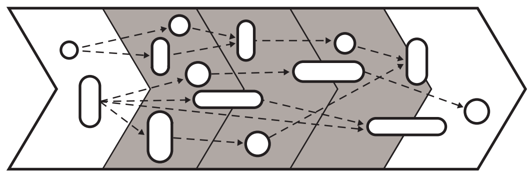
'Production' is a critical activity in the value network and typically represents the majority of a firm's assets. The CIM approach, now used with many multinational companies across a wide range of sectors, guides the design of global production networks to reduce cost, improve access to growing markets and vital resources, and improve agility and resilience in the face of changing market conditions.



Production footprint

Gaining competitive advantage across the end-to-end supply chain

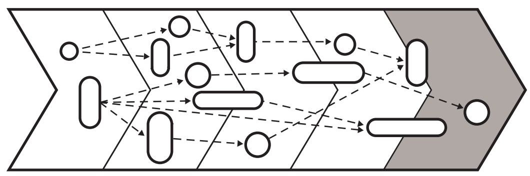
The key challenge associated with taking a more extended or even end-to-end supply chain perspective is the alignment of configuration and capability across both internal functions and external partners. CIM research has led to new approaches that selectively seek to integrate end-to-end capabilities within the context of enhanced supply network configurations. This design methodology has, in turn, led to the concept of 'meta-capabilities' – unique clusters of capabilities, linked to distinctive configuration characteristics that underpin sustainable competitive advantage.



End-to-end supply chain

Developing a successful service supply network

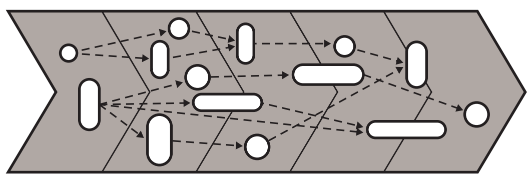
Many product manufacturers are developing a service offering as a way of creating new revenue streams and getting closer to their customers. However, this introduces a new supply network challenge, often with multiple 'primes' as partners delivering different and significant service elements that require effective on-site integration. CIM research has developed a set of approaches that can help companies configure these complex multi-organisational networks of service partners, in order to enhance the returns available from their integrated product-service offerings.



Service supply network

Configuring global value networks for emerging and disruptive technologies

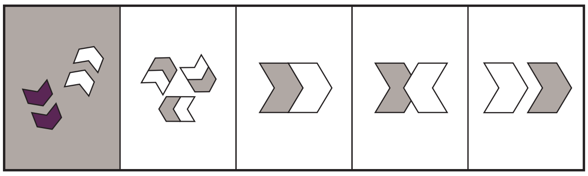
New technologies and disruptive business models are driving the emergence of novel value networks and radically changing existing network models. This can have significant impact on the major companies operating in these areas, but is also of interest to government agencies seeking to encourage high value industrial activities. CIM has developed a set of structured approaches that support the needs of both the corporate strategist and the national policymaker by guiding the mapping of complex industrial ecosystems, the configuration of new and disrupted global value networks, and the integration of these networks to enhance performance.



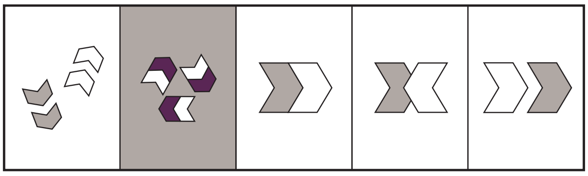
Global value network within its industrial ecosystem

Emerging themes

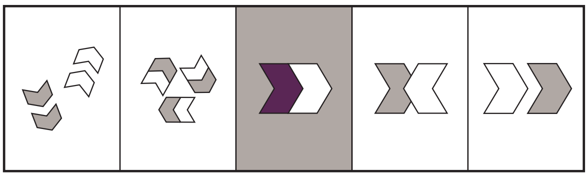
Ongoing research activities are focused on creating the next generation of strategic approaches in response to some of the most pressing themes identified by industry. These themes are all explored in the second part of this report in terms of their impact on global value networks.



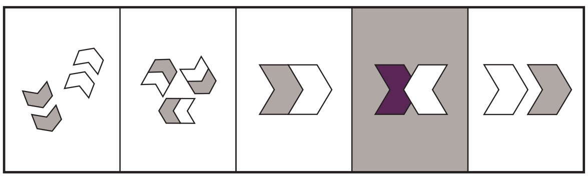
Risk and resilience



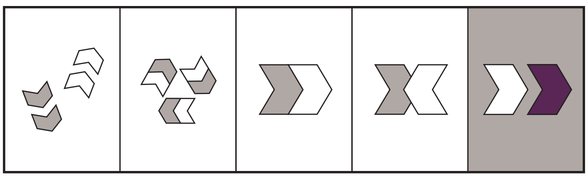
Sustainable supply networks



Mergers and acquisitions



Knowledge integration



'Last-mile' logistics

Risk and resilience
Risk is an important issue in today's increasingly uncertain world, with companies needing to know that they can prepare for, and quickly recover from, unforeseen events. CIM is developing a systematic approach to managing network risks and to building resilience into the overall global value network.

Sustainable supply networks
Sustainability is becoming an important business criterion. However, developing a sustainable global value network encompassing a large number of firms presents a major challenge. Researchers at CIM are developing approaches which support an engineering-driven design of sustainable supply networks. These approaches take a network configuration perspective of the industrial systems in which firms operate and explore capability models designed to improve industrial practice.

Mergers and acquisitions
Growth through merger and acquisition (M&A) is the norm for most multinational companies but integrating two or more existing global value networks can cause major problems which companies often fail to anticipate. CIM research into M&A has resulted in a framework for ensuring that a company's operational needs are aligned with its strategic objectives, both pre-merger and in post-merger integration.

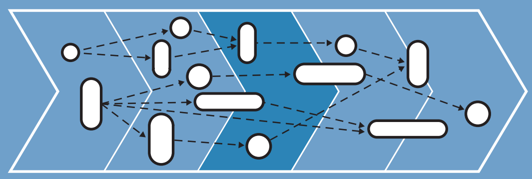
Knowledge integration
Multinational companies have a particular challenge in bringing together knowledge across their geographically dispersed sites, where there are likely to be differences in language, culture, equipment and operational conditions. By understanding the various types of knowledge and their characteristics, CIM has developed an integrated and proactive approach to considering knowledge management in the context of international value network design.

E-commerce-driven 'last-mile' logistics
The rapid growth of e-commerce-based supply chains for consumer goods and the sustainability concerns arising from increased traffic and congestion in all sectors, presents firms with a new set of challenges. CIM has developed an innovative approach to 'last-mile' delivery systems and service models which, crucially, reflects the interests of all stakeholders: industrial, institutional and end-user.

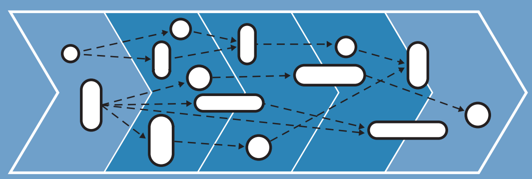
1. STRATEGIC NETWORK DESIGN

The first part of this report describes four strategic approaches for configuring global operations, each addressing different elements within the value chain: production, supply, service supply and global value networks within the context of their industrial ecosystems.

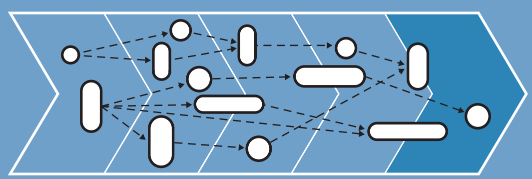
- 1.1 Designing production networks
- 1.2 Managing the end-to-end supply chain
- 1.3 Developing service supply networks
- 1.4 Configuring global value networks within industrial ecosystems



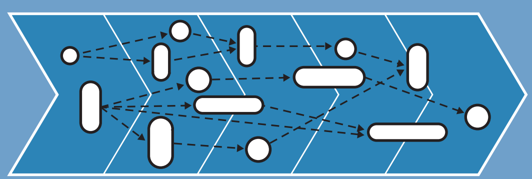
Production footprint



End-to-end supply chain



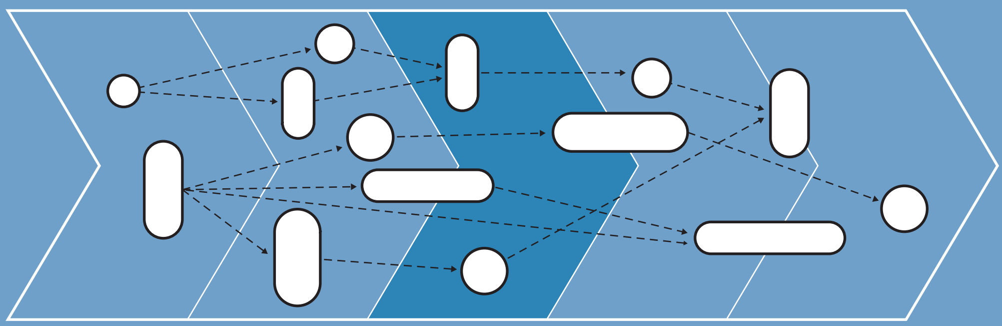
Service supply networks



Global value network within its industrial ecosystem

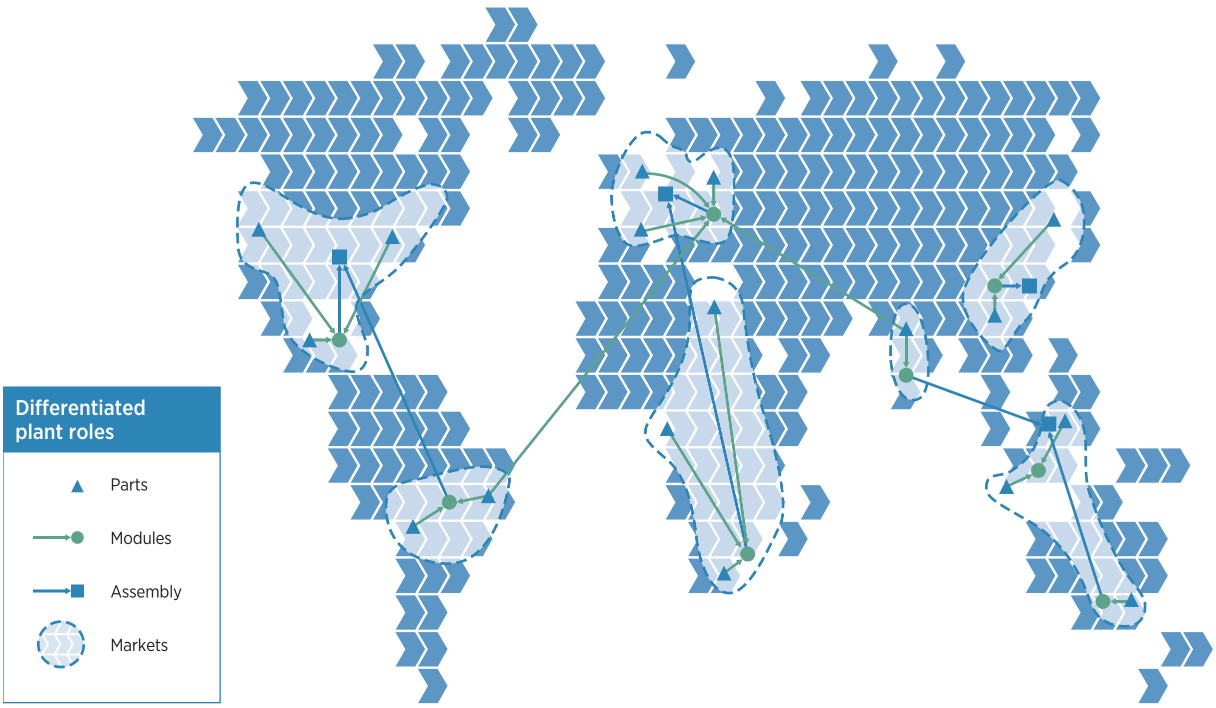
1.1 DESIGNING PRODUCTION NETWORKS

Paul Christodoulou, Don Fleet, Yongjiang Shi and Jagjit Singh Srai



'Making things' is a critical activity in the value network. Today's production networks need to be more cost-efficient and deliver better access to attractive markets than ever before. In this context, it is imperative to develop a strategic reconfiguration process that takes a long-term perspective. We call this process 'Production Footprint Strategy' or the art of 'Making the Right Things in the Right Places'.

- Developing a footprint strategy
- Putting it into practice
- *Application case study: global packaging*



Configuring global production networks for strategic advantage

Background

In the last 30 years, as multinationals have extended their global reach to access new markets and resources, the academic study of global production networks has accelerated in parallel.

Arguably, the earliest work in the field goes back to the 1960s, and by the 1980s and 90s researchers were starting to recognise the importance of studying the production network as a whole rather than focusing on factories in isolation. In 1998 Yongjiang Shi and Mike Gregory published *International manufacturing networks – to develop global competitive capabilities*. This seminal paper firmly established the production network as a key unit of analysis and laid the foundations for CIM's pioneering approach to research in global manufacturing.

Over the last 20 years, CIM has developed a range of concepts relating to production networks, including: strategy, capabilities, performance, design and risk. These have been integrated to form a set of structured approaches which has been applied in leading companies to support 'Production Footprint Strategy'. In these companies, footprint strategy is starting to supersede lean production as the primary enterprise adaptation imperative. Whilst it is essential for plants to perform well, a collection of individually lean factories is no longer enough to deliver internationally competitive cost and responsiveness.

"We worked closely [with IfM ECS] to develop and direct the Global Manufacturing Strategy which will expand our global production capabilities in developing markets around the world, as well as re-aligning our existing production into manufacturing centres of excellence within an optimised network. Our goal is to significantly improve our operating efficiencies, lower our overall cost structure and implement new technologies more effectively, whilst not compromising service, quality or EHS." The company reported a series of updates in press releases over the period 2008 to 2011, where it announced that the overall project involved capital expenditure of $220m, and delivered repeating savings of $55m per annum.

Vice President of Global Manufacturing and Vice President Supply Chain Europe, Sealed Air

A long-term approach

A common misconception is that footprint strategy is a short-term restructuring project involving offshoring and outsourcing, coupled with the establishment of production footholds in key emerging markets. Indeed, one senior executive described footprint strategy as a project that had been 'completed two years ago'. This approach underestimates the potential benefits of – and the potential barriers to – implementing a successful footprint strategy. It also ignores the fact that the target is constantly changing as macroeconomics and technologies shift.

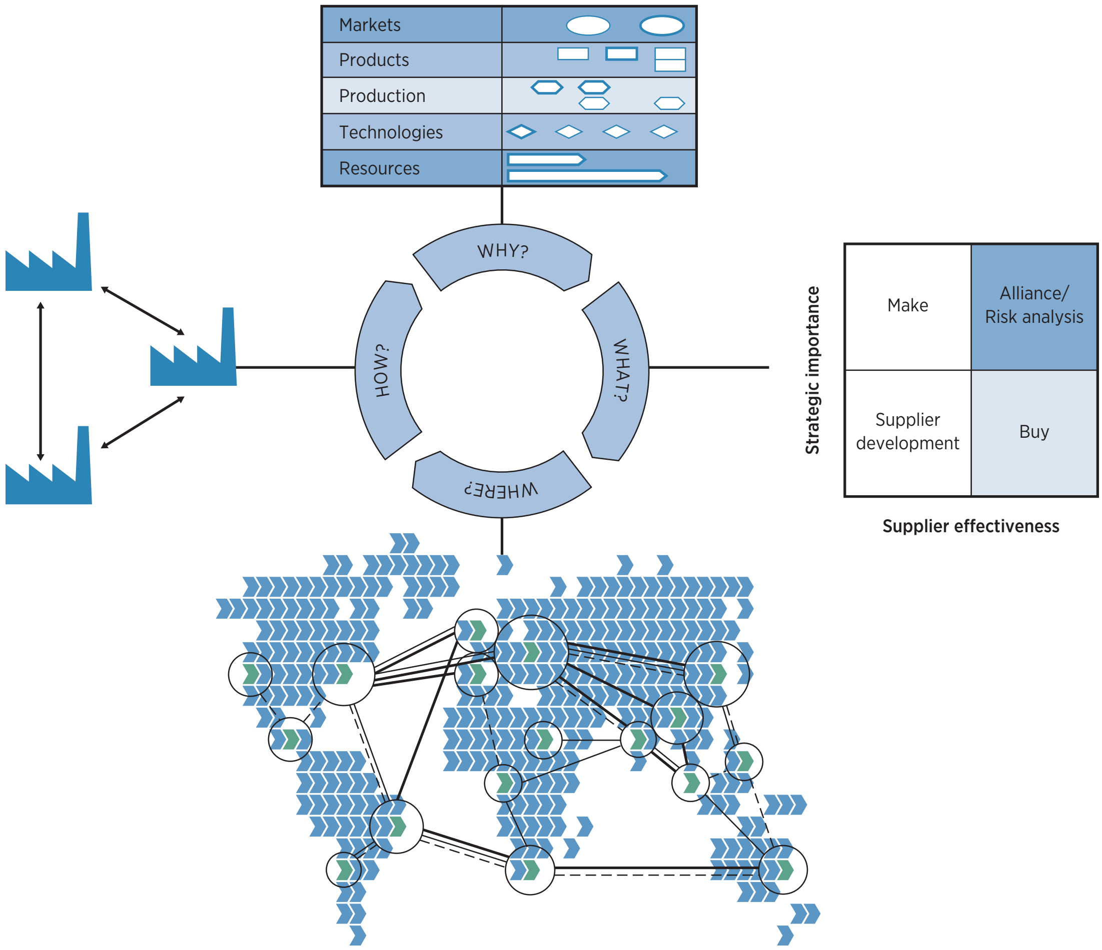
Footprint strategy is a repeatable, long-term process that needs to be embedded in annual business planning. Implementation is via a portfolio of projects which are continually refreshed and tested for consistency and alignment. New roles and responsibilities are needed at enterprise, product and regional levels. New measures and mechanisms have to be created to ensure companies know whether they are succeeding. This new enterprise adaptation process needs to be in place for the long term. Even as the impact of globalisation stabilises and infrastructures become more mature, new challenges arise: resource scarcity, building resilience to potential disruption and new channels to market. These all renew the need for constant footprint adaptation.

"Our work with IfM ECS over the last five years has helped to guide our strategy in this vital area of our business. Over the period 2008 to date this has resulted in the building of three new factories and significant transfer between the factories in Europe in general. And it has supported an average annual growth of 8%."

Group Senior Vice President, Grundfos

Developing a footprint strategy

CIM's approach addresses four key questions. Why does a network need to evolve? What is the basis of a company's distinctive market position? Where should each type of plant be located and how many of each should be doing what? How best to achieve the transition and monitor its success?



Four-step approach for developing a production footprint strategy

The need for change?

Cost reduction is often the primary motive for reconfiguring a production network, and in applying our work with leading companies we have seen typical cost reductions of 10–20%. In one case, the company declared $55m annual cost savings five years after publicly announcing the strategy.

But cost reduction is not everything. Accessing the most attractive markets is at least as important and there are other strategic factors to consider, such as access to key resources, innovation capability, agility and risk. As well as being clear about their own strategic objectives, firms also need to take into account external market forces and the technology discontinuities that create new product and process opportunities. This is the background against which reconfiguration should be considered.

"We are one of the world's largest manufacturers, with sales approaching $50bn, and the main reason for starting this process [with IfM ECS] was to secure the long-term optimisation of our production network. Over time the 'burning platform' has changed but the process remained the same, allowing us to constantly update the vision as conditions evolve. Since 2008 this approach has been used in all business divisions and serves to guide Caterpillar's annual, multi-billion dollar capital spend through coordinated investments across the vertically integrated company."

Manager of Global Production Network Planning, Caterpillar

What to make and what to outsource?

Tempting as it is to think about outsourcing and offshoring at the same time, it is important to separate decisions about 'what to make' from considerations of 'where to make'. This is essentially about establishing the right degree of vertical integration regardless of where the production plants are to be located. Only when it is clear which products and processes comprise the core competence of the business can we consider the configuration of production facilities. Similarly, once it is apparent what needs to be outsourced, it becomes possible to establish the right kind of strategic supply relationships. Of course, 'what to make' and 'where to make' decisions then need to be interlinked, as location aspects can sometimes influence ownership models.

'Where to make' and in which types of plant?

A pragmatic, structured approach is taken to determining the preferred location of plants which involves data analysis and visualisation to draw out the underpinning principles for designing the network. This is a real-world problem that is not easily solved by mathematical modelling alone because the variables – including cost, responsiveness, resource access and other factors – are far too complex. Nevertheless, a systematic and clear process is essential, supported by valid data.

This process has three main stages:

1. **Plant roles:** firstly the plants themselves must be given clearly defined roles. This is critical both to the design of an effective network and in countering the tendency of plant managers to grow the role of their plant beyond its prime purpose.

2. **Coordination principles:** the second step is to specify the coordination principles underlying the network. A network is more than just a collection of independent plants. The activities of the plants must be coordinated to meet customer needs in the most efficient way. Defining how plants interrelate with each other and with R&D and other key functions is referred to as 'network coordination'.

3. **Footprint scenarios:** determining a range of future footprint scenarios is the third stage in designing the network. Looking at where the plants need to be located to meet the requirements of each market takes place only at this point in the analysis. There are many reasons why the answer is neither one large facility in China nor separate plants in every market. For reasons of practicality, footprint reconfiguration is often handled at the level of the global product line or business unit. A large part of the synergies available, however, are derived from a co-ordinated approach across business units. This requires an additional step in the design process, termed here 'aggregation', which also has implications for implementation.

How to make it happen, and knowing whether you are succeeding

A strategy is of little consequence without proper execution. Network reconfiguration entails a large number of closely integrated and interdependent projects. These are executed over a wide geographic spread, require significant capital expenditure, and involve large numbers of staff. This alone would make the task very difficult, but the fact that it affects a wide range of stakeholders both in and outside the company means it is also very sensitive politically. It is not just a question of detailed project control.

Network reconfiguration is a process that makes decisions on a portfolio of business opportunities which all need constant filtering and prioritising within a changing context. Other factors to be considered include raising capital, legal implications, HR issues, internal communications and investor relations. The term 'mobilisation' is used to describe these factors collectively. Transferring products to new sites, plant closures and plant migrations are likely to become regular features of a production business. Managers will therefore need to become familiar with best practice in the transfer of production capabilities.

Finally, it is essential to put in place a measurement system that reflects the operation and transformation of the network. Measuring what is going on at plant level is a relatively well-established discipline; network-level metrics, however, are generally much less mature.

Practice guidelines

The full approach is described in the IfM publication *Making the Right Things in the Right Places*. This presents a set of guidelines for establishing the new business process of global production reconfiguration. This can be used as a benchmark for evaluating maturity, and as a framework for ongoing strategic development.

Electrolux has been conducting a collaborative programme with IfM ECS during 2012 and 2013 aimed at applying IfM's research on optimising global manufacturing networks. The project is still ongoing and the future impact is not yet finalised. However, the outcome is expected to guide investment in the future footprint over the next 3-5 years in the order of 3.5 Bsek (400m euros) where the targeted cost savings are in the order of 1.3 to 1.6 Bsek (180m euros) annually. "This project forms a major part of our corporate business strategy and will help to guide the optimisation of our footprint of over 45 plants around the world. This will drive structural changes in terms of cost reduction and responsiveness to customers which will underpin our future competitive differentiation."

Senior Vice-President of Global Manufacturing Operations, Electrolux

Putting it into practice

This approach was co-developed with a leading global manufacturer between 2003 and 2005, and has since been applied in a variety of multinational companies. The companies involved have undergone radical transformation or gradual evolution, or various stages between the two. CIM researchers and IfM ECS practitioners continue to expand and refine the approach via background research and active co-development with industrial partners.

	SCALE	OUTCOME	HARD BENEFITS	SOFT BENEFITS
LARGE VEHICLES	$40bn, 110 plants	10 year evolution strategy	Significant cost savings	New processes across 33 SBUs
FILM PRODUCTS	$4bn, 50 plants	5 year aggressive realignment	$55m pa declared cost savings	120 top managers aligned with change
FOOD EQUIPMENT	$1bn, 12 plants	2 year turnaround plan	Business survival	Minimised business disruption
TRANSPORT SERVICES	$2bn, 17 plants	5 year strategy	20% cost saving	M&A integration framework
SPECIALITY CHEMICALS	$2bn, 21 plants	5 year consolidation / pre-merger plan	Significant cost savings	Refocusing of core business
HYDRAULIC PUMPS	$3bn, 14 plants	Staged evolutionary strategy	Access to growth markets	Trained trainers for staged roll-out
ELECTRICAL DEVICES	$15bn, 200 plants	Footprint design model	Significant cost savings	Post M&A optimisation
FMCG	$5bn, 20 plants	Continuous strategy process	Enablement of global expansion	Pre-empt need for periodic restructuring
PLASTIC PRODUCTS	$1.5bn, 45 plants	5 year re-configuration plan	Significant cost savings	Consensus across complex organisation
PETROCHEMICALS	$10bn, 60 plants	Ideal future network	Fundamental shift in network approach	Distillation of key drivers
AEROSPACE	$16bn, 40 plants	Impact of new process technologies	Optimum return on investment	Filled key gap in corporate process
PLASTIC TOYS	$2bn, 12 plants	Revised vision following turnaround	Scalable model for high growth	Clarity on core competences
WHITE GOODS	$16bn, 45 plants	In depth process for value creation	In process	In process

Major applications to date

For more than 10 years, IfM ECS has worked with leading companies to apply these research-based approaches to international production networks as live strategy projects. The major collaborations – illustrated above – are anonymous, due to the confidential nature of the projects. However, the work has led to some general observations that may be helpful to other companies considering similar undertakings.

Understanding the 'network levers'

A fundamental question to be addressed in footprint strategy is 'how will the network perform as more than merely the sum of its parts?' Considering this question has led to the definition of a set of possible 'network levers' – ways of creating network-associated benefits over and above those derived from running an independent set of plants. These benefits can be achieved through intrinsic network design features or modes of operation. More than 20 different network levers have been observed and used in unique combinations in the different case studies. One example of such a lever is designing the footprint for short lifecycle products. This involved shaping the network around three types of plant – prototyping, production scale-up and mass production – to match the different phases of the lifecycle.

Production networks are inherited not designed

Most global manufacturers do not get the chance to design their footprint from scratch. They tend to have inherited a network which has evolved over time as a result of ad hoc market entry strategies and multiple mergers and acquisitions. This typically results in a collection of plants that lacks cohesion and is better suited to serving yesterday's markets than tomorrow's.

The generic CIM approach to production network design needs to be tailored for each application

IfM ECS collaborations have covered a wide range of industry sectors and strategic contexts and the general approach is transferable but it needs careful tailoring to fit each environment and to meet the particular objectives of the network redesign. Two simple examples of the need for tailoring:

1. The basis for make-or-buy analysis varies between product and process-based industries and getting this classification right is fundamental. Effective make-or-buy guidelines can have a major impact. In one case study 40% of product families were identified as non-core; these could be outsourced to strategic partners, thereby supporting significant consolidation.
2. The critical criteria that determine global footprint design vary widely. For example, some firms will see the economic range of products (how far they will travel) as a determining factor, while for others it is the need for economies of scale in production that is more important. Balancing transport costs, economies of scale and the need for customer responsiveness can have very different outcomes.

There appear to be no fixed archetypes for footprint strategy – the solution needs to fit uniquely with the context and competitive positioning of each company.

Benefits are not just cost savings

The range of typical benefits achieved or targeted in the case studies is outlined in the table below. Cost reduction was, unsurprisingly, a major objective in each case, but other strategic factors such as the need to improve access to emerging markets were also perceived to be important.

Consultation and building consensus is key

Footprint strategy is a high-stakes agenda in complex organisations. This is natural for strategies that must cross regional, product and functional accountabilities within the matrix structure. Strategy development needs to engage with a broad range of internal stakeholders in a structured way to help deal with internal politics and emotions. This is not a challenge which can be solved by data analysis alone. The approach needs to tap the accumulated wisdom and judgement of the management team using a structured process to determine the guiding principles and identify attractive options. Data analysis can then serve to explore and validate the potential outcomes.

BENEFIT	EXAMPLES
Cost reduction (10-20%)	A key driver in each case. Typically 10-20% cost reduction was achievable. In one case, the company declared $55m annual cost savings five years after publicly announcing the strategy.
Access to emerging markets	Considered equal in importance to cost. Most of these network optimisations involved reshaping of the footprint towards emerging economies (for accessing markets rather than low-cost labour).
Performance through better focus	All the case studies introduced a range of differentiated plant roles as a means of improving performance in cost, quality and responsiveness. The logic for determining the plant roles varied depending on product, process and market attributes.
Innovation	The need for the network to support ongoing innovation was an achievable objective in many cases. One company managed this by a co-ordinated commitment to new quick-changeover production technology in designated plants to provide ultra-responsive service (sold at a premium).
Link with mergers & acquisitions (M&A)	Most of these companies are expanding via M&A and recognise the need to align this with footprint strategy. One firm enshrined footprint optimisation as part of its M&A process regarding both pre-deal valuation and post-deal integration.
Network agility	All the companies recognised the need to develop a network that is flexible in response to unplanned changes (e.g. market or macro-economic shifts). This has led to increased harmonisation of products and processes and new global roles in co-ordinating transfers.
Sustainability	The importance of developing sustainable global networks has increased due to rising fuel costs and rising consumer and political pressures. More attention is being paid in the footprint design process to maximising resources and reducing impacts like transportation cost. The medium-to-long term vision for most of the companies involves locating production closer to market. However, the broader implications of sustainability in this context are not fully understood and this is the focus of ongoing research.

Benefits observed in the application of the approach

Taking a long-term view

Many companies have a two- to three-year strategic horizon, usually driven by the short-term needs of shareholders. Footprint strategy, however, requires a long-term perspective and in all these case studies the companies' senior teams were urged to consider a much longer strategic horizon than usual. Major investment decisions for new production lines and complete plants are likely to be required. Accountants model such decisions over at least 10 years and engineers expect possibly 20 years of life from the assets involved. Taking a long-term view liberates thinking beyond the configuration of what we have today and may result in a very different vision of the future.

Separating 'what to make' from 'where to make'

One common problem in traditional footprint strategy thinking has been the merging of 'outsourcing' and 'offshoring' as strategic options. The CIM approach separates these issues so that 'what to make' can be judged independently of 'where to make'. 'What' deals with establishing the core production competences of the business; 'where' deals with locating those operations. The two issues then need to join up and this may require some iterative thinking. The overall result is a range of more creative and subtle strategic alternatives including a 'make some' approach, different strategic outsourcing options, regionally tailored approaches and postponement strategies.

Developing a continuous process

One final observation from the major applications undertaken to date has been a general shift away from 'project-' to 'process-' based thinking regarding footprint strategy. In the past, many companies have considered this challenge as a discrete project, often resulting in an intense restructuring programme. One problem with this is that it tends to drive a reactive approach, where footprint strategy is typically only high on the agenda when there is an urgent need for cost reduction. Several of the case studies made significant progress in defining a continuous process based on innovative modelling techniques. This analyses forecast demand against critical market, product and production criteria to recommend the ideal future footprint.

