Institution: University of Bath

Unit of Assessment: 19: Business and Management Studies

Title of case study: Changing Approaches to the Production of Cars

1. Summary of the impact

University of Bath research has contributed to a lean, 'build-to-order' (BTO) production strategy for the European automotive industry. The study of 'intelligent logistics' and supply chain configurations led to recommendations for building new production systems that are helping to address significant industry problems: global overcapacity, rising stock levels and low profitability. The research findings have been widely shared with vehicle manufacturers, suppliers, industry trade associations and government bodies, original equipment manufacturers (OEMs) and suppliers. The Bath research has had an impact on: the reduction of waste that is integral to the former 'build to stock' production model; the development of an environmentally friendly manufacturing approach; improved profitability through the reduction of 'inventory' (new cars losing value in large distribution parks); and on future innovation and growth challenges for the automotive industry. The research has influenced manufacturers and suppliers seeking to implement a more flexible automotive component supply chain across Europe.

2. Underpinning research

Over the past fifteen years, the 'built-to-order' model of car production has challenged the automotive industry to reduce waste, to be more environmentally friendly, and to produce benefits for the industry that can improve profitability. The former production model (build-to-stock) led to a surplus of 'inventory' – new, unsold cars that are parked over long periods in large distribution sites. University of Bath researchers have estimated that lead manufacturers may hold approximately €10 billion of inventory in distribution parks across Europe (reference 1). Research conducted in the School of Management on innovation in the automotive industry has focused particularly on the implementation of a BTO production strategy and generated research insights with high practical relevance for this industry. The research has been led by Prof. Andrew Graves (Bath since 1994), Director of the Lean and Agile Research Group (LARG). It has included the following Bath academics: Howard (Mar 1999 – Sept 2007), Miemczyk (Apr 1999 – Aug 2006), Parry (Jun 2005 – Jan 2007) and Squire (Bath since Sept 2010, Professor since Nov 2012).

We provide two examples of research projects that have led to commercial impacts based on the development of new thinking and therefore new approaches to car production:

(1) The '3DayCar' project (1999 – 2001) was a collaborative research project with the goal of designing a system wide process within which a customer's need for a vehicle could be fulfilled within 3 days. The project was funded by a £1.5 million EPSRC grant with partners at the University of Cardiff and the International Car Distribution Programme. Initially, the research mapped the lead time and process of a customer's order through the system. Using value stream mapping techniques, the research findings indicated an average delivery time of 39.8 days. Analysis of the processes responsible for this delay revealed that only 1.4 days was attributable to physical production, compared to 38.4 days of order processing and distribution. The research showed car manufacturers the benefits of a focus on reducing order processing and distribution delays rather than on further attempts to improve factory operations and production (reference 1). This research therefore set the agenda for the investigation and development of 'intelligent logistics' and the innovative production technologies needed to implement them.

(2) The 'Intelligent Logistics for Innovative Product Technologies' (ILIPT) project (2004 – 2008) was a four-year, joint European Commission and industry-funded project (€9 million of funding in total) designed to investigate the findings of the '3DayCar' project within a European context. This also became known as the '5DayCar' project (reference 1 and sources 4 and 7). The project consisted of 31 project partners across eight EU member states and participants from Russia, Brazil and

Switzerland. ILIPT was divided into three work packages: (WP1) product configuration and customisation for build-to-order supply chains; (WP2) new concepts in delivering flexible production networks; and (WP3) integration of complex processes. The University of Bath led the third stream and participated directly in the other two.

Research attributable to the University of Bath focused on motivation and barriers to ICT adoption, innovative product design, logistics design and the environmental impact of the BTO model (reference 1). More specifically, published research findings highlighted: (1) the problems associated with information technology delays in the supply chain, and particularly the dissonance between the expected and realised benefits of e-hub technology (reference 2); (2) the benefit and implementation barriers of supplier parks (reference 3); (3) the implications for inbound and outbound logistics (reference 4); (4) the global implementation of supply chain strategies for build-to-order (reference 5); and (5) the implications of BTO for product design (reference 6).

3. References to the research

1. Parry, G. and Graves, A. (Eds.) (2008). *Build To Order - The Road to the 5DayCar*. Springer: London. 465 p. 160 illus., Hardcover, ISBN: 978-1-84800-224-1 (http://www.springer.com/engineering/mechanical+engineering/book/978-1-84800-224-1?cm_mmc=Google-_-Book%20Search-_-Springer-_-0)
2. Howard, M. (2005). Collaboration and the '3DayCar': a study of automotive ICT adoption, *Journal of Information Technology*, 20: 245–258. DOI:10.1057/palgrave.jit.2000050
3. Howard, M., Miemczyk, J. and Graves, A. (2006). Automotive Supplier Parks: An Imperative for Build-to-order? *Journal of Purchasing and Supply Management*, 12 (2): 91-104. DOI: 10.1016/j.pursup.2006.05.001
4. Miemczyk, J. and Holweg, M. (2004) Building cars to order: What does it mean for inbound logistics? Journal of Business Logistics 25 (2): 171-197. DOI: 10.1002/j.2158-1592.2004.tb00186.x
5. Miemczyk, J. and Howard, M. (2008). Supply Chain Strategies for Build to Order: Managing Global Operations, *Supply Chain Management: An International Journal*, 13 (1): 3-8. DOI 10.1108/13598540810850265
6. Howard, M. and Squire, B. (2007) Modularization and the impact on supply relationships, *International Journal of Operations and Production Management*, 27 (11): 1192-1212. DOI: 10.1108/01443570710830593

Associated Grants:

- EPSRC IMRC (Innovative Manufacturing Research Centre) Grant, 2001-2006, 5-year funding to take forward research on lean manufacturing across the aerospace/ construction/ automotive industries: £2,245,000.
- EU ILIPT, Bath, (July 2004 – December 2008) €402,215 (£290,408).
- EU ILIPT, Bath, extension funding (July - December 2008) €97,000 (c. £70,000).

