Building Cars to Customer Order

The Lean Legacy

More than two decades have passed since lean production was documented and the automobile industry set out to employ Japanese best practice to close the productivity gap recognised by international research groups. However, the industry still suffers in a climate of overcapacity, spiralling costs and perforated profits. While lean efforts have delivered considerable improvements in manufacturing efficiency, they’ve been largely ineffective in increasing profitability due to a myopic focus on factory processes. This article presents an overview of a current European project that considers the implications of a move towards the new paradigm: building cars to a tangible customer order.

Research conducted in the US indicates 74% of consumers would rather specify and order a customer built car and wait rather than simply buying one from the dealer’s stock. However, build-to-order (BTO) customers in Europe currently have to wait an average of 48 days for their European car to be delivered or 63 days for a Japanese model built in Europe (ICDP 2000). Most volume producers in European have instigated feasibility trials on Build-to-Order because they recognise the concept appeals to a considerable market. However, the most significant advantages are to be gained by the automotive companies who would benefit from reduced stock and increased profit margins by building the majority of their cars to customer order. The question for many automotive executives is not when but how, exactly, will such a radically ‘different’ business model operate?

Build to Order - ILIPT

The European Integrated Project ‘Intelligent Logistics for Innovative Product Technologies’ (ILIPT) is a consortium of thirty leading automotive focused partners with representatives from across Europe and throughout the supply chain. Their aim is simple - to define, validate and operationalise processes, product structures and supply network structures that enable the purchase and on-time delivery of a new, customer specified car, across Europe within a 5 day window. The project has three core themes. Theme 1 examines design and the product configurations necessary to achieve build-to-order, Theme 2 explores new concepts in delivering flexible production networks, the planning execution and ICT requirements and Theme 3 is developing novel methods and tools to model, assess and validate this radical business model and provide a transition path for industry.

Changing Product Design

Almost every vehicle manufacturer faces increasing product complexity and reduced lifecycle time, whilst having to develop and manufacture a larger number of variants within shorter time-to-market cycles. The solution requires a dramatic shift in thinking, away from production-push and economy of scale, towards customer-pull and economies of scope and involves reconsidering vehicles in terms of commonality; the process starts at the design stage.

A platform strategy enables car manufacturers to offer a complete range of product families, with different appearance, style and image, based on common and standardised technology. The platform strategy has been widely accepted over the last decade and provides a method for spreading the cost of development across many models. However, increasingly sophisticated consumers push auto-manufacturers to rapidly increase the number of models and model variants available on what is now a global market.

ILIPT has developed a digital prototype of a passenger vehicle. This uses a modular body and an innovative system of flexible body frame panels which break from the traditional unibody or ‘monocoque’ concepts that are in use today. The body frame is subdivided into four main modular pieces. Three and five-door hatchback, saloon and estate variants may be assembled utilising combinations of the modular elements as the separation of the body as a scalable frame functional structure from the styling surfaces allows for greater product variance. To aid assembly, the conceptual modular components developed have interfaces that utilise cold joining techniques while incorporating tolerance compensation to allow rapid assembly. Once the body frame is assembled the ‘body work’ styling surface is attached. The styling surface panels may be made from a number of different pre-coloured thermoplastic or thermoset plastic materials. Here again a reduction in components
through commonality of panels is achieved with all four conceptual variants sharing major panels. Using pre-coloured panels has further removed the need for a paint shop and lowers the production time, bringing associated cost savings.

Internally, a modular cockpit has been designed that may be configured to the customer’s specification off the main production line and installed in sequence.

Modularity allows a broader range of products to be delivered whilst maintaining low cost by maintaining a ‘handful’ of modules. This complements the ILIPT concept as economies of scale, scope and substitution can be achieved. Efficiencies of scale are achieved with components rather than products, allowing greater scope efficiency by the multiple configurations of those components into products. Greater efficiencies are provided by reduction of components and the increase commonality of between products. The concept is linked to delayed product differentiation, where the commitment of a product to its end form is delayed for as long as possible, facilitating fast market response.

The ILIPT approach towards large scale customisation of vehicles may suggest the introduction of high levels of additional complexity, but this is balanced by simplified ordering, product handling and reduced inventory. Approaches ILIPT can point to that limit the impact include process based approaches, such as flexible manufacturing equipment and product based approaches, such as and modularity or postponement which allow for high variety whilst reducing the level of component variation.

A fundamental issue for ILIPT is the reliability of the production and delivery system. An unreliable production and delivery process would create buffer stocks and perpetuate the stock push system. Therefore, a fundamental change in mindset is required to shift towards BTO and dramatic rises in flexibility and responsiveness across supply chain partners.

