

## **A Model of e-Service Flexibility**

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This handout first provides some background material on the concept of strategic flexibility that comes out of the manufacturing operations literature. It first presents a short review of manufacturing flexibility concepts, along with a framework of types of manufacturing flexibility. Next, we consider the small amount of literature available on service flexibility. Then, we consider a model of flexibility for electronic services.

### **Flexibility in Manufacturing Organizations**

Most manufacturing flexibility research has viewed flexibility as a characteristic of processes contained within the boundary of a firm. Adler (1988) differentiates between flexibility dimensions according to whether they are oriented toward (i) product demand state flexibility characteristics or (ii) process state flexibility characteristics. Adler (1988) further differentiated between manufacturing process flexibility derived from individual machines, from systems of machines, and from the overall plant.

Table 1 summarizes the conceptual dimensions of manufacturing flexibility proposed and examined in the academic literature. Table 1 also summarizes the strategic uncertainties and strategic objectives motivating the development of flexibility, in cases where they were available from the literature. Table 1 follows Adler (1988) and differentiates between manufacturing process flexibility dimensions according to whether they were oriented toward product demand state or process state flexibility characteristics.

**Table 1: Dimensions of Manufacturing Flexibility**

<b>Flexibility Dimension</b>	<b>Type of Uncertainty</b>	<b>Strategic Objective</b>	<b>Description: “The ability to ...”</b>
<b>Product</b>	Market rejection of product in favor of competitor product <sup>1</sup>	Responsive to market, first to market <sup>1</sup>	introduce novel products or modify existing ones, to change part mix
• Mix	Market acceptance of kinds of products	Diverse product line	produce a number of different products at the same point in time
• Modification	Specific product characteristics	Responsiveness to customer specifications	make functional changes in the product
• Quality	Segmentation by competitor <sup>1</sup>	Product line extensions <sup>1</sup>	change planned product quality levels
<b>Machine</b>	Machine setup cost variability <sup>1</sup>	Low inventory cost, high machine utilization, production of complex parts, product quality	handle a variety of operations that the machine can perform without incurring high costs or expending prohibitive amounts of time in switching
• Operation	Unreliable machines	Improved (real-time) part production scheduling, machine availability	produce a part in different ways, using alternate process plans which may be generated by an interchange or substitution of operations
• Material	Characteristics of materials	Product quality	handle uncontrollable variations in the composition and dimensions of the parts being processed; to handle multiple substances for the same or different components
• Material Handling	Movement between machines within plant <sup>1</sup>	Machine availability, throughput time	move different part types effectively through the manufacturing facility, including loading/unloading of parts, inter-machine transportation and storage of parts under various conditions of the manufacturing facility
<b>Process</b>	Manufacturing system setup variability <sup>1</sup>	Lower inventory costs, smaller batch sizes	produce a set of part types without major setups
• Design	Non-competitive processes <sup>1</sup>	Process innovation <sup>1</sup>	redesign and/or expand the manufacturing process
• Volume	Aggregate product demand	Market share	change the aggregate amount of production of a manufacturing process, operate profitably at different overall output levels
• Routing/Rerouting	Unexpected machine breakdown or downtime	Customer due dates	change the sequence of operations through which the parts flow
• Changeover	Length of product life cycles	Product innovation	deal with additions to and subtractions from the mix over time
• Expansion	Random new product introductions or modifications <sup>1</sup>	Implementation time, reduced cost for new products, product variations	increase the capacity and capability of a manufacturing system when needed

• Program	Setup variability, inspection variability and improved control processes, tool and fixture wear	Lower labor cost <sup>1</sup>	run virtually unattended for a long enough time period
<b>System dynamic</b>			
• Market Flexibility/ Flexibility Responsiveness	Changes in the level of uncertainties	Strategic adaptability	be increased or decreased through a redesign of the manufacturing process, to adapt to the changing market environment
• Production Flexibility/ Flexibility Range	Entry by more flexible competitor <sup>1</sup>	Strategic banking of flexibility <sup>1</sup>	have a system with an envelope of capability or range of process states.
• Flexibility Mobility	Improved flexibility range of competitor <sup>1</sup>	Strategic banking of flexibility <sup>1</sup>	have low penalties for modifying the process within the flexibility range.
• Performance Measure Uniformity	Unknown cost function, imperfect accounting systems <sup>1</sup>	Cost uniformity, price stability, price improvement, profit enhancement <sup>1</sup>	have some performance measure stay the same within the flexibility range.