These observations are used to inform CIM's ongoing research and ensure that it aligns closely with the needs and priorities of its industrial collaborators.

"This was a major strategic thrust aimed at developing and implementing the right Supply and Manufacturing Footprint to achieve operational and service leadership within the group. As a result, we are running an investment program of €8–10 million per year for three to five years to implement the desired footprint as designed. The estimated repeating annual cost savings achieved to date are €3–5 million per year."

Executive Director of Supply Chain Operations, Wavin Group

APPLICATION CASE STUDY:

Global packaging

Project aims

This project involved the transformation of the global production network of a multinational packaging company over the period 2004 to 2010. This company had grown by acquisition, leaving a legacy of country-based operations with limited global synergies. The combination of retailer pricing pressure and raw material inflation was a significant threat to the company's traditionally healthy margins so cost reduction was the major imperative for change. But this project was about much more than reducing costs. It was an opportunity to renew competitive leadership.

Nature of the collaboration

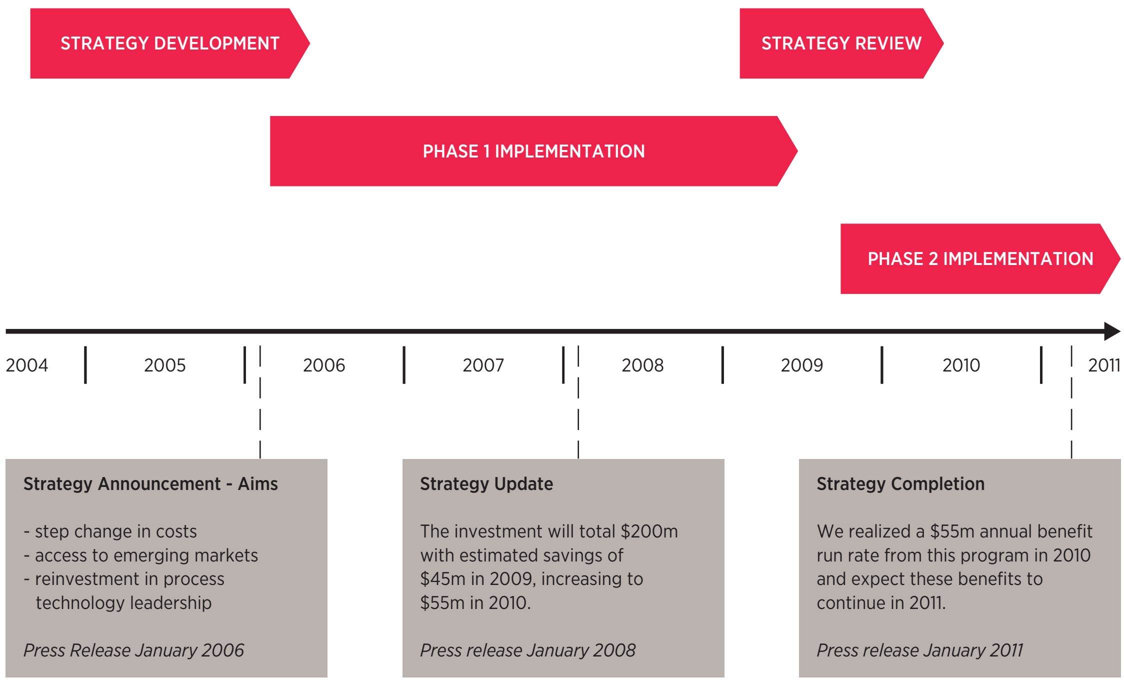
IfM ECS worked with the company on a global production network strategy development programme over 18 months. This involved 120 senior managers across five global product lines, followed by an aggregation process driven by geographic region across product line. This resulted in a publicly announced restructuring programme which required investor funding. The company then implemented the strategy over the next five years with IfM ECS continuing to provide light support on strategy refinements.

Plant roles – a key aspect of transformation

The single most important aspect of the strategy involved the precise definition of differentiated plant roles within the global production network. Before the project, most plants were vertically integrated and locally focused. After the change, each plant's role was closely defined in terms of a smaller portion of the vertical process span, process technology expertise, identified segments in the global product range, product lifecycle scope and geographic purpose (e.g. access to low-cost labour or access to customers). This tailored framework of plant roles served to guide the transformation and to deliver a wide range of performance benefits.

Benefits

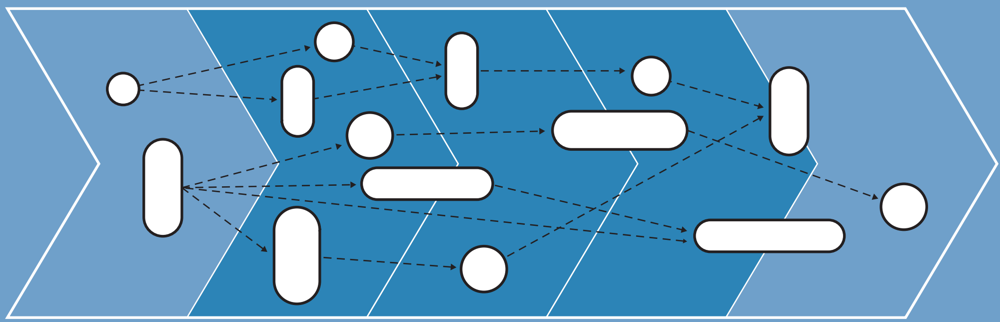
Various updates on the project were provided in the press releases accompanying the company's annual results over the years 2008–2011 (examples shown below). The overall project required \$220m investment and realised \$55m repeating annual savings. This implied a payback of around four years, reflecting a long-term view of strategic transformation. This facilitated additional benefits that were arguably much more important than cost reduction. First, the project allowed the company to establish mature footholds in the emerging BRIC nations to support long-term growth (alongside accessing low-cost labour sources). Secondly, all production investment involved latest process technologies, prompting a step jump in operational performance and flexibility. Thirdly, the transition initiated a long overdue harmonisation of the global product range. Last, but by no means least, the change helped to instil a balanced global-local culture.



Development and realisation of transformational footprint strategy

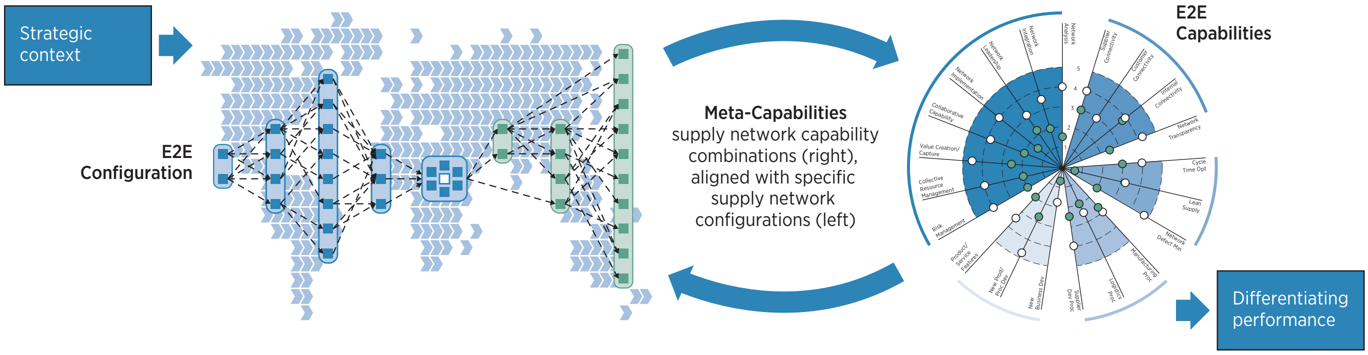
1.2 MANAGING THE END-TO-END SUPPLY CHAIN

Jagjit Singh Srai, Paul Christodoulou and Dennis Lewis



For many global manufacturers, having a fully integrated end-to-end supply chain is a key aspiration. However, with supply chains becoming much more fragmented and dispersed, network integration has become an increasingly difficult task. The art of getting physical products to the final customer now involves coordinating a multi-tier network of upstream and downstream partners – distributed globally – across which innovation needs to be ever quicker and more relevant, all in the face of increasing risk of disruption. This requires a new strategic approach that both addresses network configuration and develops advanced capabilities.

- Configuring the end-to-end supply chain
- Developing end-to-end capabilities
- ‘Meta-capabilities’ and competitive advantage
- *Application case study: premium consumer goods*



The end-to-end supply chain design process involves linking supply network configuration, capability and performance

Background

Research at the Centre for International Manufacturing in the 1990s started to explore network-associated aspects of production rather than the single factory. During the early part of the new century, this thinking was extended to cover the end-to-end supply chain, with particular focus on the relationships between network 'configuration' and 'capabilities', and their impact on network 'performance'.

A number of academic studies have focused on the importance of linking configuration and capability of end-to-end supply chains as a route to achieving differentiating strategic performance. CIM research led by Jag Srai has focused on bringing these concepts together and developing a new strategic process for redesigning the end-to-end supply chain, by aligning network and product configuration with desired network capability. The structured approaches and techniques developed from this research have been applied in more than 35 leading companies across multiple product categories spanning both emerging and mature industry sectors.

Linking end-to-end configuration, capability and performance

At the heart of CIM's approach to end-to-end supply chains is a model that links the key aspects of configuration and capability to improve performance (see diagram above).

Configuration is seen as the 'essence of strategy' and requires pattern, coherence and consistency. CIM uses a holistic definition of end-to-end configuration covering four essential elements – network structure, unit operations, partnership roles and product structure. This model is described in further detail on pages 24 and 25.

Capability assessment model

The CIM definition of network or end-to-end capability relates to the business processes required to operate complex, multi-tiered networks involving a range of functions and partners. This model includes 21 capabilities in five categories which relate specifically to end-to-end business processes covering:

- network strategic design
- network connectivity
- network efficiency
- supply chain processes development
- product/service enhancement.

This definition goes beyond thinking about capabilities as being linked to individual activities or players in the supply chain. It defines the key differentiating capabilities as organisational routines that need to consider the entire end-to-end supply chain. This model is described in further detail on pages 26 and 27.

Meta-capabilities are the source of competitive advantage

Linking configuration and capability has led to a further concept which represents a new approach to supply chain strategy thinking. The term 'meta-capability' has been coined to describe this concept, which relates to the unique clusters of individual capabilities, linked to distinctive configuration aspects that underpin differentiating strategic performance. The uncomfortable truth behind this premise is that configuration aspects and individual capabilities, whilst valuable and often complex, are relatively easy for competitors to analyse and copy. It is the unique combinations of capabilities and configuration elements, purposefully designed around specific strategic aims, that constitute a competitive edge which is much more difficult to emulate.

> **"Our work with IfM ECS has resulted in a range of new strategy tools with very practical application. These tools have helped in important decision-making areas in our supply chain that have enabled us to drive business performance in manufacturing and supply chain, and commercially. We estimate that this work has underpinned investment decisions affecting more than £50 million of investment and supported the development of our new product capability supporting revenue in excess of £500 million."**
>
> *SVP Head of Network Strategy, Global Manufacturing and Supply, GSK*

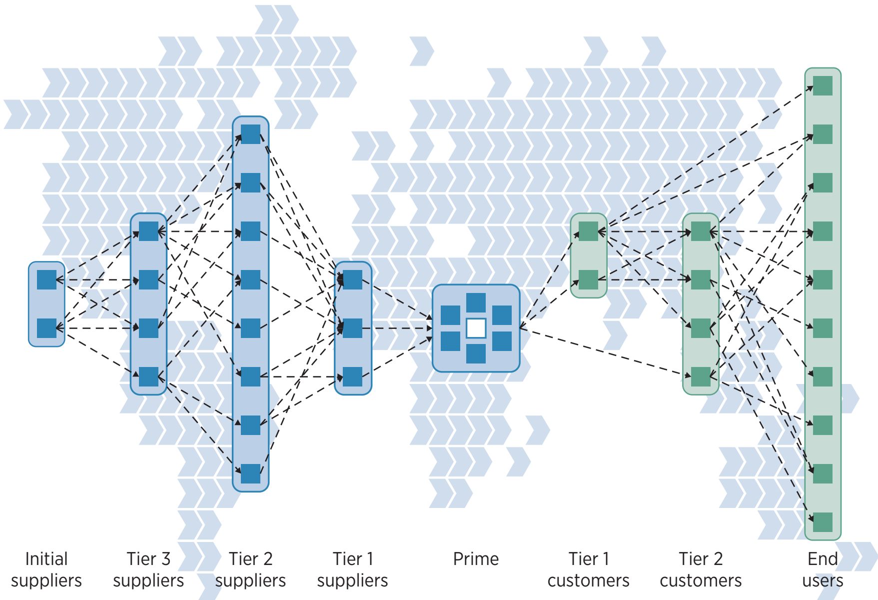
> **"The study has enabled Huawei to articulate its global supply chain strategy for wireless products for the first time, with a detailed capability assessment activity setting out development and implementation opportunities. The detailed analysis is now available for the company to exploit as it supports the move to 4G as well as for geographic growth opportunities around the world. There has been considerable transfer of know-how, leaving the Huawei team able to conduct future studies across different product groups."**
>
> *Senior Specialist, Supply Strategy Planning and Senior Engineer NPI Business Steering, Huawei*

Configuring the end-to-end supply chain

Configuring supply chains is particularly challenging when it involves a range of geographically dispersed partners whose roles and responsibilities need to be aligned. Furthermore, research suggests that the product architecture itself – aspects such as level of product modularity and degree of standardisation – is often a determining factor in supply network design. Methodologies for visualising and reconfiguring such globally dispersed supply networks are required to support this complex design task.

CIM research has developed a structured approach for visualising and reconfiguring complex end-to-end supply chains. The approach facilitates deeper understanding of the nature and dynamics of global supply networks at both the big picture 'globally dispersed network' and the more detailed 'operational' level. This stimulates meaningful dialogue on potential opportunities for improvement. The approach consists of four mapping tools.

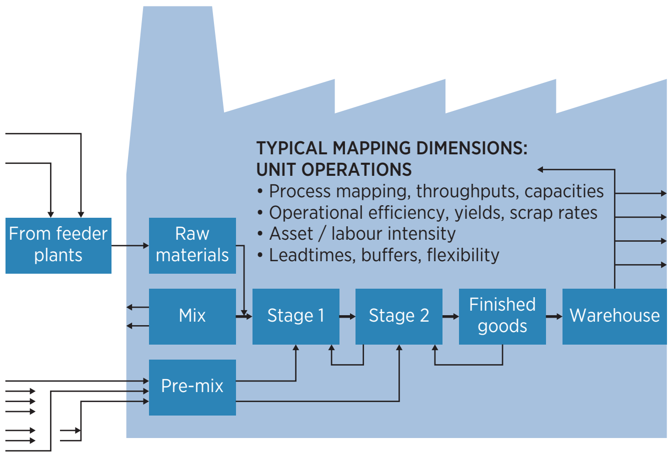
1. Total Supply Network Structure
The Total Supply Network Structure mapping approach (see graphic below) describes the tier structure and interrelationships of the entire supply system. It uses a visualisation approach to carry out meaningful analysis of the total network, and captures key macro-level data such as sales volumes, geographic dispersion, cost allocations and lead times. The approach typically involves nested maps showing the total network in overview as well as sub-networks in more detail.



TYPICAL MAPPING DIMENSIONS:
NETWORK STRUCTURE
- Geographic and sector volume analysis
- Key players, role, scale
- Cost structure
- Supply network shape A/T/V/X
- Inventory days of supply
- Cash-to-cash cycle time
- Service levels

Supply network structure map

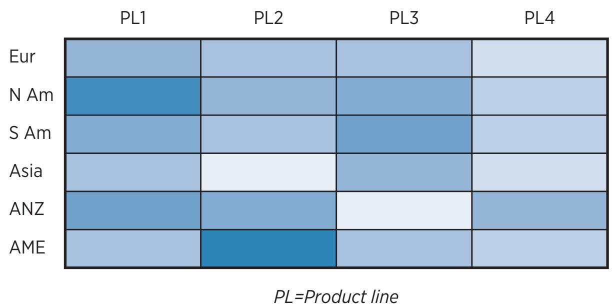
2. Unit Operations
The Unit Operations mapping approach (see right) analyses the structure of the major operational units in the product replenishment system using the same datasets one level down. This mapping at multiple levels – total network, sub-network and unit operations – involves standardised approaches that help to uncover reconfiguration opportunities and potential flaws in the current network design, and provides a practical balance of top-down and bottom-up stress testing of the end-to-end configuration.

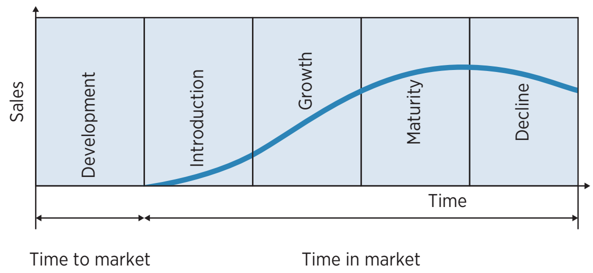


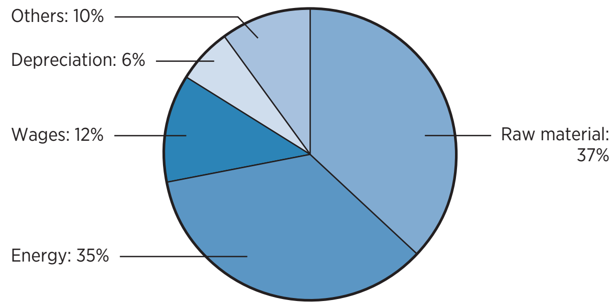
Focal firm production site

3. Product Value Structure

The third mapping approach – Product Value Structure – covers the key aspects and dynamics of the products in question. This is important as the nature of the product architecture and product portfolio often directly influences the ideal supply chain structure. For example, introducing product standardisation or modularisation will result in totally different supply chain configurations. It is also important to understand how characteristics such as product mix, innovation rates and product costs relate to the supply chain structure.





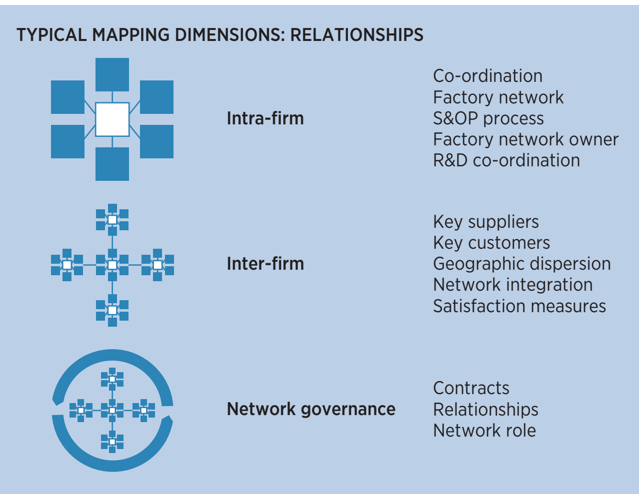


TYPICAL MAPPING DIMENSIONS: PRODUCT STRUCTURE
- Product modularity / platform structure
- Shape of product structure A / T / V / X
- Product mix by product line/geography
- Product lifecycle / innovation churn
- Offering: product only, product/service, mainly service
- Forecasting accuracy and planning horizon
- Fulfilment process and lead time
- Product value intensity vs. transport cost
- Supply chain cost / sales price

Product value maps

4. Supply Network Relationships

The final mapping approach – Supply Network Relationships – explores the roles and relationships between the key partners involved in the network. This 'softer' side of the configuration toolset is crucial in understanding how modern, fragmented supply networks integrate and operate. This includes relationships within the firm (often involving complex matrix organisations) as well as between different firms, and characterises the overall governance model of the network.



Supply network relationship mapping

The process

The end-to-end configuration methodology involves a mix of selective data mapping, stakeholder interviews and management workshops driving an analytical and creative process. The maps can then be assessed objectively as to how well they support strategic aims. This helps to reveal opportunities for redesign at both macro and micro levels that directly support improved performance by addressing the structural issues in the supply network. With over 35 examples within and across different sectors, the maps present a rich source of in-depth sector and archetype configuration models which highlight integration points, potential clustering/decoupling opportunities, network vulnerabilities and resilience.

Example

The end-to-end configuration approach was applied in a leading beverage company in 2005. This led to a redesign at a number of levels. The inbound supply network was consolidated to form a smaller number of strategic supply partners arranged in clusters. This was done by increasing the modularity of the product design and by rationalising the product mix. This was carried out alongside a refocusing of factory roles in the network and rationalisation of the regional distribution structure. The major benefit of this approach was the co-ordinated reconfiguration of the supply network when previously the supply network structure, replenishment model, supply chain governance and product mix/design had developed in isolation from each other as independent continuous-improvement activities.

Developing end-to-end capabilities

Creating advanced capabilities that span all activities and all players is critical in reconfiguring these increasingly complex networks. CIM has developed a framework for assessing current and desired end-to-end capabilities which also establishes a powerful language for engaging cross-functional teams in strategic development. This process often uncovers hidden capability strengths that have evolved over many years, as well as gaps that need urgent attention.

End-to-end capability assessment

The CIM approach looks at a company's existing and desired capabilities and uses the results to underpin a strategic development plan. As illustrated in the table opposite, this model identifies 21 capabilities in five categories. It is important to note that these definitions go beyond the traditional core competences that individual firms might pursue and relate more to the key business processes and organisational routines that need to operate across firms in the supply network.

1. **Network strategic design** relates to how the overall network is configured in line with a firm's strategic aims. This poses fundamental challenges that often inspire management teams to think outside their normal field of vision. These can include:
   - How can we show leadership to improve the collaborative dynamic across the network?
   - How can we maximise value creation and capture within the network?
   - How can we design the network for reduced risk of disruption?

2. **Network connectivity** considers the different aspects of connectivity across the network: with suppliers, with customers and internally within the firm. This section also tests the level of transparency of the network in terms of ability to monitor end-to-end operations and pre-empt problems.

3. **Total network efficiency** considers efficiency in terms of timeliness, cost and quality across the end-to-end supply chain – not just within the firm.

4. **Network processes development** deals with the creation of integrated business processes in the areas of manufacturing, logistics and supplier development.

5. **Product and service enhancement** considers the network's capability to create new product/service features, new process technologies and new business opportunities.

The process

Applying the toolkit involves cross-functional workshops where the model drives assessment of 'existing' and 'desired' capability maturity. A typical output is shown in the radar chart on the next page.

One surprising benefit of assessing existing capability is that this often uncovers key strengths that have not been explicitly recognised. Another observation arising from the research is that it is not important to be world-class in everything – it is better to focus attention on specific capability sets that link directly with strategic positioning. The difference between existing and desired capabilities drives prioritisation of major strategic thrusts. However, this is not a quick fix: closing typical capability gaps requires several years of determined action. Perhaps most revealing are the complex interrelationships between network configuration and network capability. Case studies suggest a range of archetype supply models that align specific capability sets with particular configuration models.

> **"Our work with IfM has resulted in innovative strategy tools – linked to original research – that have been embedded as part of our on-going strategic processes. These are helping to guide significant investments (~£0.25bn) in our supply chain that will generate tangible business value over the life of the investments (>£0.75bn), and which will contribute to competitive differentiation."**
>
> *Director of Corporate Planning, Rolls-Royce*

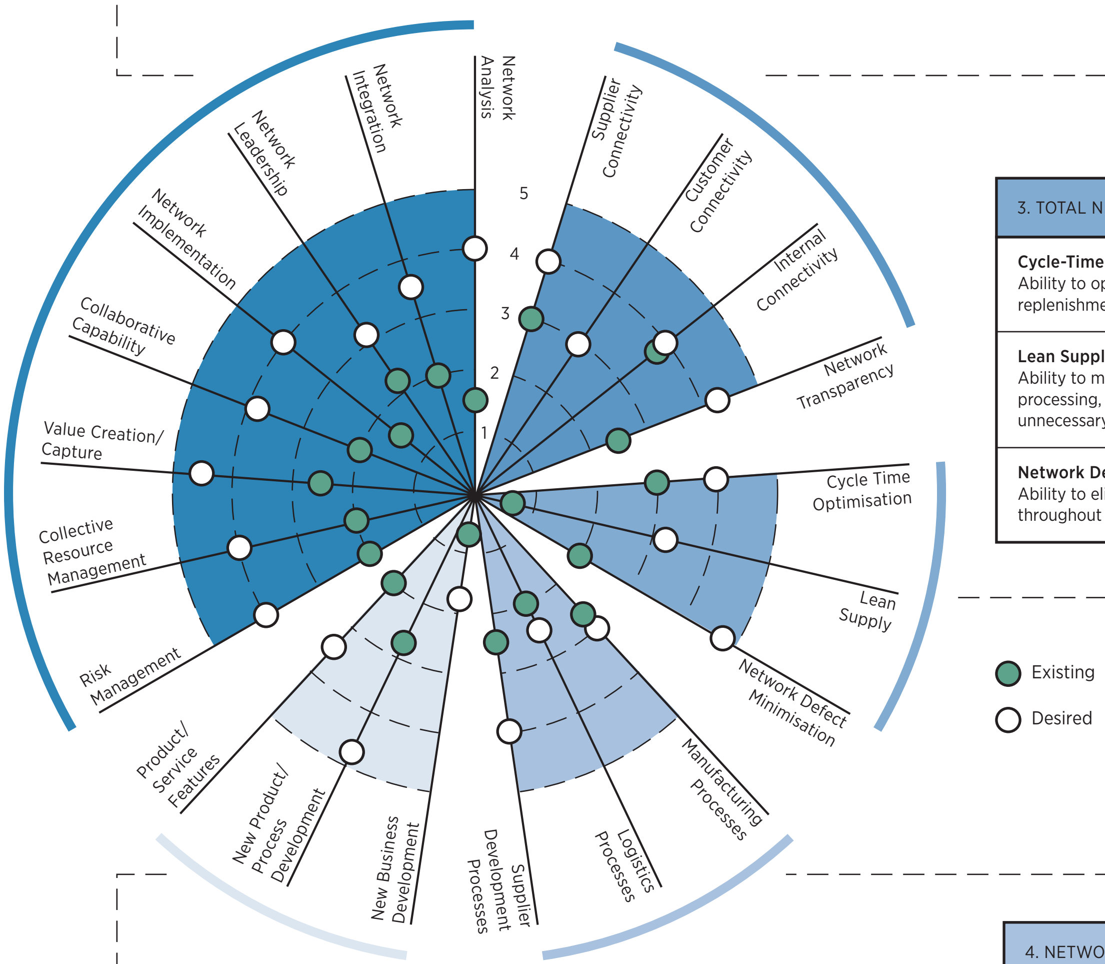
> **"We highly value our work with the IfM in contributing inspiring thinking to help us constantly step up in our approach to optimising end-to-end operations."**
>
> *Chief Operating Officer, The LEGO Group*

1. NETWORK STRATEGIC DESIGN

Network Analysis Ability to analyse & redesign the total supply network to fit strategic aims	**Collaborative Capability** Ability to collaborate with current and potential partners
Network Integration Ability to integrate critical network partners at the network design level	**Value Creation / Capture** Ability to maximise value in the network and hold / retain value created
Network Leadership Ability to lead the network & facilitate improvement programmes between players	**Collective Resource Management** Ability to optimise the collective resources of all partners
Network Implementation Ability to implement network optimisation on a continuous basis	**Risk Management** Ability to manage the trade-offs between supply security, quality & cost for minimum risk

2. NETWORK CONNECTIVITY

Supplier Connectivity Ability to engage & interact with suppliers to improve quality, cost & service
Customer Connectivity Ability to engage, interact & integrate with customers to improve efficiency & service
Internal Connectivity Ability to engage, interact, & integrate within the firm to improve efficiency & service
Network Transparency Ability to visualise & optimise network operations on a continuous basis



3. TOTAL NETWORK EFFICIENCY

Cycle-Time Optimisation Ability to optimise product replenishment time
Lean Supply Ability to minimise waste (materials, processing, energy), inventory & unnecessary movement
Network Defect Minimisation Ability to eliminate quality defects throughout the network

4. NETWORK PROCESSES DEVELOPMENT

Manufacturing Processes Ability to integrate standard routines in core manufacturing processes
Logistics Processes Ability to integrate standard routines in core transport & logistics processes
Supplier Processes Ability to integrate standard routines in core supplier processes

5. PRODUCT & SERVICE ENHANCEMENT

Product & Service Features Ability to create new product features, functionality and product service ability
New Product Development Ability to create new product and process technologies, optimising product-process lifecycles
New Business Development Ability to utilise own and network capabilities to create new business opportunities

Example application of the capability assessment toolkit

‘Meta-capabilities’ and competitive advantage

Better configuration and mature capabilities in end-to-end supply chains can help firms forge ahead of competitors but the advantage can be short-lived. This is because individual configuration aspects and generic capabilities are relatively easy to copy. It is the unique clusters of individual capabilities combined with innovative configuration elements – or ‘meta-capabilities’ – that create sustainable differentiation.

What are meta-capabilities?

The concept of differentiating meta-capabilities and developing practical ways to apply them introduces a novel approach to supply chain design and is the subject of ongoing research. Almost by definition, the process to define these distinctive combinations of end-to-end capabilities and configuration is difficult to codify – otherwise all firms would be able to do it. CIM has developed a structured, logical sequence of steps, while recognising that a high degree of creativity and expert judgement are also an integral part of the process. Its success depends, therefore, on the cross-functional engagement of senior managers throughout the company.

The meta-capability definition process is illustrated below. It involves aligning business strategy with possible supply network configuration models and network capability through three straightforward steps:

- identifying existing meta-capabilities
- identifying desired meta-capabilities
- defining the strategic plan that closes the gap.

The first step is often ignored in strategy development as it is largely focused on the past. However, this is an essential step in gaining understanding and acceptance of the concept of meta-capability and in raising awareness of the complex interactions between individual capabilities and configuration aspects that underpin existing strengths. The graphical display of ‘gap’ versus ‘existing capability’ helps to inform this discussion by categorising individual capabilities as: non-core, current deficiencies, mature strengths and emerging strengths. The visual display then supports clustering of the capabilities in or around the ‘mature strengths’ quadrant by linking with aspects of current strategic differentiation.

The second step follows a similar process but the graphical display here represents ‘gap’ versus ‘desired capability’. This drives a different discussion around the future strategic vision with the quadrants describing different options (fix, maintain and step up). The desired meta-capability clustering process then puts the focus on the ‘step up’ quadrant. Importantly, it also considers the ‘maintain’ quadrant. These more mature capabilities are often taken for granted but they can provide a foundation for desired meta-capabilities and should be purposefully maintained.

The final step in the process follows a conventional gap analysis to understand the key strategic actions required to create the desired meta-capabilities. This also serves to integrate enabling configuration developments.

Benefits of the meta-capability approach

The meta-capability approach explores how individual capabilities and configuration aspects of end-to-end supply chains can be linked in complex ways that are highly distinctive and difficult to emulate. Applying this approach fits with mid- to long-term strategic planning and leads to tangible outcomes in terms of major strategic thrusts. The additional (and often the most important) benefit is the improved understanding embedded in a senior cross-functional team regarding the complex dynamics that can underpin sustainable supply chain differentiation.

