Product and Service Innovation

in

Small and Medium-Sized

Enterprises

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1.0 EXECUTIVE SUMMARY

The National Institute of Standards and Technology (NIST) contracted with the Smeal College of Business at The Pennsylvania State University to conduct a review of literature that concerns how small and medium-sized enterprises (SMEs) develop new products and services. Our team extensively reviewed the literature for concepts and research on new product and service development. We also identified several cases of successful implementation of innovative new product and service development practices. Based on what we learned, we developed recommendations to enhance SME competitiveness and the ability of MEP consultants to assist SMEs in this endeavor.

SMEs face unrelenting pressure from powerful customers and competitors to lower prices and accept shrinking margins on sales. They have responded to this pressure by adopting innovations in operational excellence, e.g., lean manufacturing and six-sigma. As these innovations approach their limits, SMEs are starting to seek revenue growth from new products and services. They must offer their customers something different than their competitors offer in order to avoid the same low-margin trap that they now face. This report suggests that a powerful way for SMEs to do this is to offer customers new products and services that allow more efficient and effective use of the products that they currently sell. These new products may complement existing products, and require new manufacturing and design skills, but offering new services is uncharted territory for most SMEs. Their service experience is often limited to offering customers free or below-cost installation, training, and maintenance. They must learn to offer services that can make their products yield greater total return over their useful life than can a competitor's products. These services include customization of products to specific customer uses, training for optimal performance, product disposal, and even taking over customer operations that pertain to the use of the product.

The above mentioned services require SMEs to form deep and trusting relationships with their customers so that they can co-discover ways to make the best use of their products, and learn new ways to develop and implement ideas for new services. Our literature review led us to propose a "total solution development" model that synthesizes existing new product and new service development models and reflects the dynamic relationship between SMEs and their stakeholders as well as the complex problem-solving required in such endeavors. We also identified five mini-cases of SMEs that developed compelling new business models that were accompanied by the creative use of information technology and proprietary databases to help customers use their products more effectively. Changes in organization structure and culture are almost always required to do this effectively.

We offer guidance to SMEs that want to transition from a product-centered to a service-centered business. The transition must occur in phases that involve mastery of new skills and capabilities at each phase before graduating to the next one. Finally, we offer recommendations to help MEP centers become more capable of offering their clients the advice and consultation they need to make the transition to a service-centered business. This can be facilitated by development of a dynamic knowledge management portal that MEP consultants can access to share ideas across the entire MEP network on the most effective methods to bring about change.

2.0 INNOVATION STRATEGIES FOR SMALL AND MEDIUM-SIZED ENTERPRISES

The purpose of this report is to explore how small and medium-sized enterprises (SMEs) can enhance their competitiveness with innovation strategies that leverage their strengths and minimize their weaknesses relative to larger enterprises. These strategies can involve partnering with large enterprises rather than competing against them. To achieve our purpose, we must first recognize that a single set of recommendations is not appropriate for all SMEs because their attributes and environments vary considerably. Second, there is a wide range of innovation options that can serve different purposes at different times. No one option is right for all SMEs, but innovation in products, processes, or services of varying type and degree can be appropriate for different SMEs in different industry sectors or product life cycle stages. Thirdly, we can't discuss innovation for SMEs without recognizing that they differ significantly from large enterprises, and most of the existing research on innovation was developed from studying the latter. Lastly, given all of the above qualifiers, we explore SME innovation strategies that exploit a firm's current capabilities and help them develop potentially valuable new ones. One innovation strategy that we will explore in depth is the development of industrial or product-related services that complement the sale of a firm's current products.

2.1 Generalizations about SMEs and Innovation are Difficult to Make

SMEs vary in their interest and approach to innovation because of differences in their sources of capital. Senior managers of privately held firms (i.e., most SMEs) have much greater discretion in strategic pursuits than do those in publicly held firms (Nooteboom, 1994). Public stockholders focus mainly on return on invested capital, which narrows senior management's range of acceptable strategies (including innovation). Private capital providers (personal, family, friends, and local banks) do not have a similarly limited focus, which allows more individual variation in behavior, i.e., preference for independence, informality, life-style (Gray, 2002). Personality and emotions are allowed to play a larger role in decisions made in privately held SMEs. Research suggests that the age and tenure of an SME CEO are negatively related to his or her interest in innovation (Khan and Mattapichetwattana, 1989). Research also suggests that only 20% of SMEs are interested in growth through acquisitions, geographical expansion or innovation (Nooteboom, 1994). However, with SMEs accounting for 99.7% of all firms in the U.S., this represents a large number of entities (U.S. Census Bureau, 2003).

Our focus in this report is mainly on established small owner-managed businesses, mostly, but not exclusively, in mature industries. These businesses consume the majority of their owner-managers' time. They are the primary source of income for owner-managers and an extension of their personality and family; their personal lives overlap with their business interests (Carland et al., 1984; Gray, 2002; Blumentritt and Danis, 2006). Although they value growth and profitability, it is not their major or sole preoccupation. Such firms are to be distinguished from entrepreneurial start-ups, especially those that are heavily science-based and knowledge intensive. These firms are headed by entrepreneurs who are primarily motivated by opportunities for growth and profitability through innovation in new products, processes, and markets. These entrepreneurs are already seeking opportunities wherever they can find them.

They don't need our help to stimulate their interest in innovation, although they might benefit from the guidance that we provide to owner-managers of established businesses.

SME innovation behavior varies by industry sector. Chemical and machinery industries are capital intensive, thereby making SMEs in these industries very cautious about innovations that require large capital investments. Thus, it is understandable that half of the innovation in the chemical and machinery industries is incremental (Huang et al., 2002). Similarly, customers in food, textiles, and furniture tend to be conservative, thereby leading firms to be cautious about their innovation initiatives (March-Chorda et al., 2002). Although innovation tends to be incremental in textiles and food, it is more radical in optics, ceramics, and chemicals. Similarly, textile, lumber, wood and paper mills, printing and publishing, and construction firms rely heavily on equipment suppliers for process innovation (Pavitt, 1984).

The type of innovation that SMEs pursue also depends on whether their industry is emerging (where radical innovation is more likely) or is mature (where incremental innovation is more likely) (Nooteboom, 1994). Apparel is highly seasonal and fashion oriented, which prompts shorter and inexpensive innovation efforts. In contrast, computers and electronics have high product obsolescence rates; which means higher and more continuous investment in incremental innovation (March-Chorda et al., 2002).

Wright et al. (2005) suggest that the hostility of the environment influences innovativeness. Firms operating in highly competitive (hostile) markets are likely to be more successful innovators by increasing the number of new product introductions through incremental innovation in order to meet customer needs. The study suggests that the resources of firms embedded in highly competitive markets would be better spent on incremental innovations rather than radical ones because of the cut-throat nature of the environment. In contrast, Khan and Mattapichetwattana (1989) found that environmental hostility lessened SME innovativeness.

Few of the available SME studies focus on U.S. firms, and it is likely that countries differ significantly in institutional factors (e.g., government subsidies and support to SMEs) that will affect their approach and interest in innovation (Siu et al., 2006). Government plays a much more prominent role in the economies of most European and Asian countries.

The type of customers that SMEs serve also influences the type of innovation they undertake. SMEs that sell consumer products generally serve a larger number of customers directly or through distributors than do SMEs that sell products or services directly to other businesses. They also must devote more time and attention to market research and advertising and generally have more difficulty getting timely and accurate feedback from their customers. SMEs that sell products to other firms, such as equipment, components, or instrumentation, generally have fewer customers than those that sell consumer products. Pavitt (1984) referred to such firms as specialized equipment suppliers. This type of firm is the main focus of this report. Their customers tend to be large, scale-intensive firms in industries such as food, metal manufacturing, shipbuilding, automobiles, glass and cement. Poor operating performance, especially down-time, is very costly for them. Thus, they may be receptive to outsourcing their in-house technical services, if convinced that a supplier can do a better job, and thereby allow them to concentrate

on their core competencies (Quinn et al., 1990). In contrast, their SME suppliers are not scale-intensive, but rely on firm-specific technical skills in design and manufacturing that they deploy quickly to meet their customers' needs. Small customers are candidates for services too. Ashton et al. (2003) advise SMEs to consider segmenting their markets to identify small customers that lack the technical resources needed to effectively install, use, or maintain operations that are essential to their business. Also, high-end specialty customers may value the SMEs services more than low-end customers.

2.2 Types of Innovation that SMEs Undertake

SMEs can introduce process innovation to enhance the capability of their production processes or their supply chain operations (e.g., increase reliability or reduce cost). These innovations are developed for their own use; in-house engineering is used to customize them to suit specific applications. SMEs also can introduce product innovations into existing or new markets. Product innovation can include the introduction of new functions, enhanced performance, or added features to existing products. Innovation of this type is generally incremental. The underlying technology can be new to the firm, but is unlikely to be "new to the world". Radical innovations are relatively rare events, of course, and enhance product performance significantly or even create new product categories or industries.

Innovative technology can be "pushed" by technical staff or "pulled" by customers. In the former case, products may differ significantly from the firm's or its competitors' existing products (Salavou, 2005). There is the risk that technical staff will push too far ahead of customers and lead to a product failure. Products with "pushed" technology may require customers to change behavior or perception significantly before they are accepted and used. In the case of technology "pull", "lead-users" can be a significant source of innovative ideas (von Hippel, 1988). Lead-users are firms or individuals that are on the very edge of the target market. They are generally very highly-specialized and sophisticated, requiring different innovations than the average customer. In fact, lead-users are so advanced that they often modify existing or develop new products to meet their own needs. Thus, they can work collaboratively with the firm's technical staff to fix shortcomings of existing products and to design new products to meet their needs (von Hippel et al., 1999). However, caution should be taken when using input from customers as they can only suggest innovative ideas from what they've experienced. It is more important for firms to ask customers what outcomes they value instead of just looking for solutions (Ulwick, 2002). In addition, taking ideas from lead-users can be dangerous as lead-users are often a step above common users and may suggest ideas that are only considered valuable to those in lead-markets, thus making them harder to sell to common users.

