CUSTOMIZATION EXPERTS – ANALYSING KEY CENTRES OF EXPERTISE IN THE FRONT-END OF THE ORGANISATION

Jo Bramham
Operations Management Division, Nottingham University Business School,
University Park, Nottingham, NG7 2RD, United Kingdom
johanna.bramham@nottingham.ac.uk

Bart MacCarthy
Operations Management Division, Nottingham University Business School,
University Park, Nottingham, NG7 2RD, United Kingdom
bart.maccarthy@nottingham.ac.uk

ABSTRACT

The customer interface – interaction, design and specification, order taking and linking with operational processes – is complex in mass customization environments (Franke, 2003). The challenges in eliciting customer requirements accurately, checking feasibility and translating into feasible build instructions cannot be underestimated (Shapiro et al, 1992; Jensen, 2001). Customer interaction processes usually culminate in the manufacturer proposing a product specification, delivery commitments and pricing details that match individual customer requirements to manufacturing capacity and capability. We refer to the business resources used to develop this information as the 'front-end' of the organization. The front-end includes information systems, knowledge and expertise but can be people intensive because considerable organizational knowledge and expertise needs to be drawn upon. Empirical evidence of customer response processes is used to investigate key decision centres that contribute to preparing a customer response. Our analysis highlights four key decision centres of individuals or groups of people with high levels of skill and expertise. We propose that customer response processes can be described by generic models of decision centres that are specific to business context. A set of generic models are defined based on process performance requirements. We review the expertise needed in front-end decision centres to support performance requirements. These models provide further understanding of how customer quotation or proposal processes can be analysed, designed and managed for mass customization and enhanced customer value.

KEYWORDS

Customer Interaction, Skills, Quotation, Product Customization.

1. INTRODUCTION

Customer interaction processes usually culminate in the manufacturer proposing a product specification, delivery commitments and pricing details that match individual customer requirements and requests with manufacturing capabilities and capacity. We refer to the business resources and processes used to develop this information as the 'front-end' of the organization. The front-end system sustains the business by securing profitable transactions with the customer and building relationships with customers to encourage future transactions.

Previous empirical research has revealed significant challenges in combining multiple modes of customization (MacCarthy et al., 2002; MacCarthy et al., 2003) in high complexity and / or high variety environments and where product and applications knowledge are scarce. Customer response processes have been highlighted as consuming considerable resources and time (Waller, 2002). Central to customer response processes are the preparation of quotations that require assessment of customer needs and that provide customers with precise specification and delivery information. Significant process improvements may be required to enable organisations to meet customer expectations through a rapid quotation with effective use of resources.

Few sectors have achieved fully automated customer interaction processes despite the considerable research focus on information technology solutions (e.g. Kroemker, 1997). Reliance remains high on human resources to provide responses to customer enquiries. Here we analyse these resources to review

the key centres of expertise used by businesses that customize products. We examine four 'decision centres': (1) Customization request initiation and information gathering on customer needs, (2) Classification and routing of customer requests, (3) Prioritisation and resource management and (4) Identification of potential for information reuse. Empirical evidence is captured and analysed to provide insight into what expertise is used and how it is used to progress customization enquiries. Models of front-end processes are developed to classify different customer response mechanisms.

2.   PREVIOUS RESEARCH

2.1 Background to the front-end system

Information systems have made improvements to many business processes – in speeding up processes, providing decision support and distributing activities in the value chain (Coronado et al, 2002). There have been dramatic impacts on the front-end of the business including web-based customer interfaces and sales decision support systems. Product configurators have dominated sales decision support systems. Configurator technology has changed the nature of customer interactions by embedding rules to offer customer options and configuration potential. Surveys have been conducted to assess the impact of the configurator technologies (Forza & Salvador, 2002). However the true impact on the organization is still unclear.

The front-end system responds to a customer request or problem. The customer problem might be identified by the customization strategy that the business has adopted (Amaro *et al.* 1999). Differences in customization strategies have different impacts on the activities required to be conducted by the organization. Spring & Darymple (2000) classify the types of activities but stop short of analysing the organizational competences required to carry out these activities.