Assessing existing and desired meta-capabilities

APPLICATION CASE STUDY:

Premium consumer goods

Project aims

This project, conducted by IfM ECS in 2012, involved a leading premium consumer goods company and the aim was to inspire breakthrough thinking regarding its approach to end-to-end supply chain strategy. The company already enjoyed a leading market position over its competitors, supported by a markedly different end-to-end supply chain approach. Despite this success, the senior management was concerned that the supply chain aspects that underpinned recent success were poorly understood. With the company now entering an aggressive global expansion phase, it was imperative that existing meta-capabilities were made explicit, and that these were purposefully enhanced as part of the future plan.

Nature of collaboration

The collaboration lasted 12 months and involved a senior cross-functional client team working closely with CIM and IfM ECS's team of researchers and practitioners through a series of workshops and analysis steps. The project was structured around the toolkit of end-to-end configuration and capability as described above, culminating in a highly creative set of workshops to define existing and desired meta-capabilities. The final step of the project involved interactive presentation of the recommendations to the annual strategy review involving the company's 25 most senior executives.

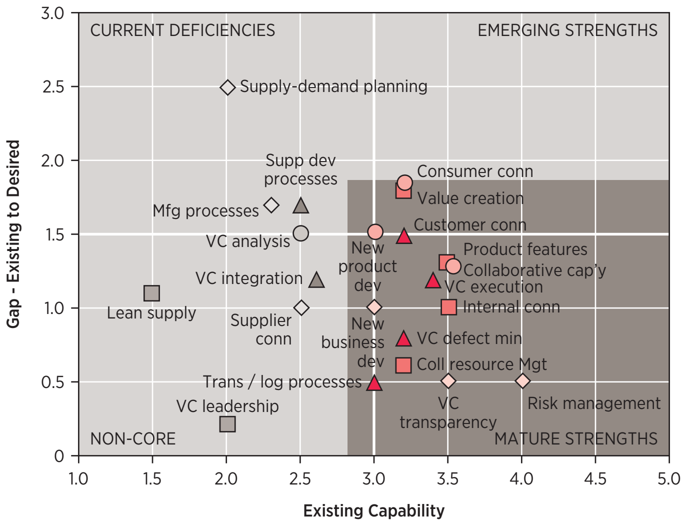
Results

The project results, illustrated below, have been adjusted and generalised to avoid disclosure of sensitive materials. The chart on the left is the result of the end-to-end capability assessment showing 'gap' versus 'existing capability'. This shows the existing capability distribution across the four explanatory quadrants, and the clustering of items in and around the 'mature strengths' to help explain existing meta-capabilities. The existing meta-capabilities are described on the right-hand side in terms of how they have enabled the recent industry-leading performance. A similar output was developed for the desired meta-capabilities (not shown here), which was used to prioritise a set of strategic thrusts.

Benefits

This project challenged the company's senior team to consider end-to-end supply chain development in a radically different way. This helped to develop a set of strategic action plans that went beyond incremental improvements to encompass fundamental changes in terms of: how they should approach innovation end-to-end; how they need to collaborate with network partners; how they must respond to disruptive changes in distribution channels; and how they need carefully to guide expansion of the globalising supply chain.

The company has recently announced another year of record growth and profits.



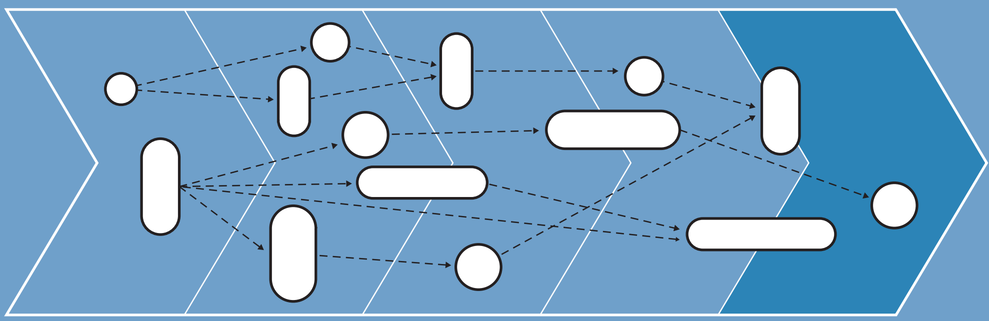
Four meta-capabilities based on clusters of capability strengths:

- TOTAL QUALITY END-TO-END
  Underpins zero defect capability via end-to-end transparency and partner collaboration
- LATE CUSTOMISATION
  Underpins late customisation through product design philosophy and flexible production technology
- BEST PRODUCTS
  Underpins demonstrated excellence in new product introduction driven by customer intimacy
- RESILIENT SUPPLY CHAIN
  Has enabled the development of a risk-mitigated, globally integrated supply chain

Clustering capability strengths to form distinctive meta-capabilities

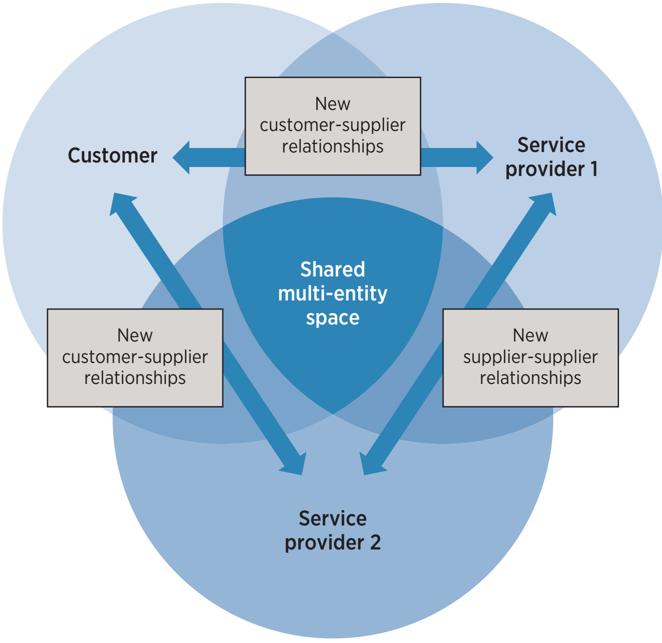
1.3 DEVELOPING SERVICE SUPPLY NETWORKS

Tomás Harrington, Jagjit Singh Srai and Paul Christodoulou



In recent years, many global manufacturers have added a service dimension to their business model and thereby introduced new challenges for network design. These product-service supply networks often involve multiple 'primes' that need to be highly integrated to enable effective product-service delivery. In some cases, product-service activities may take place on a single customer site, which will require a shared 'concept of operations' to be established for the participating organisations. In many cases, service delivery is needed at the point-of-use, which can mean multiple, geographically dispersed locations all requiring differentiated location roles for lead sites and local support operations. New strategic approaches are needed to help configure and integrate these extended product-service networks.

- Configuring the service supply network
- Integrating a multi-organisational service network
- Service location roles
- *Application case study: aerospace and defence*



Multi-organisational service network

Why the shift to product-service systems?

From the equipment manufacturer's perspective, the move to product-service systems presents opportunities for growing revenues and enhancing competitive differentiation. For customers, 'servitisation' means a greater emphasis on 'service outcomes' rather than product/spares acquisition and maintenance. CIM research has focused on the design of service supply networks where the design-build-service activity requires the close integration of multiple organisations/primes, and where firms have moved from a complex product (equipment/spares) supply model to outcome-based service delivery. (This research aligns with the work of the Cambridge Service Alliance which is based at the IfM and looks at servitisation more broadly.)

Service supply network design

The graphic shown above illustrates the central challenge in which the servitising firm needs to develop new supplier-supplier, as well as new customer-supplier, relationships within a new 'shared multi-entity space'. This problem brings particularly high risk and exposure where supply partners are working directly with end customers, often co-located at the customer's site. CIM's methodology extends supply chain network design and network integration approaches to tackle the specific challenges of the multi-entity, product-service environment. Where these activities are also co-located at a customer site, CIM has developed the Concept of Operations (ConOps) approach from which a single set of governance rules can emerge to support the integration of multi-partner processes.

CIM's approach to service supply network design is based around three methodologies:

1. **Configuring the service supply network** involves the strategic design of integrated product-service supply networks.

2. **Integrating a multi-organisational service network** identifies the cross-network business processes that are critical for enhanced performance of the network, and defines the key enablers for integrating these critical 'touch-point' processes.

3. **Service location roles** defines how firms might differentiate particular locations/sites within their network in order to meet the specific challenges of product-service delivery within a multi-entity context.

The three approaches are described in more detail in the following sub-sections.

> **"The network design tools developed by the Centre for International Manufacturing provide a structured approach to develop industrial capability, and help guide the proactive reconfiguration of the network to shape future engineering and industrial capability across the design-build-service-support operation. We have used these methods and supporting tools to help design and down-select options for our Engineering operating framework."**
>
> *Engineering Director, Systems and Strategy, BAE Systems*

Configuring the service supply network

Existing approaches for the design and operation of service supply networks are largely product-oriented and pay little attention to the customer-involving and relationship-based nature of services. A key area of CIM research has been extending theory on supply network configuration to fit the specific challenges of multi-partner service delivery.

STRUCTURE	Dispersion	Company-wide / enterprise centres	Enterprise centres for key activities	Project specific / group centres	Line of business (LOB) centres	Individual site centres
	Interdependence	Interdependent across company / enterprise	Interdependent across enterprise on key activities	Interdependent within projects / groups	Interdependent within LOB	Interdependent centres
NETWORK DYNAMICS	Standardisation	Common processes enterprise-wide	Mandated processes for key activities across enterprise	Common processes within projects / groups	Tailored processes for individual sites	Ad-hoc practices
GOVERNANCE & COORDINATION	Commercial control	Company-wide / enterprise level control	Project specific / group control with central influence	Project specific / group control	LOB control	Distributed individual site control
	Engineering control	Company-wide / enterprise-level control	Project specific / group control with central influence	Project specific / group control	LOB control	Distributed individual site control
SUPPORT INFRASTRUCTURE	Engineering systems	Common systems across enterprise	Common basic systems across enterprises	Common systems within projects / groups	Customised systems for individual site needs	Isolated individual site systems
	Engineering resources	Enterprise-wide resource management	Enterprise management of key resources	Project specific / group resource management	Resource management within LOB	Individual site resource management
	Culture	Common culture across enterprise	Common orientation for key activities across enterprise	Project specific / group cultures	LOB cultures	Individual site cultures
RELATIONSHIPS	Partnership - supplier	Strategic partnership across enterprise	Strategic partnerships on key activities across enterprise	Project specific / group partnership	LOB partnership	Transactional relationship
	Partnership - customer	Strategic partnership across enterprise	Strategic partnerships on key activities across enterprise	Project specific / group partnership	LOB partnership	Contractual relationship

Existing Desired

Network configuration – understanding 'existing', and designing 'desired' states

Overview

The approach uses the end-to-end supply network configuration model and extends its application to the design of integrated 'product-service' networks. The model, illustrated above, is used to: a) assess the existing configuration and understand its strengths and weaknesses; and b) to design the desired configuration to align with future business strategy. The 'swim lanes' running down the rows characterise the 'existing' and 'desired' configurations of the service network in terms of the relevant design options.

Service network configuration dimensions

The five major dimensions of network configuration include:

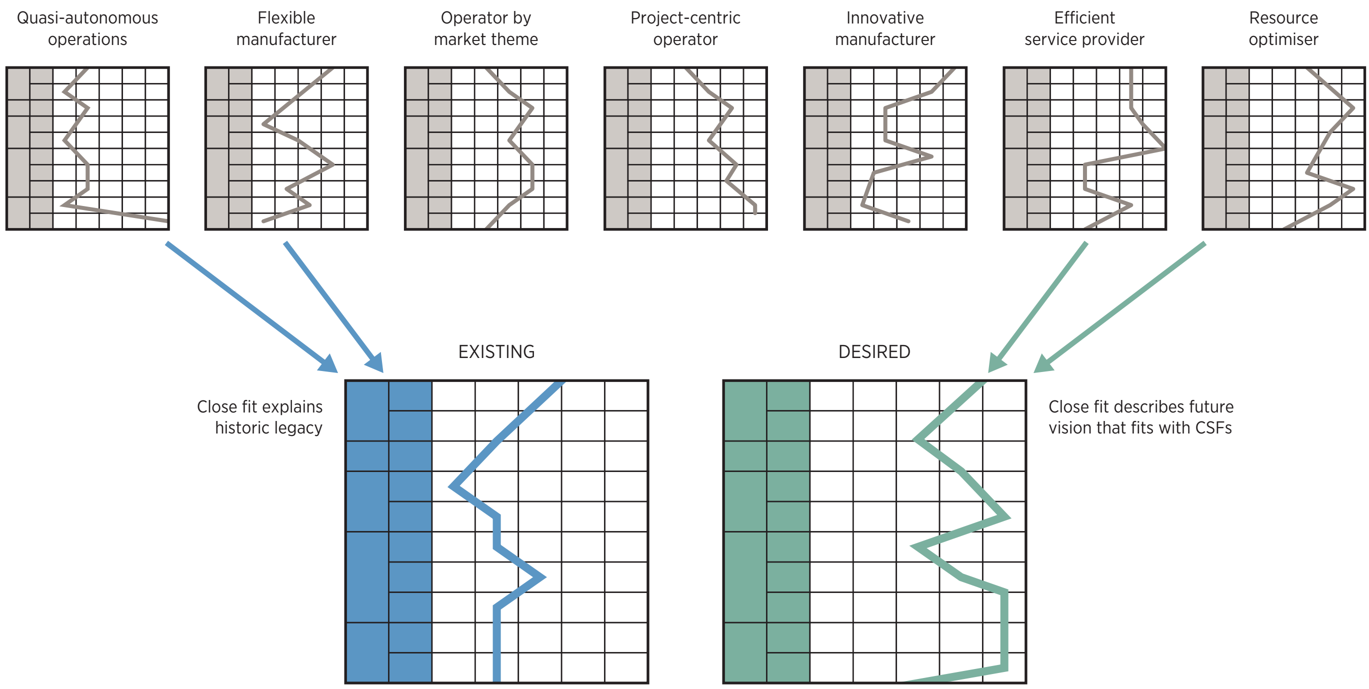
- **Structure** – to characterise the geographical footprint of a network (e.g. exploring sub-elements of dispersion and interdependence)
- **Network dynamics** – to characterise the supply processes adopted by network members (e.g. exploring the sub-element of replenishment and modularity)
- **Governance and coordination** – to characterise the governance system and coordination mechanism of a network (e.g. exploring sub-elements of commercial and engineering control)
- **Support infrastructure** – to characterise support infrastructures of a network, such as IT systems (e.g. exploring sub-elements of engineering systems and infrastructural resources)
- **Relationships** – to describe the linkage between network members including customers, suppliers and users (e.g. exploring the sub-element of partnerships).

Developing configuration options

Applying the service network configuration approach typically involves management workshops where the model is used to understand existing, and design the desired, configurations. This structured process helps to stimulate discussion and insights regarding associated trade-offs, issues and risks. A series of critical success factors (CSFs) for the network under investigation is typically established before the workshop in order to objectively assess configuration options regarding their alignment with the firm's business strategy.

One important step in the process involves comparing the existing and desired configurations with a range of network 'archetypes' that have been derived from the academic literature. This helps to support deeper understanding of the 'existing' configuration and how it has evolved, and helps generate 'desired' options where elements of different archetypes can inform the particular strategic intent of the organisation in question.

The process illustrated below shows the existing and desired configurations, how they link with the archetypes, and their alignment with the CSFs. There are a number of archetypes that have been identified, namely Innovative Manufacturer, Flexible Manufacturer, Efficient Service Provider, Resource Optimiser, Quasi-Autonomous Operations, Operator by Market Theme, and Project-Centric Operator. As seen in this example, the existing configuration (which is similar to that of Flexible Manufacturer and Quasi-Autonomous Operations) is considered a poor fit with the CSFs of the organisation. However, the desired configuration (which is a hybrid of Efficient Service Provider and Resource Optimiser) has a better fit with the CSFs. The final step in the process involves refinement of the desired configuration and the development of strategic plans for implementation.



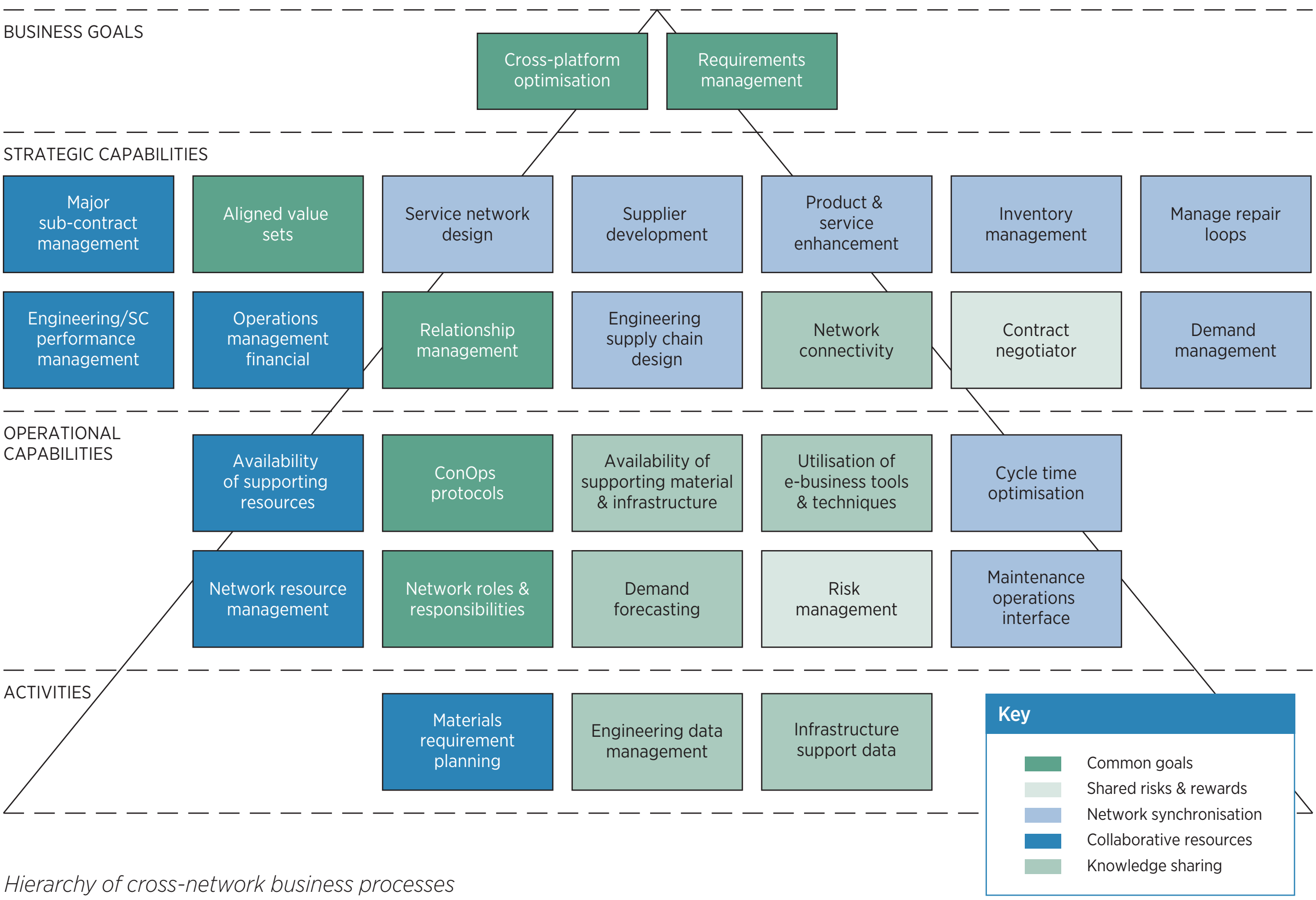
Comparing existing and desired configurations with theoretical archetypes

Integrating a multi-organisational service network

Despite the inherent complexity in multi-organisational networks, integration challenges can be narrowed down to the key processes or 'linkages' between partners. The next challenge in the design of service supply networks is to integrate the business processes that need to work across the network. The approach helps to define the important cross-network business processes, and identifies the key enablers for integration.

Overview

The methodology involves two key stages. The first stage identifies the processes or 'touch points' that are key to integration across multi-organisational service networks within a structured hierarchy. The second stage develops a common set of network integration enablers – as identified from the academic literature – which can then be used to assess the processes key to network integration. The overall approach provides insights to the key business processes (and capabilities) that require integration and alignment within complex operating networks of customer groups, partner firms and suppliers, delivering services to end users.



Hierarchy of cross-network business processes

Process hierarchies

The process hierarchy model defines the cross-network business processes that require integration. In this case study (below), 29 processes were identified as key to network integration. The processes are classified hierarchically in the four layers, namely:

- Business Goals (e.g. cross-platform optimisation, requirements management)
- Strategic Capabilities (e.g. major sub-contract management, aligned value sets)
- Operational Capabilities (e.g. availability of supporting resources, ConOps protocols)
- Activities (e.g. materials requirements planning, engineering data management).

The model is typically used in team workshops to help explore and define the business processes that need to work across the partners involved in product-service delivery. The resulting framework then informs discussion regarding major strengths and weaknesses, and helps to prioritise areas for attention.

Network integration enablers

The second part of this methodology involves linking the prioritised business processes defined above with key enablers for integration. The framework developed for this is illustrated below and is structured around five categories of network integration enablers: common goals, shared risk and reward, network synchronisation, collaborative resources and knowledge sharing.

COMMON GOALS	SHARED RISK & REWARD	NETWORK SYNCHRONISATION	COLLABORATIVE RESOURCES	KNOWLEDGE SHARING
Shared goal & objectives • Common vision • Common language • Top management support	**Risk & benefit sharing** • Gain share mechanisms • Incentives alignment	**Synchronisation of operations** • Coordinated workflow • Synchronised planning	**Allocating & prioritising resources** • Shared resources • Resource flexibility	**Data sharing** • Information transparency • Data capture • Data quality
Relationship management • Trust • Role specificity • ConOps protocols	**Risk management** • Risk analysis • Contingency planning • Risk pooling	**Joint improvement plans** • Value stream mapping • Process integration	**Utilising collective manpower** • Team building • Continuity of staff engagement • Reduced resource duplication	**Interoperability** • Shared language • Knowledge transfer • Common tools
Shared decision making & control • Joint ownership of decisions • Collective responsibility for outcomes		**Responsiveness** • Agility • Customisation	**Utilising collaborative expertise** • Skill complementarity • Build collaborative capabilities • Shared learning	**Efficient IT systems** • Network connectivity • Real-time / timely data exchange • Efficient IT infrastructure

Network integration enablers for the prioritised business processes

Service location roles

The previous two sections have described approaches for configuring and integrating service supply networks. This section tackles the final challenge – that of defining the roles of the different network locations where the integrated product-service offering has to be delivered – typically involving multiple partners working closely with the end customer.

Overview

In advanced service networks, different locations need to focus on different roles covering specific activities required in delivering an integrated product-service offering. These roles are likely to vary 'through-life', from the initial identification of requirements to the end of a service contract. So as organisations servitise, locations may need to grow or adapt their service activities to serve future location-specific requirements and those of the overall service network. The approach developed to address this strategic design challenge adopts the concept of 'plant roles' used in production network design and extends it to the product-service context.

Developing service location roles

The first stage of the service location roles approach defines the different categories for the 'strategic role' of each location, covering options such as Lead, Source, Contributor, Server, Offshore and Outpost. This categorisation helps organisations understand their locations' current roles as well as desired 'future state' roles that align with strategic drivers. For the 'current state', an activity role matrix (illustrated below) is used to design the specific configuration of each role type. The example shown here is for a Server role in an engineering-driven product-service environment.

This matrix is structured around the CADMID (Concept, Assessment, Development, Manufacture, In-Service and Disposal) framework which is used in advanced product-service environments to represent the six key stages of the product-service lifecycle. Within this matrix, the model defines 76 'product-service' activities across the various functions within the location (New Platform, Enhancement, Service and Engineering Systems). This matrix is then used to define the activities that need to be carried out in each location role and at each stage of the CADMID cycle. A separate template is adapted to define each of the roles Lead, Source, Contributor, Server etc. For the Server role illustrated in the example below, 'green' shows the primary activities, 'blue' the support activities, and 'grey' are activities not required within this role definition. In this way, each location role is tailored to fit its unique strategic purpose, and defined in full detail in a way that ensures coherence of the network. One key benefit is that the differentiated roles ensure optimised performance via clear focus, while avoiding duplicated costs.

ENGINEERING ACTIVITIES	CONCEPT	ASSESSMENT	DEVELOPMENT	MANUFACTURE	IN-SERVICE	DISPOSAL
New platform / **Enhancement**	• New market opportunity (customer requirement) capture & analysis • Emerging technologies exploration & exploitation • New solution idea generation, & features definition • Solution improvement concept • Solution service & support concept development • Option selection against customer requirement	• Partner/supplier assessment • Design for open architecture and through life • Rapid prototyping and demonstration • Risk assessment • Manufacturability assessment • Reliability assessment • Make/buy decision • Interface definition • Market & technical analysis • Business & financial analysis and business case development	• Prototype development & demonstration • Detailed design & drawing • Pre-production demonstration • System integration • Validation, verification & acceptance • Organisation & system design • Risk mitigation • Selection of equipment and services providers • Manufacturing process & facility design • Pilot manufacturing • Supportability verification • Plant maintenance planning	• Production trials • Qualification & acceptance testing • Product performance verification • Product de-bugging • Proving compliance with operation capability specification • Product introduction & ramp-up • Partner & supplier management • Continuous improvement • Product enhancement	• Support transfer into service • Operate failure analysis, engineering change, reliability and reliability improvement processes • Managing partners and suppliers • Continuous improvement of maintenance techniques • Documenting and implementing product specification changes • Service and support concept adjustment • Product components obsolescence and upgrade • Support planning and coordination with customer • Support on customer locations	• Hazardous material management • High value material management • Archiving documentary evidence against legislation • Recovering security or IP sensitive materials • Refit for resale • Recycle
Service			• Support solution design • Support facility design/selection • Partner & supplier selection • Training solution development	• Network and facility reconfiguration for in-service support • Issuing technical instructions & repair schemes		
Engineering systems	• Engineering strategy development • Engineering standards • Contracting and approvals, terms and conditions • Learning and development • Product safety • Resources, recruitment and retention		• Research and technologies • Tool sets and support people who need to use them • Best practice identification and transfer • Processes, including documentation and lifecycle management • Project management		• Estimating • Knowledge management • Performance measurement • Capability and maturity management • Legislation and environment adherence • Configuration management	

Primary activities Secondary activities Not required

Activity set for 'Server' location role

APPLICATION CASE STUDY:

Aerospace and defence

Project background

This project involved a global leader in aerospace and defence systems that needed to transform its business model from a traditional design-build product orientation to embrace full lifecycle support of its products in the field. The context was particularly challenging with stringent zero-failure performance requirements and growing political pressures for cost reduction. The expectation was that a radical change in organisation was required to support this transformation, involving collaborative sharing of resources with supply partners and clients, and the identification of new cross-business, multi-functional organisational entities.

Nature of collaboration

The collaboration lasted approximately 12 months and involved a senior cross-functional team engaging in a series of workshops and analysis steps. The project used the three approaches described earlier in this section as follows: **Configuring the service supply networks** – the first phase defined the strategic intent for the business, leading to an aligned view of the desired high-level configuration of engineering and service networks needed to support the delivery of full lifecycle support. **Integrating the multi-organisational service network** – the second phase provided clarity on core and non-core 'activities' and 'capabilities', including mechanisms to manage partner operations, in a range of globally dispersed locations. **Service location roles** – the third phase of the project defined and assigned differentiated network location roles around a matrix of functional capability centres, cross-functional centres of excellence and cross-network leadership roles. The final step of the project involved a detailed report of the recommendations to a future strategy review committee.

Project outcome

The project outcome, illustrated below, has been adjusted and generalised to avoid disclosure of sensitive materials. This shows the summarised strategy for three sub-networks: A, B and C. For each sub-network, the current and desired future configurations have been generated and associated network location roles defined (e.g. A1, A2, A3) in terms of their role evolution at three five-yearly intervals. This graphical output proved a simple, powerful aid in synthesising and communicating the strategy.

Benefits

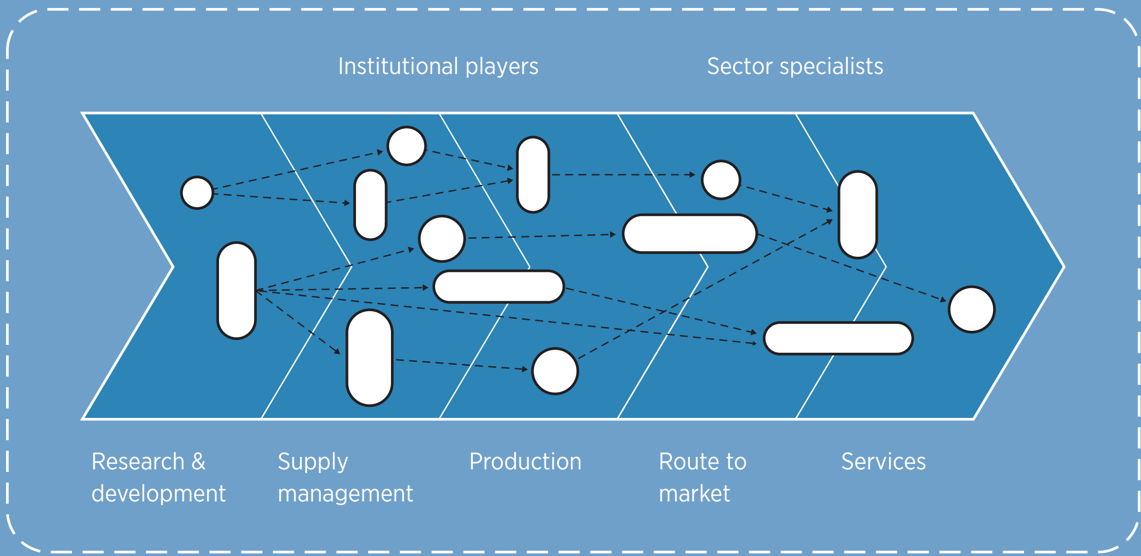
The company benefited from the development and articulation of a clear framework for guiding the transformation of a complex supply network to provide full lifecycle support. The development of a vision for the desired future configuration was a vital step which could be seen to align closely with the strategic aims. The definition of the essential business processes requiring cross-network integration was key to success in this multi-partner collaboration context. Finally, the allocation of clear roles for each location, linked by a coherent network philosophy, enabled organisational clarity, enhanced performance, and avoidance of duplicated overheads.