**New Process and Software Solutions**

ILIPT is contributing towards the development of future ERP tools that will monitor and view the movement of parts accurately and in real-time along with the variance between planned and actual production. The overall aim is making the connection between reality and electronic systems.

The flow of material and information, planning and control processes as well as supporting ICT systems, are pivotal concepts. Today, the flow of information between partners is frequently limited. The flexibility needed in supply networks to fulfil the demand of a 5-day-car will only be attained by realising new levels of collaboration in the supply network.

The current lack of system integration means new standards are required to support information exchange. ILIPT has identified, specified, and developed requisite tools and processes. These include a Virtual Order Bank (VOB) and new processes and data standards for capacity utilisation handling and planning.

Unfortunately, the current development of ICT infrastructure and systems within the automotive industry do not fulfil the new requirements for systems capable of interpreting the output of diverse formats (Howard et al. 2006). This is not an easy task and several collaborative initiatives of automotive companies have faltered in recent years. ‘Covisint’ was acclaimed to ‘herald a new era in purchasing and supply chain management’ and the founding auto-manufactures poured in $500 million. However, the project was shelved after rivalry from the competitors systems prevented new partners joining. The ‘Everest’ project, a collaboration between Ford and Volvo, was similarly abandoned, but largely because of system compatibility issues. Supply chain integration is still a major challenge for the automotive industry and ILIPT has tasked itself with a range of responsibilities that identify and address the main barriers to implementation. ILIPT is working on an interoperability model that links a diverse range of software from the various planning, production and customer requirements operations. All parts of the car must be described so that each software system knows what is meant when referring to a specific part or component. The system, capable of interpreting the output of diverse formats, moves the supply chain towards the goal of accurate, real-time monitoring and observation of the movement of parts, along with the variance between planned and actual activity.

**Validation and Transformation**

ILIPT’s theme 3 models and validates the process changes detailed and seeks to create a road-map for the transformation of the industry.
While variety helps marketing to entice new customers, developing and producing variety is both challenging and costly. Therefore, product variety defines a strategic interface between marketing, operations and customers. We find a trade-off between the choices offered in the marketplace, the volume of production and operations effectiveness. Subsequently, the cost of vehicle complexity has now become an important topic in the literature.

ILIPT has completed initial work, building a 'complexity' cost model, using data directly from an automotive production plant. The model has been developed based on an analysis of cost patterns against increasing complexity. Both information and material flows have been included. Preliminary analysis of predicted against actual cost data show high correlation and the case study company is already employing the model as a guide during scenario planning.

To validate and measure the transition to a BTO system a set of key performance measures have been developed. The KPIs fall into four groups: finance, process, structure, and resource. The measures all integrate within the proposed process and product structures and form part of ILIPTS supplier process simulation models. These models initially use static data sets to test the ability of potential supply networks to deliver a vehicle within timescale to a customer. Once a set of possible networks has been identified a second piece of software utilises dynamic simulation methodologies to identify the optimum supplier network to deliver the product on time. This methodology forms the basis of a prototype model that validates and demonstrates the potential of the ILIPT BTO concepts to deliver finished cars to customers.

The final stage of research will be to describe the transition path, from current state to the future vision of BTO. This aspect of the work embarks as the ILIPT concepts start to ‘firm up’. However, no matter how compelling the business case put forward, pioneering agents of change will be required to drive this radical agenda – a process we hope you will contribute to through our questionnaire feedback detailed at the end of this document.

Concluding remarks
Lean has delivered significant value to the automotive industry, but has not yet delivered on zero stock or on a just-in-time approach to customer order. The decoupling point, where build-to-stock becomes build-to-order, is all too frequently absent at the vehicle purchasing interface where both customer and financial drivers show it is desirable.

ILIPT represents a radical leap for the European automotive industry from the "stock push" and "mass production" thinking of the last century, to a stockless "build-to-order" (BTO) production strategy. This will require the re-invention of the complete automotive value stream from material producers to end consumers of cars, through a cost optimised system delivering what the customer really wants without delay. ILIPT is exploring three synergistic approaches through changes to the product, ICT and supplier network. ILIPT presents new modular products, flexible production networks, it addresses collaboration across complete value streams and interoperability of these processes. Finally, it provides novel methods and tools to assess and validate this radical business model for the European automotive industry.

The challenge for the industry and its leaders will be to rapidly transition to exploit the emerging ideas, processes and technologies. Most volume vehicle manufacturers have already expended a great deal of time and money attempting to achieve short delivery cycles based on true customer orders. The ultimate change agents may come from a number of different areas. Indeed, the first to market with an operational BTO system will generate a significant cost advantage that may be difficult to emulate.

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