2.2 Defining expertise in the context of the front-end system

Theory on expertise can be found in the domain of expert systems. Experts, referred to as the people who own the expertise, provide specialist advice to solve relatively unstructured problems. Expertise allows a person to be competent in a specialist field. A network of experts provides an organization with expertise to be able to compete and give an organization power (Black & Porter, 2000). This is important in sustaining the business as an ongoing concern.

A definition for expertise that provides a good start point for the problem domain of the front-end is provided by expert systems thinking:

'Experts have specific knowledge and experience in the problem area. They are aware of alternatives, the chances of success, and the benefits and costs the business may occur', Turban & Aronson (1998), p. 17.

In the context of the front-end, actors generate product offering alternatives, predict the probability of success of customer responses and make judgments on the risks and implications to the business.

2.3 Providing expertise in the front-end for customization

It is a gross simplification to consider that customizers can rely on automated information systems (MacCarthy et al, 2002). Human resources are important in providing flexibility in systems. Flexibility is recognized as being particularly important for versatile customization strategies (e.g. Amaro et al, 1999). Despite this, industry focus on the front-end has been on developing information technology tools to automate processes (Kroemker, 1997). This over-emphasis of intelligent quotation systems has led to a neglect of understanding on how people create flexibility and value in the system - how people use expertise to respond to a range of customer requests. Hart (1995) calls for flexible organizational structures to respond to customization demands but there is a lack of understanding on how expertise can be arranged in this flexible structure.

Expertise is often considered in two distinct groups according to functional boundaries– [1] Sales and Marketing expertise (e.g. Hakansson, 1982) and [2] Technical expertise (Sanchez & Mahoney, 1996). Some research suggests that there is a dichotomy of perspectives between sales and technical orientations (Safizadeh *et al,* 2003). However, a simulation model developed by Zulch & Grobel (1996) suggests that project teams are required for improving system performance. This implies that expertise needs to be merged. These models also show that different routes required for processing customization requests according to type.

What is not clear from theory or research is how front-end systems vary according to customization strategy and how best to organize and manage expertise to complement the information system. Expertise is the ability of the people in the front-end system to translate customer needs into a product offering. Expertise has been divided into technical and administrative expertise by management theorists (Boddy, 2002). It is the administrative expertise that has been severely neglected in operations management research because it is often treated as residing in the sales domain. This research seeks to address how operations management theory may be applied to the handling of customer requests.

3. RESEARCH DESIGN

3.1 Research aims

The aim of the research is to provide operational improvements to the front-end to provide more customer value. A key element to achieving this end is to provide tools to allow capture and analyse front-end systems. This allows the identification of key elements within the front-end system – it is this research that is reported in the paper.

Our aim is to understand the expertise needed to transform customer needs into value. There is a dearth of literature in this area. Therefore we begin by understanding the subtasks and key elements within the system. The front-end may be a complex system made of many entities and processes. The key process should aim to transform customer value into a feasible proposition. The research is based on understanding which elements and factors influence expertise needed to make this transformation. We propose that different expertise is required according to the strategy adopted and that formalizing of expertise into roles improves system performance.

3.2 Approach

Emphasis was given to structuring of the research to guide the outputs of this exploratory research. The data collection was open to search out the key themes but with sufficient focus and attention to detail to allow the development of a coherent research framework for future research work. This paper reports on the exploratory phase of the research only.

The approach to the research is based on exploring the key themes and factors associated with the front-end system. A list of relevant questions was compiled to scope the collection of data. The data collected in response to these questions for each case provides the basis for describing each of the cases. The issues we addressed during data collection are as follows:

- Who are the experts in the front-end system?
- What purposes do these experts serve – what do they do?
- Why do these experts exist?
- Where are the experts in the organisation?
- How do they collaborate?

3.3 Root definitions

The development of root definitions is a key stage in exploratory research (Stake, 1995). Essentially it requires the compilation of research issues used to gather information in the case studies.
Our key terms are defined as follows:

- Front-end system – translates customer value into organizational capabilities and services.
- Quotation process – customer response mechanisms that generate cost, delivery and specification information.
- Quote – the document that details cost, delivery and specification information.