NETWORKS	CURRENT CONFIGURATION	FUTURE CONFIGURATION	NODE	LOCATION ROLE 2010	LOCATION ROLE 2015	LOCATION ROLE 2020
Network A	'Project-centric operator'	'Resource optimiser'	A1 A2 A3	Outpost Server Contributor	Outpost Server Contributor	Contributor Contributor Lead
Network B	'Innovative manufacturer'	'Flexible manufacturer'	B1 B2	Outpost Server	Contributor Server	Lead Contributor
Network C	'Innovative manufacturer'	'Efficient service provider'	C1 C2 C3	Outpost Server Server	Outpost Contributor Server	Contributor Lead Contributor

Evolution of network location roles

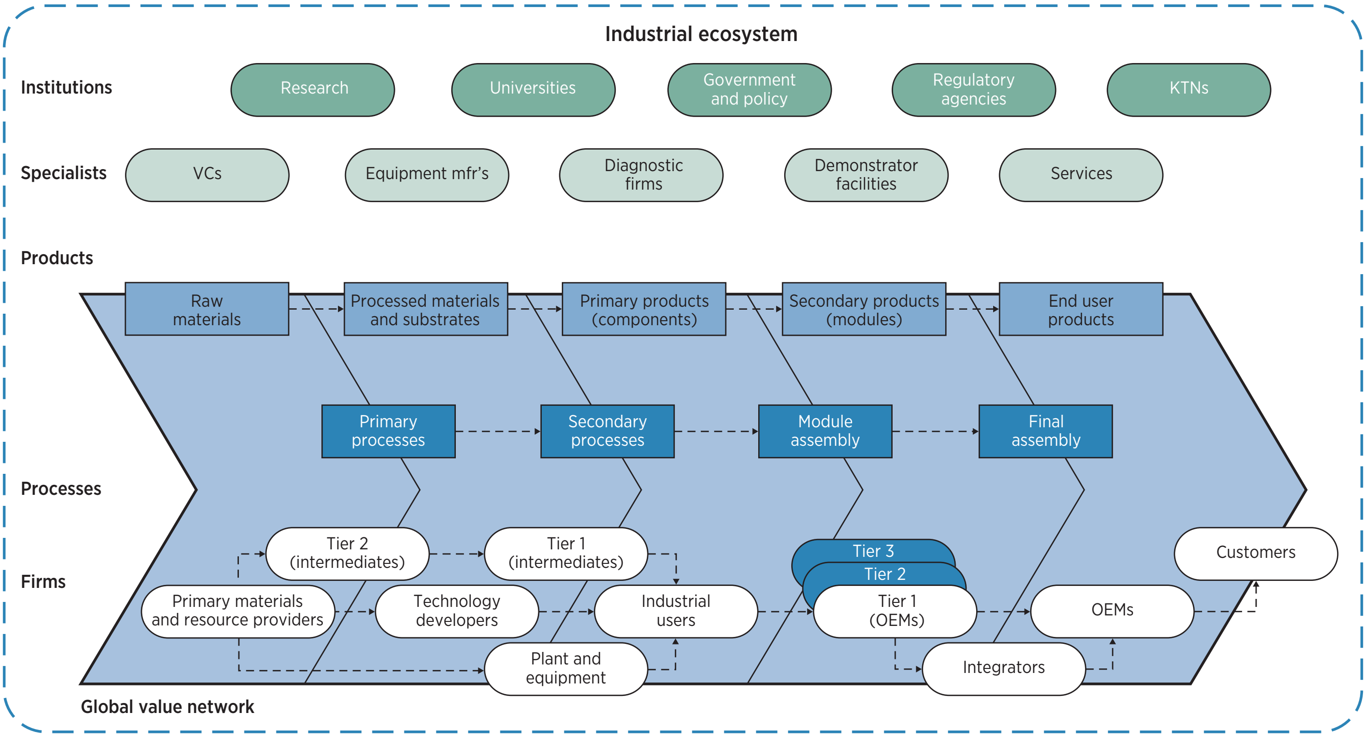
1.4 CONFIGURING GLOBAL VALUE NETWORKS WITHIN INDUSTRIAL ECOSYSTEMS

Jagjit Singh Srai, Paul Christodoulou and Tomás Harrington



The increasing complexity of global value networks has set new challenges for both the corporate strategist and the national (and regional) policymaker. The strategist now needs to guide the ongoing reconfiguration of these complex networks within the context of evolving industrial ecosystems, in order to maximise value for the firm's shareholders. The policymaker's interest lies in nurturing high value activities, often involving emerging technologies, to enhance national competitiveness. CIM research has developed new approaches that can help these separate but linked objectives.

- Designing global value networks
- Mapping industrial ecosystems
- *Application case study: automotive sector in NW England*
- Configuring global value networks
- *Application case study: photovoltaic industry*
- Integrating global value networks
- Reconfiguring UK pharmaceutical supply chains
- *Application case study: pharmaceutical industry*



Mapping industrial ecosystems

Background

Many industries have witnessed both the progressive 'disaggregation' of their value networks driven by specialisation and the geographic dispersion of key activities driven by globalisation. Previous research has provided rich narratives on these changes to industry structure but much of it has focused on efficiency-driven outsourcing and off-shoring trends, and not on the bigger picture of how to configure global value networks 'end-to-end'. Recent research at the Centre for International Manufacturing aims to address this gap. This has led to a more holistic view, including the identification of different patterns of specialisation and internationalisation, as firms seek to develop competitive positions across the value network while also seeking to integrate external capabilities and capture the benefits of location.

One key observation is that, in many sectors, the disruptive impacts of new technologies or novel business models have resulted in radically reconfigured value networks. Healthcare is a good example of an industry sector where remote diagnostics, ageing populations and new approaches to patient care have resulted in very different network configurations featuring increasingly distributed information flows and innovative revenue models.

Reflecting ever-changing network dynamics

There is a caveat to be added, however, to the notion that the dynamic nature of global value networks always leads to the dispersion and fragmentation of its activities. In some cases, technology changes may actually drive consolidation when new conversion processes require fewer steps or when co-location becomes beneficial. 'Re-shoring' or 'near-shoring' of activities may also become an attractive proposition when companies need to be more responsive to local customer needs or when technologies require more closely coupled activities. Near-shoring, for example, is already evident in the fashion garment industry.

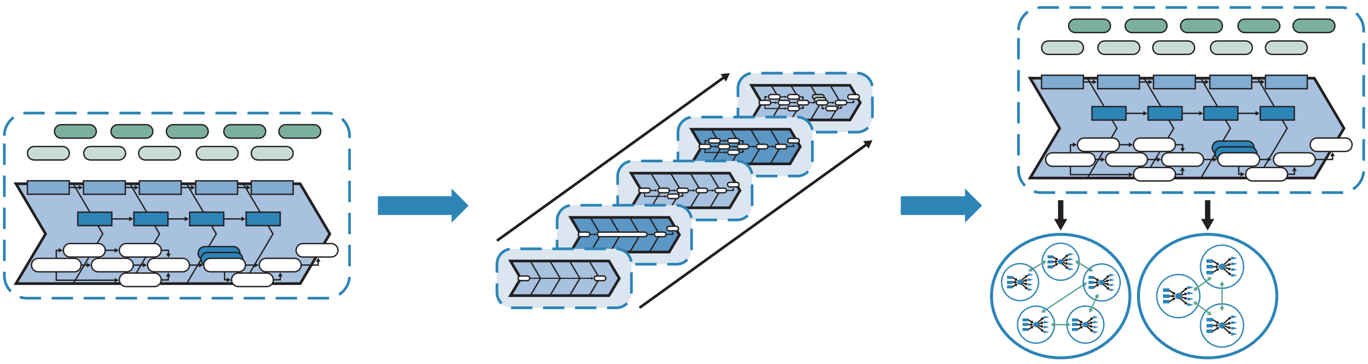
Understanding the complete industrial ecosystem

Research at CIM suggests that these changes require new approaches that not only consider the dynamics of the total value network but also the industrial ecosystem in which it operates. This broader ecosystem, as illustrated in the diagram above, includes not only the firms directly involved in creating valuable products and services but also a set of external stakeholders – institutional players and sector specialists – who have a strong interest and influence in ongoing reconfiguration. These stakeholders include investors, governmental institutions, research agencies and universities. Only by fully understanding this complete ecosystem is it possible to support the needs of the corporate strategist and the national policymaker in reconfiguring global value networks.

Understanding the structure of the industrial ecosystem, including all players and stakeholders, enables strategists to identify the key material, information and value flows between organisations. The mapping also needs to model the transformation of raw materials into final products, showing the sequence of conversion processes and their enabling technologies. One key consideration is to identify the degree of coupling required within and across these transformation processes, both from a knowledge perspective (such as, how tacit or codified is the knowledge?) and from a physical perspective (for example, to what extent do product value density and modularity limit or enable network configuration options?). Deeper understanding of these ecosystems also requires analysis of sector-specific factors such as new regulatory environments to which companies must adapt if they are to participate in disruptive technologies. Equally important can be the identification of critical sector-specific agencies and institutional players which support new technology adoption and provide support services.

Designing global value networks

CIM's approach to configuring global value networks comprises three related activities: mapping, design and integration. New mapping approaches are needed to capture inherent complexity. New approaches to global network design need to reflect the typical stages in network development and the typical trends that drive reconfiguration. And new approaches to network integration are required because fragmentation within the network often results in suboptimal performance.



Mapping **Configuring** **Integrating**

Three-part toolset for mapping, configuring and integrating global value networks

Mapping industrial ecosystems

A structured visualisation approach is used to capture the global value network and its external stakeholders in order to aid understanding of the entire industrial ecosystem. This typically focuses on a specific industry, in the context of new technology emergence or disruptive changes to an existing network. The approach supports a deeper awareness of the intrinsic nature of the ecosystem, including the key relationships and inter-dependencies between players and influencers, and the value flows between them. It also provides an important template for defining the ecosystem, which can be used to map existing and desired states in different scenarios and for cross-sector comparison.

Configuring global value networks

This methodology uses the mapping template (described above) as part of a structured approach to configuring global value networks to reflect different stages of development. Five archetypal development stages of the value network are included – nascent, emergent, mature, reconfigured and disrupted – to describe the various stages of global value network evolution from technology origination through to ongoing cycles of reconfiguration and disruptive change. The approach enables the development of different network scenarios to correspond with different governing trends and strategic horizons. This, in turn, supports the analysis of various intervention strategies leading to staged transition plans.

Integrating global value networks

This approach develops a deeper understanding of the drivers of, and interactions between, the main sub-systems that make up complex, multi-tier value networks. Global value network performance is often hindered when semi-independent sub-systems become disconnected, often as a consequence of changes in key drivers. This approach helps to reveal reconfiguration opportunities that support the re-integration of these sub-systems and enhanced performance for all players.

Typical applications

These approaches address a number of the challenges faced by the corporate strategist and the national policymaker. For the strategist, this can help to define how novel product, production and supply chain technologies can be used to transform value networks to deliver previously unattainable capabilities in terms of product variety, volume flexibility, cost and responsiveness. For leading primes or OEMs within these industrial systems, this can help to formulate intervention strategies to change industry dynamics and improve end-to-end capability and resilience. For the policymaker, this can define how institutional players might facilitate industry development, identifying research priorities and skills gaps. Collaborative use of this toolset by firms and governments is also important, particularly when disruptive technologies and supply network models might radically change current value networks. In this way, coordinated corporate strategy and national policy can identify the major opportunities for first mover-advantage in the race for global competitiveness. The three-part toolset is described in more detail in the following three subsections.

Mapping industrial ecosystems

Understanding the nature and dynamics of complex value networks, and the ecosystems within which they operate, provides the platform for designing future intervention strategies. This requires a structured, multi-layered mapping approach that aids visualisation and communication, and leads to a deeper awareness of key issues and opportunities.

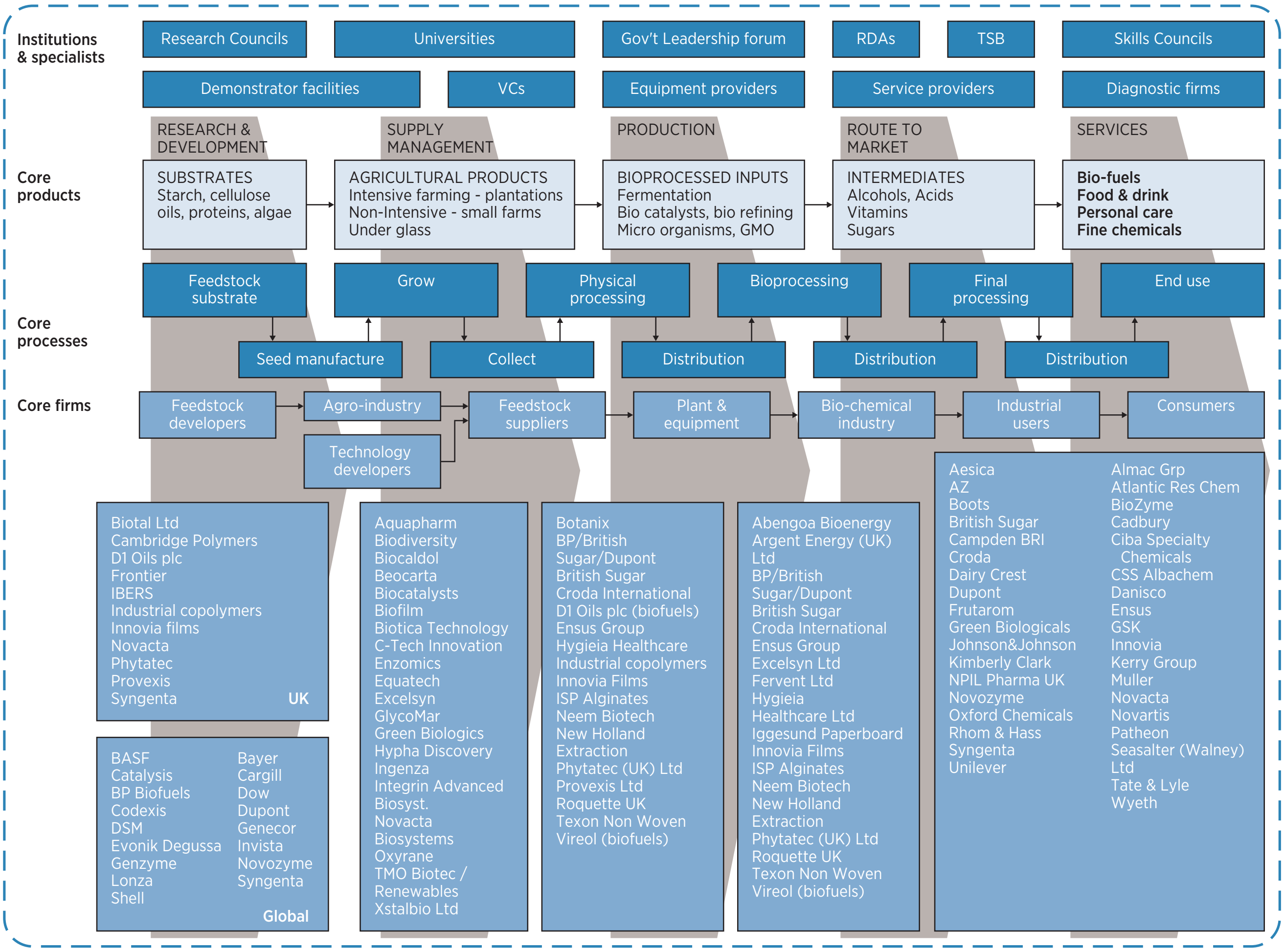
The generic mapping template

The industrial ecosystem mapping approach is illustrated below using a simplified version of a recent application in the UK biotechnology sector. This shows the generic layers that collectively build up a rich picture to aid visualisation and ongoing analysis. Working from the bottom up, the key layers – and their relevance – are described as follows:

Core Firms – this defines the complex network of principal firms directly involved in supplying products and services in a chosen industry sector, together with their interdependencies, value chain contribution and geographic location. This basic definition of the 'global value network' then allows capture of associated key data, such as flows of revenue, materials and information.

Core Products and Core Processes – these linked layers are included to add vital information required to help characterise the global value network in terms of the product structure and how this relates to the transformation processes and technologies. These layers are particularly important when disruptive product or process changes might radically alter network structures and dynamics.

Institutional Players and Sector Specialists – these two layers complete the ecosystem by identifying the external stakeholders who do not directly add value to products and services but who may play key enabling roles and have an interest and influence in industry development. These players are particularly relevant when they are providing finance, infrastructure, equipment or fundamental research that can affect the outcome.



Industrial ecosystem map from UK biotechnology study

Typical applications

The industrial ecosystem mapping tool has been applied in a range of sectors where disruptions to product or process technology, or fundamental changes to supply and business models, are leading to radically different value network models. In the case of emerging technologies (such as biotechnology or nanotechnology), the approach has helped to define embryonic value networks associated with new industries. In the case of disruptions to an existing supply network, the approach has helped to: identify key aspects such as the emergence of systems integrators; map industry consolidation or fragmentation; and define critical changes in supply capability, such as scale of supply, geographical reach, replenishment model, modularity and postponement. The mapping approach therefore becomes an essential prerequisite to considering global value network reconfiguration options.

For policymakers or industry consortia, the use of a standardised approach to industrial ecosystem mapping enables more effective comparisons between sectors. The approach has been used, for example, to explore how nascent, emergent and mature industry models differ in industrial biotechnology, photovoltaics, plastic electronics, specialist maritime, service aerospace and pharmaceuticals. The approach has also been used to capture the relative strengths of particular geographically bounded clusters by analysis of key OEMs, Tier 1 and Tier 2 suppliers, for example in the automotive sector in NW England (see case study opposite) and China's white goods sector.

The table below summarises the industry sector mapping studies undertaken using this approach, setting out the geographical scope, nature of the industrial innovations observed and the firm, institutional and country advantages that are being exploited.

Sector	Industry sector mapping – observations						
	Innovation patterns				Exploiting advantages		
	Process innovation	Product innovation	Business model innovation	Evolving industry structures	Firm specific advantages	Institutional specific advantages	Country specific advantages
Maritime – Norway							
Photovoltaics – global							
Industrial biotechnology – UK							
Built environment							
Automotive North-West – UK							
Last-mile logistics							
Defence/aerospace – UK							

Recent industry sector mapping studies

APPLICATION CASE STUDY:

Automotive sector in North West of England

Project aims

This sector study was commissioned by the Northwest Automotive Alliance (NAA) to help vehicle manufacturers in the North West of England, and their tier 1 suppliers, address some of the challenges facing the automotive sector in general, and this region in particular. The findings were used to inform a supply chain improvement and strategy development process for the region.

Approach

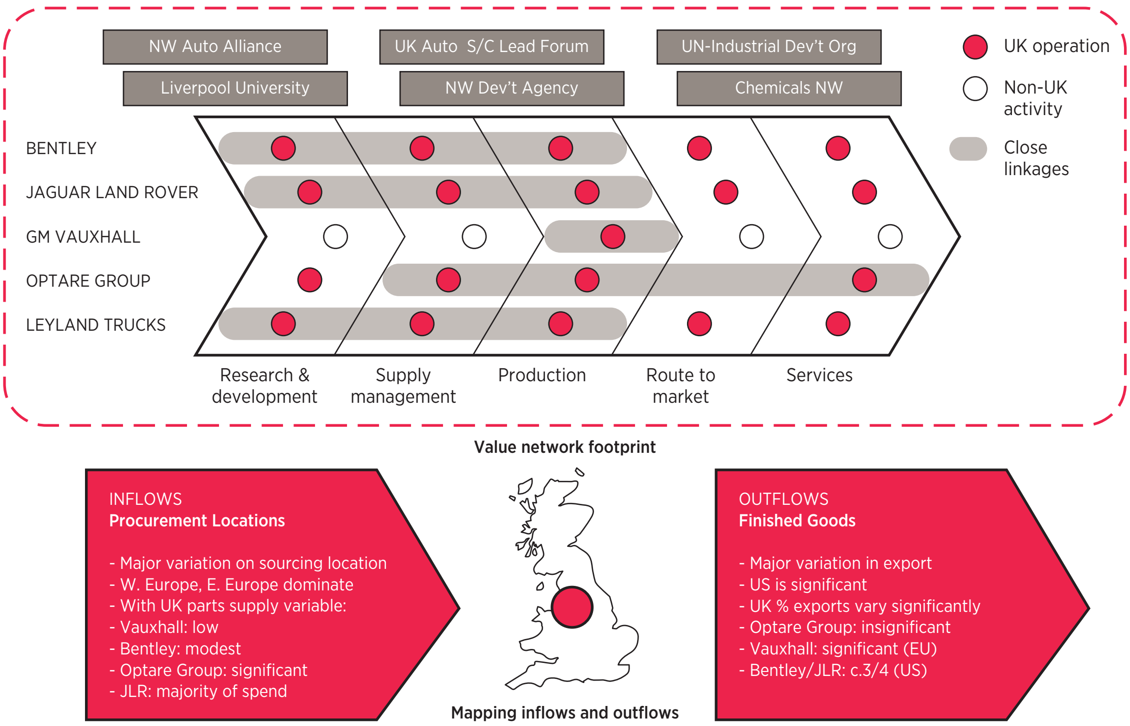
The industrial ecosystem mapping techniques included a review of the previous literature on network structure, workshops, interviews and site visits with all the main vehicle manufacturers and tier 1 suppliers in the region, and data collection and analysis. This approach led to a clear understanding of the firm and tier 1 supply chain and its challenges, the strengths and weaknesses of the sector as a whole and the strategic priorities to be addressed.

Key findings

The study highlighted a set of priorities resulting from: a changing strategic and technological context as key business and operational functions become ever more globally dispersed; the difficulties caused by tier 2 suppliers being located outside the region; the importance of tier 1 and 2 technology companies that are changing industry structures and capabilities; and a continuing reliance on international markets for growth. The mapping process also identified important gaps in value network capabilities, including a lack of regional innovation strategy, a need for tier 1s to improve their business processes and a major skills shortage at graduate engineer and senior technician level.

Recommendations

The report made a number of key recommendations, including that the automotive sector in this region would benefit from institutional support to mitigate the effects of economic downturn. It also recommended that the skills and activity gaps it had identified could be addressed by introducing a number of measures, such as: putting in place a supply chain capability development programme; developing new value networks specifically to target those market segments which have potential for high growth; and addressing sustainability issues by setting up projects to look at more efficient use of resources and the implications of climate change for the automotive sector.



Mapping the industrial ecosystem for the automotive sector in NW England

Configuring global value networks

Building on the industrial ecosystem mapping toolset, CIM has developed a structured approach to redesigning complex value networks. This approach has important applications for those who need to understand the impact of disruptive changes in technology on network structure and dynamics. It also helps to define how companies and countries can gain competitive advantage by proactively adapting to new industrial landscapes.

Linking global value network strategy with business, product and technology drivers

A range of strategy tools exists for formulating business, product and technology strategies. However, the challenge of configuring global value networks from an industrial network perspective is not so well supported. The aim of recent research at CIM has been to fill this gap by developing an approach that guides value network reconfiguration to align with business, product and technology drivers. This approach, focusing specifically on the industrial value network, is particularly relevant for designing new value networks where significant changes to the supply chain or business model are required to support new technologies (for example, the recent emergence of the photovoltaics industry) or when a new disruptive technology replaces an incumbent technology (for example, the advent of near-net-shape fabrication technologies).

In nascent and emerging industries, one of the key challenges for firms is that there is no predetermined strategy that they can adopt. The lack of certainty in the environment and about consumer needs forces them to experiment with global value network configuration. This process can be very time-consuming, may increase time to market and its inherently haphazard nature makes it difficult for firms to maintain their 'first-mover' advantage. CIM's methodology supports the exploration and evaluation of possible network configurations even at these early and chaotic stages of network evolution.

Methodology

The methodology is structured around distinct stages in the evolution of global value networks (as illustrated in the chart opposite). The diagram shows five archetypal stages of the value network evolution.

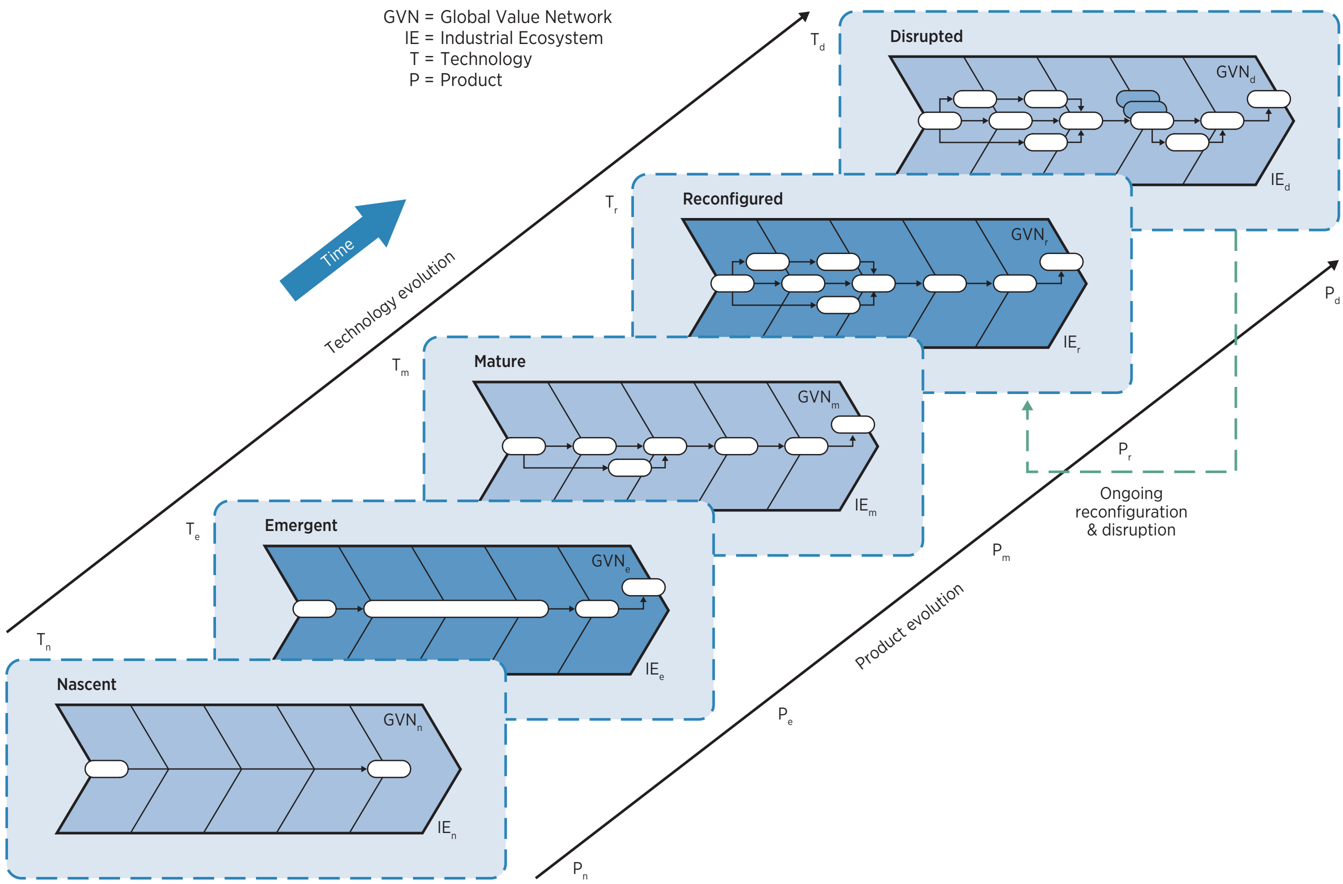
1. The first stage is the formation of a **'nascent'** value network associated with a new technology. Here the technology, still unproven, is just coming into existence and the 'global value network' may just consist of a laboratory in a university research centre with dialogue between potential supply chain partners and technology developers. It may evolve to a stage where the network starts to show signs of 'order', such as emerging commercial strategy and potential for partnering arrangements.

2. The second stage is **'emergent'**. This phase encompasses a series of transitions from:
   - a viable pilot production of a new technology or delivery platform, to
   - a completed value network with an end-user in the form of an early adopter, where multiple customers and competitive technologies begin to emerge, to
   - the stage when the network starts to cohere into the form it will take for a mature, viable industrial system.

3. The third stage is **'mature'**. Here, the global value network typically becomes significantly more complex, possibly with multiple tiers and interconnections, where specific roles are defined for a broader range of niche players that are often globally distributed. Five key network types have been identified at this mature stage of evolution. These align with different organisational models ranging from 'distributed' to 'centralised', with various matrix options between the two.

4. The fourth stage is **'reconfigured'**. This comes about when the mature network has become suboptimal – often due to cumulative changes in market or resource conditions, prompting the need for redesign, which often results in better network performance.

5. The fifth stage – **'disrupted'** – reflects the change to the network brought about by disruptive influences. Here there may be radical changes to the fundamental structure and dynamics of the network. New players may take a key role, and some existing players may not feature at all. And, of course, cycles of reconfiguration and disruption then continue over time to create further generations of value networks.



Five stages in the evolution of global value networks

Exploring trends, scenarios and intervention strategies

The mapping approach described in the previous section provides the structured template around which different global value networks can be configured – current and future – and evaluated. This provides a vital platform for exploring trends, scenarios and intervention strategies. An analysis of governing trends involves predicting a number of future states based on a range of variables. These variables depend, in particular, on technology evolution status and new product adoption rates, but also need to consider key changes in the industrial ecosystem, such as the impact of new business models, competitor initiatives, market growth and distribution, and the effect of government support programmes. This is a highly creative process where the mapping templates provide focus for crystallising the underlying logic of reconfiguration, and provide vital visualisation and communication aids for the project leaders and stakeholders. The aim is to create a set of possible future scenarios to match different strategic themes and time horizons. These can be compared and evaluated to define 'most likely' scenarios that describe the possible or likely evolution path. From this, firms and government stakeholders can formulate intervention strategies – investing in technology, production assets, skills or infrastructure, for example – and test their business viability.

Key applications

A number of projects have been carried out using this approach to assist corporate strategists and national policymakers in understanding the evolution of complex value networks. In practice, projects tend to split into two broad categories: the development of nascent-emerging-mature stages for new technology areas; and the ongoing reconfiguration or disruption of mature global value networks. The CIM approach has been used in the nascent-emerging-mature evolution context to characterise and compare different value networks within the biotechnology sector, and network reconfiguration has been applied in the photovoltaic industry, as described overleaf.