4. Details of the impact

Since 1999, this research has helped to change the ways in which the automotive industry thinks about the production of cars. At that time, built-to-order was a challenge to the conventional wisdom of the manufacturing process. In the past fifteen years a series of well-funded UK and European research projects, involving academics from the University of Bath, have helped this way of thinking to become established as an industry norm. Bath research has contributed to specific aspects of intelligent logistics in practice and has informed ongoing developments in the processes that underpin intelligent logistics. Bath research has contributed to improved profitability through the dissemination of insights into lean production strategies. BTO has helped to decrease waste through processes designed to reduce ‘inventory’. Research at Bath continues to support the development of innovation and growth strategies and to provide recommendations to both industry and government. For example:

(1) *Profitability*: As a result of sharing research findings on intelligent logistics, vehicle manufacturers, suppliers, industry trade associations and government bodies, original equipment manufacturers (OEMs) and suppliers have coordinated changes to support a leaner, smarter BTO production strategy built on an improved and more flexible automotive component supply chain across Europe and "profoundly affected the car ordering and manufacturing system" (Member of the European Parliament, source 1). A specific example of how Bath research has contributed to this is in the development of 'spaceframe' technologies, designed to increase model variety and reduce delivery times. Manufacturers have used these technologies to highlight changes to core industry configurations (source 1). Through their application of the BTO approach, manufacturers have been able to see "improvement in productivity and increased profit margins which have been reinvested in new technologies, materials, working methods and outsourcing strategies as defined by Professor Graves' research" (Strategy Director, Morgan Technologies, source 2).

(2) *Disseminating the BTO Approach*: Several major manufacturers have BTO initiatives in place, which underscores the degree to which industry leaders are committed to implementing the research findings. These include: BMW, DaimlerChrysler, Siemens, ThyssenKrupp Automotive, TRW Automotive, Dana Corporation and Hella Autotechnik. BMW's Internal Consulting Division requested copies of 'Build To Order: The Road to the 5DayCar' (reference 1) and continue to develop BTO expertise as a potential core competency. Bi-Monthly research workshops were hosted by partnering companies around Europe, such as ThyssenKrupp, CLEPA (European Association of Automotive Suppliers) and VDI/VDE-IT at which Bath academics disseminated the research. The CEO of CLEPA has said that that "the Road to the 5DayCar Bath research provides us with a vision of a sustainable future" (source 5). The EU's Information, Society and Technologies (ICT) web pages highlight the 5DayCar as 'high impact ICT research' with 'results that lead the way' (source 3). The project's final public event took place in February 2009 where research findings, posters and a production line simulation were featured at AutoWorld in Brussels. The Bath research was covered extensively in the automotive press, both in Europe and the USA (source 6).

(3) *Innovation*: In April 2008, the Director of LARG (Prof. Graves) was invited to become a member of the New Automotive Innovation and Growth Team (NAIGT). This industry-led project was launched to develop a collective strategic view from the automotive industry highlighting the innovation and growth challenges it faces in the years ahead. (Members of NAIGT include representatives from BMW, BERR, Bosch, GKN, JCB, Nissan, Jaguar/ Land-Rover, RMSG, Ricardo, SMMT, the Technology Strategy Board, the Universities of Bath, the University of Cambridge, and automotive consultants). The NAIGT's report, along with a study examining the competitive status of the UK automotive industry, has been instrumental in shaping a vision for the automotive industry and specific recommendations to Government and industry to achieve this (source 4). In 2009, Professor Graves was asked to participate in the Gordon Murray Design Ltd. (GMD) project for a new prototype electric sports car, the TEEWAVE - T27. This project harnesses innovative production methods, using 'iStream technology' to enable a car's powertrain and all major components to be fitted directly onto the chassis prior to fitting the body panels and then being delivered to the end of the line. "The revolutionary manufacturing system (iStream) totally changes the economies of scale and cost base of producing cars and was a key finding of the 3/5 Day Car Programme" (Chairman of GMD, source 5). This project has attracted a £4.5m development grant from the Technology Strategy Board and demonstrates the continuing importance of the Bath research in this area (source 5).

5. Sources to corroborate the impact

1. Testimonial letter from the MEP for the West Midlands on the importance and influence of the 3/5DayCar projects and the BTO research at Bath.
2. Testimonial letter from the Strategy Director, Morgan Technologies, that Bath research on BTO has helped manufacturers to improve profitability within the car industry.
3. The EU Information, Societies and Technology web page that highlights the 5Day Car as high impact research http://cordis.europa.eu/ictresults/index.cfm?section=news&tpl=article&ID=90487

4. The NAIGT report and study of competitiveness of the UK industry.
5. Testimonial letter from the Chairman of Gordon Murray Design Ltd. to corroborate the influence of Bath research and involvement of Bath researchers in future innovation.
6. A portfolio of press articles from 2008 highlighting the 5DayCar project**:** (a) The Five-Day Car Project, *Automotive Logistics Magazine*, November; (b) Europe Considers the 'FiveDayCar', *Automotive Engineering International*, October; (c) Innovative 5DayCar, *Engineering Magazine*, September; (d) The 5DayCar will feature Lightweight Materials, *Assembly Magazine USA*, 13th August; (e) 5DayCar could cut industry's Carbon Footprint, *Environmental Data Interactive Exchange* – edie.net on 1st August and Climatebiz.com on the 5th August; (f) Build-to-Order – Fast and Eco Friendly, *Materials World*, July.