Source: Adler (1988), Bernardo and Mohamed (1992), Gerwin (1987, 1993), Gupta and Somers (1992), Slack (1987), Upton (1994)

<sup>1</sup>Not described in article that proposed or described the dimension.

While Table 1 seems fairly comprehensive, the concept of flexibility can be defined at many different levels of an organization. Koste and Malhotra (1999) presented a hierarchy of manufacturing process boundaries to better understand the process levels related to manufacturing flexibility dimensions. Table 2 presents their model. We expand upon it by further sub-dividing the organization into several additional levels of flexibility. Note that the shaded areas in Table 2 indicate process levels for which no flexibility dimensions have been defined by academics.

The hierarchy of process boundaries begins at an atomic level of product and process states, with machine or product parts. Parts, when combined together, lead to modules, and in turn to products and machines. Linking machines together, whether through physical closeness or information technology, creates processes, which when further linked together create factories, systems of factories, and inter-organization networks. Combining inter-organization

networks together creates another inter-organization network. At the functional level, one can consider the combination of functional area networks, both within and outside the organization. At the top, the strategic business unit describes the last organizational boundary. Associated with each of the levels of Table 2 are corresponding flexibility dimensions from Table 1.

**Table 2: Organizational Boundaries and Corresponding Flexibility**

<b>Koste and Malhotra (1999)</b>	<b>Expanded Boundary Definitions</b>	<b>Manufacturing Process/Product Flexibility Dimensions</b>	<b>Service Flexibility Dimensions</b>	<b>e-Service Flexibility Dimensions</b>
<b>Strategic Business Unit</b>	<b>Strategic Business Unit</b>	Strategic Flexibility		
	<b>Cross-Organization Functional Network</b>			
	<b>Intra-Organization Inter-Functional Network</b>			
<b>Functional</b>	<b>Functional</b>	System Organizational R&D Manufacturing		
	<b>Inter-Organizational Factory Network</b>			
	<b>Factory Network</b>			
<b>Plant</b>	<b>Factory</b>	Manufacturing <ul style="list-style-type: none"> <li>• Volume</li> <li>• Modification</li> <li>• New Product</li> <li>• Mix</li> <li>• Expansion</li> </ul>		
<b>Shop Floor</b>	<b>Shop Floor/Resource Cell</b>	Operation Routing Individual Resource		
	<b>Process</b>			
<b>Individual Resource</b>	<b>Resource</b>	Machine Labor Material Handling		
	<b>Module</b>			
	<b>Part/Tool</b>			

## **Flexibility in Traditional Service Organizations**

While flexibility clearly is an important managerial consideration for service operations, service flexibility has been mentioned only infrequently by academics. Reviews of the service literature have found little mention of flexibility in service typologies and taxonomies (Menor, Roth and Mason 1998, Cook, Goh and Chung 1999). However, few examples of service flexibility do exist. Correa and Gianesi (1994) included the flexibility of the process in their classification of types of service flexibility. Roth (1993), Roth and Jackson (1996) and Menor, Roth and Mason (1998) used an abstract concept of service process flexibility in their empirical studies. Roth (1993) operationalized this flexibility concept as a multiple item measurement scale that included four items related to system responsiveness, new product introduction speed, rapid staffing changes, and customization.

While not explicitly discussed, many dimensions that have been employed in the service literature appear to be conceptually related to flexibility or to strategic uncertainties. These dimensions include customer involvement, capital intensity, labor intensity, employee discretion, customization, audience size, process complexity, and continuous versus discrete transactions. Using the same framework as we used to organize the manufacturing literature, Table 3 organizes these traditional service dimensions based on their relationship to flexibility and strategic uncertainties.