Marketing innovation includes the use of new channels of distribution and new advertising approaches for selling current or new products. SMEs can expand their revenues by selling their current products in new regional or international markets or by expanding their existing product lines into new segments of existing markets (Branzei and Vertinsky, 2006). This kind of innovation, "application innovation" involves applying existing technology for new uses in new markets (Moore, 2004).

Business model innovation involves creation of a value proposition that offers to satisfy the same or different customer needs in new ways by performing a function, solving a problem, or creating an experience through the sale or lease of a product and/or service. The value proposition may be targeted to a select set of customers whose needs are best met by the product or service. Innovation of this kind may or may not require product innovation. If it does, it is more likely to be a re-configuration of existing technology that results in a product or service that is better suited to the needs of a set of customers that a larger company overlooks. Christensen and Bower (1996) indicate that large companies often dismiss innovations of this type (which they call "disruptive") because their existing customers don't value them or the emerging market is too small to interest them. Chesbrough and Rosenbloom (2002) indicate that business model innovation, besides a new value proposition and targeted customers, also requires articulation of a value chain to produce the new product or service, and a plan to establish and maintain a competitive advantage over potential competitors. We return to the topic of business model innovation in section 3 where it relates directly to adding new services that complement existing products.

Moore (2004) suggests that different types of innovation are important at different points in a product's life cycle. For example, Moore suggests that niche strategies are useful for firms that offer leading–edge technology to early adopters. He also suggests that business model innovation is useful after mainstream products have commoditized. SMEs can offer customers customized products perhaps supplemented with services. The same SME is unlikely to be nimble enough to modify its strategy to match the evolution of life cycle stages, especially at its opposite ends. SMEs at the front-end of the life cycle are likely to be science-based firms (Pavitt, 1984), and if successful, they might grow with their industry and become large companies (e.g., electronics and software). SMEs that focus on the middle or end of the life cycle may be specialized equipment suppliers.

2.3 SME Strengths and Weaknesses and Required Capabilities for Innovation

Yap et al. (2005) suggest that SMEs have smaller top management teams, which means less functional diversity in experience. Moreover, owner-managed SMEs often favor placing family members in senior management positions over hiring outside professional managers, which can lead to poor management decisions and generational transition problems (Crosetto, 2004). They also have less developed HRM practices (i.e., they are at a disadvantage for reaching the labor pool, which leads to poor recruiting, etc.) and less access to materials and financial resources. The main reason why SMEs may be weak in technical or marketing capability is the number and quality of their professional personnel. Assuming an SME can attract appropriate personnel, there is the question of senior management's motivation to invest resources in their continued development through training, provision of research journals, travel to conferences, and giving them challenging assignments.

SMEs often have limited financial resources to invest in innovations that are expensive to develop, require long development cycles, and long payback periods. They also cannot spread R&D expenses over large sales volumes nor spread the risk of failure across multiple projects. This tends to make them more cautious about innovation than larger enterprises. There is a

strong correlation between R&D expenditure and innovation success in SMEs. Such expenditures are often underestimated in SMEs because investments are less in "R" and more in "D", such as in design and engineering tools (CAD), prototypes, customization, etc.

Further, SMEs often have an inadequate knowledge of their competitors and their products. They need to scan their environment regularly to learn what their competitors are doing (Woodcock et al., 2000; Camp, 1989; Frost, 2003). They also need to compensate for their lack of resources by partnering or networking with customers, suppliers or even competitors (Freel, forthcoming; Vossen, 1998). A firm with strong marketing skills and weak technical skills can partner with a firm with a reverse set of strengths and weaknesses (Huang et al., 2002). There is some evidence that SMEs draw upon a greater variety of sources for information and ideas than do larger firms (Bommer and Jalajas, 2004). Firms vary in their ability and interest in partnering. Rothwell and Dodgson (1991) suggest that SMEs may prefer to partner with other SMEs rather than with larger firms because the latter's culture is often bureaucratic, has a longer payback horizon, and increases the risk of intellectual property loss.

Although only a small proportion of SMEs engage in innovation activities, those that do so appear to have a higher yield for their effort, especially in number of new patents issued (Nooteboom, 1994). This underestimates the yield, however, because many SMEs don't have the legal resources to file for patents, would rather rely on trade secrets, have minimal codification, or stay enough ahead of competitors to allow for an imitation lag.

SMEs often carry out the new product development (NPD) process less completely or thoroughly than do larger companies (Woodcock et al., 2000). Most SMEs do not use all of the thirteen new product development "stage-gates" recommended by Cooper (1999). March-Chorda et al. (2002) found that 54% of Spanish firms use nine or less of Cooper's recommended thirteen stage-gates. Huang et al. (2002) found that Australian SMEs undertook market-related activities less frequently than technical activities, and this distinguished successful from unsuccessful new products. Lindman (2002) suggests that SMEs that have close relationships with a limited number of customers may be able to forgo marketing steps because there is less need for market research. SMEs in the Finnish metal working industry (most with less than ten customers) do market research and learn about their customer's needs by working closely with them. SMEs with a formal written product development strategy are likely to complete more NPD stages with higher quality (Huang et al., 2002).

SMEs have fewer employees, each with multiple roles (Yap et al., 2005), but they may be able to form cross-functional teams more easily than large enterprises because their professional specialization is less complete. Employees of SMEs interact more often with their counterparts and may have shared or swapped tasks with them. This gives team members a clearer idea of their respective contributions to the NPD process. The downside of less specialization is difficulty in keeping up with the latest knowledge in a given specialty. Assuming that senior management has a clear idea of what it wants its cross-functional teams to do, there is less risk of a disconnect between levels due to bureaucracy, delays, and miscommunication.

SMEs also vary in how much they focus on learning (Salavou, 2005). Most SMEs don't focus on learning, but even if they do, they vary in how much they codify their learning so that it can be used for developing similar products (Mosey, 2005). Many SMEs don't recognize the value of data, have minimal archives and don't learn from experience (Woodcock et al., 2000). Uncodified or tacit knowledge has benefits and shortcomings for SMEs. On the one hand, it is harder to identify what a firm is doing wrong if it has not codified its NPD process. Similarly, tacit knowledge plays a role in how SMEs learn from other firms. They are more influenced by being in direct contact with people (suppliers, customers) whom they know well and trust (Lindman, 2002). On the other hand, tacit knowledge is difficult to imitate so other firms cannot easily appropriate an SME's intellectual property (Kogut and Zander, 1992).

Dynamic capabilities are the specific knowledge and skills that firms learn in order to carry out specific activities, including formation of effective cross-functional teams and conducting an effective NPD process (Eisenhardt and Martin, 2000). They differ from "core competencies" (Prahalad and Hamel, 1990) in that they need not be rare or inimitable. For example, best practices in NPD can be learned and easily transferred between firms. Core competencies rely on leverage across NPD projects within a single firm for competitive advantage, but conditions may change too rapidly for this to happen. Instead, dynamic capabilities allow existing sets of knowledge and skills to be recombined and emergent requisite skills to be developed to meet new opportunities. The dynamic capabilities of particular concern are those that accelerate internal learning (e.g., degree of codification and learning routines) and networking capability (e.g., highly trained personnel who know what to look for and where). The choice of NPD projects feeds on itself to strengthen current dynamic capabilities or develop new ones (Branzei and Vertinsky, 2006). As part of a strategy to develop dynamic capabilities for NPD (e.g., technical, market, collaborative skills), SMEs need to carefully consider the types of NPD projects they undertake and the customers they serve (Mosey, 2005).

2.4 What Innovation Strategies Should SMEs Pursue?

Based on the review and analysis above, we can recommend specific focus areas for innovation in which SMEs can apply their inherent advantages and mitigate the influence of their shortcomings. We postulate that SMEs need to pursue innovation strategies that do not rely on scale in production or marketing (Nooteboom, 1994). Product customization and customer intimacy are ways to do this, especially in delivery of industrial services. Scale should be sought by geographical expansion to similar ("narrow but deep") product markets, not by product-line diversification (Simon, 1996). Large firms have more resources, but SMEs have behavioral flexibility. SMEs need to play to their strengths.

SMEs should cultivate relationships with a small number of captive customers (Lindman, 2002). Intimacy helps make up for lack of resources for market research. This relationship can be characterized as "relational" rather than "transactional" (Siu et al., 2006). It is even suggested that firms can "outsource" innovation to customers by giving them tools to articulate their needs, which can then be given back to the firm for actual development and production (Thomke and von Hippel, 2002). There is a paradox in customer closeness and a risk, however, in that firms that work closely with only a few customers begin to depend mainly on their own internal

resources for ideas rather than seek new information from the outside. Nevertheless, this level of customer intimacy is especially appropriate for SMEs that pursue industrial services to complement the sale of their products.

Nooteboom (1994) suggests that SMEs pursue product innovation strategies in emerging markets and marketing innovation strategies in mature niche markets. Moore (2004) also suggests that business model innovation is a very effective strategy in mature markets with products in late life cycle stages. As we indicated earlier, we will focus little attention on SMEs in emerging markets, other than to indicate that these SMEs are better at quickly forming unique technology/market/product combinations that exploit new technology than they are at conducting fundamental research (which large firms do better). SMEs in mature niche markets should pursue price inelastic customers who still want products that larger companies have dropped or ignore.

Pavitt (1984) indicated that the specialized equipment suppliers he studied tended not to diversify technologically either vertically or otherwise. His explanation was that their current market was stable enough not to require them to moderate sales volatility through diversification. Ledwith (2000) found similar results in a sample of Irish electronics firms. Cooper (1999) and Meyer and Roberts (1986) advised such firms not to diversify into new markets because they don't have the resources for it. If SMEs don't diversify in this way, then what paths of growth remain for them? They can add new customers in their current market by offering them variations of existing products, take market share from competitors, or seek new revenue opportunities from existing customers by offering them a more complete solution to their needs (Simon, 1996). Any of these options are possible, but we are going to focus mainly on the last one.

The possibilities for the last option include taking over activities in the value chain that either the customer or another supplier currently performs. For example, Flinchbaugh Engineering, a small employee-owned company in Pennsylvania, now operates transfer lines for customers such as Caterpillar, SKF and Siemens that previously owned these lines (Anonymous, 2006). It has mastered lean manufacturing practices so well that it can operate these lines more efficiently than its customers. Fine (1998) discusses how Johnson Controls and Lear continued to acquire suppliers that first made up car seats and eventually the entire car interior including door panels and dashboards. These companies now have much more leverage over their customers, the automobile companies. Few SMEs have the resources to pursue such an acquisition strategy, but it illustrates the point.