3.4 Case study analysis

Boundaries of the system have been defined to focus the study. This is to allow rigorous comparison between different front-end systems. Initially, the boundaries have been defined encompassing the sales and engineering functions. However, it is acknowledged that the boundaries may not be organizational or physical boundaries. The inputs to the system can be described as the customer needs. Outputs were considered to be the commitment of capabilities to generate customer value. The bridge between input and output is expected to be made by the translation process which is provided by key actors. There may be other people who influence the system such as the production function but if they do not contribute to the direct action of translation then they are considered to be outside the system. Data collection was conducted by interviewing with the key actors including sales and engineering managers.

The case analysis was based on the analysis of the entities of the system as described by CATWOE analysis in soft systems methodology (Pidd, 1998). The exploratory research focused on learning about the following factors:

Customers – customers, stakeholders and other functions such as production
Actors – applications experts
Transformation – converts customer needs into organisational capabilities
World View – there should be some benefit to both parties in the quotation
Ownership – management of front-end system`
Constraints – competitors, dynamic catalogue, changing customer needs.

3.5 Research framework

We propose that there are four key decision centres that are used to translate customer requirements.
1) Customization request initiation
2) Classification of customer enquiries
3) Resource management
4) Identification of potential for information reuse

These decision centres are derived from the definition of an expert system as consisting of diagnosis, monitoring, interpretation, design and planning, and control, Wu (1992)

3.6 Research tools and techniques

Process modeling techniques were used to decompose complex processes into key stages. An important process modeling techniques was role activity diagramming (Ould, 1995). This allowed the responsibility of activities to be modeled.

4. CASE STUDY ANALYSIS

4.1 Selection of cases

Ten businesses cases were chosen for investigation to provide a broad cross section of types of customization. Customization strategy was anticipated to drive different business practices and demands for process variation. Cross-sectoral analysis provided the opportunity to compare customer triggers and the response mechanisms that had developed under different environmental conditions.

Companies offering only consumer products were screened out of the sample, ensuring that all cases were business to business transactions as their main line of business. This selectivity was exercised because business to business (B2B) companies often have a range of niche markets with customers exerting varying levels of power. The result is that the B2B companies are usually engaged in multiple modes of customization (MacCarthy *et al,* 2002) and means that different types of customer request are handled, often through the same front-end resources. Examination of the processes that absorb the variations of customer requests was anticipated to provide interesting observations of practice.

4.2 Company profiles

Table 1 collates the profiles of the ten cases. Each business is categorized according to the types of customization they perform. 'Configuration' is used to refer to businesses practices that rely on pre-engineered products that are selected based on customer options. 'Canibalization' describes the modifications to products usually on the basis of the promise of repeat business. 'Customer solutions' refer to practices where the customizers are aiming to analyse customer needs more closely and provide a more complete customer solution. Such a customer solution may consist of a package or bundle of hardware, software and service elements. The solution is likely to expand on the existing offering of the business. One indicator that a company is actively pursuing opportunities to expand their product range for increasing customer value is that they are prepared to incorporate competitor manufactured product in the product offering.

The classification of customization types are, in summary, as follows:

- Customer solution – extending the product offering envelope with new technology and a new description of customer requirements.
- Canibalization – expanding the product envelope with modifications to existing product.
- Configuration – assembly of existing, pre-designed product elements to meet customer requirements

Table 1: Summary of company profiles

	Customization type			Product
	Customer solution	Canibalization	Configuration	
1) Automotive	*	**	***	Commercial vehicle - product options with legislative constraints.
2) Industrial supplies	***	**	**	Cutting equipment – properties and dimensions can be customer specified.
3) Furniture	*	**	***	Office furniture tailored to meet business requests e.g. logo.
4) Computer hardware	***	*	***	Customer solutions including hardware installations.
5) Aerospace	*	*	*	Product offering to meet customer's operating requirements – hardware / software and service.
6) Household installations		**	***	Products installed to fit household infrastructure.
7) Luxury automotive	*	**	***	Customer specified car interiors
8) Consumer		**	***	Consumer entertainment products – designed and packaged to retailer requests.
9) Healthcare		*	**	Health care products - formulated to order based on hospital requests.
10) Complex electronics		**	***	Instrumentation customized to suit customer's application – aerospace / automotive / equipment

Key:
Customization is rated based on relative volumes of customization types:
*** high
** medium
* low

5. FINDINGS

5.1 Emergent themes

Table 2 summarises the themes arising from analysis of each case against organizational characteristics. It also reports which of the decision centres the businesses placed the highest emphasis on.