APPLICATION CASE STUDY:

Photovoltaic industry

Background

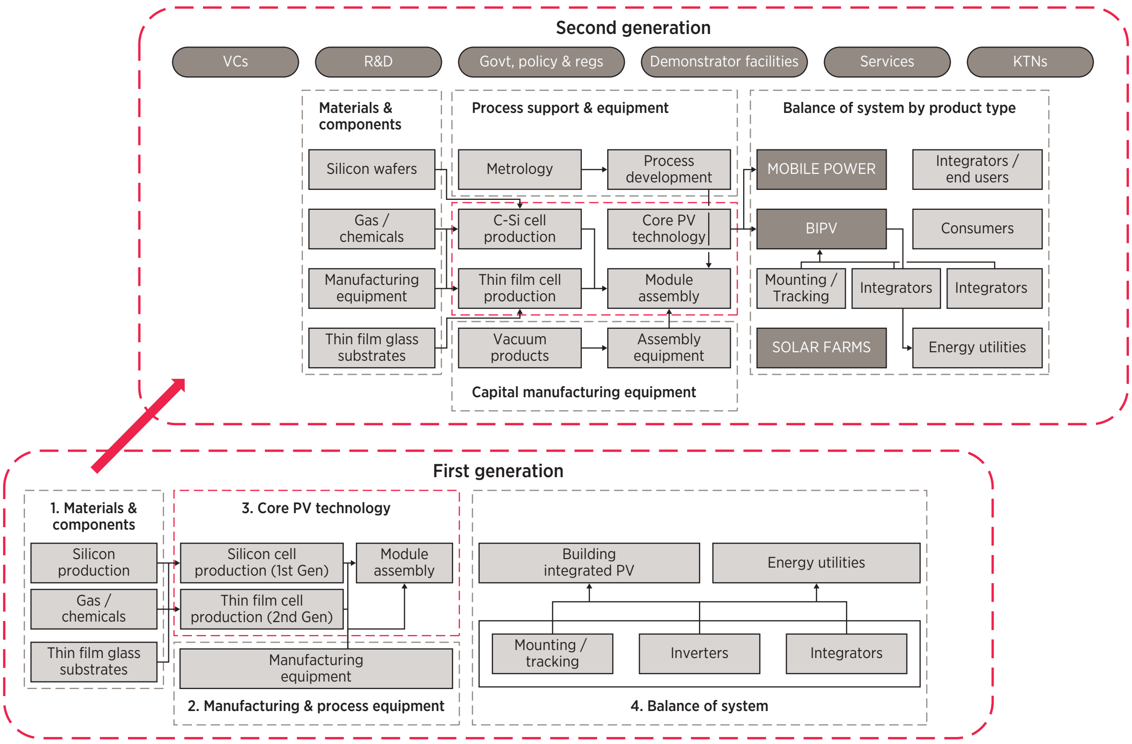
The photovoltaic effect was first observed in 1839, but it was not until 1955 that the first commercial photovoltaic device was marketed in the US, with 2% efficiency. Efficiency then progressively increased – alongside manufacturing cost reduction – to improve viability, and from the 1980s onwards adoption rates accelerated rapidly. More recently, governmental subsidies have fuelled further growth, leading to a peak around 2011 when the combination of the economic crisis and industry over capacity led to a slump. Despite this, the upward growth profile is predicted to resume over the next years. One important but less well-documented aspect of the photovoltaic story is the role global value network evolution has had in the development of this major global industry. CIM tools have been used to map the progression of the global value network through emergence and various cycles of reconfiguration, to identify key patterns and learnings that might apply to other industries.

Observing evolution stages and characteristics

One key aspect of the study was to define the key evolutionary stages that have occurred, and to explain the key transition steps that enabled the shift between value network configurations. The findings identified four value network generations where the major cause of reconfiguration was the emergence of new technologies linked to specific end applications. The interesting aspect from a value network perspective is the shift in the nature of the network across the technology generations, starting with a vertically integrated model in the first generation or nascent phase, splitting into a tiered model with stable, mature partners at second generation and then becoming increasingly fragmented and complex at third and fourth generations as new players enter with specific expertise in emerging technologies and applications. Future evolution might be expected to include repeated cycles of consolidation to remove complexity, and fragmentation associated with continued innovation in this sector.

Understanding ecosystem enablers for early maturity

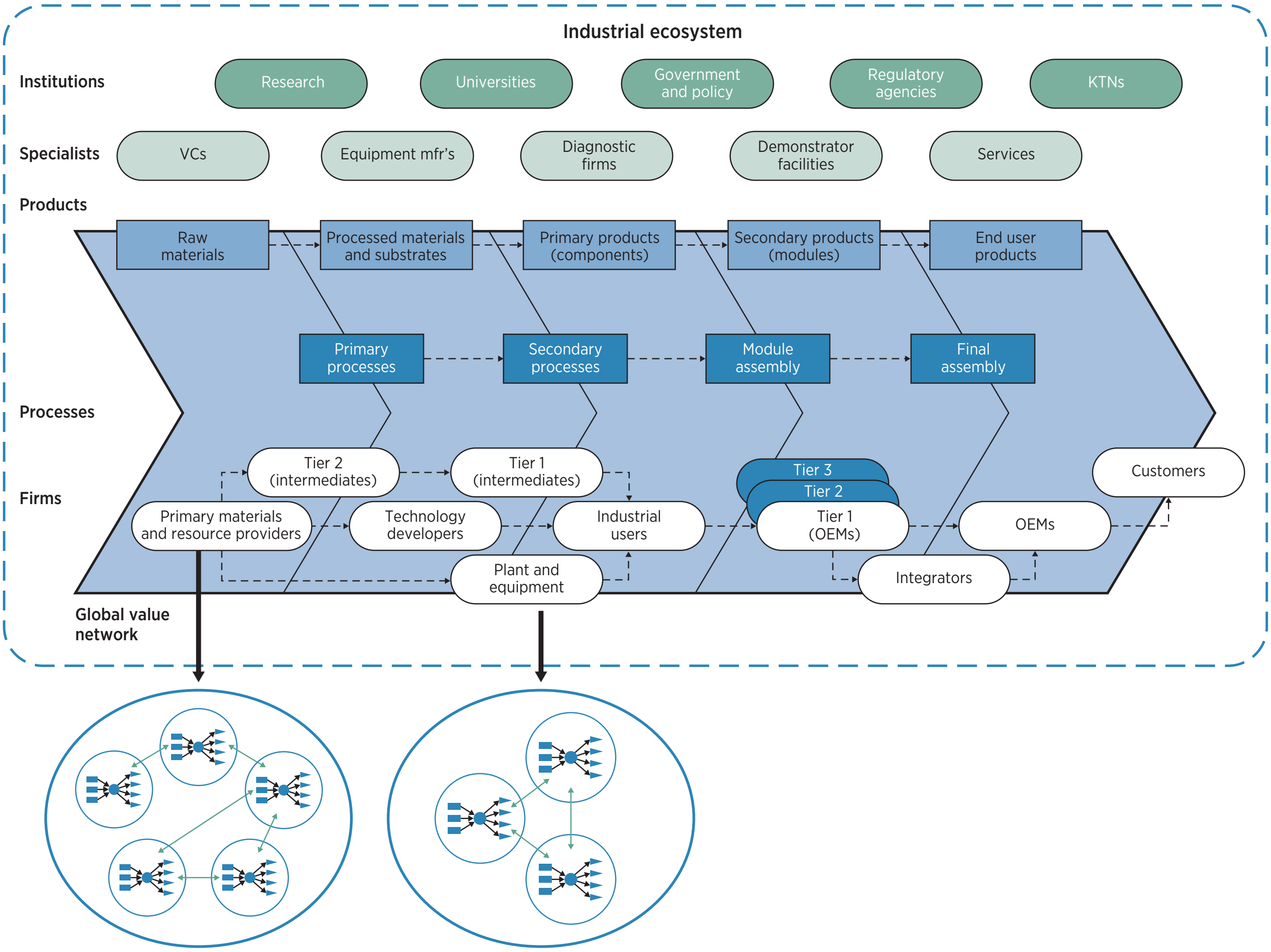
Another key aspect of the study involved analysis of the ecosystem enablers for early maturity. The analysis illustrated here focuses on the transition between first and second generation networks (with the ecosystem conditions for the latter also shown). The study helped to identify the key ecosystem players that had an impact on enabling the shift to early maturity, and – most interestingly – the nature of their interventions. For example, this helped to answer questions such as: Where are the sources of funding coming from? Where is the R&D being carried out? Which policy groups are important? Where are the demonstrator facilities for new technologies? Which critical service providers do they use?



Evolution of the photovoltaic industry global value network

Integrating global value networks

CIM's third value network methodology explores how complex, multi-tiered value networks, often managed as semi-independent sub-systems, can be better integrated end-to-end. The approach adopts a more holistic approach to industrial system design by analysing opportunities for better integration between the sub-systems that make up the value network.



Integrating key subsystems within complex global value networks

Sub-systems analysis and integration

The approach explores the drivers of, and interactions between, the main sub-systems in complex, multi-tier value networks. Case data from CIM research suggest that these networks often comprise semi-independent sub-systems that have evolved over time and have become part-disconnected, operating as silos of activity with independent governance and coordination mechanisms. The approach introduced here helps to reveal reconfiguration opportunities that support the re-integration of these sub-systems.

A key premise is that taking a broader systems perspective can stimulate radical innovation that seeks to optimise value across sub-systems. This approach is particularly relevant in multi-tier value networks where sub-systems have emerged to improve coordination across these extended networks, often involving production of sub-assemblies and intermediate products. However, while these sub-systems have often evolved to drive innovation and efficiency, they tend to do so independently, sometimes to the detriment of the end-to-end value network.

This kind of structural development may also become 'locked-in' by regulatory frameworks. For example, in pharmaceuticals, the clinical supply chain 'system' can impose process and regulatory constraints for the full-scale commercial supply chain. In aerospace, complex component supply chains have emerged at regional and national levels that are not easily scalable to the global markets the primes are faced with serving. The rapid development of substantial intermediate goods supply chains in food, consumer electronics and textiles also provides opportunities for improved value network integration and reconfiguration.

The approach presented here identifies opportunities for taking a more end-to-end value network perspective, reconnecting upstream and downstream elements and potentially informing a radical innovation agenda for reconnecting semi-isolated sub-systems. This proactive redesign approach to value network integration and optimisation can be used to direct the product-process research and technology agenda. Alternative product and process models that emerge are then evaluated to explore the scale of opportunity and identify whether previously established sub-system constraints can be overcome. This approach can result in a radical redefinition of value network drivers, and the identification of the breakthrough innovations that might support a paradigm shift in value network performance.

Examples of this approach include new or radically different product-process reconfiguration models that can support major breakthroughs in total value network performance, such as: continuous-processing and crystallisation in previously batch-process-oriented pharmaceuticals; additive manufacturing in component manufacture that replaces traditional subtractive processes; and post-dosing product finishing models that enable more near-market supply. Although these developments often rely on significant technology breakthroughs and/or new delivery models, different redesign options should be informed by broader value network analysis that considers a total value network systems optimisation agenda. The result of this redesign approach may deliver different product, process and business models that enable new or previously elusive markets to be served economically.

Methodology

The methodology involves capturing the drivers of, and interactions between, the main sub-systems across the value network. Invariably in the application of this approach, the systems boundaries are extended to encompass both ends of the value network, with the end-user focus most critical in informing potential sub-system trade-offs.

The approach has four key steps:

1. **Identifying barriers**
   The first step identifies barriers to adopting alternative product-process technologies and business models that might be used to serve existing markets more effectively or deliver unmet end-user needs. CIM research suggests that barriers may be real or perceived, and arise from combinations of socio-political, technical and regulatory factors. Unmet end-user needs, on the other hand, are either driven by new capabilities that create new markets or known market segments that have been previously considered uneconomical to serve. Personalised medicines or niche product markets are examples where advances in diagnostics, information technologies and digitisation are enabling more disaggregated value network models that now have the potential to be served economically.

2. **Identifying and defining sub-systems**
   Step two uses the supply and value network mapping approaches described earlier in this report to identify and define the drivers and design factors that predominate in each sub-system. An end-to-end value network performance metric analysis then identifies the current state configuration design parameters and trade-offs.

3. **Exploring alternative scenarios**
   Step three considers a range of scenarios that could emerge by adopting alternative product-process-business model innovations. These alternatives may be based on emerging process and production technologies or even technologies that are still yet to be fully developed (such as continuous processing and crystallisation in pharmaceuticals). These scenarios will need alternative scale production footprints (dispersed, close-to-market, low-scale integrated plants, for example), or alternative supply models that might now be possible due to advances in ordering or replenishment (such as e-commerce-based last-mile supply chains). In practice, scenarios will depend on various disruptive influences that challenge the current value network model and introduce possible product or product-service models.

4. **Integrating the analysis**
   The final step is a total value network systems analysis which integrates the analysis of the alternative scenarios under consideration and how they might redefine the sub-systems of the current state configuration. The approach incorporates:
   - the potential benefits of particular scenarios as a 'delta' analysis on the current state for key system metrics
   - the value proposition in making the transformation from a business context for key value network players (for example, in absolute terms, the potential impact on revenue, margin, inventory reduction, etc) against the investments required
   - the technological feasibility of the identified disruption.

These three elements of the evaluation are incorporated into a total value network analytical framework.

Reconfiguring UK pharmaceutical supply chains

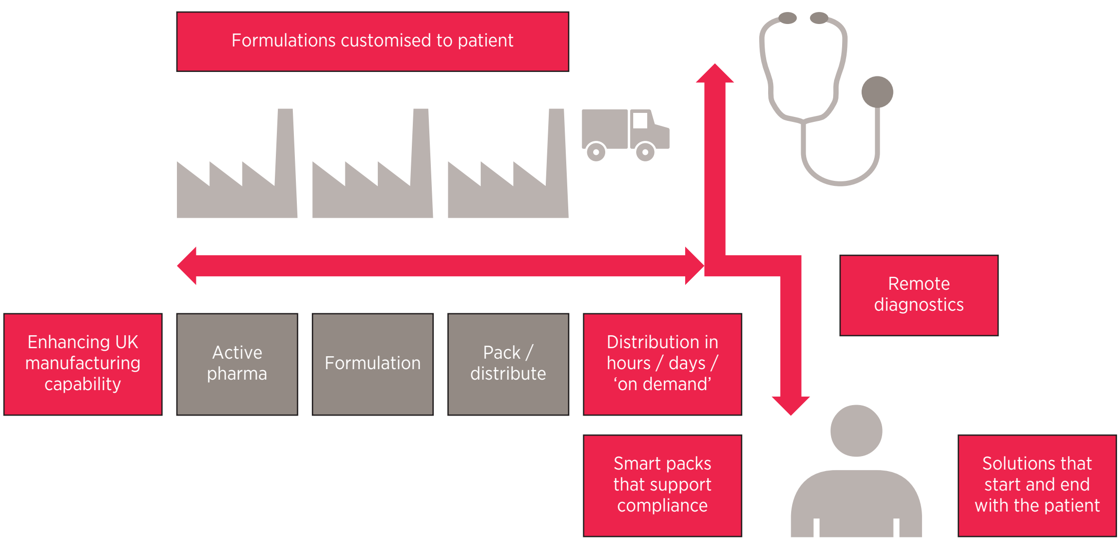
A new £23m project that includes £11m of UK government funding provides an opportunity to reconfigure existing pharmaceutical supply chains in the UK, end-to-end, by exploiting the latest technology advances in medicines and patient-centric delivery models.

Although UK pharmaceutical firms lead global markets, significant challenges lie ahead of them relating to the affordability of drugs, product portfolio fragmentation and the ability of existing supply chains to embrace emerging technologies. These challenges compound existing problems of inventory across the end-to-end supply chain, and poor 'right-first-time' processing which costs the industry £20bn per annum globally. Part of the UK government's Advanced Manufacturing Supply Chain Initiative (AMSCI), the project will be led by GlaxoSmithKline, providing major inputs on clinical supply chains, with the Centre for International Manufacturing leading on commercial supply chain and overall research coordination, AstraZeneca focusing on formulation developments and the University of Strathclyde team within the Centre for Continuous Manufacturing and Crystallisation looking at active processing.

CIM will lead this new research activity into more patient-centric and integrated end-to-end supply chains as part of this major sector-wide initiative that will evaluate new technology innovations within the UK pharmaceutical supply chain.

Other industrial partners include the major contract manufacturing organisations, equipment manufacturers and technology and system providers spanning the end-to-end pharmaceutical supply chain.

The collaboration also involves key institutional bodies across the UK pharmaceutical ecosystem (skills agencies, user representatives, regulators and health sector specialists) to ensure more adaptive future supply chain models are supported by consistent standards and a unified approach to regulation. Activities will include two sector-wide platform projects focused on the end-to-end clinical and commercial supply chain, and several technology-specific application workstreams.



APPLICATION CASE STUDY:

Pharmaceutical industry

Project aims

This ongoing project seeks to explore possible future global value network configurations for the pharmaceutical industry that align with a disruptive switch in technology from batch-based manufacturing processes to continuous process manufacturing. It is a phased multi-year project involving a cross-sector consortium tailoring and applying the CIM approach. One key aspect is the integration of critical sub-systems within the total network.

Approach and key findings

A four-step process was used to identify alternative value network opportunities.

Step 1: identifying potential opportunities, barriers and target markets Initial research identified a number of opportunities for the implementation of continuous manufacturing in the pharmaceutical industry, and potential barriers to their adoption (as illustrated in the table below). The aim of the project is a highly ambitious step-change in operational performance. The barriers, however, are significant, and require a coordinated and systematic approach to redesigning the entire value network.

POTENTIAL OPPORTUNITIES

- Plant footprint reduction by 70%
- CapEx reduction by 25%
- Operating cost reduction by 30%
- Yield improvement by 10%
- More consistent quality
- More controllable, repeatable processes

POTENTIAL BARRIERS TO ADOPTION

- Regulatory uncertainties
- Under-utilisation of existing capacity
- Technological readiness and uncertainties
- No clear and specific vision as to how continuous manufacturing may impact industry structure
- Transformation challenge and behavioural issues

IMPACT VARIABLES	CLINICAL TRIALS	PRIMARY	SECONDARY	PACKAGING	END-TO-END
Inventory					
Lead time supply					
Lead time to market					
Scale-up (going into)					
Volume flexibility (mix & volume)					
Process control; reliability; safety					
Quality; purity; counterfeit					
Yield					
IP protection /ext'n/ counterfeit					
Cost (Proc / Pkg / Transport)					
Investment cost					
Fiscal / Tax					
Environmental impact / solvent					
Viability / adaptability					
Asset utilisation					

Potential benefits of continuous manufacturing in the pharmaceutical industry

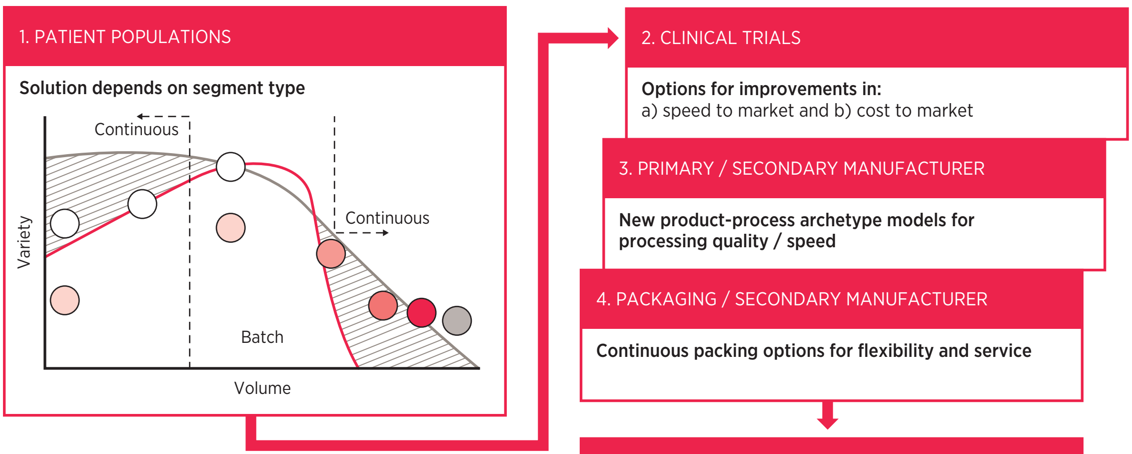
APPLICATION CASE STUDY: PHARMACEUTICAL INDUSTRY continued

The analysis identified, at a conceptual level, the potential end-user target markets and products where continuous processing technology might provide attractive value network opportunities, either in meeting unmet user needs or providing step changes in cost, flexibility or reliability.

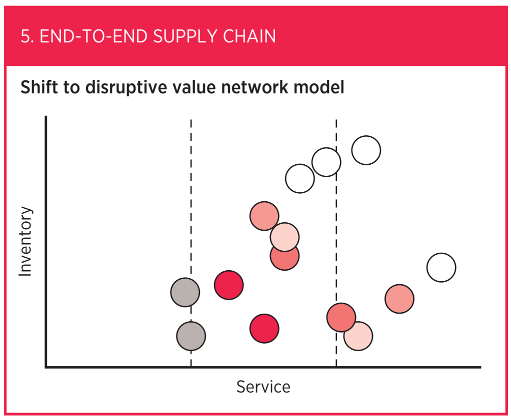
Step 2: current state mapping and definition of critical sub-systems The second step involved mapping the current state of the batch-based global value network for the pharmaceutical industry (using the mapping approach described in section 1.2). This led to the identification of the critical sub-systems that would be affected by the shift to continuous manufacturing. Initial analysis was conducted to identify the potential of the shift for each sub-system. The result is shown in the table on page 50, where the columns show the five critical sub-systems (clinical trials, primary, etc), and the rows the potential areas of benefit, with the scoring setting out the potential scale of the benefit for each sub-system.

These benefits could accrue to patients, government health service providers and industrial value network partners. These factors were considered in selecting potential products and markets for the adoption of new continuous processing technologies.

Step 3: sub-systems analysis against desired benefits Deeper analysis of the sub-systems was then carried out to support a tailored future configuration aligned with the specific benefits identified in step 2. The graphic below illustrates the outputs, where the five graphics refer to the five sub-systems. The 'bubbles' in each graph represent the different product-process segments making up each sub-system. Shaded areas signify attractive boundary conditions for continuous processing. This analysis supported deeper understanding of the ideal future configuration for each sub-system.



Step 4: integration of the critical sub-systems The final step of the process guided the integration of the sub-systems. This involved detailed examination of the interactions between the five areas (clinical, primary/secondary manufacturing, packaging and distribution, end-to-end supply) to identify target applications for continuous manufacturing that could work within and across the sub-systems. The target applications were then assessed in terms of different transformation scenarios, bringing together inputs on technology readiness and business viability.



Deep-dive analysis on five sub-systems (showing detail on first and last)

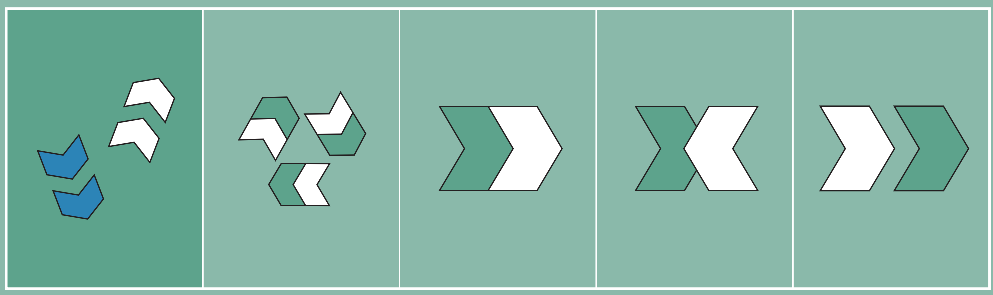
Future work

This study is part of an ongoing research agenda that seeks to understand future disruptive changes in the pharmaceutical industry global value network. This involves extending the preliminary analysis described above to cover other key areas in terms of patient populations and product-process segments. This work will seek to explore the attractive business propositions alongside technological feasibility, and will consider the behavioural changes and dynamic capabilities required to make the transformation across the total value network.

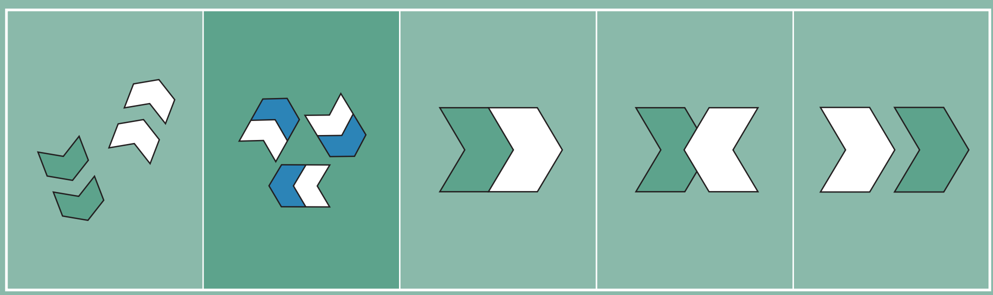
2. EMERGING THEMES

Part Two of this report describes five emerging themes linked to the central objective of 'capturing value from global networks'. The research in these areas will underpin the development of a new set of methodologies that will have practical applications for industry and government.

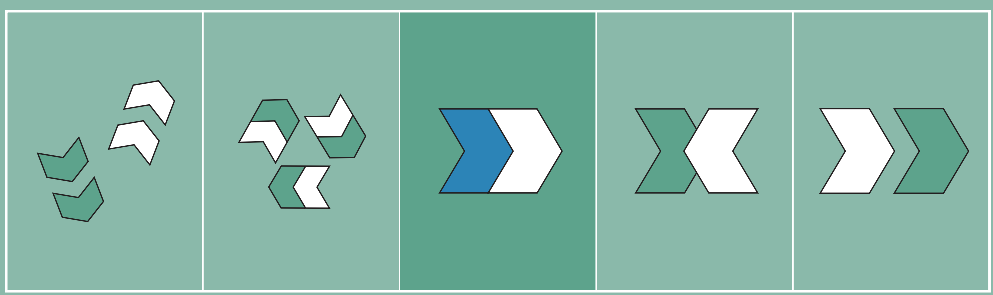
- 2.1 Risk and resilience
- 2.2 Sustainable supply networks
- 2.3 Mergers and acquisitions
- 2.4 Knowledge integration
- 2.5 E-commerce driven 'last-mile' logistics



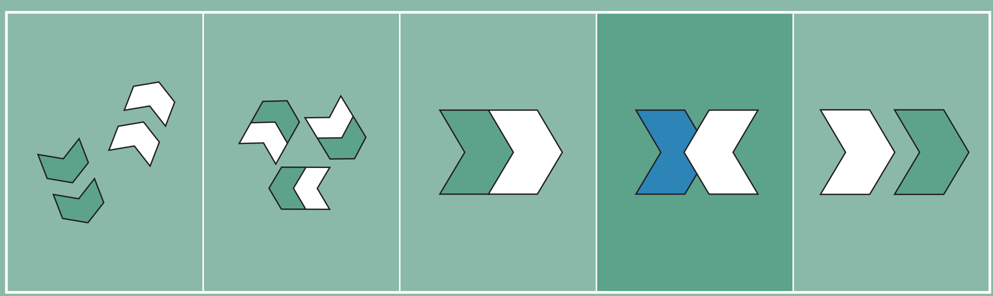
Risk and resilience



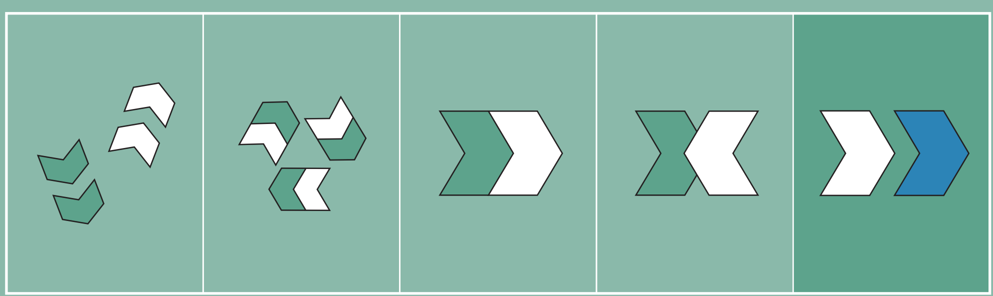
Sustainable supply networks



Mergers and acquisitions



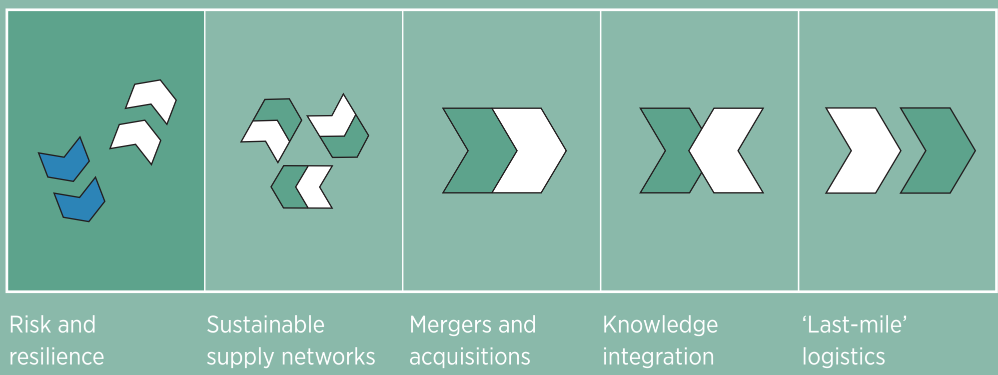
Knowledge integration



'Last-mile' logistics

2.1 RISK AND RESILIENCE

Mukesh Kumar and Jagjit Singh Srai



Companies and, indeed, governments are increasingly concerned about the risk and resilience of the global supply networks on which they depend. Traditionally, the key criteria for successful network design were speed, efficiency and use of resources. In an increasingly uncertain environment, however, corporate decision-makers and policymakers are anxious to ensure that networks will be able to recover from risk and unexpected disturbances. But it is simply not feasible to design an entire supply network to cope with all unpredictable events. It must build in resilience by being flexible and easy to reconfigure.

Background

Researchers at the Centre for International Manufacturing have been exploring risk and resilience in relation to international networks since 2005. Early research investigated production networks in eight multinational companies, mainly looking at their plant location decisions. This revealed that the investment risks in establishing new plant locations were managed by a variety of implicit and explicit methods, usually as part of routine strategic and financial assessments. None of the companies had a comprehensive and systematic approach to the analysis and mitigation of risks. Without this, risks cannot be explicitly identified or objectively evaluated. It was also clear from the research that risk was being considered at the individual plant level, whereas, to understand it fully, it needs to be seen in the context of the production network as a whole.

Developing a systematic risk management approach to deciding plant location

To try to overcome this gap in both research and practice, CIM has developed a new systematic approach to risk management and applied it with a leading global manufacturing company.

The approach has four steps:

1. Identification of risk through event and network vulnerabilities
2. Risk assessment based on probability and financial impact
3. Administration/mitigation
4. Monitoring.

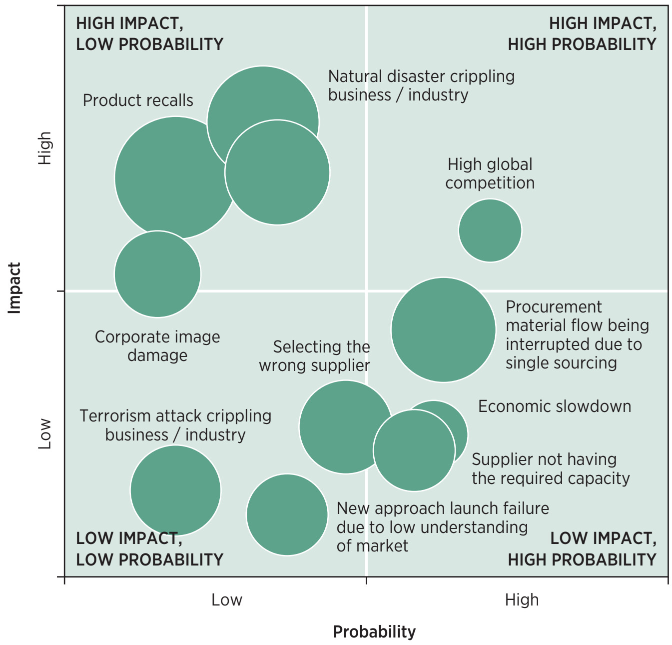
Each step has processes linking multiple tools and guidelines for practice. This approach also includes risk management governance, risk analytics and reporting structure.