Another option for SMEs is to perform industrial services that their customers currently perform or propose new services that will help them operate more efficiently. The most well known industrial services are maintenance and provision of spare parts. We will provide a much longer list of such services in the next section of the report. If SMEs are allowed to work closely with their customers, they might be able to propose new services to perform by observing "points of pain" (Gustafsson and Johnson, 2003) that perplex and frustrate their customers when they use their product or other firm's products. Lastly, new service revenue opportunities can be generated by thinking beyond the sale of the product and about its installation, operation and

disposal. Gustafsson and Johnson (2003) suggest viewing "products as services waiting to happen".

The next section develops these themes further by exploring in depth one potentially attractive innovation path for SMEs, namely the addition of services to product offerings.

3.0 SERVICE INNOVATION IN MANUFACTURING COMPANIES

3.1 Background

The period from approximately 1985 to 2000 saw U.S. manufacturers responding to the competitive challenges arising primarily from Japanese firms. Focus was on improving productivity and quality using such techniques as TQM, six sigma and lean manufacturing practices. However most of the firms that have sustained their operations in this period have implemented such programs successfully and, in line with the manufacturing sector in general, are again looking for organic growth to enhance both revenues and profits. This requires innovation skills and new innovative business models as outlined in our previous report (Warren and Susman, 2004). One way that SMEs can achieve such growth is by adding services to or around their products and this section reports on such new opportunities. Also in this section, we include five "mini-cases" that illustrate how these opportunities can be realized. In section 5, we discuss details of the challenges posed by the transition to service-centered manufacturing, which demand different skills and indeed a different organizational structure and culture both within the management of SMEs and the consultants that can help them.

3.2 Why Add Services?

There are many reasons why the addition of services can provide significant growth opportunities, greater stability, and higher profit margins to SMEs (Reinartz and Ulaga, 2006). Among these reasons are:

- Improving predictability of sales and cash flow. Many industries suffer from cyclical variations, e.g., seasonal for the building sector, economic for the automotive sector, etc. In addition, many product categories are becoming more saturated with tough competitors competing for market share. This results in "commoditization" of products and hence lower profitability. Global supply chains, with their increased purchasing power, are also forcing lower prices, and meeting these demands by improving productivity has nearly run its course. Adding or substituting service revenue can mitigate against some or all of these factors.
- These same pressures on SME customers, on the other hand, are forcing them to focus on their core competencies and turn to outsourcing to provide many of the functions that were once performed in-house.
- Adding services can help consolidate and protect the core product businesses of an SME. Services can differentiate a company from competitors and establish closer relationships with customers. It is relatively easy for a competitor to provide a better and/or lower cost product, but much more difficult to replace an "intimate and trusting" relationship between suppliers and customers.
- Innovation in services typically results in increased customer satisfaction and loyalty. Both are concerned with the direct attributes of the service offering, but also with the image of the supplier, and with the unique relationship that the customer and the supplier may have. Typically, service is about transferring additional values and functions to those gained by just owning or leasing a product to better satisfy customer needs. This will eventually have an

impact on the financial results because of repeat purchases by the customer, and because of recommendations to other potential customers.

3.3 Definition of Services

There are several different definitions of service found in the research literature. Among the most useful are:

- To place a bundle of capabilities and competences (human, technological, organizational) at the disposal of a client and to organize a solution which may be co-produced with the client and given to varying degrees of precision, codification, and customization (Gadrey and Gallouj, 1994).

- Service products are something a customer pays for receiving even though it may be intangible. The service may be attached to a tangible product however, although a great many service products are intangible even though they may have a physical manifestation. Often, where customers and employees are in relatively constant contact, inter-personal experiences are critical to the delivery of service products (Tidd and Hull, 2002).

- A service is an activity or series of activities of a more or less tangible nature that normally, but not necessarily, takes place in interaction between a customer and service employees and/or physical resources or goods and/or systems of the service provider, which are provided as solutions to customer problems. Advances in information technology increasingly may remove the person-to-person interaction as a service is provided. Examples of this are the ubiquitous deployment of ATMs and more recently, check-in terminals at airports and hotels (Gustafsson and Johnson, 2003).

3.4 Types of Product-Related Services

Servicing the Installed Base. In describing the service elements provided by manufacturing firms, several labels are used in the literature: industrial services, service strategy in manufacturing, product-related services, product-services, or after-sales services. SMEs are motivated to develop these services in order to complement their existing product base as well as to enhance revenues. This is done by showing customers the importance of services during the life of a product. In the past, many services have been offered as add-ons in order to make a sale, but the product was the main source of revenue. Servicing the installed base requires firms to make services a higher priority. A firm's installed base (IB) refers to its products that are currently in use. For example, one of Hewlett-Packard's installed bases is printers. Although Hewlett-Packard's servicing is in terms of a product (i.e., the ink cartridge), the model still stands. The company sells a product that is its main source of revenue (i.e., the printer), and then sells a service to keep the product running (i.e., the ink cartridge, albeit a product). This example highlights the main idea of servicing the IB. Selling a product that has needs (not deficiencies, but needs), such as installation, operation, upgrades, maintenance, spare parts, decommission, etc., requires some sort of service (Oliva and Kallenberg, 2003). IB services include all services

that are needed to keep the product functioning properly throughout its life-cycle. The firm that originally sold the product is usually in better shape to do the servicing than a competitor because the firm knows its product well, but it is conceivable that firms can service a competitor's IB. In this way, the firm can use the product's life-cycle in order to generate service revenues and a competitive advantage. Focusing on servicing an IB is one way that a firm can develop new services for its existing market, and it is also less risky than other innovations, since the firm already has a customer and knows its product.

By considering the IB in this context, we realize that it leads to a more competitive market with greater size and scope. The fundamental principle is integrating the value chain from the initial stages of product development with providing service to the end user.

The original equipment manufacturer (OEM) has a distinct advantage when servicing its IB. The OEM collects data at the sale and has reduced costs associated with acquiring new customers. The OEM has inherent product knowledge and requires less cost to acquire any additional knowledge about the requirements of service over the product's life. The OEM will also realize lower costs in fabricating spare parts or upgrading existing technologies.

We later discuss the phase of organizational change where the firm consolidates its service offerings and creates a separate organization to handle the service offering. Once this step is complete the firms can optimistically enter the IB service market.

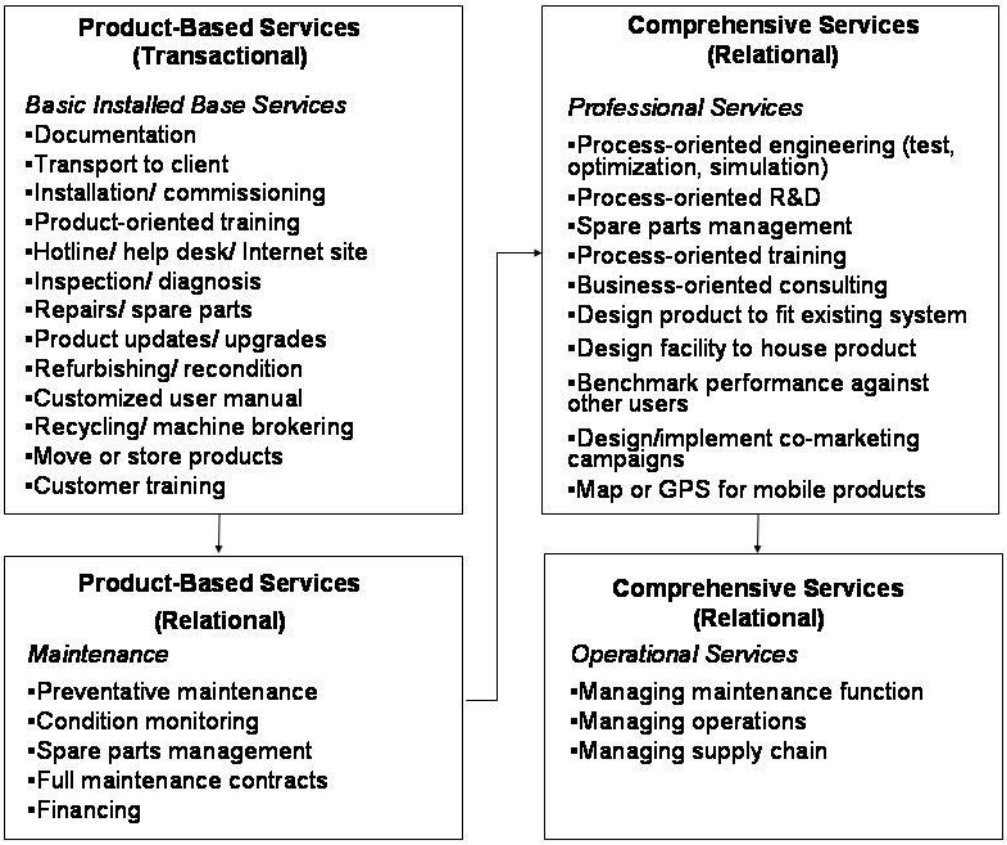
Once the profit opportunity within the service arena is identified, the firm must set up the structures and processes to exploit it. We discuss later in this report the major cultural changes that must occur to shift the firm's understanding of the tremendous potential of the service opportunity. The firm must collectively learn to value services and how to manage the service process. In order for a successful expansion of the IB service offering to take place, the firm must have already made its cultural and structural transformations to the service focused strategy.

The first critical step then becomes changing its customer interactions from transactional to relational-based selling. The optimal agreement for the service provider is a fixed-price contract, covering all services over an agreed period. This transfers the risk of equipment failure to the service provider and focuses on relationship-based services centered around the product and operational availability and response time in case of failure. This allows the service provider to better predict demand and utilize its human resources more effectively.

It is now pertinent to list the different classes of services that can be added around a product sale. They are listed in order of increasing differences in management and organizational factors required. The earlier categories are often included in a product offering and are transactional one-time services. They may in fact be of considerable value to customers yet are bundled in "free-of-charge" because of perceived or actual competitive pressures. Clearly, this does not add to revenue and profits. More complex service additions that involve a closer relationship with the customer and leverage the OEM's advantages have greater potential to contribute significantly to financial performance.