Table 2 – Business characteristics and emerging themes

	Focus of the business	*Organisational characteristics*	*Themes*
1) Automotive	DC(II) Class / DC(IV) Info reuse	~ Multi-national organization ~ Two centres for technical expertise based at both of the manufacturing plants	~ High level of effort in maintaining rules in multiple configurators. ~ Complexity of product means that feasibility check by expert still required in addition to configurator
2) Industrial supplies	DC(I) Initiate / DC(II) Routing	~ Sales unit sourcing from any supplier within group and externally	~ Focus on routing to relevant expert for speedy response. ~ High level of structuring of processes in DC (II)
3) Furniture	DC(IV) Info reuse / DC(III) Resource	~ New organisation with highly formalized systems	~ High reliance on information systems for monitoring and customer interaction.
4) Computer hardware	DC (I) Initiate / DC(IV) Info reuse	~ International company ~ Recent re-organisation to formalize roles for providing customer solutions – project team	~ Focus on expanding the customer offering. ~ Drive towards incorporating more activities in the value chain.
5) Aerospace	DC(II) Class / DC(I) Initiate	~ Collaborative supply chain means that experts may be outsider organization	~ Intensive risk assessment. ~ Additional actors in the front-end in comparison to the other companies. More investment. More external consultations.
6) Household installations	DC(III) Resource / DC (IV) Info reuse	~ International sales franchises	~ Difficulties with product and customer information reuse
7) Luxury automotive	DC(III) Resource / DC(IV) Info reuse	~ Contract workers in design function ~ Low level of technical resource	~ Systems driven by engineering change database – lead times and logging of changes ~Informal communications high because of rush jobs for key customers
8) Consumer	DC(IV) Info reuse	~ Product managers negotiate market specific variants with retailers	~ Difficulties in setting up the product database of base products and variants
9) Healthcare	DC(II) Routing	~ Recent re-org. to provide focus on retailer customization	~ Legislative constraints limit product modifications to changes in strength and mix of medicines ~ Customer interaction may include diagnosis
10) Complex electronics	DC(II) Class	~ International sales with centralized technical facility and one local technical facility	~ Classification systems for different products interpreted differently by different parts of the organization.

5.2 Core elements of the front-end system

The analysis of decision centres allowed the generic attributes of the key decision centres to be defined in more depth. Table 3 consolidates the findings from all the cases on the aims of each decision centre. These findings informed the development of definition of each decision centre.

Table 3 – Aims of each decision centre

	Decision centre	Aims of the decision centre
	DC(I) Customization request initiation and information gathering on customer needs	~ Collect information in dialogue with the customer on their requirements.
	DC(II) Classification and routing of requests	~ Route customer enquiries to the relevant experts in the company. ~ Understand the scale of the modifications to meet customer requirements ~ Recognise the closest match product which might be cannibalised to meet customer needs OR initiate new product development to meet customer needs.
	DC(III) Prioritisation and resource management	~ Prioritise customer requests. ~Assign technical resources to the consideration of customer requests.
	DC(IV) Identification of potential for information reuse	~ Assess what information is likely to be useful in the future for further customer orders or quotations. ~ Analyse the feedback on the success of quotations and accuracy of estimates associated with customization requests.

5.3 Expertise supporting the decision centres

Table 4 shows extracts from the analysis of key front-end roles. The analysis distinguishes between informal and formal roles. Informal roles are not recognized officially by the organization (e.g. in job descriptions) but have evolved in response to system needs. The descriptions of these roles have been developed from process descriptions by the key actors in the front-end. Evolved roles that are not recognized by the organization can have detrimental impacts. Two businesses identified several key roles that had been lost through re-organisations and redundancies. Both were considering returning to previous organizational structures.

New actors in customer request processing have been identified from the analysis, e.g. production estimator, who might not have initially been considered because they are outside the functional boundaries of Sales and Engineering – the two functions commonly associated with front-end activities.

The teams that support the decision centres are dynamic, although the core team does remain unchanged in most cases. Collaboration mechanisms between actors in the decision centres were found to be supported by individuals with extensive personal networks, particularly those with long service with the company. These actors described how they assembled key experts together according to the eccentricities of the customer requests.