A survey: industrial risks and risk mitigations

In 2011, CIM researchers conducted an industrial risk survey with 69 companies across 21 different industries. The research tested a framework of risks and risk mitigation in seven risk categories – R&D, procurement, production, distribution, sales and marketing, organisation and external. The results suggested that high value-adding activities have the greatest risks and that different industrial sectors have different risk profiles due to factors such as industry structure, production processes, product characteristics and geographical footprint. The results also suggested that – R&D aside – companies were most worried about supply network risk. The figure top right illustrates the top 11 industrial risks across all sectors, the probability of their occurrence and the scale of their impact.

Multinational companies and supply network risk management

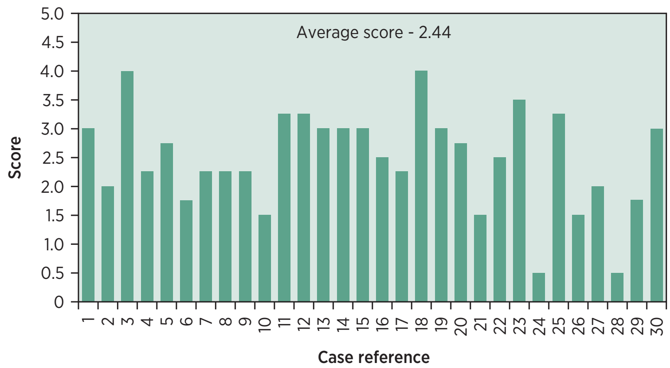
For more than 10 years, CIM has been collecting data on the supply network capabilities of multinational companies with an average annual turnover of more than $5 billion. One of the key capabilities of a supply network is 'risk management'. Analysis of the dataset, comprising 30 global companies, confirms that they lack systematic processes for identifying, assessing, administrating and monitoring network risks (see graph right).



Assessment of top 11 industrial risks (from survey of 69 companies)

ACCIDENTAL / INITIAL 1	REPEATABLE 2	DEFINED 3	MANAGED 4	MASTERED / OPTIMISED 5
No formal risk assessments made	Internal risks identified through a formal process	Network risks identified through a formal process	Network risks managed routinely	SC & product / service offering redesigned to offset key risks

Risk management capability level

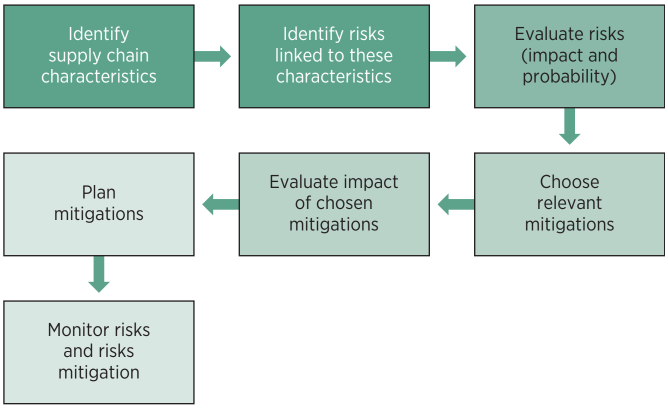


Risk management capability level of 30 case companies

Risk and resilience of global supply networks

Managing supply chain risk is becoming a critical capability for international firms as global supply chains become increasingly lean, fragmented and geographically dispersed. World events, from natural catastrophes (such as the Japanese tsunami and the Icelandic volcanic ash emission) to political developments as witnessed in the Arab Spring, have demonstrated that even advanced supply chains are vulnerable to these largely unforeseen incidents. Furthermore, shorter product life cycles and the adoption of advanced technologies present their own uncertainties and complexities. Consumers and business customers alike have nonetheless become highly demanding and intolerant of supply chain disruptions. Much improved communication channels mean that reports of supply failures can rapidly spread, resulting in rapid loss of confidence and damage to brand reputation and future business.

CIM has developed a process for supply network risk management which has been tested in two leading companies. This research suggests that risk can be managed by introducing new processes/practices, and in some cases by changing the configuration of the supply network.



Supply network risk management process

A framework for understanding risk and resilience of supply networks

Another observation arising from CIM research is that the terms 'vulnerability', 'risk' and 'resilience' are often used but poorly understood. We have developed a framework (right) to explain these concepts. At its centre is 'event' (such as climate change, war, new regulation or financial crisis), which might have significant impact on supply networks. Next is 'vulnerability', which is associated with the structure of the supply network and particularly its lack of flexibility. 'Risk' appears when key events and vulnerability interact with each other. 'Resilience' is achieved by continuously changing supply networks in response to risks by using risk mitigation approaches, such as adopting new processes and/or practices or by structural reconfiguration.

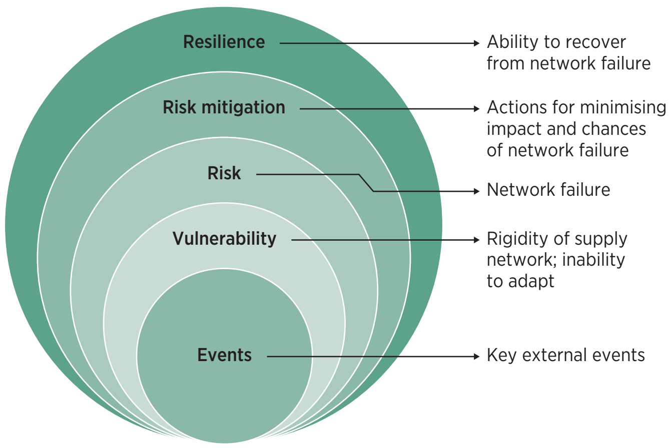
The resilience of the supply network is considered both by applying a 'stress-testing' process and by evaluating the opportunities to develop proactively more 'resilient' supply networks through network redesign. These reconfiguration approaches may involve supply tier structural changes to support improved supply network integration and visibility, alternative governance and coordination mechanisms that promote transparency, risk pooling and partnering arrangements and de-risking the product or service offering. By extending risk assessment and organisational resilience methods beyond their traditional firm focus to the entire supply chain, the aim is to provide businesses and risk management professionals with new approaches to evaluate the hidden risks and vulnerabilities in their supply chains, and the contingency and mitigation plans needed to offset these where practicable.

Looking ahead

CIM's risk and resilience research is currently focusing on the configuration of international supply networks, looking at whether particular network structures, governance and partnering models, and product/service systems have inherent resilience/vulnerability characteristics. Specific projects also include the impact of climate related events in collaboration with the British Antarctic Survey and the Cambridge Centre for Climate Change Migration Research (4CMR). Within these projects, future research considers:

- risk implications of future industrial systems based on new technologies and materials
- regional and sector level risks studies
- integrating qualitative and quantitative assessment approaches in risk studies.

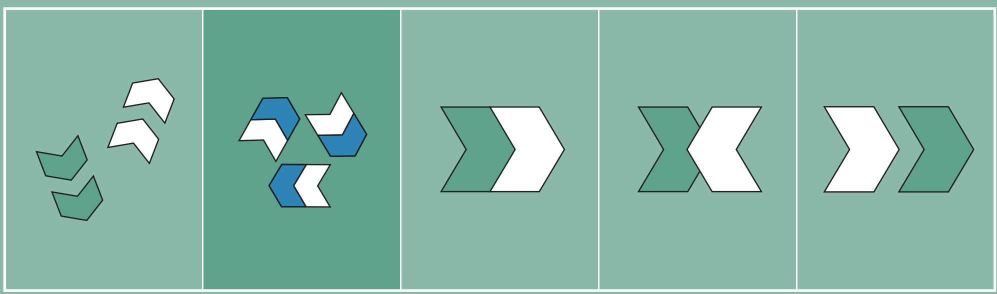
Management and mitigation tools and strategies are being actively developed to help stakeholders plan contingency measures, proactively redesign supply networks to reduce vulnerability and to better manage the consequences of risk incidents. Finally, the role of institutional players – international trade regulatory bodies, for example, or those providing new services, such as 'insurance providers', as part of the menu of mitigation practices against supply chain risk incidents – is being explored in terms of a more comprehensive supply network risk framework.



Supply network risk and resilience framework

2.2 SUSTAINABLE SUPPLY NETWORKS

Jagjit Singh Srai and Leila Alinaghian



Risk and resilience | Sustainable supply networks | Mergers and acquisitions | Knowledge integration | ‘Last-mile’ logistics

Developing sustainable supply networks has become an increasingly important objective for many multinational companies, driven by a number of imperatives including customer expectations and the need to comply with increasingly robust regulatory frameworks. This has led to a greater focus on energy, resource efficiencies and waste reduction. While many organisations successfully use quantitative approaches to sustainability measurement – such as carbon footprinting – within the firm, these methods are often difficult to apply across a complex and extended supply network.

Background

As the sustainability of industrial systems becomes a major consideration for many organisations, recent research has recognised that in order to address sustainability concerns effectively, firms need to adopt a comprehensive view of the supply network and to incorporate a waste-free, 'cradle-to-cradle' perspective into their strategic planning. However, this poses a significant challenge for firms if they try to extend existing measurement systems such as carbon footprinting across the network as a whole, where visibility and data collection are significant barriers. But collecting data is not the only issue. If all the partners in a supply network are to meet their social and environmental goals, there needs to be more concerted and more flexible interaction between them, which cannot easily be achieved by applying traditional financial and operational measures.

Sustainable supply networks: a capability maturity model approach

If it is impractical to use existing measurement systems such as carbon footprinting across the supply network, how can companies realistically progress this agenda?

Centre for International Manufacturing research has identified an alternative approach based on the process maturity model that incorporates a systematic review of organisational practices relevant to sustainable manufacturing. The approach involves assessing how well-developed sustainable practices are across a firm's supply network. Incorporating sustainability dimensions within an established supply chain maturity model architecture also provides a basis for assessing potential trade-offs with traditional supply network performance dimensions.

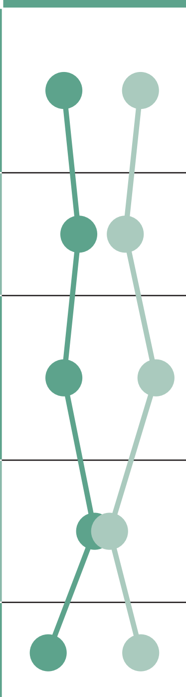
This approach has been developed by integrating distinct areas of operations management research, including supply network capability assessment and sustainable industrial systems. The maturity model builds on established capability maturity model architecture developed by the research team. The dimensions of sustainable supply network capabilities relating to the five clusters of strategic networks – design, connectivity, efficiency, process development, and product and service enhancement – have been identified from a review of the literature.

To test the maturity model framework, 10 multinational firms were chosen, representing a range of industrial sectors. All of them are major companies with complex and geographically distributed manufacturing footprints and with some level of published sustainability credentials. They have all actively invested in sustainability initiatives and practice and could, therefore, be expected to have relatively mature processes in place.

To collect the data, CIM researchers used semi-structured interviews with a cross-functional group of senior managers, including those with supply network and sustainability lead roles, combined with documentation reviews. The findings were subsequently reviewed with representatives of the companies involved to draw out patterns in terms of the profile of results, best practices, potential links with industry structure and to review the utility of the model itself.

The sustainable supply network maturity model

The table (below) is a schematic version of the maturity model framework showing the five clusters with multiple (24) sub-dimensions. The model uses a scale of five levels of maturity, with each of the primary network domains having top-level common descriptors to ensure that the level of maturity among each of the sub-domains is aligned. The fuller version of the framework includes definitions, descriptions and measures supporting the assessment of maturity level.



Existing / Desired	1 2 3 4 5	Maturity level 5 – world class
NETWORK STRATEGY DESIGN Business vision and strategy Customer segmentation Leadership values and objectives Programme and project portfolio management Supplier / partner integration strategy Strategy marketing and positioning		Driven by a mutual understanding of customer requirements and a strategy to inform and co-develop these requirements. Understand the full product life cycle and its impact across the sectors. Sustainability values embedded in the leadership and demonstrated to the rest of the organisation.
NETWORK INTEGRATION & CONNECTIVITY Network coordination and leadership Product service systems offerings Effective intra-firm integration and business tools Network improvement and performance measurement		Understand the extended value network with structurally embedded processes at the network level. Metrics and support tools transferable across the entire organisation.
NETWORK EFFICIENCY Energy efficiency and effectiveness Resource utilisation Waste minimisation Carbon footprinting New product and service design People capabilities and organisational design		All product and service design accounts for full life cycle sustainability footprint, and Energy, Resource, Waste and Carbon (ERWC) targets are in place for all assets throughout the value chain. Organisational processes include staff assessments and rewards, inextricably linked to sustainability performance
PROCESS DEVELOPMENT & REPORTING Network performance measurement Environment Societal Economic Communication		Sustainability scorecards and triple bottom line reporting are in place across the supply network, publicly shared and independently verified. Strategic decisions recognise the inherent trade-offs required to deliver sustainability targets.
PRODUCT & SERVICE ENHANCEMENT Science and technology Industrial process innovation Regulatory and legislative compliance		R&D programmes are driven by sustainability requirements. Lean and TQM processes are in place. Actively involved in the development of appropriate national / global regulatory and fiscal ecosystems.

Capability maturity model for sustainable supply networks

Overview of applications and key findings

The application of this maturity model framework in these 10 case studies is shown below. The approach also identified potential drivers for manufacturing sustainability linked to the industrial supply network position, including upstream regulatory controls and downstream consumer sentiment. Integrating sustainability dimensions within an established supply network maturity model also provides a basis for potential trade-offs with other supply network strategic dimensions.

Initial results from the use of this model suggest the following:

- The architecture enables a high-level capability cluster analysis as well as assessments conducted at the sustainability dimension level.
- The strong correlation between capability clusters used in the supply network capability framework and this current framework provides potential opportunities for trade-off analysis.
- Initial scores indicate an ability to differentiate capability and that there are a range of maturities across industrial sectors with opportunities for cross-sector learning.

Key findings from the 10 case studies include:

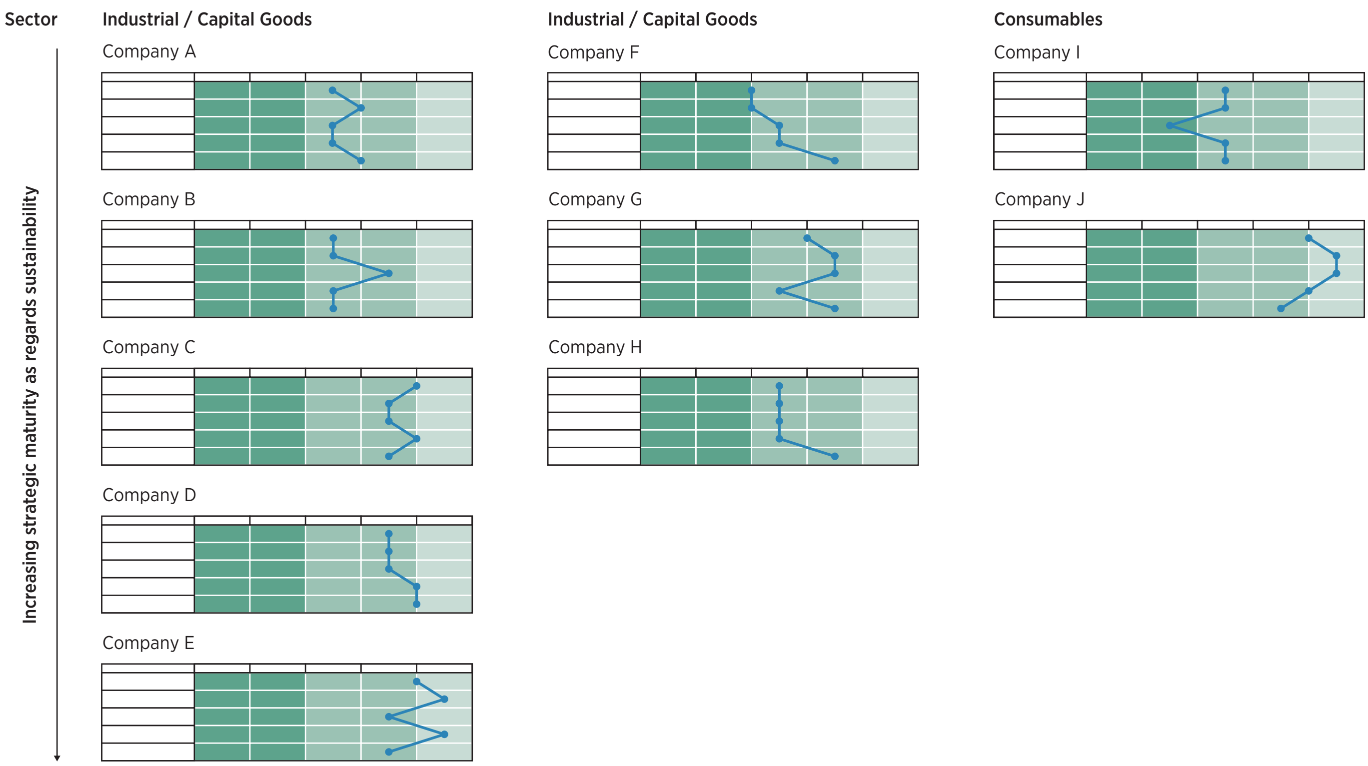
- Sectors that are more consumer-oriented appear to have a more proactive sustainability agenda. Indeed, more than one firm in the case group is seeing sustainability as a differentiator against competitors.
- Some sectors exhibit more advanced capabilities in sustainable supply chains than others, driven by highly regulated environments. This may be as a result of manufacturing considerations (such as carbon emission during production) or driven by aspects of product functionality (product safety, for example).

This research suggests that, in a complex multi-tiered network environment, process maturity analysis can provide a more feasible approach to assessment than one relying on measurement-based metrics. The framework adopts a network perspective and provides an alternative and complementary approach to other, more metric and measurement-centric analyses. It is attractive in that it is potentially less onerous to conduct and provides direction on intervention strategies for the firms involved. The framework itself has identified sustainable supply network dimensions mapped across five capability clusters representing both functional and system perspectives of supply network capability. The importance of industry type and supply network position also provides new contextual dimensions when considering industrial sustainability.

Looking ahead

Configuring sustainable supply networks is a significant – and growing – area of focus for all multinationals, and one that CIM is actively researching and for which it is developing new frameworks that firms will find both feasible and effective to apply. Current projects looking at the design of sustainable supply networks include:

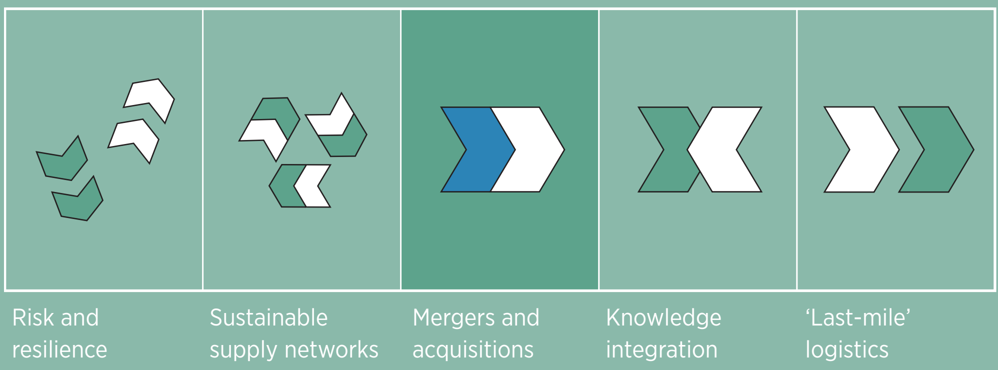
- Design of sustainable automotive supply networks through (energy, resource, and waste streams) configuration mapping, and 'hot spot' analysis involving both quantitative and qualitative analysis methods
- Design of less intensive chemical processing methods including moving from batch to continuous process pharmaceutical manufacturing
- Use of renewables to replace petroleum-based supply networks as part of the design of more sustainable chemical feedstocks
- Engineering-driven sustainable supply networks research in four complex multi-tiered manufacturing sectors
- A toolkit to improve sustainable supply chain practices using the maturity model approach.



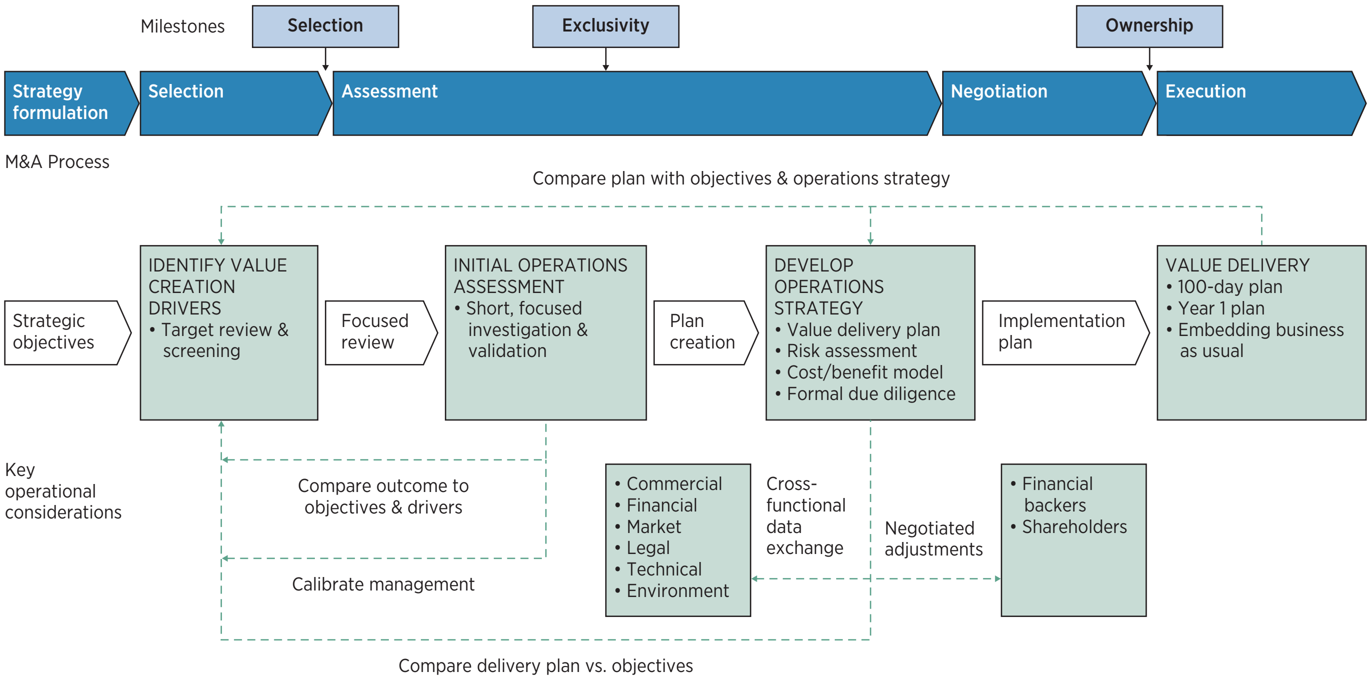
Sustainable supply network practice maturity in 10 case companies

2.3 MERGERS AND ACQUISITIONS

Don Fleet, Jagjit Singh Srai and Yongjiang Shi



Mergers and acquisitions (M&As) are widely used as a rapid way to grow or restructure a business. However, research has shown that these deals often fail to deliver their anticipated benefits owing to failures in assessing the need for, and then managing, operational integration.



Understanding the overall M&A process – operational perspectives

Background

The Centre for International Manufacturing has carried out a study of over 30 international M&As from an operations perspective, looking at the typical motives for these major deals, developing a framework for M&A execution and identifying the common causes of failure in post-merger integration.

Executing M&As

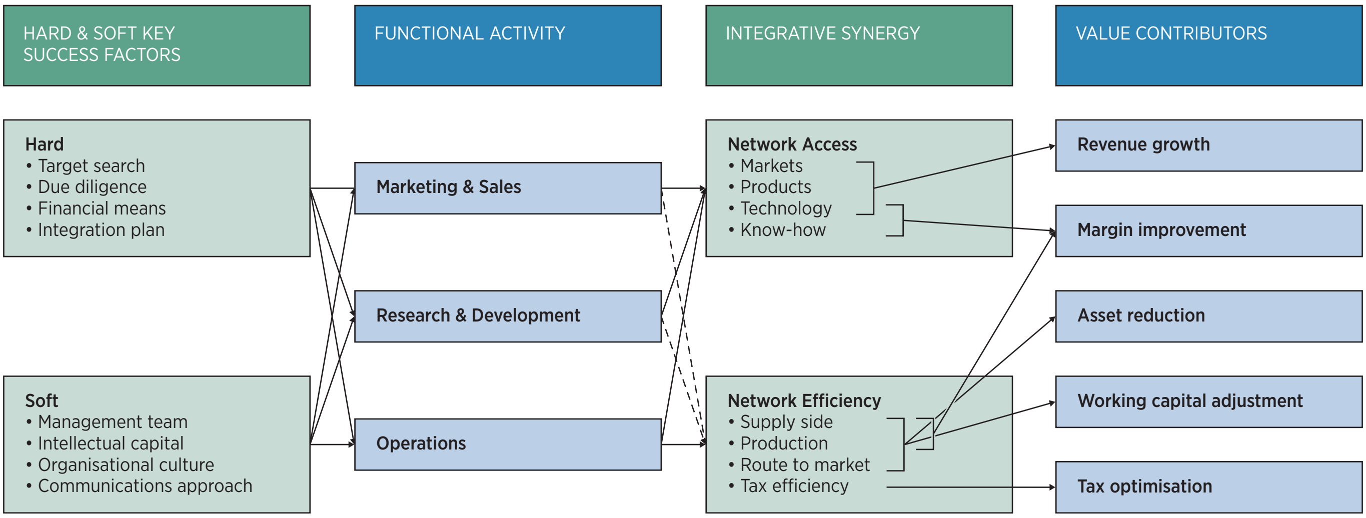
The M&A framework (illustrated above), which has been tested with a wide range of M&A practitioners in industry and in the legal and investment professions, is used to discuss the main findings of the research. It takes an operations management perspective and ties operational considerations to the higher-level strategic processes of initial target selection, assessment and execution, linking them together and setting them in the context of the key milestones in M&A deals.

The framework sets out four main activities that operations teams need to consider: identifying value creation drivers, assessment, developing an operations strategy and delivering value.

1. Identifying value creation drivers

The ways in which drivers are determined vary widely from the very analytical to the largely unsubstantiated judgements of senior managers. Value creation is, of course, the fundamental objective of any M&A and defining the synergies to be achieved is essential if that objective is to be met. The sources of value may differ, however. For example, when Haier sought to buy Maytag for $1.3bn it was doing so to enhance its presence in the US market, while Aditya Birla's acquisition of copper mines in Australia and a pulp mill in Canada secured sources of vital raw materials. CIM research has distilled a clear set of value creation drivers which were recognised and validated by experienced M&A practitioners from City institutions. The first figure overleaf identifies the two principal drivers – from an operations perspective – of value creation in international M&As:

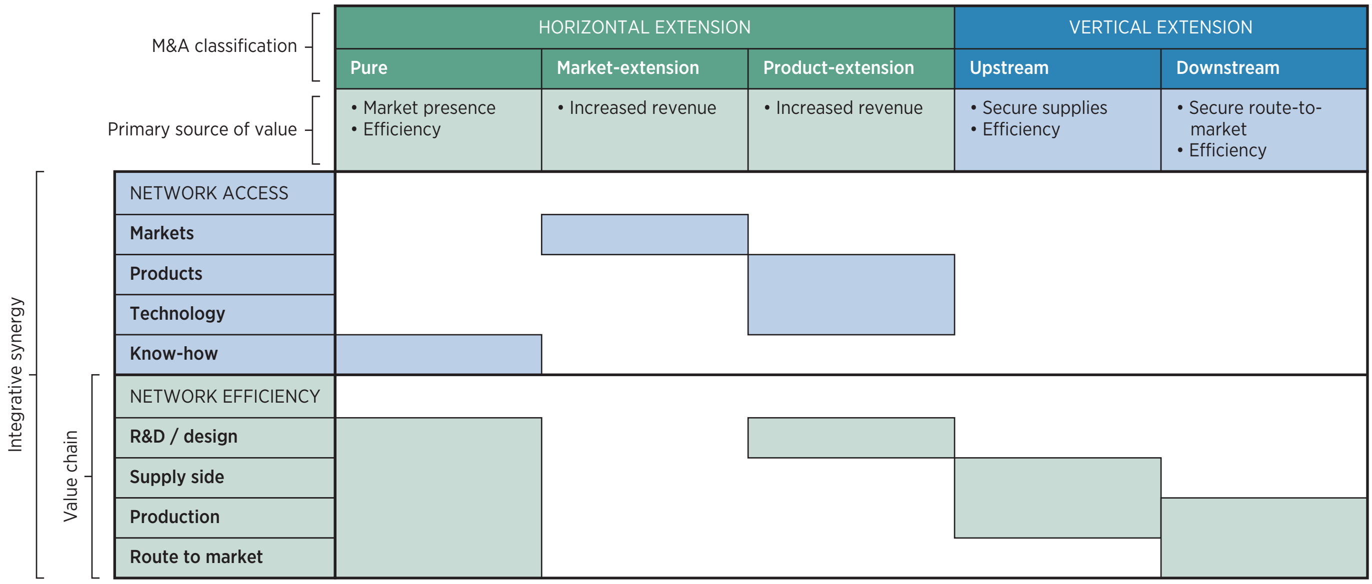
- network access to resources markets, products, technology and know-how
- network efficiency from the supply-side through production to route-to-market.



Drivers of value creation in M&As – operational perspectives

M&As may be classified in many ways, but the categorisation adopted by CIM (see figure below) clearly shows that there are strong links between the type of M&A and the drivers of value and hence to where any potential synergies will lie. The main categories are:

- Horizontal extension – when the operations of one firm need to integrate with similar operations in the other
- Vertical extension – when the firm's operations need to integrate with those of a potential supplier 'upstream' and/or customer 'downstream'.



Shading indicates primary value sources from integration

Classification of M&As by value driver and type

2. **Assessment**
   Different types of M&A with different strategic objectives will have different sources of value. A critical assessment of the target company (both in the initial assessment and in due diligence while developing the operations strategy) is the process of evaluating assumptions to form a better estimate of the value potential in the deal and to identify the critical steps in releasing it. It both refines the valuation of the target and ensures the integration plan does not compromise value. Operations due diligence is particularly complex, not helped by the fact that the necessary information is rarely available or has not been suitably collated, particularly in 'unfriendly' or contested take-overs.

   While due diligence during operations strategy is the norm, an initial operations assessment was a stage that was found to be recognised and executed by sophisticated M&A practitioners, but which is often poorly carried out by businesses with little experience of M&A and where the high-level strategic drivers dominated the M&A decision. In some cases the market dominant logic did outweigh operational considerations, but more often the weaknesses in this process led to serious and unanticipated negative consequences.