Following Oliva and Kallenberg (2003), we arranged these services into four clusters (see Table 3.1). These authors suggest that firms must master product-based services first before graduating to comprehensive and relationship-based services. Firms that don't do this usually fail at transitioning to services. Two of these clusters involve migrating from a transactional to relationship-based approach with customers (vertical path) and the other two involve migrating from selling services focused on single products to selling comprehensive services in which the firm's products and ancillary products and services are embedded (horizontal path).

Table 3.1 Service Opportunities for Manufacturers

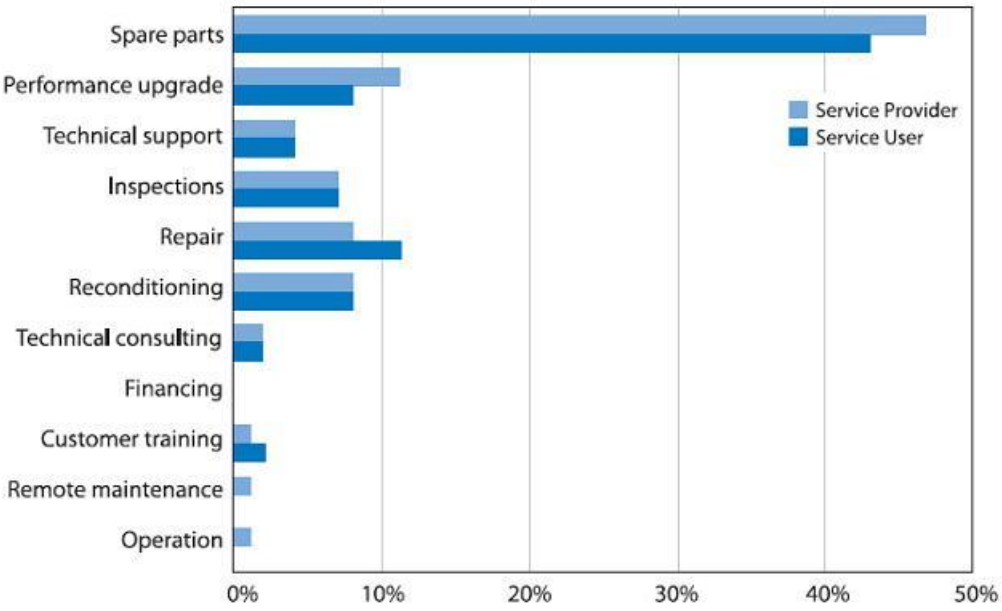


Adapted from Oliva and Kallenberg, 2003 and Monitor Group, 2004.

As firms seek to increase their service offerings and gain access deeper into their customer's value chain to offer more complete solutions, it is critical for them to understand both their individual customer needs as well as the overall market potential for their service offerings. Figure 3.1 provides perspective as to where the largest portions of customers' spending and providers' sales are taking place in the industrial service sector.

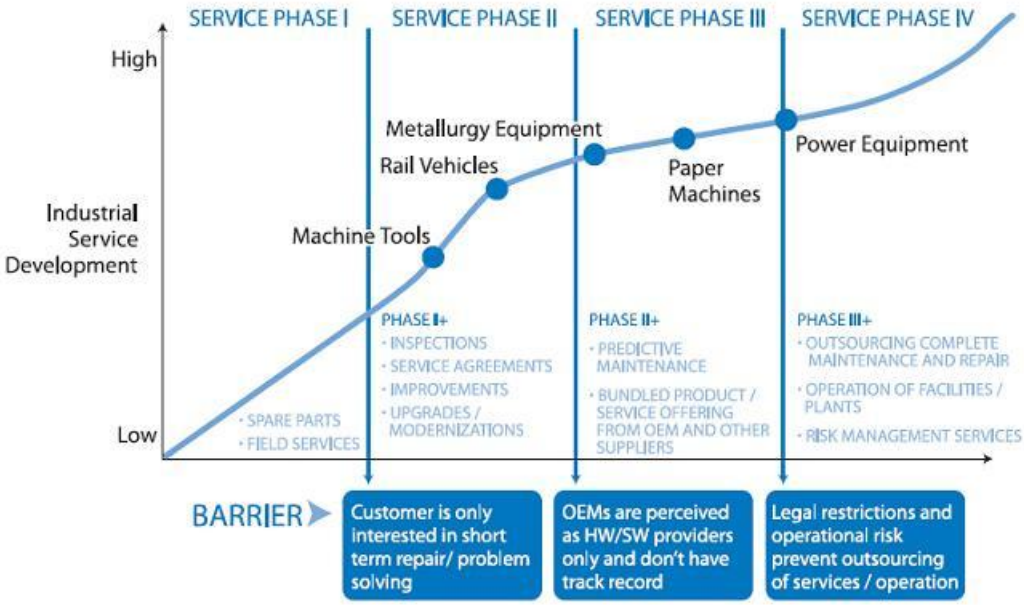
Figure 3.2 shows the evolution of service offerings from less involved, transaction-based to comprehensive, relationship-based, and higher margin solutions. There are major barriers to reaching the higher phases of service offering, as the service firm's risk increases and higher levels of solution expertise must be available.

Figure 3.1 Share of Service Sales/Spending Volume by Type



Source: Monitor (2004) Industrial services strategies: The quest for faster growth and higher margins.

Figure 3.2 Market Penetration of Services



Source: Monitor (2004) Industrial services strategies: The quest for faster growth and higher margins.

3.5 Mini-Cases

The first "mini-case" illustrates how a supplier of a commodity product changed its business model to provide a complete service thereby satisfying previously unmet, indeed unvoiced, needs of its existing customers. Additionally the data accumulated from having a greater knowledge of customers' behavior enables the company to continually add value and build barriers against competitors. (The importance of acquiring and building databases as tools for adding value and defending against competitors is returned to later).

> **Mini-Case Example #1:** Greif Packaging, a supplier of metal drums for shipping bulk chemicals, many of which are toxic, realized that they had no real competitive position and profit margins were thin. An internal entrepreneur decided to listen carefully to customers. He saw there were unmet needs and new sources of value to be accessed. Customers did not want to buy and own steel drums, they wanted to move toxic chemicals efficiently and safely; they did not want to deal with all of the details such as finding a licensed trucker, filling in the government forms, washing, cleaning and refurbishing the drums, etc. To meet its customers' actual needs, Greif converted its business model to being a "trip leasing" company for specialty chemicals – the FedEx® of problem chemicals. Now Greif solves the total trip problem for its customers – drum supply, cleaning, refurbishing, regulatory compliance, transportation, and tracking. It built a new web application and became an "(Internet-enabled company". Although Greif sub-contracts out most support functions, it captures the value in the supply chain and builds long-lasting client relationships. Moreover, it buys support services in volume, and its database of trip costing enables the company to accurately quote on "trips" and to provide customized and traceable service. This shift has significantly improved Greif's profit margins and cash flow, which it can direct to further innovations. The business model also builds barriers against competitors. Source: Warren and Susman, 2004.

Additionally, services can help to establish "customer lock-in". Customers, by foregoing certain tasks, increase their dependence on their suppliers. Switching costs therefore are increased. The second mini-case illustrates how special skills can be used to capture and retain customers for later delivery of products and services.

> **Mini-Case Example #2: General Fasteners,** a supplier of components to the major automotive companies, had been squeezed more and more on price as the global competition in this sector became increasingly tough. Even if a supplier has some proprietary technology, the power of the large buyers such as GM and Ford are such that they insist that their suppliers share their unique know-how so that they can play-off multiple competing suppliers against each other. Life is particularly tough when the component is simple to make, the product is non-proprietary and there is an over-supply. Faced with these daunting pressures on

profits, General Fasteners (GF), a manufacturer of bolts and other metal fasteners for the automotive industry looked for an innovative business model to change its competitive status. It started by participating in the engineering design of new car "platforms", taking responsibility for how major sub-assemblies, such as frame, interiors, engine, and transmission of the car will be reliably fastened together. This requires special, hard-to-come-by engineering skills which GF can attract as the engineers have a number of challenging projects to work on, which might not be the case within an automotive OEM. GF then contracts to supply the car company with just-in-time components directly to the production lines, with 100% quality inspection and guarantees. GF uses fasteners either made in its own plants or by purchasing from other suppliers. It manages an integrated supply chain from design to final assembly. This requires GF's computer systems to seamlessly integrate with car plants exchanging data in real-time. GF is "locked-in" to its customers both in design and operations making it difficult for competitors to displace them. It provides both products and services. In addition, by taking over the front-end skilled design work, GF's customers have no need to retain these expensive skills in-house for occasional use, and therefore become more dependent on their supplier when it comes time to design a new family of cars. (For a more complete discussion of supplier/OEM relationships see Clark and Fujimoto (1991) where distinctions between "supplier propriety parts", "detail-controlled parts" and "black box" components as alternative approaches to supplier-OEM design relationships are explored). Source: Warren and Susman, 2004.

Providing a service component to existing customers builds on past relationships and increases revenue and profits from the installed customer base. This reduces cost of sales, while adding revenues and profits. In many cases, the addition of complementary services such as scheduled maintenance, remote monitoring of performance, benchmarking, etc. can also increase sales of *physical product* and take market share away from competitors.

Services demand closer relationships with customers, sometimes requiring regular on-site engagement. These interactions can uncover unmet needs, or possible future demands for products and services that would not normally be encountered with a more "arms-length" product-sale relationship.

The company may also innovate entirely new services. The latest information technology standards and infrastructure can be used to provide services that were not even conceived by customers until their providers innovate. For example, using advanced data collection and data mining tools, coupled with real-time data collection over the Internet may provide a whole new level of product and service reliability. The third "mini-case" provides an example.