Table 4– Extracts from analysis of key roles supporting each decision centre

 DC(I)

Formal roles	Informal roles	Expertise *Able to: ...*
Sales Engineer		~ Find the right person in the customer's organization to speak to about needs. ~ Interrogate customer needs ~ Define the benefits of the product offering to the customer ~ Sell service to the customer ~ Communicate information to technical functions ~ Use intelligence in Customer Relationship ~ Management database to make accurate assumptions about buying behaviour ~ Offer the customer an appropriate amount of choice – avoids generating custom products unless there is benefit to the manufacturer. ~ Make commercial judgement ~ Weigh up the impact of product changes on manufacturing ~ Tap into organizational knowledge to get prompts on considerations when defining an initial specification.
	Sales manager	~ Provides coaching on the 'right questions' to ask of the customer
	Product Manager	~ Provides technical advice to sales
Applications engineer		~ Provides demonstrations to understand customer needs
Field support engineer		~ Provides technical support to Sales in customer dialogue
Engineer		~ Liaise with the customer for clarification of detail

 DC(II)

Formal roles	Informal roles	Expertise *Able to: …*
'Triage' coordinator		~ Judge the urgency of a customer request ~ Route requests according to risk and technical expertise. ~ Respond to quick turnaround requests using their own experience to provide estimates. ~ Judge the level of detail that is expected by the customer.
Engineer		~ Judge the similarities between products
Engineering manager		~ Judge the need to contract out work
	Sales manager	~ Route queries to personal network of experts
Production estimator		~ Judge that lead time category the request falls into.

 DC(III)

Formal roles	Informal roles	Expertise *Able to: …*
Manager of the design team		~ Re-prioritise customer requests if some require special attention
	Sales	~ Pursue a customer enquiry through the front-end system

 DC(IV)

Formal roles	Informal roles	Expertise *Able to: …*
Product development manager		~ Provide information of product standards used by the local market to feed into the central configurator
Project engineer		~ Update the configurator with designs and parameters
	Applications expert	~ Analyse customer needs for re-sale of custom product to a new application
Information systems		~ Provide a database to describe product options

6. DISCUSSION

6.1 Control of front-end system

System performance was observed to be measured only rarely by the managers of the system. The measures used tended to be based on lead time based with respect to customer response. Quality was rarely measured. Targets set in the information systems to drive the system that may not be based on the amount of work involved in responding to a customer request but usually based on standards. The systems were often driven on sales incentives and individuals' motivation.

The role of the manager in this context was found often to be in providing coaching to their team although this was rarely explicit in their job description. This was usually due to the manager being promoted based on sales success or technical prowess giving them more experience than the rest of the team.

Usually the control of the decision centres was local to the decision centre rather than being centralized in headquarters. Prioritisation was invariably based on pull from sales or customer expediting the information on their request.

6.2 Performance of systems

Accuracy of customer responses is likely to be dependent on the first and second decision centres - (I) Initiate and (II) Class. If complete data on customer needs is not collected, recorded and transmitted accurately then the performance all other decision centres will be affected. The recording or transference of knowledge generated by the front-end system to the information system by (IV) Info reuse will create cumulative problems.

The speed of the request is controlled by all four decision centres. Insufficient data collection by DC(I) will result in lengthy delays in processing the customer enquiry . Classification is also important because there may be faster routes through the organization which the classification decision centre DC(II) determines. Speed and prioritisation are closely connected. If the fourth decision centre [DC(IV)] is performing then sufficient knowledge may be able to be accessed to avoid starting from first principles and providing some shortcuts.

6.3 Comparison of cases

Different jargon was used by each business to refer to the output of the front-end for responding to the customer including 'bid', 'proposal' and 'quotation'. Key differences were observed in process impacts based on the level of risk assessment required by the system. The outputs of the process differed on the level of detail in the information communicated to the customer. This varied from request to request. Where this varied significantly the level of detail was assessed in the initial information collection. An example of this is when there is judged to be a risk that a competitor may be given access by the customer specification details in order to prepare another offer.