3. **Developing an operations strategy**
   The international scope of today's firms makes successful integration an extremely challenging task involving a huge number of functions and attributes including: facilities and assets, operational processes, management, organisation, IT systems and support, human resources and culture, as well as suppliers and customers - all spread across many countries. For example, when Hindalco, part of India's Aditya Birla group, acquired Canadian-based Novelis for $5.9bn in 2007, it not only expanded downstream but it also acquired significant operations in 11 new countries.

   While different types of M&A will require different integration approaches, the post-merger integration process generally has three main steps:
   a. Make sure that the integration process is aligned with the M&A objectives by developing appropriate integration objectives and working principles, and by defining critical success criteria.
   b. Identify critical integration issues.
   c. Develop action plans to address these key issues.

   All M&As need to develop such an operations strategy, but the robustness and effectiveness of these strategies were found to be closely linked to the 'friendliness' of the merger or acquisition and the extent to which the acquiring company found itself in a competition for the target firm. Acquirers might be denied sufficient access to data to develop appropriate strategies or might 'shortcut' the process in order to make an early and winning bid.

4. **Delivering value**
   Once the deal has been agreed, acquirers move to realise the benefits identified in the original business decision. Here again, practices varied widely though there was much evidence that practitioners believed that a robust and energetic '100-day' plan was essential to ensure that older processes and habits did not endure and that new lines of control and monitoring – consistent with the acquirers' objectives – were rapidly embedded. There was some evidence, however, that once the '100-day plan' was completed, attention was often distracted from pursuing the longer-term potential benefits of the merger or acquisition.

Role of operations managers in the M&A process

In practice, target selection, assessment and execution are often undertaken by different groups of 'experts', typically with very little communication or exchange of data and with the minimal involvement of operations specialists. As it is often difficult to obtain the data needed to undertake an initial operations assessment and then to develop the operations strategy and post-merger integration (PMI) plan – and since such data will also require interpretation by operations specialists – this can be a problem. As a result, assessments are frequently only done in financial terms, overlook critical operational detail and may not reflect the original strategic objectives of the deal.

When the PMI plan is being implemented, it often exposes unexpected operational issues which can completely undermine the original M&A rationale and/or require a different integration plan. It is vital, therefore, that the people executing the operations integration plan (typically operations managers) do not forget the original motivation for the acquisition.

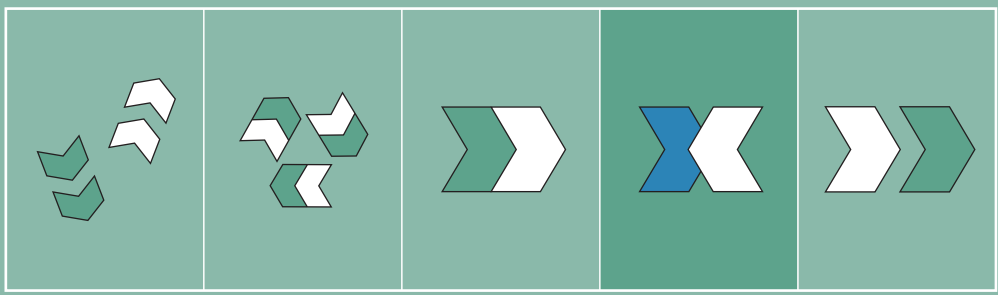
For both these reasons, there is a strong argument for the involvement of operations staff at an early stage of the project. However, they will need to be able to work in a different environment to the one they are used to. There is usually neither the data nor time to make assessments at the level of accuracy normally expected in operations projects. In addition, the evaluation will have to be carried out under conditions of extreme confidentiality. Finding the right operations members with the right skills and orientation is therefore a critical task – especially as they may have to act across a range of operational disciplines, in order to keep the team to a manageable size.

Looking ahead

Clearly M&As will continue to have a major impact on global value network configuration. This research argues strongly for more proactive engagement of operational leaders and strategic network planners in pre-bid processes, and in post-deal integration. The concepts and frameworks emerging from the research provide useful analytical tools, and work is ongoing to convert these into practical business tools for use by corporate strategists.

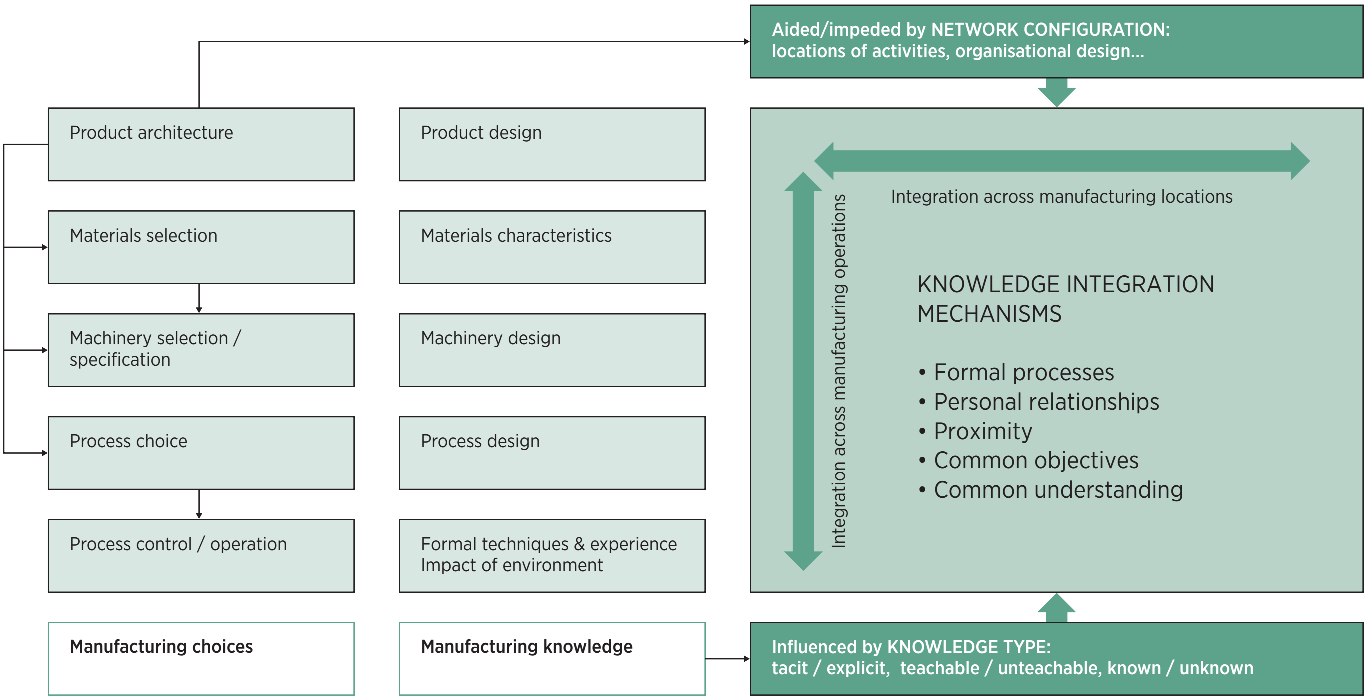
2.4 KNOWLEDGE INTEGRATION

Don Fleet, Tomás Harrington and Jagjit Singh Srai



Risk and resilience | Sustainable supply networks | Mergers and acquisitions | Knowledge integration | 'Last-mile' logistics

Integrating knowledge presents an infinitely greater challenge for multinational corporations than it does for a smaller company operating from a single site. Although the problem is obvious, addressing it is complicated. There are many factors to consider and it relies on collaboration between different sites and different functions – all of which may have a different view of the issues. Only by understanding the various types of knowledge and how they – and the configuration of the network – affect how knowledge is shared, can a proactive and integrated approach to knowledge management be developed.



Model for knowledge integration showing key linkages

Knowledge integration and the multinational company

In a single-site company many issues of knowledge integration may be dealt with relatively simply, and even informally. Information in the production function may be passed between different teams or shifts by face-to-face contact (shift change-over meetings, for example) or through log-books and documentation. Integration between different functions is similarly straightforward and may entail the exchange of documents and emails. Proximity helps in communication and in quickly detecting and resolving misunderstanding.

In a multinational company, knowledge integration is much more complicated. Sharing knowledge across different production sites is hampered not only by distance but potentially by language, culture and different equipment or operating conditions. As a result, some of the ways of doing things on one site may not work on another. When a production process is first transferred from one site to another it may expose gaps in knowledge about critical conditions (such as humidity, temperature and air pressure) for the process which may previously have been taken for granted. If it is difficult to integrate knowledge across different sites performing the same function, it is arguably even more challenging to do so across multiple sites and different functions – given the divergent perspectives of the various functional groups.

For companies internationalising for the first time, the problem of knowledge integration is often far more important than the concerns they have about specific issues in the new site. Companies with a history of international operations are much more familiar with the problems, yet few – if any – claim to have overcome them. This may be due to the observation that companies tend to adopt pragmatic solutions which focus on only part of the problem. Again, functional bias may lead to suboptimal initiatives. For example, an HR initiative directed at learning, a production initiative directed at line improvement and a development initiative aimed at process improvement may all be intended to solve the same or similar problems, but unless they are integrated their effectiveness will be compromised.

A model for knowledge integration

To understand the issues underlying knowledge integration, it is necessary to develop a clear picture of how various knowledge areas are related and how integration is facilitated or impeded by various factors. The diagram above shows some of the more important linkages.

The design or architecture of a product influences many things. It has a strong influence on the selection of materials from which the product will be made. Both, in turn, influence the choice or specification of process equipment and the specification of the production process. All of these choices then influence how the process will be operated and controlled. Each of these decision areas requires the possession of a body of knowledge which informs the decision. However, the process is never as linear as the diagram implies. For example, process control capabilities in a particular site may influence the choice of process and, ultimately, the product design. Moreover, things change, and changes in any decision area will affect choices 'upstream' and 'downstream'. For this reason, it is important to integrate the knowledge across both different functions and across the various geographic sites. Some approaches to design can reduce the need for knowledge integration. For example, when products can be modularised, a change in a component may not affect the overall design of the product in which it is used or the process by which that product is produced.

The means to bring about integration will be strongly influenced by two factors: the type of knowledge to be integrated and the configuration of the operations network.

Impact of knowledge type

It is well understood that it is easier to transfer explicit knowledge than tacit knowledge and, for this reason, it is desirable to convert tacit knowledge to explicit knowledge wherever possible. Similarly, it is much better to transfer an understanding of why something must be done rather than just a set of instructions about what must be done as this enables the recipient to respond to unexpected circumstances. Traditionally, the transfer of uncodified /tacit knowledge has been by secondment – the training of the 'recipient' in the 'sender's' location or the temporary transfer of a 'sender' specialist to the 'recipient' location, but success is by no means guaranteed. Fortunately, the availability of cheap, interactive audio-visual communication via the internet may offer a quicker and more cost-effective solution.

Knowledge integration may also be impeded by the difficulty of teaching or learning it (quantum mechanics theory, for example, is totally explicit, but nevertheless difficult to learn!) and when attempting to transfer similarly difficult concepts, it may be useful to simplify or use rules-of-thumb supplemented by some form of 'help line'. Another consideration is the loss of knowledge: if a process has been operated successfully for some time, the reasons for some of the manufacturing choices may be forgotten over time, when those who made them retire or move within the organisation. In such a situation, changing the process may give rise to unforeseen problems. A similar vulnerability exists when a process actually depends on an unacknowledged condition which, as mentioned before, might include factors such as humidity, temperature and air pressure.

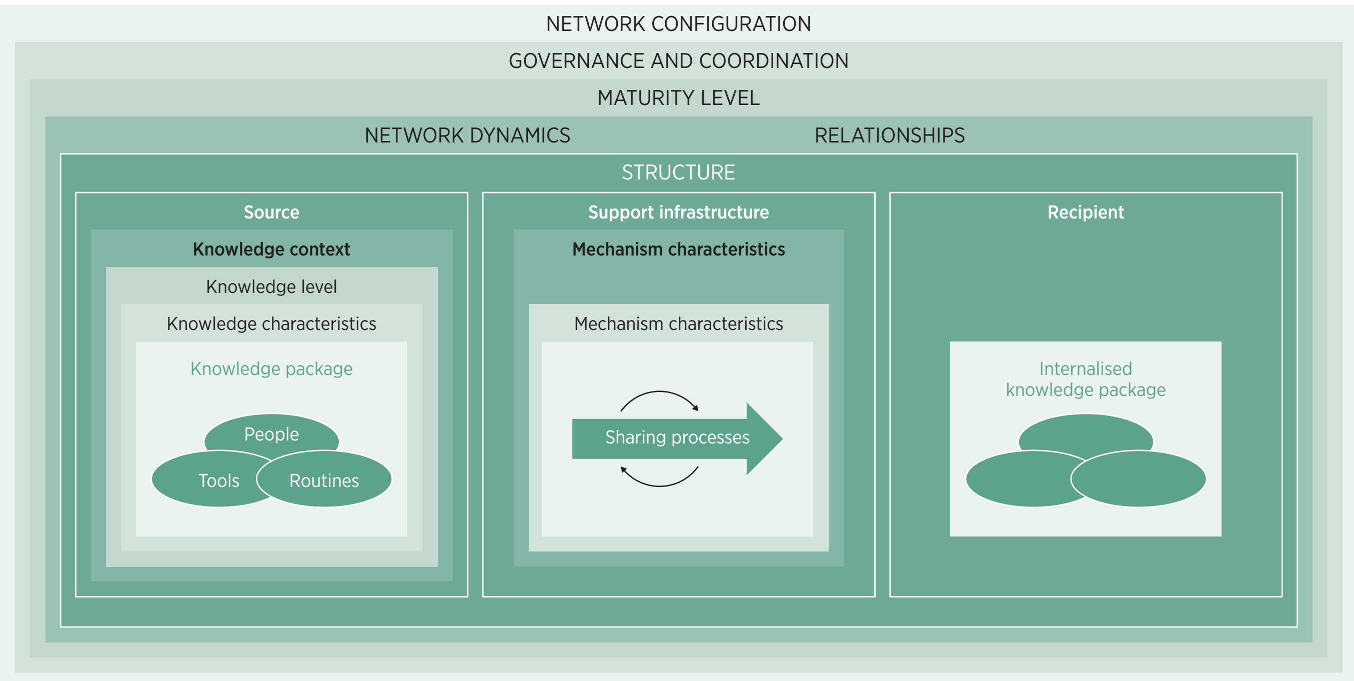
Impact of network configuration

As discussed in relation to end-to-end supply, product architecture has a strong influence on the configuration of the operations network. Nevertheless, companies have some degrees of freedom in selecting their network configuration and they may have more or less well-developed capabilities to manage it. Recent CIM research examining the relationship between network configuration and knowledge integration mechanisms has extended and refined the dimensions and sub-dimensions of the latter. By examining knowledge integration mechanisms within the context of network maturity, the research has illustrated how both the knowledge integration task and also the available knowledge integration mechanisms are modified by network maturity and industry context. As a result, not only will the choice of integration mechanism be influenced by the type of knowledge being transferred, it will also be influenced by the industrial context and the maturity of the network within which the knowledge is being integrated (see figure below). This more nuanced approach has been used successfully as a basis for a proactive and differentiated approach to knowledge integration within the network.

Looking ahead

Knowledge integration across global value networks of diverse, specialist players is increasingly important and is arguably becoming a strategic differentiator. CIM research in this field goes back to 2004 (see pages 76 and 77 for key publications) and has resulted in a number of innovative concepts and frameworks. Activities are ongoing to convert these concepts into practical business methodologies that can be used by companies and network partners who wish to exploit the synergies available from network coordination. These methodologies focus in particular on the capture of tacit knowledge and the establishment of dynamic knowledge transfer network configurations.

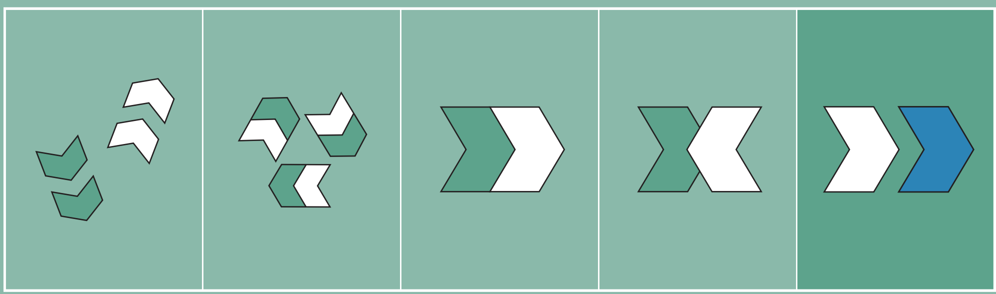
The implications of knowledge type and extent on the transfer of production processes are covered in a series of CIM workbooks which use the concept of 'Fitness for Transfer'. These workbooks have been used by many companies to help identify and manage potential problems. See www.ifm.eng.cam.ac.uk/resources/workbooks/ for more information.



Linking knowledge integration to network maturity and context

2.5 E-COMMERCE-DRIVEN 'LAST-MILE' LOGISTICS

Jagjit Singh Srai and Tomás Harrington



Recent years have witnessed the development of new routes-to-market involving specialist 'last-mile' consolidation and distribution service providers. In the business-to-consumer (B2C) context, this has been largely driven by the need for improved service delivery and the rapid growth in e-commerce-based supply chains. However, sustainable development has also been a key driver, with many business-to-business (B2B) applications seeking to reduce congestion (as well as costs) through smart consolidation practices that deliver 'just-in-time'. Building on the supply network design configuration and capability tools developed for multinational companies and presented earlier in this report, the Centre for International Manufacturing has developed a last-mile methodology which addresses the interests of the various stakeholders – institutional players, companies and customers.

Background

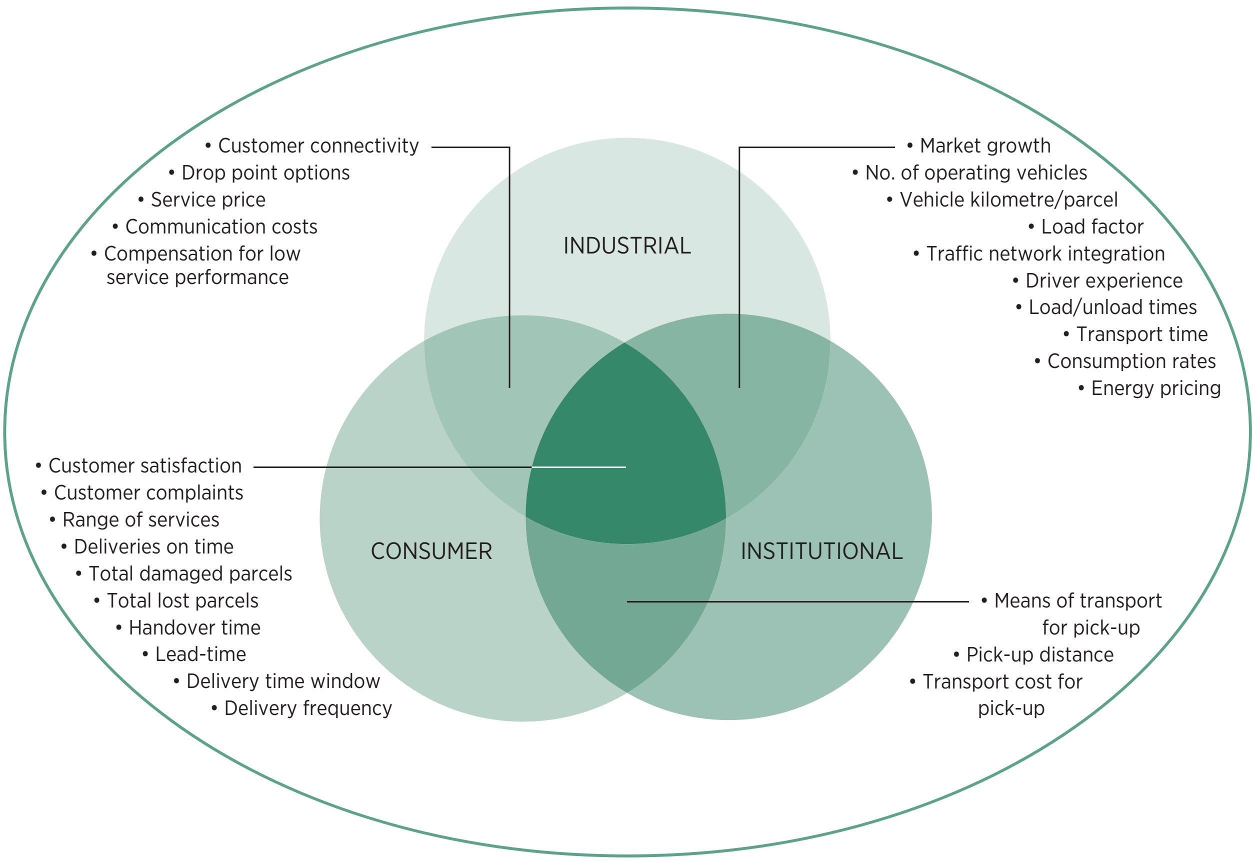
In 2009, CIM (as academic lead partner) began research on two application projects emerging from the UK Technology Strategy Board (TSB) 'Informed Logistics' call. These projects looked to develop new innovative supply network delivery systems and service models in last-mile logistics. In parallel, a number of research projects have considered the impact of e-commerce supply chains on the changing value propositions possible for customers, retailers and manufacturers, driven by changing customer behaviours and postponement strategies.

The importance of the 'last mile'

CIM research in this area has shown that many last-mile delivery models require close collaboration between the manufacturer or retailer and the end customer. In consolidation models serving multiple manufacturers and one or more end customers, the role of local government institutions is also critical in enabling, and sometimes promoting, these alternative delivery models. Local government often has significant impact on traffic movement, secure supply and business development and can play a critical role in the design of the 'last mile' by, for example, regulating access and pricing, supporting freight transportation infrastructure and reducing congestion to lower carbon emissions. In addition, small logistics providers often need the support of local institutions in order to prove the benefits of new last-mile concepts and business models.

Overview of the approach

CIM has developed a multiple stakeholder approach to the design of last-mile systems. The approach is illustrated in the Venn diagram below, which shows the three major stakeholders – industrial, institutional and consumer – with the areas of overlap highlighting the common areas of interest between the different stakeholders regarding the last-mile logistics system and how it delivers service benefits to the end customer. For example, the industrial/consumer interests include factors such as improved service and lower costs; industrial/institutional interests include factors such as improved traffic management; the institutional/consumer interests include factors such as transport and pick-up logistics. The middle of the Venn diagram shows the areas of common interests of all three stakeholder groups, including factors such as customer satisfaction and overall service performance.



Overlapping interests of key stakeholders in last-mile logistics systems

Mapping the configuration of last-mile logistics systems

The multiple stakeholder analysis described above provides a framework against which the last-mile logistics system can be configured. The diagram below illustrates the multi-layer approach used to guide this configuration process which is structured to fit the same three stakeholder groups of institutions, industry and consumers. This visualisation approach helps to define the main flow principles of the last-mile system at different levels of granularity covering vehicle types and movements, consolidation centres and drop points, and customer pick-up arrangements.

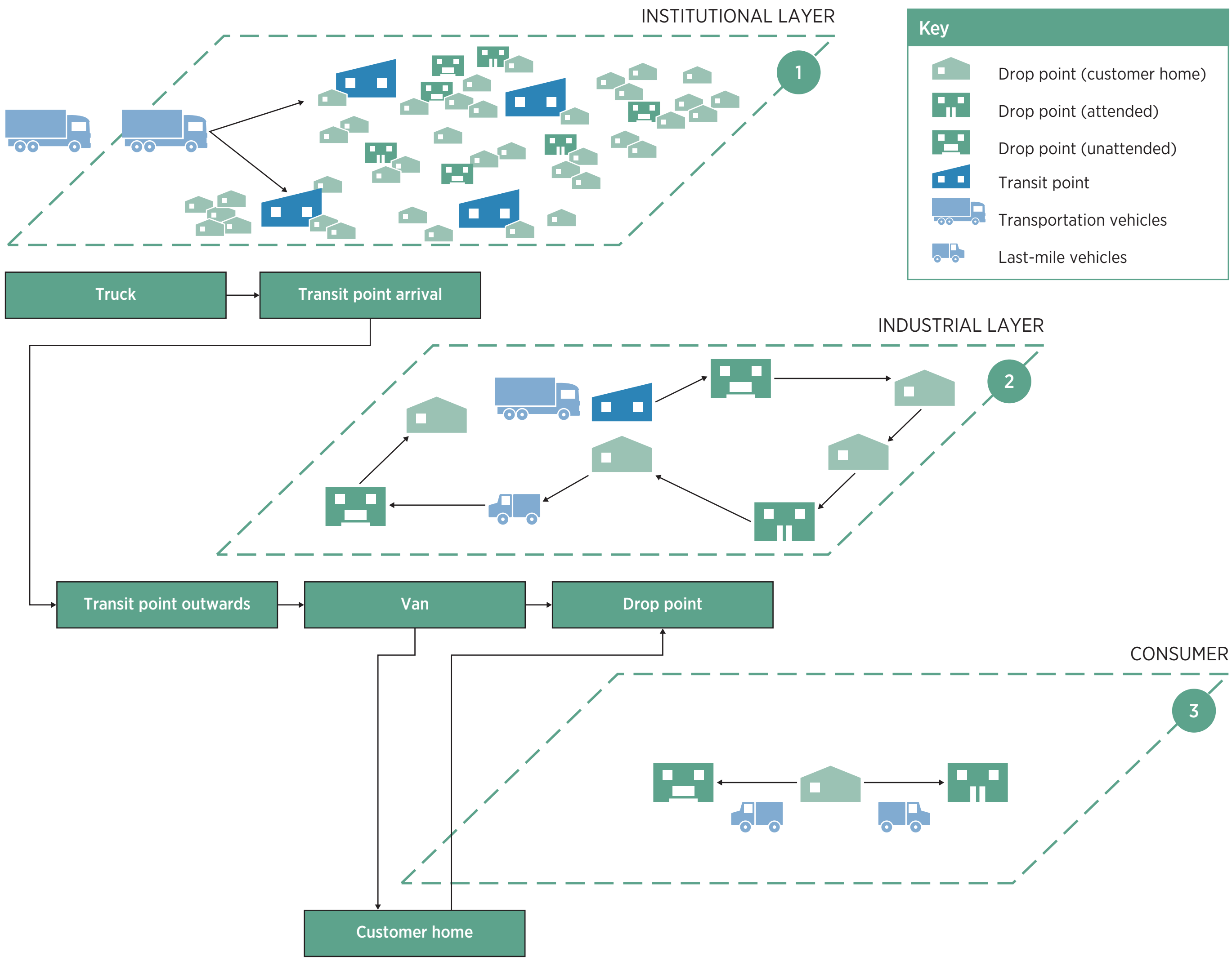
The approach was used in two UK-government supported projects to develop a future vision for e-commerce-based last-mile logistics systems. These projects focused on consolidation-and-service providers operating in the 'last mile' using e-commerce channels. The approach resulted in:

- the development of a multi-stakeholder metrics framework involving each of the main stakeholder groups
- the development of a two-echelon supply chain design for the 'last mile' involving a consolidation step that enabled a 'pull'-based customer model
- a better understanding of the requirements of customer, industrial and institutional players
- exploration of the usage habits of actual users, including their key drivers and motivations.

These projects are described in more detail in the following case studies.

Looking ahead

Building on this research, CIM is currently involved in a series of projects involving reconfiguration within an e-commerce context. These explore how consumer behaviours and preferences might change in terms of product range and type, and how supply models might be improved in the light of specific ordering and pick-up/delivery models. This research is leading to the development of novel supply chain models for 'high value' products, with the focus on developing range, growing niche brands and enhancing sales opportunities whilst minimising inventory across the supply chain. It also involves development of joint retailer-manufacturer replenishment capability, incorporating opportunities for third-party consolidation, transport sharing and assessing alternative retailer-manufacturer configuration models through the development of future scenario options.



Multi-layer approach for configuring last-mile logistics systems

APPLICATION CASE STUDY:

Business-to-consumer

This project focused on the delivery of packages to the home, driven by an online portal and supported by a packaging consolidation centre located next to a densely populated urban environment.

Background

The total UK postal services market was valued at £11bn in 2007/2008, including £4bn in courier and express delivery items and £1.5bn in parcels. At present, UK logistics providers report that 30% of small packages dispatched to customer homes fail to be delivered first time, resulting in poor customer service and avoidable logistics inefficiencies. This, in turn, results in larger numbers of delivery runs which exacerbate urban congestion, pollution and accident levels. For the general public, there are significant negative environmental and societal impacts caused by increased numbers of vehicles, which are often unsuitable for urban infrastructure. Failed deliveries significantly reduce the productivity of the logistics provider with lack of integration meaning many courier firms are engaged in multiple drops to the same urban area each day, with no value added to the consumer.

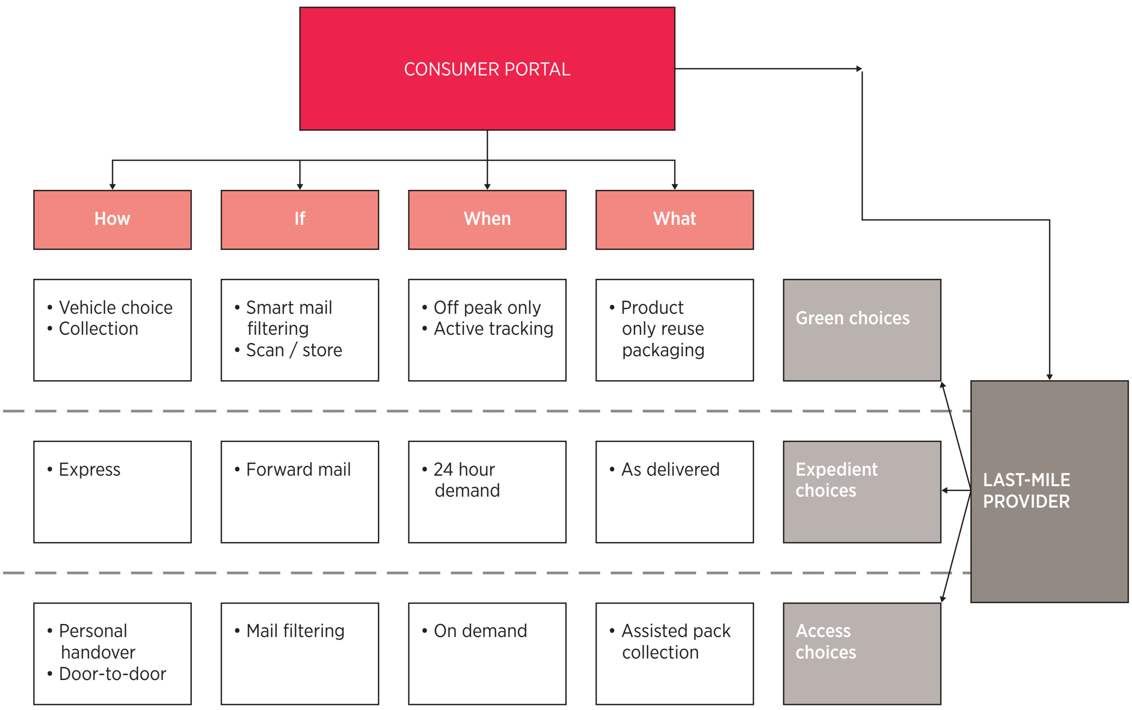
Initial results from the pilot suggest a significant improvement on first-time deliveries with successful delivery rates in excess of 99%.