Mini-Case Example #3: Taprogge GmbH, (www.taprogge.com) a family owned business headquartered in Germany, has over 90% of the world-wide market for cleaning condensers and heat-exchangers in power plants. The company has a strong patent position covering its unique invention of using

"scrubbing sponge balls" which are randomly circulated through the condenser tubes to remove scale build-up. Initially, Taprogge supplied the equipment together with sponge balls tailored for particular water quality. The balls wear out, so the company has an ongoing revenue stream once the equipment has been installed. Recently the company has moved towards a "total service" business model starting with the installation of the plant and taking responsibility for its operation. The latest equipment has a number of embedded sensors that monitor the performance and relay the data over the Internet back to a central office. Analysis of these data enable the company to predict possible performance deterioration and ship parts followed, if needed, by a qualified service engineer. Shutdown of a central power plant may have an enormous economic impact. Taprogge's service model is therefore highly valued by customers who are willing to pay for the reliability and security that the company provides. The responsibility for down-time now shifts from user to supplier, which implies that Taprogge must be able to support its claims and be willing to enter into contracts that may contain significant penalty clauses for failure to perform.

The company's most valuable asset is a complex database covering all operating parameters of every installation. This is now enhanced by its on-line monitoring systems that give it real-time access to customers' systems. These data enable Taprogge to a) predict the behavior of a system in most if not all locations and environments ("water is not just water"), b) design new products, systems and services more effectively, c) provide fast turn-around service or even on-line help that reduces service time and costs. This strategy is particularly important when the product is customized. Again we see the power of using information technology innovatively to create added-value for customers while building barriers to competitors.

The service business model improves customer relationships**.** As mentioned above, the company prides itself on reputation and reliability. It now embodies customer contact on a regular basis by using remote monitoring that gives a basis for pre-emptive actions and regular interaction with all customers either from the local office or from the German HQ. The importance of this cannot be over-emphasized. Two major advantages thereby accrue – better service at lower cost and the ability to detect problems early. Customers initiated most of the new products by coming to the company with an unrelated water problem, and knowing that it will do its utmost to solve the problem. In this way the company has built the reputation as the "problem-solvers" in the sector and this capability is promoted. Source: Warren and Susman, 2004.

With all of these potential financial and strategic benefits available, we might expect that SMEs would be readily adding services to their product portfolios. However relatively few manufacturing companies have introduced services to their product offerings. There are some noticeable exceptions, such as IBM and GE of course. But even these large companies have struggled with making the transition. The reasons for this are complex. The next section of this

report examines the differences between products and services and how innovation practices differ substantially between the two. As we shall see, the situation becomes even more complicated when a company attempts a hybrid model of products *plus* services, where the organizational, cultural, and management tasks are challenging and require significant change management.

3.6 Differences between Products and Services

As SMEs are used to thinking in terms of physical products, it is useful to compare them with services. Services are in fact inherently different from products in a number of key attributes (de Jong and Vermeulen, 2003; de Jong et al., 2003):

- **Intangibility:** this characteristic best differentiates products from services. Services are intangible and often, but not necessarily manifest themselves together with the customer. On the other hand, products are a) more often shipped to the customer, b) are developed with limited customer input, and even then, at the formative stage of development, c) the supplier may have limited knowledge of how the customer actually uses the product and d) most importantly not fully understand the commercial benefit or value accrued during its use.
- **Ownership:** a pure service also does not transfer the ownership of a tangible item to the customer.
- **Heterogeneity:** services tend to be heterogeneous; that is they are customized to the specific needs of the recipient. On the other hand, products are usually created in an identical series and can be sold from a catalog, either printed or on-line. Because products have a physical identify, it is a challenge for a manufacturer, other than those classified as a job-shop, to manufacture many products each different and made for a specific customer. Customization implies an inherently different relationship between supplier and customer.
- **Perishability:** Services are perishable and are usually created as they are used, whereas products can be made ahead of time and held in inventory or within a distribution supply chain.
- **Imitatability and opportunities for "bundling":** Services can be more readily combined into customized packages compared with product features. This differentiates products from services and makes them more difficult to imitate by competitors, thus increasing competitive advantage. When we categorize different classes of services, it is clearly seen that, in many instances, they may be flexibly combined to meet the specific needs of a customer.
- **Integration of an external factor:** this means that during the preparation of a service, an external factor, an object or a subject will be involved in the process, e.g., such as a car in a car rental contract.
- **Need for synchronous contact between customer and service supplier:** Often there is a simultaneous production and consumption of a service. Customers may participate in production because the service preparation and the service delivery are identical (e.g., at the hair dresser) (Kupper, 2001).

The distinction between products and services is often unclear. For example, software service providers may offer homogeneous products that are not produced or consumed simultaneously, and manufacturers increasingly offer products that are accompanied by services, such as repair and maintenance (de Jong et al., 2003). Products and services can be viewed as a continuum because many products have services embedded in them and vice versa (Johne and Storey, 1998). At one end of the continuum are physical products that are exchanged for payment. The relationship between buyer and seller starts and ends with the sale. At the other end of the continuum are services that consist of dialogues between service providers and clients, e.g., consultation or therapy. The client participates in the delivery of the product, which is intangible and perishable. Services such as banking and insurance are further along the continuum because the client receives a product, e.g., mortgage, policy. Services such as transportation, telecommunications and courier mail require systems that are designed, developed, and optimized for performance or delivery of the service.

3.7 Innovation in Product-Based Services

We have seen that services have a number of attributes that are inherently different from products. Based on these findings, we now examine the similarities and differences in the innovation processes needed for each type.

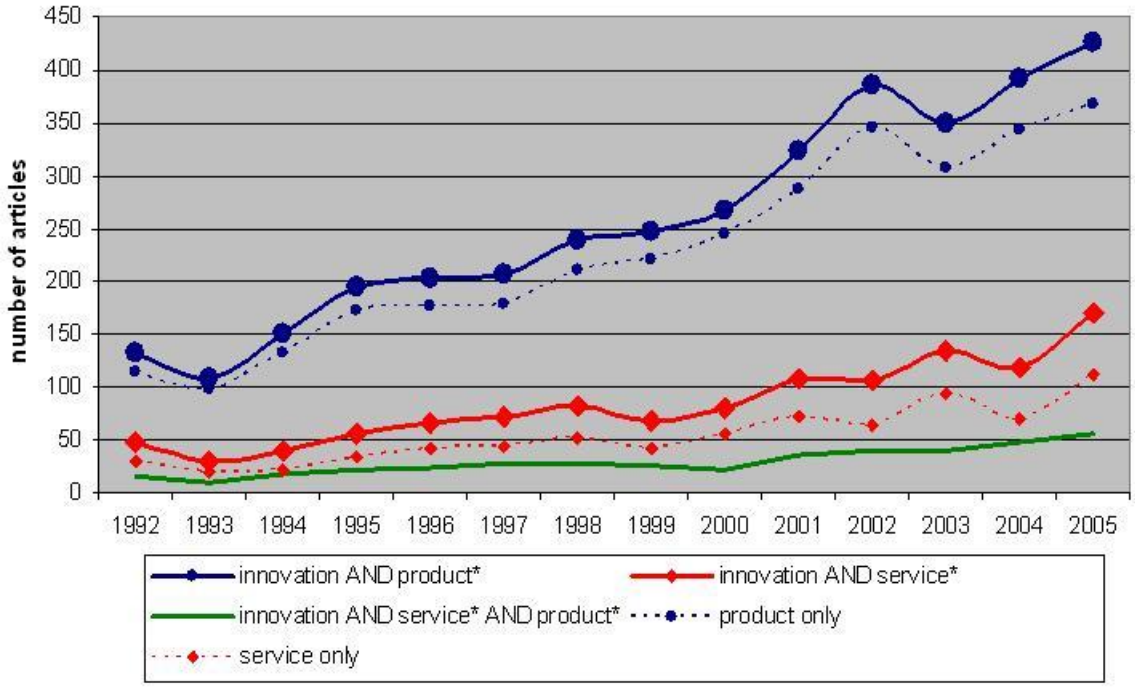
Innovation in service and manufacturing (products) industries differs because of the contrasting general characteristics of the two offerings. Due to the labor intensive nature of services, typically service innovations require much less capital investment. Service innovations usually require less R&D, require less in fixed assets, and need less investment on patents and licenses for the development of new services (Brouwer and Kleinknecht, 1997). Technology is also less important for the development in new service as many times the face-to-face relationship building component becomes more important.

Because less of a financial and technological commitment is needed for service than manufacturing innovation, service innovation can be easier to imitate. As competing firms realize these features of service innovation, they may be tempted to copy the offering. However, it is not as easy as it may appear to imitate a competitor's service innovation. Though capital investment may be low, organizational aspects play a larger role in the success of service innovation. One common barrier to innovation in service firms is the lack of a robust human resource strategy. A fatal flaw for a service company can be the lack of well-educated co-workers capable and committed to the firm's mission, which can have a larger influence on the success of new services than on new manufactured products.

We start by reporting on the research literature covering both product and service innovation. Figure 3.3 shows the focus of academic work in the field of innovation models over the last thirteen years. The database analyzed was the ISI "Web of Knowledge" (ISI, 2006) using the social science sub-set of indexed publications. Specifically, we searched for the terms shown in the figure within the title, abstract and key words only. All categories show a gradual upward trend. However, despite the fact that there has been a major shift in the GDP of developed nations from product-based to service-based economies, research agendas have not kept pace.

Indeed, the research literature on innovation divides strongly into two separate areas of endeavor – product innovation and service innovation. Service innovation research is heavily targeted at specific market sectors such as financial, telecommunications and transportation. Our review of this literature indicates that, although there are some results that are relevant to SMEs, much of the work is so sector specific, the value is limited. Indeed, apart from some relevant research in Finland and Holland (de Jong et al., 2003; Paloheimo et al., 2004), there is an extreme paucity of work that has focused on innovation around a combination of both product and service. Further, examining innovation processes that encompass *both* product and service, the topic of this section, we see that the research intensity is actually falling behind the other two categories.

Figure 3.3 Comparison of NPD, NSD and TSD Processes



Source: Garud and Tuertscher, 2006.

Other general observations arising from our literature analysis show that:

- Research on service innovation models has grown much faster in Europe in locations such as Finland, Holland and Switzerland rather than in the U.S.
- Research on "hybrid" innovation models combining services with products is extremely limited, again led primarily by European teams. This research is mostly anecdotal and not underpinned, as yet, with a solid theoretical background.

We find, therefore, that there is a significant shortfall in fundamental research on service innovation, particularly when embedded within a manufacturing enterprise. We will return to this issue in the recommendation section.