7. DEVELOPMENT OF GENERIC MODELS OF THE FRONT-END SYSTEM

We propose that these companies can be grouped according to the relative importance of decision centres due to different performance demands. Table 5 develops the relative value of front-end system elements into generic models of the front-end system.
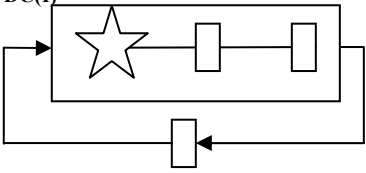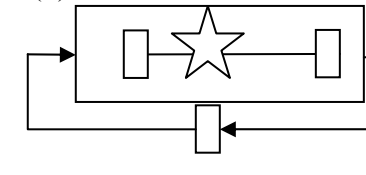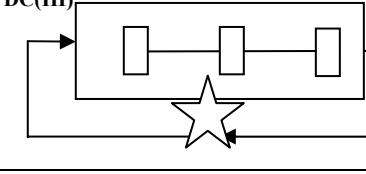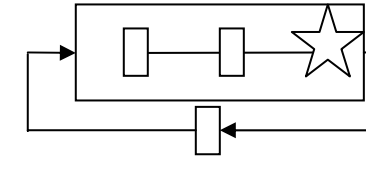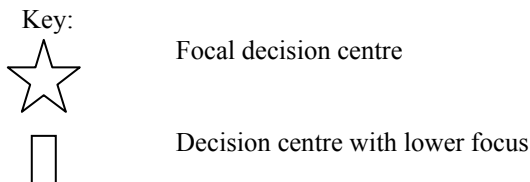
8. IMPLICATIONS

8.1 Implications for mass customization

The term 'mass customization' can encompass a broad spectrum of customization strategies, including product configuration and an evolving product envelope driven by customer requests (MacCarthy *et al,* 2003).

This research has examined a range of types of customization. It has examined the mechanisms that are likely to be needed by a mass customizer. There has been little research to date that examines the competencies required by a mass customizer. Instead, the main focus has been on technologies (e.g. Duray, 2000; Bourke, 1999) and design of the customer interfaces (e.g. Franke, 2003). The research is this paper provides a start point to address the question of how the flexibility can be provided using human resources to achieve the vision set out in the customization strategy.

Table 5 – Definition of generic customer response processes based on decision centres

Focal decision centre	Characteristics	Process termed as:
DC(I)	Providing a customer solution	*Value proposition*
		Companies: 2 & 4
DC(II)	Risk assessment - routing to key experts for high accuracy	*Proposal*
		Companies: 1, 5 & 10
DC(III)	Speed and accuracy important	*Competitive bidding*
		Companies: 3 & 6
DC(IV)	Information reuse important for economies	*High frequency quotation*
		Companies: 7, 8 & 9

Key:

  Focal decision centre

  Decision centre with lower focus

8.2 Implications for organizational design

Analysis of an organization using the decision centres framework gives insight into the activities of core groups that work together in the front-end system. Operational improvements should be focused on these decision centres. Understanding of informal roles will give insight into how to implement process re-engineering for performance improvements. Some questions to be asked in the re-organisation of the front-end system should include:

1) Are there roles within the decision centre that would benefit from formal recognition by the organization?
2) Is each decision centre co-located?
3) What are the methods of communication between experts within a decision centre? Can the effectiveness of communication be improved within decision centre networks?
4) Is it appropriate to centralize decision centres or use local expertise? How can expertise be exchanged between 'sister' decision centres?

This research has focused on recording the expertise at the decision centre level. The impact of formalizing expertise at an individual level is not clear. There may be negative effects because the success of the system is in its ability to flex to meet customer requests. Formalization may constrain the ability of actors to respond. Further research should be conducted to analyse the impact of role formalization.

9. CONCLUSIONS

Analysis of empirical evidence of customizers' processes has provided insight into the nature of the elements of the front-end system. Models of front-end systems have been proposed that are built from key decision centres. The relative importance of decision centres provides insight into different types of response processes and points to differences in customization strategy.

The analysis has confirmed the importance of expertise that supports the response mechanisms to the individual customer. The collective expertise of the front-end underpins essential business processes. It provides organization power in the value chain because it has direct impact on how the customer is handled through product offering accuracy and speed.