Resulting supply chain configuration

The CIM approach was applied to develop a novel last-mile supply chain configuration. One key element of this is a 'consumer portal' as illustrated in the diagram below. This shows an innovative approach that enables the consumer to make informed decisions regarding the mode of last-mile delivery and to take control of timing, cost, reliability and 'greenness'. The approach also led to detailed mapping of the order/delivery system for a single parcel, and development of a physical consolidation centre that handles the incoming packages from the logistics provider for last-mile provision.

Benefits

The key benefits delivered by the project included improved consumer choice on delivery mode and timing, alongside improved service, reduction in congestion and improved environmental performance.



Consumer portal for selecting optimum last-mile delivery choices

APPLICATION CASE STUDY:

Business-to-business

The aim of this project was to assist the development of an Urban Construction Consolidation Centre (UCCC). Solutions were designed which would promote the efficient flow of construction materials through the supply chain to the workface on site, providing just-in-sequence consolidated supplies to multiple construction sites, reducing vehicle deliveries and reducing the impact of congestion, pollution and waste.

Background

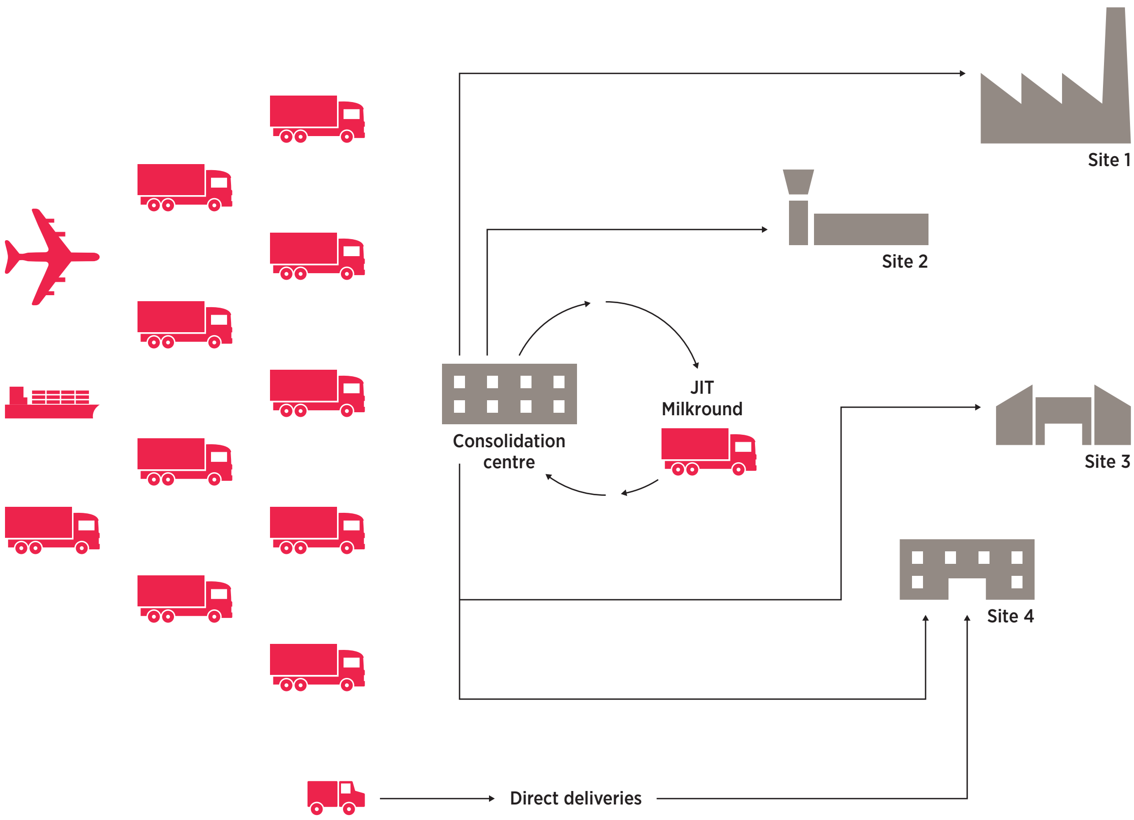
The challenges facing the UK construction industry reflect many of the inefficiencies in current practice. Of planned vehicle deliveries, 60% do not arrive on time and 20% of all UK waste comes from construction (15% from over-ordering of materials and there is nearly one hour of lost productivity per person per day on every construction project due to materials delay). This project looked at identifying the hard and soft factors that influence public sector approval in the context of UCCC to aid the development of a collaboration model between private companies and public resources, and then link the key processes and requirements of the stakeholders to inform the potential development of a new industry standard for the UK construction industry.

Resulting supply chain configuration

The diagram below shows how the role of the UCCC is to promote the efficient flow of construction materials through the supply chain to the workforce on site. Construction material is delivered to the UCCC, formed into work packs as defined by the various contractors, and delivered to the workface 'just-in-sequence'.

Benefits

This approach is highly innovative in terms of the design and operation of a semi-permanent UCCC spanning multiple projects with different start and end dates, served by just-in-sequence supply to local sites. This results in significant reduction in traffic congestion and consequent environmental benefits in addition to cost savings.



Urban construction consolidation centre for efficient material flow

CONCLUSION

Jagjit Singh Srai and Paul Christodoulou

A practical approach based on research

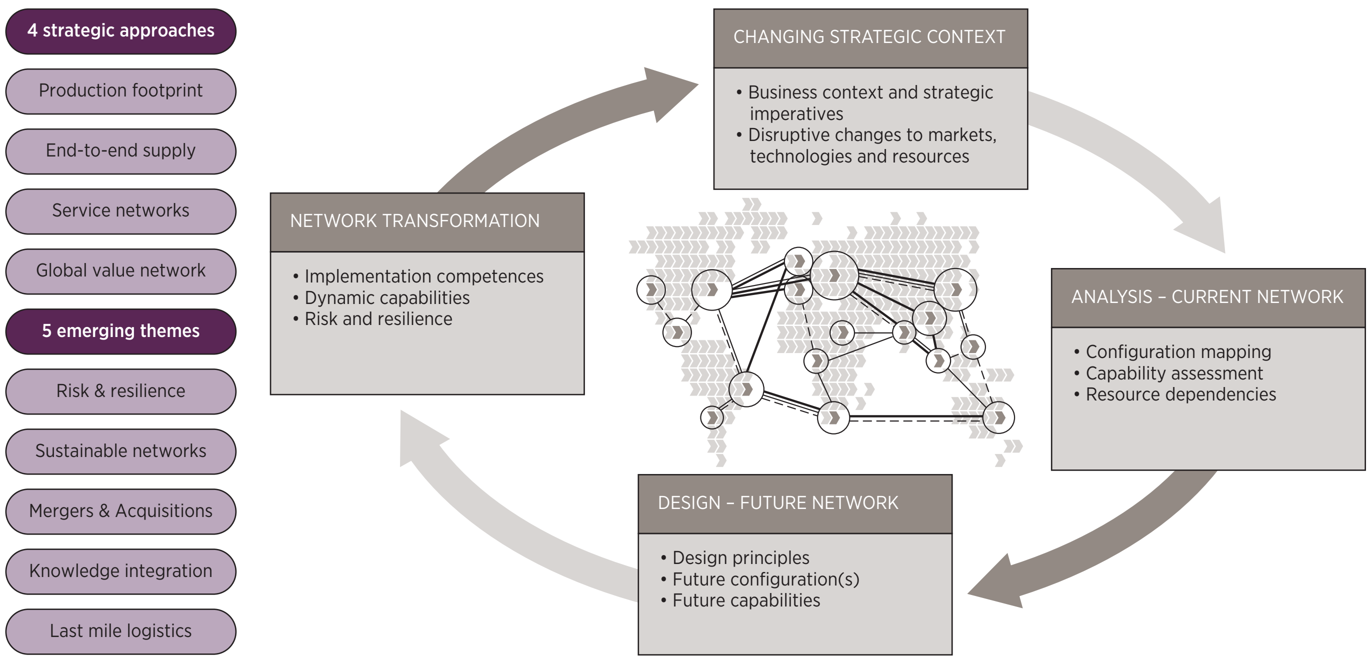
This publication has set out work undertaken at the IfM's Centre for International Manufacturing over recent years in the area of global value networks. CIM's activities are founded on research but it also designs practical support methodologies for industry and government that can guide strategic development and deliver real impact. The diagram below summarises the practical approach that results. This consists of a generic strategy process that can be applied by companies seeking to reconfigure complex global value networks.

This generic approach is applied at four levels – namely, production, end-to-end supply, service and total global value network, as described in Part 1 of this report. The approach also needs to align with five emerging themes which have high resonance regarding future trends – namely, risk, sustainability, M&A, knowledge integration and e-commerce, as described in Part 2 of this report. This generic process and modular, matrix approach aims to support all types of stakeholder and address a wide range of challenges.

Creating and capturing value for our stakeholders

The core mission of CIM's work in this field is to help manufacturing industry create and capture value by leveraging global operations networks. The value creation targets three main stakeholder groups – industry, government and academia. For industry, this means creating value for manufacturing firms at all stages of development, from start-ups to mid-size companies to major multinationals. For governments, it means creating value for broader society through the generation of high quality jobs and economic wealth, and includes governmental stakeholders at local, national and regional levels. For academia, CIM's activities involve collaboration with a wide range of academic partners – locally in Cambridge, nationally and internationally – in the common pursuit of new knowledge via a range of cross-disciplinary programmes.

We would like to thank the many individuals and organisations that have worked with us on major network collaborations over the last few years, including BAE Systems, Beiersdorf, Bombardier, Caterpillar, Electrolux, GlaxoSmithKline, Grundfos, Huntsman, Huawei, Invensys, Johnson Matthey, The LEGO Group, Rolls-Royce, Sealed Air, Schneider Electric, Shell, Unilever and Wavin. We would also like to thank our close collaborators in UK government, particularly at the Technology Strategy Board and the Department of Business Innovation and Skills, and international bodies such as the OECD World Investment team, United Nations Industrial Development Organization (UNIDO) and the World Economic Forum Supply Chain Risk Group. Last but not least, we would like to thank our academic partners: those within the IfM who focus on related topics in management, technology and policy as well as our wide network of international academic partners, especially those that contribute to the Cambridge International Manufacturing Symposium held each September. We look forward to strengthening these relationships – and building new ones – in the coming years, and on working together on the next generation of research and practical application that can help capture value in global operations networks.



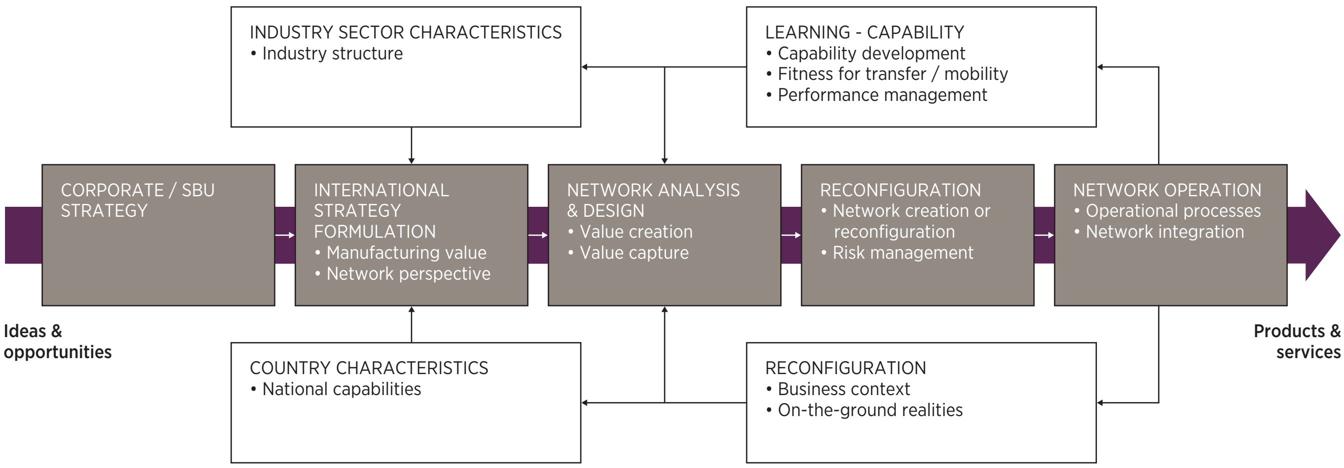
A generic strategy process using a modular approach

ABOUT US

- Our research
- Recent publications
- Research and practice team

Our research

The research domain covered by CIM is illustrated in the diagram below. This shows the core business process relating to international operations management which facilitates the transformation of ideas and opportunities into valuable products and services. The process starts with the translation of corporate strategy into international strategy, which is generally conducted at total enterprise and at strategic business unit (SBU) levels. The core activity at the centre of the process is network analysis and design, which is generally a long-term strategic process that results in visionary future scenarios aligned with major trends and drivers. The penultimate activity involves planning the reconfiguration required to deliver the vision, which often involves structural, transformative change. The final activity covers the day-to-day operation of the network, which needs to align with the design philosophy and the nature of the ongoing reconfiguration. The research domain includes two feedback loops for 'organisational learning' which are important for international operations management. The first involves learning in relation to 'capability', which covers the key capabilities required for managing network planning and transformation (including areas such as manufacturing mobility and performance management). This often requires tailoring to fit different industry sector characteristics, and this aspect is included as a further step in this feedback loop. The second feedback loop covers learning in relation to 'context', which covers business context and on-the-ground realities affecting international operations. This requires consideration of geographic variations and individual country characteristics, and these aspects are included as a further step in this loop. This domain provides a guiding framework for aligning all the research conducted in CIM, and for the integration of the strategic approaches that emerge from the research.



Research domain covered by the IfM's Centre for International Manufacturing

Recent publications

This selection of academic publications from CIM represents the underpinning research behind the methods, tools and real-world applications described in this report. The authors are always happy to engage with academics, practitioners and policymakers in developing the next generation of research and practice methodologies.

CONTEXT: INTERNATIONAL MANUFACTURING OPERATIONS

Srai, J.S. and Shi, Y.J. (2008) *Understanding China's manufacturing value chain*, University of Cambridge Institute for Manufacturing, ISBN: 978-1-902546-69-8.

Srai, J.S. and Fleet, D.E. (2010) 'Exploring the configuration of emerging country multinationals, in *The emergence of southern multinationals and their impact on Europe*, L. Brennan (ed.), Palgrave Macmillan, Basingstoke

Holweg, M. and Srai, J.S. (2013) 'Exploring interfaces: making the case for interdisciplinary research', *International Journal of Operations and Production Management*, 33 (7) 792–799

Brennan, L., Ferdows, K., Godsell, J., Golini, R., Keegan, R., Kinkel, S., Srai, J.S. and Taylor, M. (2014) 'Manufacturing in the World: Insights for the Future', *International Journal of Operations and Production Management*

Rezk, R., Srai, J.S. and Williamson, P. 'Product attributes as constraints on firms' configuration choices', *Journal of International Business Studies* (in review)

STRATEGIC NETWORK DESIGN

Configuring production networks

Shi, Y. and Gregory, M.J. (1998) 'International manufacturing networks – to develop global competitive capabilities', *Journal of Operations Management*, 16, 195–214

Colotla, I., Shi, Y. and Gregory, M.J. (2003) 'Operation and performance of international manufacturing networks', *International Journal of Operations and Production Management*, 23(10), 1185–1206

Institute for Manufacturing (2007) *Making the right things in the right places: a structured approach to developing and exploiting 'manufacturing footprint' strategy*, ISBN: 978-1-902456-61-2

Managing the end-to-end supply chain

Srai, J.S. and Gregory, M.J. (2008) 'A supply network configuration perspective on international supply chain development'. *International Journal of Operations and Production Management*, 28(5): 386–411

Srai, J.S. (2009) 'Process organisation, capabilities and supply networks – enterprise organization and operation', Chapter 15, *Springer Handbook of Mechanical Engineering*, Karl-Heinrich Grote, Erik K. Antonsson (eds.), Springer, Heidelberg, pp.1279–1290.

Lorentz, H., Kittipanya-ngam, P. and Srai, J.S. (2013) 'Emerging market characteristics and supply network adjustments in internationalising food supply chains', *International Journal of Production Economics*, 145 (1): 220–232

Srai, J.S. and Harrington, T.S. 'Characteristics of emerging industry supply networks: An exploratory study of supply network structure and dynamics', *International Journal of Manufacturing Technology and Management* (in review)

Srai, J.S. (2013). 'Redefining 21st century supply chains', *Journal of Manufacturing Leadership*, November 2013 16–23

Service supply networks

Srai, J.S. (2011) 'Supply network integration in multi-organisational network systems', *International Journal of Manufacturing Research*, 6(2): 122–133.

Zhang, Y. and Gregory, M. (2011) 'Managing global network operations along the engineering value chain', *International Journal of Operations & Production Management*, 31 (7), 736–764.

Harrington, T.S., Kirkwood, D.A. and Srai, J.S. (2012) 'Performance metric selection methodology for multi-organizational service network integration', *Journal of Applied Management and Entrepreneurship*, 17 (3), 20–35.

Harrington, T.S. and Srai, J.S. (2012) 'Defining product-service network configurations and location roles: a current and future state analysis framework for international engineering operations', *International Journal of Product Development* 17, (3/4), 228–253.

Configuring global value networks within industrial ecosystems

Srai, J.S. (2008) *North-West Automotive Cluster Report. University of Cambridge*, Institute for Manufacturing: Cambridge, UK

Srai, J.S. (2010) *A preliminary map of the UK Industrial Biotechnology supply chain*, University of Cambridge, Institute for Manufacturing: Cambridge, UK, ISBN: 978-1-902546-42-1

Srai, J.S. (2012) 'The big picture: capturing value from global supply ntworks'. *The Manufacturer*, 4 December 2012

Srai, J.S. and Christodoulou, P. (2012) 'Creating value in a global network', *Journal of Manufacturing Leadership*, November 2012

Srai, J.S. (2013) 'Value-chain configurations of emerging country multinationals', in *The Competitive Advantage of Emerging Market Multinationals*, Williamson P.J., Ramamurti R., Fleury A., Fleury M.T.L. (eds). Cambridge University Press, ISBN 9781107659414: 180-187

Srai, J.S. and Alinaghian, L.S. (2013) Value chain reconfiguration in highly disaggregated industrial systems: examining the emergence of healthcare diagnostics. *Global Strategy Journal*, 3: 88–108.

Mergers and acquisitions

Srai, J.S., Fleet, D.E., Bertoncelj, A. and Gregory M.J. (2010) 'An operations process framework for international M&A value creation'. *European Journal of International Management*, 4 (1/2): 3–29

Zhang, Y., Fleet, D.E., Shi, Y.J., Srai, J.S. and Gregory, M.J. (2010) 'Network integration for international mergers and acquisitions', *European Journal of International Management*, 4 (1/2): 56–78

Knowledge integration

Grant, E. (1999) *Fitness for transfer – assessing manufacturing technologies for relocation*, University of Cambridge Institute for Manufacturing, ISBN 1-902546-01-6

Minshall, T. (1999) *Manufacturing mobility – a strategic guide to transferring manufacturing capability*, University of Cambridge Institute for Manufacturing, ISBN 978-1-902546-02-5

Pongpanich, C. (2000) *Manufacturing location decisions – choosing the right location for international manufacturing facilities*, University of Cambridge Institute for Manufacturing, ISBN 978-1-902546-05-6

EMERGING THEMES AND TOOLS

Risk and resilience

Kumar, M. and Gregory, M. (2013) 'An exploration of risk management in global industrial investment', *Risk Management*, 15 (4): 272–300

Kumar, M. and Srai, J.S. 'Configuring resilient supply networks: a network configuration approach' (in review)

Kumar, M. and Srai, J.S. 'Understanding risk of food product safety in cross-border supply chains', *Journal of Supply Chain Management* (in review)

Sustainable supply networks

Kumar, M., Srai J.S., Pattinson, J. and Gregory, M.J. (2013) 'Mapping of the UK food supply chains: capturing trends and structural changes', *Journal of Advances in Management Research*, 10 (2): 299–326

Liu, K, and Srai, J.S. 'The role of supply chain management capabilities in green supply chain management', *International Journal of Supply Chain Management* (in review)

Srai, J.S., Alinaghian L.A. and Kirkwood D.A. (2013) 'Understanding sustainable supply network capabilities of multinationals: a capability maturity model approach'. *Proceedings of the Institution of Mechanical Engineers, Part B, Journal of Engineering Manufacture*, 227(4): 595–615

E-commerce-driven 'last-mile' logistics

Aized, T. and Srai, J.S., (2013). Hierarchical modelling of last-mile logistics distribution system. *International Journal of Advanced Manufacturing Technology*, 70 (5–8) 1053–1061, doi 10.1007/s00170-013-5349

Harrington, T.S. and Srai, J.S. 'A 'last-mile' supply network design and evaluation framework' (in review)

Jin, X. and Srai, J.S. 'Characterising and designing business-to-consumer distribution networks' (in review)

Contributions to government and industrial policymakers

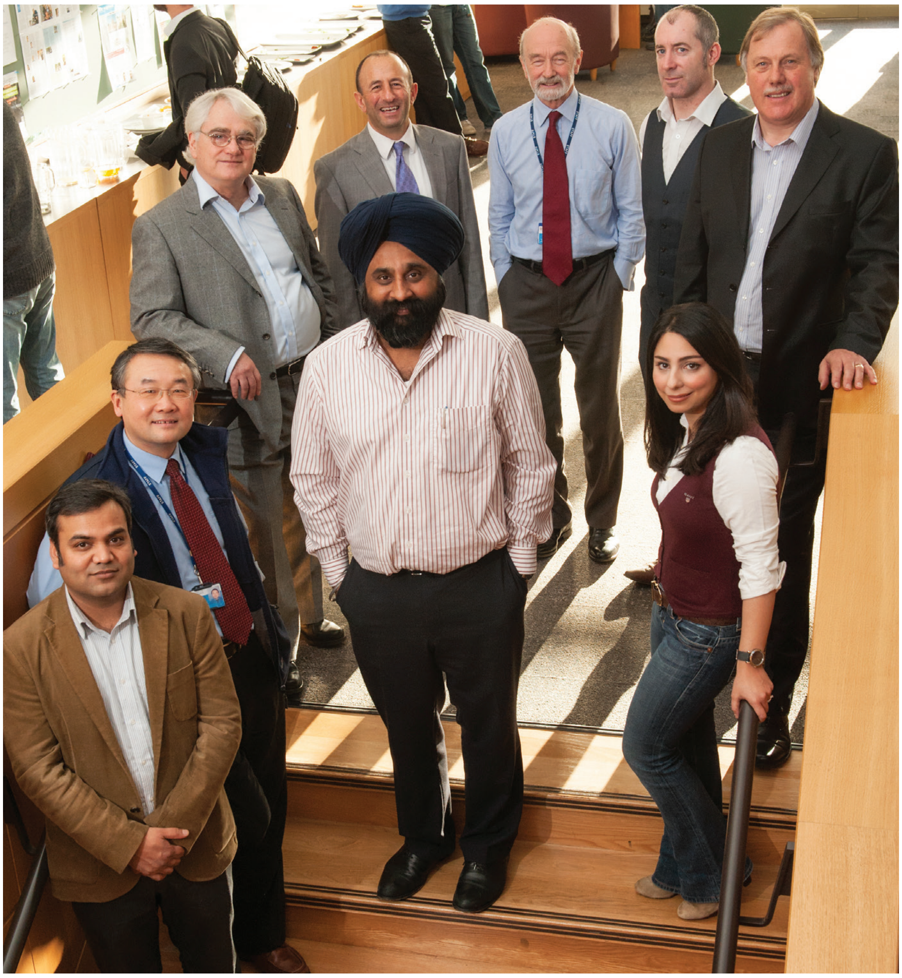
Review of UK Science & Innovation Policy, 'The Race to the Top' Report. Lord Sainsbury, HMSO (2007) – input to sections on UK manufacturing (with IfM colleagues)

The UK High Value Manufacturing Landscape, Technology Strategy Board (2012) – co-authored with IfM colleagues for the TSB

UNCTAD World Investment Report (2012) – *Non-Equity Modes of International Production and Development* – input to case studies and final report (Srai, J.S.)

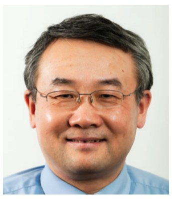
World Economic Forum Report on Supply Chain Resilience (2013) workshop and technical inputs from CIM (Srai, J.S)

Research and practice team



Paul Christodoulou joined IfM ECS in 2002 as a Principal Industrial Fellow and has led major collaborations with leading companies including Beiersdorf, Bombardier, Caterpillar, Electrolux, Grundfos, Huntsman, Invensys, LEGO, Rolls-Royce, Schneider Electric, Sealed Air, Shell and Wavin. Before joining IfM ECS, Paul spent 19 years in senior management roles in multinational manufacturing companies based in the UK, USA and France, working for Invensys, BOC, Blue Circle and Lafarge. Starting as a graduate engineer, Paul had leadership roles in production, design and sales before heading up corporate strategy projects covering global manufacturing, marketing, M&A and post-M&A integration. Paul has a first-class engineering degree from Durham University, an MBA (with distinction) from INSEAD, and is currently undertaking a part-time PhD at IfM in the area of global manufacturing.

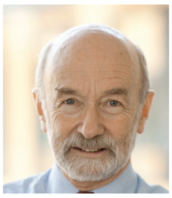
Mukesh Kumar is a Research Associate specialising in the areas of risk and resilience in international manufacturing and supply networks. He has developed risk management processes for global manufacturing investment decisions and supply networks. Before joining the University of Cambridge, Mukesh's previous roles were in the financial sector as a senior analyst and corporate finance consultant. He holds a PhD from the University of Cambridge in the area of Manufacturing Investment Risk.



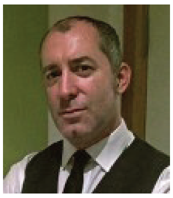
Yongjiang Shi is a lecturer in the IfM Masters programme on Industrial Systems, Manufacturing and Management and a key member of the CIM research team. Dr Shi is a former lecturer in the school of Economics and Management at Tsinghua University, Beijing, joining the IfM in 1994. He has undertaken extensive research into international manufacturing network configurations and has taken a leading role in the conceptualisation and delivery of the Centre's research programme. His research interests include global manufacturing virtual networks, business ecosystem development, and the strategies of multinational corporations in China.

Don Fleet's interest in global manufacturing footprint strategy developed during a 26-year international career in manufacturing/ supply chain with Unilever, where most recently he was director of manufacturing and logistics in Canada and then led the supply chain analysis team supporting the global product categories. He has developed this interest as a Principal Industrial Fellow in IfM ECS where, after a period in research, he now concentrates mainly on the application of research findings to help companies restructure. Don is a C.Eng and holds an MA and a PhD from Cambridge and a mid-career MBA (with distinction) from the University of Warwick, where he specialised in global manufacturing strategy.

Jagjit Singh Srai is Head of CIM, where he completed his PhD in Engineering, Manufacturing and Management. Jag's research – and that of his Centre – involves working closely with industry in the analysis, design and operation of international production, supply and service networks. Current research areas include global value network analysis, service network integration, supply network resilience, sustainable industrial systems network design, and the development of new forms of supply network that support emerging industries. Previous roles have been in industry working as a Supply Chain director of a multinational regional business, technical director of a national business and other senior management and front-line operations. Jag also has significant consultancy experience involving the application of the latest research with leading multinationals and government organisations. He holds a first-class honours degree in Chemical Process Engineering from Aston University and is a Fellow of the Institute of Chemical Engineers.



Mike Gregory is Head of the IfM. Following an early career in industry, he founded the Manufacturing Engineering Tripos, a senior undergraduate programme linking engineering, management and economics and with very close industrial engagement. Subsequent developments in research and collaboration with industry reflected this broad view of manufacturing and led to the establishment of the IfM in 1998. Mike's work continues to be closely linked with industry and government and he has published in the areas of manufacturing strategy, technology management, international manufacturing and manufacturing policy. He served as Executive Director of the Cambridge MIT Institute from 2005–2008 and was Springer Visiting Professor at UC Berkeley in 2008/9. He chairs the UK Manufacturing Professors' Forum and is a member of the UK government's Manufacturing Analytical Group. He is a Fellow of Churchill College and the Royal Academy of Engineering.



Tomás Harrington is a Senior Research Associate whose research interests include product-service network design, configuring nascent networks for emerging technologies and the mapping and analysis of value creation and capture in complex industrial systems and sub-systems. In addition to his research activities, he has been involved in a series of consultancy projects with leading multinational companies, through IfM ECS, and in the development of management tools for industry. Before joining CIM in 2009, he worked in industry in a series of senior product design and engineering roles with Intel. He holds Bachelors and PhD degrees in Chemistry and an MBA (with distinction) for which he received a Chartered Management Institute award in 2008.

Dennis Lewis a Principal Industrial Fellow with IfM ECS. He spent 20 years as a Unilever Senior Executive with Board, general management and global supply chain experience in FMCG brands. He was the regional supply chain board member for the Middle East, Turkey and Africa, occupied several managing director positions before that, and has extensive operational experience in Europe, Middle/Far East, Africa and Latin America. Dennis holds a DPhil in Chemistry and is a Fellow of The Royal Society of Chemistry. His current focus of work in IfM ECS is on global supply networks, strategic technology roadmapping, technology intelligence and sustainability.

Leila Alinaghian is part of the CIM's research strategy team and is involved in case study research that supports the EPSRC Centre for Continuous Manufacturing and Crystallisation. She also runs the Research Capability Development programme at the IfM. Her research interests include supply network configuration and dynamic capabilities, research methodologies in operations management and value network analysis in Healthcare. Leila has a Master's Degree in Industrial Engineering and an MPhil in Industrial Systems, Manufacture and Management from Cambridge for which she was awarded a Certificate of Commendation for her outstanding academic performance.

The Centre for International Manufacturing organises a Symposium in Cambridge each September aimed at bringing together leading industrialists, policymakers and academics to share their experiences and views.

Please see
www.ifm.eng.cam.ac.uk/events
for more details.

INSTITUTE FOR MANUFACTURING (IfM)

The IfM is part of the University of Cambridge. By bringing together expertise in management, technology and policy, the IfM addresses the full spectrum of industrial issues to help industry and governments create sustainable economic growth.

CENTRE FOR INTERNATIONAL MANUFACTURING (CIM)

CIM is one of the IfM's main research centres. It focuses on strategic and operations management research in close collaboration with industrial partners. The Centre has developed a strong industrial-policymaking-academic community and provides expertise and support in the area of international manufacturing and global value networks, with particular focus on capability development, strategic network design and briefing on globalisation and international manufacturing for industry and government.

IfM EDUCATION & CONSULTANCY SERVICES LIMITED (IfM ECS)

IfM ECS works with companies of all sizes to create and capture value and with national and regional governments to support and grow their industrial sectors. It does this by transferring the new ideas and approaches developed by researchers at the IfM through a programme of education and consultancy services. CIM research is disseminated via IfM ECS through collaborative projects with companies and governments. These projects involve teams of senior researchers and experienced practitioners working closely with senior client teams, leading to significant business benefits.

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