Some definitions of service innovation taken from the research literature include:

> The development of service products which are new to the supplier (Johne and Storey, 1998)
>
> An offering not previously available to a firm's customers, resulting from additions to or changes in the service concept (Menor et al., 2002)
>
> Encompassing ideas, practices or objects which are new to the organization and to the relevant environment, that is to say to the reference groups of that innovator (Van der Aa and Elfring, 2002)

3.8 Role of Information Technology (IT) in Product-Related Service Innovation

We saw in the three mini-cases, Greif Packaging, Taprogge, and, to a lesser extent, General Fasteners, that IT was an integrated part of their service business model, and not used just as a set of tools to help them manage the operations of their business. Increasingly, IT can become a powerful weapon for SMEs to create greater value for their customers.

The fall in the price of computers and data storage devices, coupled with the rise of the Internet, have made the use of digital information as a competitive weapon no longer just the domain of larger companies. Start-up companies can now harvest information technology to provide their customers with greater value and to create subtle barriers to competition. Indeed, this new low-cost digital freedom may even provide smaller companies advantages over larger firms which are encumbered by "legacy" data systems and cultures freezing them in outdated business models. It was, after all, Amazon and eBay that created on-line bookstores and auctions rather than Barnes & Noble and Sotheby's.

Here are some categories for use of IT in business model innovations. They are illustrative and not intended to be a complete list.

Data Acquisition and Mining: Capturing data on customer requirements and using it to create unique services or products can be a powerful way of adding value and keeping out competitors. Netflix has changed the way that consumers rent movies. The power of the Netflix business model comes not only from the convenience but the ability to "mine the data" obtained by combining information from ALL customers nationwide. This enables the company to make suggestions on what someone might like to rent based on not only past rentals but by matching behavior with others who have a similar taste. This ability is termed "collaborative filtering". In addition, by getting instant feedback from their database (customers provide long lists of future wants and rate past rents), Netflix is able to balance its inventory centrally to meet both current and anticipated customer requirements, something not

possible to do on a local basis. Using this novel database structure, Netflix is able to provide its customers with a convenient personalized service, as it continually optimizes its supply chain.

The following "mini-case" shows how, in a business-to-business market, acquisition of data, and its subsequent analysis or mining can provide a powerful service model for a manufacturer.

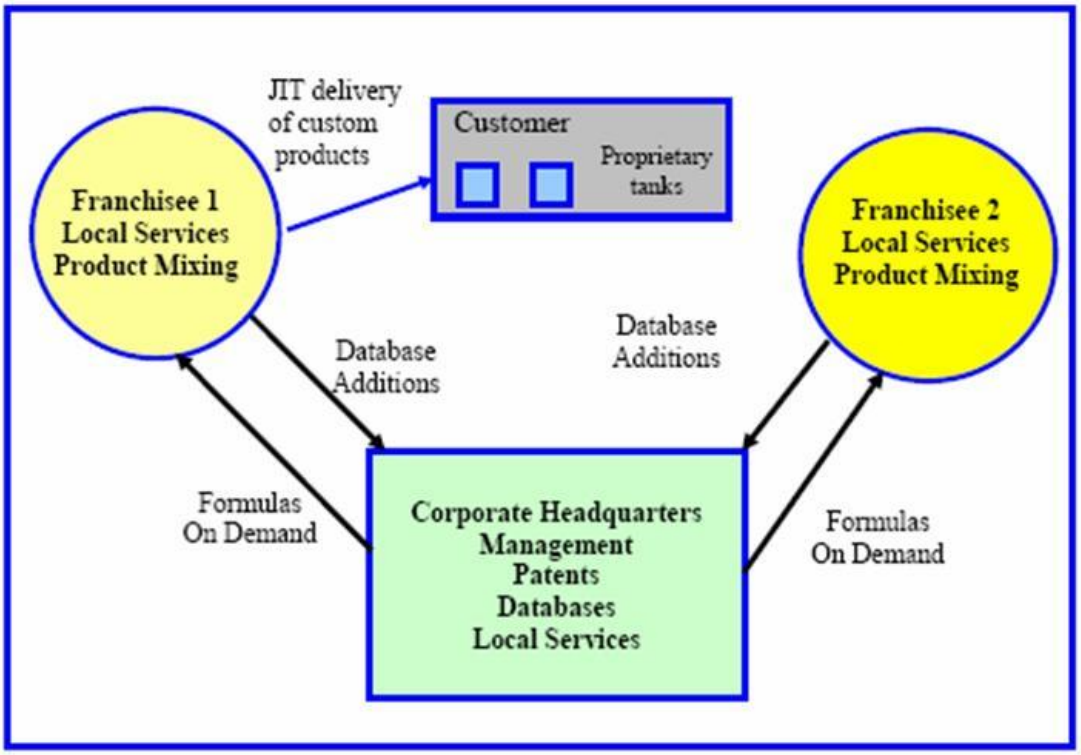
> **Mini-Case Example #4: De-Angelo Brothers:** Using a truck bought for them by their father, and some standard mowing equipment, the two brothers provide services in "vegetation management" to businesses rather than home-owners. DBI Services (www.dbi.com) learned by listening carefully to customers that businesses have greater and more complex needs than home-owners. For example, "Class I" railroads are regulated by the federal government on the amount of vegetation that may grow on their rights of way. This is, for example, to mitigate against fire hazards and to ensure that there is a clear line of sight at crossings for safety. DBI realized that the *value proposition* for these customers was not focused on low cost but on the reliability and speed with which a service provider could treat the vegetation growing along the tracks. If any equipment breaks down on the railroad, the loss of income from trains not being able to run would greatly surpass any small cost savings for the service. Understanding the customers' true needs has enabled DBI to build a dominant position in this sector by designing and building its own vegetation treatment road/rail vehicles. These rapidly mount the track and detect the location and type of vegetation along the line, mix optimized herbicides in real-time, and spot-spray using robot arms on the truck. This minimizes the amount of chemical carried and used, limiting any environmental damage and coincidentally reducing the time needed to refill the containers with herbicides. By mapping the exact location of every plant using on-board GPS technology, the company ensures that its next service run can be accomplished in minimum time with highly efficient utilization of chemicals and equipment. The proprietary data that the company collects on its clients' unique situations are a major competitive advantage, making it exceedingly difficult for a competitor to bid accurately on a contract and to compete in service. DBI's business model is based on the principle of providing customers with reliable and customized services supported with proprietary information systems. Source: Warren and Susman, 2004.

Customer Lock-in: Information can be shared between customers and suppliers so that each is closely locked into the other as business partners. A business model based on information sharing can provide high barriers against competitors as the costs involved in integrating compatible data and computer systems can be prohibitive. On the other hand, the SME must be aware of becoming too dependent on one supplier or customer when the "lock-in" can become disadvantageous. A sound business model using data lock-in will have multiple partners so that the dependence on one partner is reduced. The General Fasteners case above is a good example of so-called "customer lock-in".

IT enabled innovative business models: Entirely new forms of business can be created by employing data acquisition and mining to lock-in customers, suppliers and partners. The fifth "mini-case" provides an interesting and illustrative example of a company supplying commodity chemicals yet providing greater value to customers, and partners.

Mini-Case Example #5: ChemStation was founded by George Homan (www.chemstation.com) in 1983 after he had spent some years as a distributor of industrial cleaning chemicals. His close contact to customers led him to recognize that businesses do not want to handle bulky containers of cleaning chemicals and George saw an opportunity to provide a better service by offering custom formulated, environmentally friendly industrial cleaning and process chemicals delivered to proprietary refillable containers that are placed free of charge at customer facilities. ChemStation has used a franchise business model to expand rapidly nationally without the need for the founding entrepreneur to raise any external capital. ChemStation has used its franchisee network very effectively to get tremendous reach within the U.S. market. The first franchise was given in 1985 and since then 50 franchises have been awarded. Today there are 55 units operating in the U.S. of which only five are company owned. ChemStation's elegant business model is depicted in Figure 3.4.

Figure 3.4 ChemStation's Business Model



> The franchisor's headquarters, which is based in Ohio, serves some local customers and uses its buying power to purchase cleaning chemicals at a lower price than can small competitors. The HQ also holds the secure and coded database of proprietary cleaning formulas for specific customer needs, whether to clean egg-packing equipment or the floors of a car assembly plant. A franchisee is granted a region to service, funds the local marketing, sales and delivery services after paying an entry fee of about $1 million to ChemStation. In exchange, the franchisee gets access to the database on demand when a customer need is defined. This provides the formula for the optimum cleaner components and the usage instructions. In this way the franchisee can provide customers with an immediate proven solution to their cleaning problems. In addition, if a major national company, for example a rental car firm, would like every car to be cleaned the same way and have a distinctive brand-building aroma, ChemStation can provide the formula to every franchisee for delivery to local offices, something that a small local firm is unable to guarantee. In the event that there is no solution in the database for a customer's new problem, and the franchisee develops the answer, then the franchise agreement commits them to submit it to the central database, where it becomes available to all franchises and adds to the intellectual assets of ChemStation. In this way, the franchise model is enhanced by the continual building of a proprietary database of customer solutions adding greater value to both the franchisor and franchisees. Whatever problems are solved at a franchisee's location are fed into the software package which has been devised by ChemStation and the new solution now becomes an integral part of the ChemStation database. The sharing of such information by the franchisees with the HQ is mandated by a written agreement between ChemStation and its franchisees. The database is a key asset for ChemStation and it has the necessary software and framework in place to interpret the results and distribute the data. The database also builds barriers against competition. For example, ChemStation solved a cleaning problem at a Harley Davidson plant within its shock absorbers manufacturing division which resulted in using one cleaning solution on one line and another solution for the adjacent sister line. This subtle know-how becomes a part of ChemStation's data bank. Such captured knowledge helps to lock-in customers, and prevents competitors gaining the account. Since its founding, ChemStation captured, in less than ten years, around 25% of the $300 million U.S. industrial cleaner market by providing customized cleaning solutions in an innovative business model that includes elements of franchising, data-mining of customer information, and customer lock-in. Source: Warren and Susman, 2004.

