LOGISTICS AND SUPPLY CHAIN DEVELOPMENT: PART TWO
Design of, and Design for Logistics

David Newlands and Derek Steeple, Coventry University

This is the second of a three part series focusing on logistics and supply chain development. This article builds on part one by examining some of the **design for,** and **design of** issues that impact on the competitive advantage of supply chains.

In general industrial terms, Western manufacturers focus on product design as a facilitating element of value creation. Japanese manufacturers focus had been on process design - plant layout, minimised reverse flow, production line flexibility and extensive use of long term contract suppliers. To achieve and sustain world class performance, manufacturing supply chains must be optimised to suit the products they produce, and equally, the products must be optimised to suit the processes that will be available during the time they are being produced.

THE DESIGN DILEMMA

There are product design houses that rely on wild ideas to create off the wall solutions. These businesses find solutions by defining concepts, debugging the design and then finally setting specifications. In such businesses, knowledge and skills predominantly are intuitive. Semi-flexible and bureaucratic businesses in contrast conduct their design activities in accordance with broad guidelines. More autocratic businesses develop their designs strictly according to design checklists. These types of organisations demand provisional specifications before detailed design and type testing. This type of business focuses on commercialising existing technology and tends to be risk averse in the product development phase.

Perfect product design from a functionality and aesthetic perspective may be a disaster from a production efficiency and effectiveness perspective. The formalised processes for influencing product characteristics during their development stages is now generically called design for manufacturing. Design for manufacturing is the umbrella term used in the same way that quality is used to summarise many initiatives. As a specific subset of design for manufacturing, this article focuses on design of logistics and design of the product for logistics.

DESIGN OF PRODUCTS FOR LOGISTICS

Construction of Consumer Goods

Automobiles tend to have an aesthetically pleasing body. The body tends to be the substructure upon which running gear and trim components and modules are attached. The earliest point of variant for automobiles is either body shell construction - body in white, or at the paint booth. When the shell is painted red, the vehicle can only be sold to a customer that wants to buy a red car. This has implications on the level of finished goods obsolescence an assembler could create if they operate in a make to stock mode. In order to minimise stock, make-to-order is nominally used (even if the order is only coming from a dealer). Most mechanical parts for vehicles are reasonably generic. Variants for engines for instance may be limited to the engine management software that is flashed into the control unit at the end of the production line. The consumer is offered a range of standard specifications or can select the parts to be used from a pick list. Vehicles therefore tend to be assembled to order with a small demand backlog.

Ford's River Rouge Plant was constructed to build the Model T. Henry Ford designed the layout backward from completed product to components and raw materials. He stripped down the completed product piece by piece. Parts were then laid out available to the assembly line in a natural sequence to build up many copies of the original. In that way, Ford dramatically improved productivity. Japanese producers became recognised for optimising the production system through the promotion of total quality management and inventory control.

Electronic consumer goods are constructed from modules and sub-assemblies of pure electronics, electro-mechanics and mechanics. Smallest and lowest profile electronic components are mounted on PCBs first. Progressively larger components are then mounted. Most computer motherboards are large enough to have a single variant PCB. By changing the paste screen, a range of different packages can be surface mounted. This allows the producer to assemble to order with minimum stock holding costs. The modular board arrangement used in computers allows the assembler to kit up, assemble, quick test, configure and final test to the exact requirements of the individual order. Basic surface mount resistors and capacitors in sizes 0603, 0402 and 0201 are relatively low cost items. The sizes 0603, 0402 and 0201 refer to the number of thousandths' of an inch the components have in X and Y-axes. For example, 0201 is a component with a foot-print measuring 20 by 10 thou, that is approximately 0.5 by 0.25 mm. These components arrive on reels containing nominally 10 thousand components. Most components placed on PCBs can be individually inspected for damage, orientation and profile conformance to design parameters. Part placement machines are available to populate printed circuit boards at rates up to 40,000 per hour for 0402s.

Exterior protective and decorative components that create the shell around electronic and electro-mechanical assemblies are called 'mechanics'. This term is a contraction of 'mechanical sub-assemblies'. Mechanics include the decorative covers and in-mould-decorated windows. Mechanics are a key source of product variation and market niche differentiation. Customers can appreciate changes in colour, texture, shape and styling. The materials the mechanics are made of provide an opportunity for industrial designers to offer aesthetic product differentiation to suit various market niches.