The research has focused on making explicit the process activities and responsibilities of the front-end system that may not be formally recognized by managers of the system. The benefits of formalizing front-end processes or roles needs to be weighed against the potential impact of constraining the process actors. Further research is required on the impact of formalization of roles in this context.

ACKNOWLEDGEMENT

REFERENCES

Amaro, G., Hendry, L. and Kingsman, B. (1999), *Competitive advantage, customisation and a new taxonomy for non make-to-stock companies.* International Journal of Operations & Production Management, Vol. 19, Issue 4, p. 349.

Black, J. and Porter, L. (2000), *Management - meeting new challenges,* Prentice Hall, New Jersey, p. 17.

Boddy, D. (2002), *Management - an introduction,* Financial Times, Prentice Hall.

Bourke, R. (1999), *Achieving Success with Mass Customization: The Vital Contributions of Engineering.* Computer Aided Engineering, 18, 42-47.

Coronado, A., Sarhadi, M. and Millar, C. (2002), *Defining a framework for information systems requirements for agile manufacturing.* International Journal of Production Economics, Vol. 75, p. 57-68.

Duray, R., Ward, P.T., Milligan, G.W. and Berry, W.L. (2000), *Approaches to mass customization: configurations and empirical validation.* Journal of Operations Management, Vol. 18, p. 605-625.

Forza, C. and Salvador, F. (2002), *Configuring product to address the customization-responsiveness squeeze: a survey of managerial and opportunities,* Euroma, June 2002.

Franke, N. (2003), *From Mass Customization to User Driven Innovation,* Key note speech presented at the Second World Congress on Mass Customization and Personalization, Munich, October 2003.

Hakansson, H. (1982), *International marketing and purchasing of industrial goods,* John Wiley, Chichester.

Hart, C.W.L. (1995), *Mass customization: conceptual underpinnings, opportunities and limits.* International Journal of Service Industry Management, Vol. 6, p. 36-46.

Jensen, T. (2001), *Modeling of application knowledge in sales configuration system,* the First World Congress in Mass Customization and Personalization, Hong Kong, October 2001.

Kroemker, M., Thoben, K.D. and Wichner, A. (1997), *An infrastructure to support concurrent engineering in bid preparation.* Computers in Industry, Vol. 33, p. 201-208.

MacCarthy, B., Brabazon, P.G. and Bramham, J. (2003), *Fundamental modes of operations for mass customization.* International Journal of Production Economics, Vol. 85, 289-304.

MacCarthy, B.L., Bramham, J. and Brabazon, P.G. (2002), *Compression of quotation leadtime in a mass customization environment*, EIS conference- Workshop on Information Systems for Mass Customization, Malaga.

Ould, M.A. (1995), *Business Processes,* John Wiley, Chichester, UK.

Pidd, M. (1996), *Tools for thinking: modelling in management science,* John Wiley, Chichester.

Safizadeh, M.H., Field, J.M. and Ritzman, L.P. (2003), *An empirical analysis of finanicial services processes with a front-office or back-office orientation.* Journal of Operations Management, Vol. 21, p. 557-576.

Sanchez, R. and Mahony, J. (1996), *Modularity, Flexibility and Knowledge Management in Product and Organization Design.* Strategic Management Review, Vol. 17, p. 63-73.

Shapiro, B., Rangan, V.K. and Sviokla, J.J. (1992), Staple yourself to an order, Harvard Business Review, Vol. 70, Issue 4, p.113.

Spring, M. and Darymple, J. (2000), *Production customisation and manufacturing strategy.* International Journal of Operations and Production Management, Vol. 20, p. 441-467.

Stake, R. (1995), *The art of case study research,* Sage, California.

Turban, E. and Ronson, J. (1998), *Decision support systems and intelligent systems,* Prentice-Hall, New Jersey.

Waller, B. (2002), *Integrated capacity planning and revenue management for build to order: market responsive manufacturing in the automotive supply chain,* ICRM - Second international conference of responsive manufacturing June 2002, p.680-688.

Wu, B. (1992), *Manufacturing systems design and analysis,* Chapman & Hall, London.

Zulch, G. and Grobel, T. (1996), *Shaping the organization of order processing with the simulation tool FEMOS.* International Journal of Production Economics, Vol. 46-47, p. 251-260.