In addition to using information technology (IT) to enable creative business models, SMEs can, of course, derive benefits from the use of IT in their operations. Froehle et al. (2000) found that IT decisions play a significant role in improving both the speed of the NSD process and the effectiveness of the firm's NSD efforts. Also, the use of teams for NSD directly contributes to the overall effectiveness of developing new services. Teams appear to enhance the firm's NSD efforts through creativity and diversity, given that management provides the proper motivation. Formalization of the NSD process directly contributes to the execution speed of the company's

service design sub-process. In contrast, there appears to be no connection between the use of cross-functional development teams and process execution speed. Finally, training, employee attitudes, and perception of management support also moderate the effectiveness of adoption of new IT tools (Agarwal and Prasad, 1997; Leonard-Barton and Deschamps, 1988; Roth et al., 1997). Thus, investments in process-enabling IT can yield multiple benefits, increasing the generation of new ideas, accelerating the development of new services based on those ideas, and generally supporting the firm's goal of rapidly bringing new service offerings to market.

3.9 Do Manufacturing and Service Firms Innovate Differently?

Tether (2005) studied the presumed differences between the way that manufacturing and service firms innovate. He found that there are both similarities and differences. Innovation in service and manufacturing firms is similar in that innovation is often treated the same in both sectors. As we shall see in section 4, service innovation requires different steps than product innovation, and it also requires a different type of company culture and organization. This shouldn't be surprising based on the specific attributes of services that were mentioned earlier (see section 3.6), such as intangibility and imitatability.

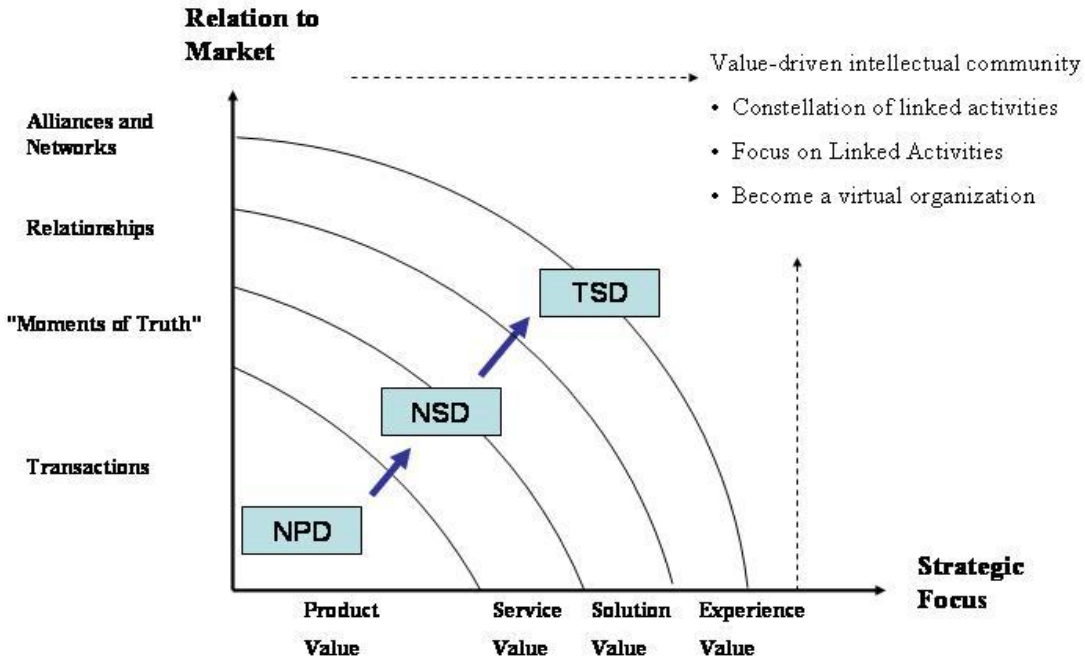
Service innovations are generally more incremental, whereas product innovations can be more radical (Tether, 2005). This is because it is natural for service firms to incrementally improve their services based on customer feedback, etc. Product innovations are also made in gradual and incremental forms, but they are also likely to be radical, i.e., something brand new to the firm or its market. Service can be thought of as much more conventional than new product development, because it is based on internal assets, such as people, instead of external ones. Although people are important in the new product development process, they are arguably more important in new service development. This is because people are the ones who generate new service ideas. New product ideas can stem from external sources, such as new technology. New service ideas come from a close interaction between customers and employees. Thus, although product and service innovation are often thought of as "the same", they are actually quite different and require different procedures.

3.10 The Customers' Role in Product and Service Development

In order to develop services that customers find valuable, it is important to have customer input. Although this will be discussed in greater detail in section 4, firms should observe customers and their "points of pain" (Gustafsson and Johnson, 2003), frustrations or unmet needs with existing products and/or services. Once these unmet needs are uncovered, the firm and its customers should work together in order to generate ideas to solve the problem. Often this can be a daunting task, as customers are prone to changing their minds about their desires (Takeuchi and Quelch, 1983). Thus, firms must be able to handle a vast amount of customer input, and use it to build new products and/or services that are valuable to the customer. It is critical that the firm realizes that regardless of how valuable the firm thinks the innovation might be, it is the customer's opinion that matters. Customers will not buy products or services that they don't find valuable for their firm. New products and/or services must be developed to add value to the customer. (Gordon et al., 1993)

Figure 3.5 below is adopted from Gustafsson and Johnson (2003) and links the evolving relationship between the firm and its customers (y-axis) to shifts in the firm's strategic focus as reflected in the value proposition it offers to its customers (x-axis). The space between curves represents regions where firms are located strategically. Firms in the lower left region of the figure offer stand-alone products to customers and sell products in "arms-length" single transactions. The new product development (NPD) process for this region involves very little interaction between the firm and its customers, other than input from focus groups and needs surveys. The NPD process is structured and focuses heavily on managing risk, and keeping the process on budget and schedule.

Figure 3.5 Evolution of New Product-Service Development



Modified from: Competing in a service economy, Gustafsson & Johnson, 2003 Page 12

Firms in the middle region of the figure offer discrete services usually on a fee-per-event basis (e.g., maintenance). Interaction between the firm and its customers during new service development (NSD) may be greater than for NPD, but the customers' role is still essentially passive, i.e., respond when asked questions or observed unobtrusively. Firms may discover new solutions to customer problems by observing the customer using the firm's products. "Moments of truth" occur when customers experience frustration with using the firm's products and the firm offers solutions that reduce the frustration. Also in the middle region, but more to the right are firms that offer comprehensive solutions that focus on using the firm's product over its useful life. Ideas for services may be offered to customers on a fixed-term contract basis. Customers are active participants in the NSD process and in service delivery.

The upper right region of the figure is uncharted territory for most firms, especially manufacturing-based SMEs. Comprehensive solutions for service delivery put the firm in the role of system architect in designing and delivering system-based solutions to current and future problems that relate to use of the firm's product. The value added is more in the system architecture than in its components, which makes the firm comfortable in forming alliances or networks with other firms to supply some of the system components. We characterize this process as total service development (TSD).

Section 4 will elaborate on differences between NPD, NSD and TSD models. Suffice it to say here that the customer's role in each development process differs dramatically. The relationship between product/service providers and customers shifts from one-way static information exchanges in NPD to two-way overlapped information exchanges in NSD to dynamic and interactive information flows in TSD.

Table 3.2 compares the attributes of the three models, NPD, NSD and TSD. The factors shown are:

- Closeness to customer, ranging from distant to intimate
- Kinetics, i.e., how the interaction occurs, ranging from static to dynamic
- Relationship type, i.e., transitioning from "remote, one-way", "arm's length" product transactions, to "one-on-one close" where a stronger relationship exists between supplier and customer, and "networked, close", whereby several stakeholders participate in parallel in an ongoing dynamic relationship to provide a total valuable solution to all parties
- Information flow ranging from one-way on an irregular basis to two-way on a continuous basis
- Operational issues, i.e., difficulty in managing the innovation process. We will see that TSD demands significant shifts in culture, management methods, behaviors, etc.

Section 5 of this report will deal with the challenges of transitioning from a product-centered firm or customer-support firm with traditional NPD and/or NSD processes to a firm that engages collaboratively in TSD with its customers, and most likely with alliance or network partners.

Table 3.2 Comparison of NPD, NSD and TSD Processes

	Closeness to Customer	Kinetics	Relationship	Information Flow	Organizational Issues
NPD	Low	Static	Remote One-Way	One-Way Out Low	Low
NSD	Medium	Flexible	One-on-One Close	One-Way In Medium	Medium
TSD	High	Dynamic	Networked Close	Bi-Directional High	High

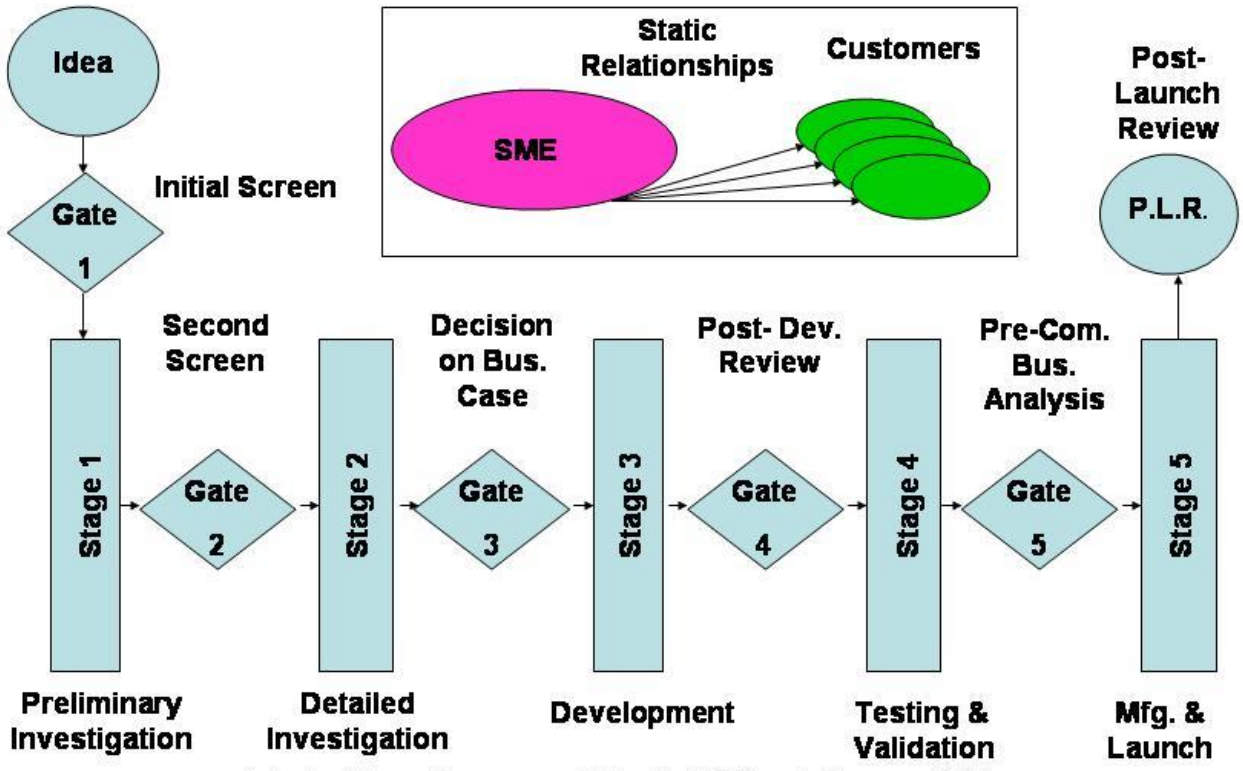
4.0 INNOVATION MODEL AND TOOLS FOR TOTAL SOLUTION DEVELOPMENT