**Table 3: Service Dimensions Related to Flexibility and Uncertainty**

<b>Flexibility Dimension</b>	<b>Service Dimension</b>	<b>Type of Uncertainty</b>
<b>Product</b>		Goal incongruence Performance ambiguity Power Commitment
• Mix	Service affects persons vs. goods Permanent vs. Temporary effects of service Reversibility vs. nonreversibility of the service effects Physical vs. mental effects Individual vs. collective services Service content and benefits Service delivery procedures Time-defined vs. task-defined People-processing services Possession-processing services Information-based services Customized vs. standardized services	Type of buyer Buying motives Buying practice Diversity of demand
• Modification	Customer contact	Customer contact
• Quality		Differentiation
<b>Machine</b>	Equipment based services People based services Degree of labor intensity Degree of interaction Degree of customization	Complexity Divergence
• Operation	Potential for customization Potential for employee discretion	
• Material		
• Material Handling		
<b>Process</b>	Professional service Service shop Mass service	Type of relationship between organization and its customers Type of service firm
• Design	Joint production by supplier and customer	Customer influence
• Volume	Project Unit or batch Mass production Audience size	Basic demand characteristics Customer ability to switch firms Audience size
• Routing/ Rerouting		
• Changeover		Diversity of demand
• Expansion		
• Program		

Source: Cook, Goh and Chung (1999), Menor, Roth and Mason (1998)

## **Flexibility in Electronic Services**

Flexibility is arguably the most important strategic capability that managers should consider when designing operations for turbulent environments such as that of electronic retailing (Hayes and Pisano 1994). Flexibility allows firms in this network era to quickly sense and respond to evolving customer needs, adapt to shifts in technologies, and recover from competitor actions and capital market downturns. However, comprehensive reviews of the service management literatures indicate that issues of service-process flexibility have largely been overlooked – see e.g., Cook, Goh, and Chung (1998).<sup>1</sup> The emergence of electronic retailing underscores the significance of bridging this gap in the literature (Rosen and Howard 2000).

Table 4 presents a (somewhat) comprehensive framework for examining the electronic service-process flexibility dimensions. The table differentiates between flexibility dimensions that are related to product and customer interactions, processes of an individual electronic retailer (i.e., intra service-process flexibility), and processes connecting multi-company alliances (i.e., inter service-process flexibility). Some of these dimensions – e.g., mix, volume, and changeover – are adapted from the literature on manufacturing flexibility (Gerwin 1993; Sethi and Sethi 1990; Upton 1994). The remaining dimensions are relevant for responding to the market uncertainties faced by electronic retailers. We propose that, in each case, uncertainties stemming from customers and from inter-linked electronic process technologies can be effectively responded to by developing process flexibility.

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<sup>1</sup> A recently published paper by Verma and Young (2000) on low-contact services is a notable exception.

**Table 4: Service Process Flexibility for E-Retailers**

Service-Process Flexibility Dimension	Type of Uncertainty	Description
<b>Product and Customer Interaction</b>		
<ul style="list-style-type: none"> <li>Mix</li> </ul>	Market acceptance of different kinds of service-products	The ability to change the range of electronic service-products offered within a given period of time.
<ul style="list-style-type: none"> <li>Security</li> </ul>	Privacy of the electronic transactions	The ability to keep electronic transactions private between provider and customer.
<ul style="list-style-type: none"> <li>Order Processing</li> </ul>	Willingness of customers to order and pay during an electronic transaction	The ability to change the range of methods used for ordering and payment.
<b>Intra Service-Process</b>		
<ul style="list-style-type: none"> <li>Volume</li> </ul>	Fluctuations in the aggregate service-product demand	The ability to respond to the aggregate level of service-product demand.
<ul style="list-style-type: none"> <li>Changeover</li> </ul>	Variations in the length of service-product life cycle	The ability to respond to the additions to, and subtractions from the service-product mix over time.
<b>Inter Service-Process</b>		
<ul style="list-style-type: none"> <li>Backward Integration</li> </ul>	Entry into, or exit from other companies' networks	The ability to manage and modify partnerships to participate in other companies' networks.
<ul style="list-style-type: none"> <li>Forward Integration</li> </ul>	Other companies' entry into, or exit from a company's own network	The ability to manage and modify partnerships to allow other companies to participate in a company's own network.
<ul style="list-style-type: none"> <li>Full Integration</li> </ul>	Entry into, or exit from other companies' network and a company's own network	The ability to manage and modify partnerships to participate in other companies' networks, and allow other companies to participate in a company's own network.