Skin base materials are currently made predominantly in various polymers, folded sheet metal, and increasingly from aluminium, magnesium or other base alloys. Metal mechanics can be colour anodised. Aluminium and magnesium require additional surface treatments to ensure oxidisation is minimised [1]. Mechanics can be colour decorated using wet or ultra-violet (UV) cured paint systems. Plastic parts can be multishot moulded in various colours. Alternatively, plastic parts can be in-mould-decorated (IMD) on either internal or external surfaces. Computers tend to be constructed from just a single colour variant of mechanics - cream coloured goods for desk tops and grey for laptops. There are exceptions though these are targeted for consumers rather than business use.

Standards and expectations of aesthetic quality of external surfaces on consumer goods in some regions are more stringent that most others. Based on empirical evidence concerning the difficulty to enter markets, the quality of aesthetic finishes on consumer electronic goods produced in the West is lower than those produced and sold in Japan. Both of these issues cause distinct supply chain and logistics challenges for automotive and electronic assemblers.

LOGISTICS AND DESIGN RULES FOR AUTOMOTIVE AND ELECTRONIC ASSEMBLERS

Assemblers are predominantly system integrators. Their design rules focus on **(1) common interfaces** - for example the touch and mounting points, and protocols used to synchronise technical systems; and **(2) commonality and carry-over** - use of the same parts in many models in the family, and reuse of existing components and sub-assemblies in future products. These rules reduce the obsolescence risk and increase the probability that new products are developed on time; and **(3)** improve after sales service, and ensuring that consumers are 'tied' to the business for **upgrade and wear parts**. Automobiles and many electronic goods have some kind of opportunity to upgrade trim or performance of functional parts. Vehicles and some consumer electronics products have wear parts. Examples from vehicles include filters, spark plugs, tyres, brake pads, window wiper blades, and low cost exhausts. Electronic product examples include batteries, replaceable covers, rotating magnetic heads and drive belts.

There may be a danger of isolating the design and development activities undertaken in the parent organisation from the day-to-day activities in production plants in far off countries. This can be avoided by producing standard interface modules that can be fitted in the same way in all assembly plants despite their location. It may be attractive to outsource some research and development to companies in the target market, especially at the component and modular levels.

Ford Motor Company introduced their World Car concept where they design a vehicle in one place to suit the same market sector in all regions. This strategy serves to reduce the amount of product development and harmonises the expectations of the various regions based on the product's common industrial design. Minor changes in specification are nominally required for products to conform to regional or country specific regulations and requirements.

COMPONENT COMMONALITY, CARRY-OVER AND OBSOLESCENCE

The availability of high-end components made in all regions is a significant challenge for electronic consumer goods manufacturers. High-end technology electronic components including chip scale packages, micro ball grid array ASICs and manufacturer-designed integrated-chips are nominally only produced in limited locations. Silicon Valley in the USA and Japan lead high-end module manufacture. Leading edge components tend to be made in one or two Fabs. Later, as technology becomes mature, industry standard chip sets, such as Intel Pentium Processors and various RAM memory devices are made under licence in many more locations. There is little a company can do to reduce long component lead times except reduce the number of engineering change requests after the component has been verified.

Many generic electronic components tend to be the lowest cost surface mount components. Basic electronic components can be sourced from local and regional distributors, though these generally have additional handling overhead costs. Basic components have high commonality across product families and product lines. This contributes to lower the obsolescence risk and increases bulk order discounts. Some manufacturers recognise an imperative to reduce the number of components or modules in a product. Other manufacturers focus on balancing the production line and outsourcing more value adding activities to suppliers. The imperative in that situation is to increase suppliers' capacity.

If a generic type or brand of electronic product becomes popular, volume demand becomes significant in a very short period of time. Historic examples are the wireless, transistor radio, televisions, battery operated wrist watches, computers, 'Sony Walkmans', Discman's, games consoles and mobile phones. In the rush to make and sell popular products, electronics producers increased annual volume output year on year for fast moving consumer electronic goods. This strategy allows the assembler to establish the brand in the global market. The strategy then drives suppliers to produce ever more standardised components and modules that in turn reduce the differentiation in the hardware between assemblers' brands. Consequently, there is a major push on software as a differentiator. The computer industry is synonymous with a variant of this - configurability.

Assemblers' production data management systems must be able to cope with the diversity created by the ability to produce significant product variety. Customer defined product configuration ordering will then become achievable. Internet interfaces or point of sale requirement entry systems will be needed to service the customer in this mode of mass customisation. Implications of this for small to medium sized companies are significant. Supplier visibility of actual sales will be needed to ensure that make-to-order and make to replenishment service levels are maintained at their optimum.

DESIGN OF LOGISTICS

The re-engineering methodology developed and promoted during the 1990s focused on micro-logistics involved in business processes. In effect, re-engineering optimised the sequence of operations, minimised hand-offs, and stimulated the process of empowering employees [2]. Nominally, re-engineering practice and guidelines do not extend to redesigning the networks businesses that are associated with complex consumer products. A notable exception is McHugh [3]. Lean thinking provides some direction on this matter [4].

In general terms, design of logistics is a focus on the processes and infrastructure required to produce goods and services. As such, the emphasis falls on the fixed assets owned by the business and the assets that are made use of by sub-contractors supplying components, modules and sub-assemblies. Purchasing and operations in conjunction with other front line roles are probably too close and involved in their daily activity to step back and view the complete picture. The role of Logistics Analysts is to perceive the bigger picture and support the business by providing recommendations for strategic and business level decisions.

Logistics analysis should indicate that true just-in-time manufacture and delivery creates the conditions for high product mix variety with reduced safety stock and risk.

There are three considerable challenges for fast moving consumer goods manufacturers in high growth sectors. Firstly, the lead time for suppliers to create and bring on line capacity at their production facilities. Secondly, the amount of stock in the pipeline tends to be inversely proportional to the profitability of the business. These are core issues in the design of the demand/supply chain. Thirdly, the location and type of operating philosophy and practices that are used to impact on product variant production lead time and delivery lead times.

Companies can have a distinct impact on the profitability of their business by focusing on the location of plants and suppliers relative to the target market. The relative closeness of quality suppliers to their assemblers, combined with the Kanban practices to deliver just in time component and sub-assembly mix flexibility, serves to reduce the imperative to carry large inventories.

A significant benefit of final assembly in regions where products are to be sold is the avoidance of import duties. Transport costs reduce. Financial value for pipeline stock can be measured in days of supply (DOS). DOS reduces as more frequent lower volume shipments are made. The closer the suppliers are to the customer and the closer the customer is to the distribution channel, the lower the DOS becomes. This is a result of significantly reduced despatch and goods receiving volumes and safety stocks.

Making use of the suppliers, assembly plants, packing and distribution plants in the marketing country will impact on the value of DOS in the pipeline. The principle driver of this type of improvement is the elimination of strategically unnecessary shipments of high cost bill of material components and modules to lower cost countries and on costs of shipping to the market.

Direct overheads associated with production in the market region must be taken into account. Variation in the gross cost per unit can be related to the location they are produced in. A KPMG report [5] ranks Japan 41.4% more expensive to produce a comparable part in the US. In this study, Germany ranked 7.9% more expensive. The UK and Canada were the two industrially developed countries that were some 7 to 8 % less expensive than the US. These types of study only highlight localised micro-logistics costs.

The key questions then, are should the products be assembled in lower cost countries from bills of material that are sourced on a global basis, when the market is half way round the world? How much pipeline stock will be required for the range of scenarios? What is the scale of the opportunity available to companies by following just-in-time practices within the target market, even if that target market has higher direct costs per unit. To contribute to answering these questions, a quantitative analysis is presented in part 3 of this series of articles. The analysis focuses on the plant location and shipping frequency as the main determinants of reduced working capital measured as days of supply.

REFERENCES

[1] Creasy, T. "Metallic Moulding" *European Plastics News,* June 1999, pp27-32.

[2] Hammer, M. and Champy, J. *"Reengineering the Corporation: A Manifesto for Business Revolution",* Nicholas Brealey Publishing Ltd, London, 1993.

[3] McHugh, P., Merli, G., and Wheeler, W. *"Beyond Business Process Reengineering Towards the Holonic Enterprise",* John Wiley & Sons Ltd, Chichester, 1995.

[4] Womack, J. and Jones, D. *"Lean Thinking: Banish Waste and Create Wealth in Your Corporation",* Simon & Schuster, 1996.

[5] Thomas, C. "Location Costs Compared", *European Plastics News*. June, 1999:23.

About the authors

David Newlands is an Associate Member of The Institute of Operations Management. He has worked in various industrial positions, from his apprenticeship through to sales, system calibration, test engineering, lecturing and research into supply chain issues. He gained a BEng. in Manufacturing Systems Engineering and is completing his PhD in Business Resource Development, which includes Supplier Development and Benchmarking.

David is a part of the Business Support Unit, at the School of Engineering, Coventry University in the UK. Currently he is working with a major consumer goods manufacturer.

Derek Steeple graduated in natural sciences from Queens' College Cambridge and followed this by completing a PhD at Nottingham University. He has over twelve years senior management experience in manufacturing industry including product and process engineering development, production and materials planning, commercial and general management.

Since joining the school of Engineering at Coventry University Derek has spent the majority of his time working with industries to improve business performance. Part of this work has involved the establishment of management development programmes.

His current position is Head of the Engineering Business Support Unit and Director of the Manufacturing and Supply Chain Management Centre.