In this section, we first review the innovation models proposed in the literature, starting from the models for new product development (NPD), and the current models for new service development (NSD). We then propose a revised model for a holistic innovation concept (Total Solution Development), which is particularly relevant to manufacturing firms. Finally, we discuss various tools available to implement each step in the proposed new model.

4.1 Models for New Product Development and New Service Development

An extensive and well understood corpus of work exists on product innovation. The most recognized work is associated with Robert Cooper and co-workers, and is known generally as the "stage-gate process" (Cooper, 1994). The stage-gate process, represented in Figure 4.1, normally starts after ideas have already been generated. The objective is to continually narrow down the options as a new product development project proceeds and provide for rigorous review stages where concepts are eliminated. In Figure 4.1, for example, five different gates are instituted, each after one key development stage. The process de-emphasizes continuous innovation and flexibility and there is a concern that rejected ideas are lost or not explored sufficiently, as the focus is more on "getting the next product out of the door". In this process,

Figure 4.1 The Linear Stage-Gate Process



Adapted from Cooper and Edgett, 1999 and Cooper, 1994.

NPD is treated as a defined programmatic effort, with clearly defined goals and resource constraints. It has worked well for larger organizations where resource management and controls are key issues. It is not clear whether it works well for service innovation, which, as we shall see, requires greater flexibility and often "co-creation" of new ideas during close interaction with customers. In addition, new services may not have as clearly defined yardsticks, as new products do, against which a fixed gate could be associated.

A defining feature of an innovation paradigm is how it posits the relationship between the firm (internal) and external parties. The stage-gate process implies relatively static relationships between a firm (SME in this case) and its customers (see insert in Figure 4.1). Customer inputs are incorporated in this type of paradigm, but most activities in this innovation process are done within the firm.

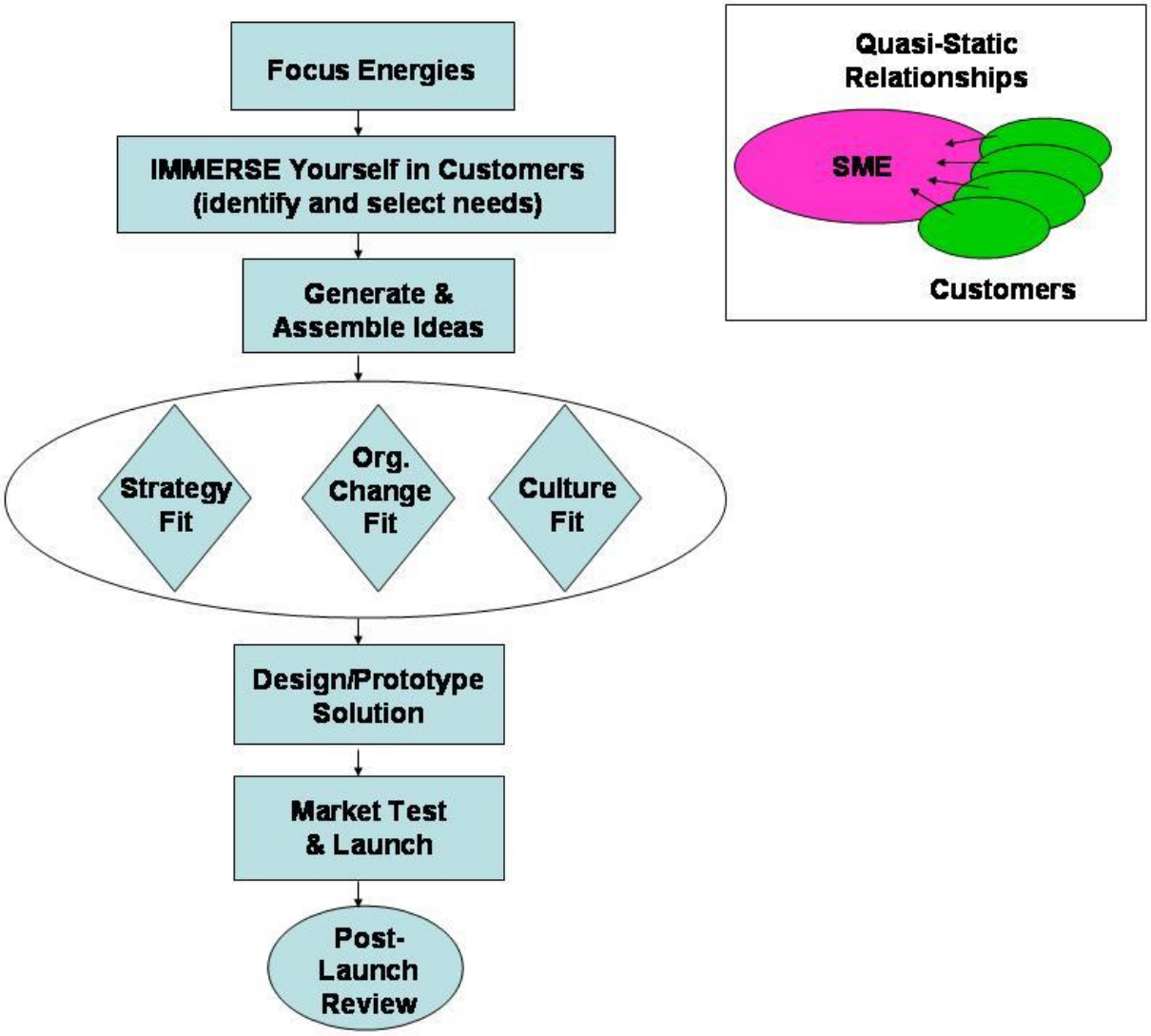
In contrast to new product development, most new services are developed in an *ad hoc* fashion (de Jong et al., 2003; Gallouj and Weinstein, 1997; Martin and Horne, 1993; Kelly and Storey, 2000; Sundbo, 1997). de Jong et al. (2003) discussed many reasons why this might be the case; for example, (1) new services can be imitated by competitors, and thus require a quick response and less formal process, (2) no natural milestones for review, unlike for new products. A new product concept, for example, must be shown that it can be engineered and, if it can, then must later be scaled up under certain cost constraints. A new service concept, on the other hand, normally does not have such relatively objective obstacles. Kelly and Storey (2000) conducted an empirical study in the U.K. and found that many firms do not have formal NSD strategies and that idea generation is done in an ad hoc manner. In cases where firms have NSD strategies, idea screening does not explicitly take into consideration these strategies.

In NPD, formalized models have proven to be critical in leading to better new products (e.g., Griffin, 1997, Cooper, 1984). It is thus desirable to develop a formalized process for NSD. Several different models have been proposed in the literature. Based on the Booz, Allen and Hamilton (1982) model for new product development, Bowers (1987, 1989) proposed an eight-stage model. Scheuing and Johnson (1989) proposed a fifteen-stage model mainly based on the financial industry. More recently, a ten-stage model (Alam and Perry, 2002) has been suggested that incorporates the concepts of cross-functional teams and parallel processing of the developments stages.

Gustafsson and Johnson (2003) have developed one of the most influential new service development models. They adapted the stage-gate process to new service development, which reduced the total number of stage-gates, but added two new parallel gates for cultural and organizational change fit. We summarize their framework in Figure 4.2 (this is an expanded version of the figure on page 121 of their book). Unlike the stage-gate process (Figure 4.1), there is much less emphasis on multiple layers of gates, instead, a key gate is included between idea generation and design/prototype solution. This gate, in essence, is a gate of idea screening and selection. Within this gate, Gustafsson and Johnson suggested that cultural fit and organizational change fit, in addition to strategy fit, should be the key criteria that determine whether an idea will move to the next phase of new service development. These two additional dimensions are necessary as new service, unlike new products, will likely require change in

culture and organization. Unlike the stage-gate process, Gustafsson and Johnson also explicitly incorporate a needs-identification stage in their framework. They call this stage "Immerse Yourself in Customers".

Figure 4.2 A Revised Stage-Gate Process for New Service Development



Adapted from Gustafsson and Johnson, 2003.

In addition, the model shows a closer relationship between the service provider and customers. It posits that service is driven by unmet customer needs, customers are "listened to" and information flows primarily from the customer to the SME (see insert in Figure 4.2). Despite these modifications to Cooper's original concepts, there is little mention of a continuous discourse and interaction between the supplier and customer, and members of the supply chain are not included in the model.

4.2 A Model for Total Solution Development

We propose that these methods can be taken further by adopting a "Total Solution Development" or TSD model. The difference between TSD and the previously discussed new product and new service development models is that the TSD model generally starts with an established base of products and customers (such as a SME), but it does not limit its future innovation to either products or services; instead it posits that a firm should let customer needs dictate the type of innovation the firm should develop, either service, or product, or a product/service combination.

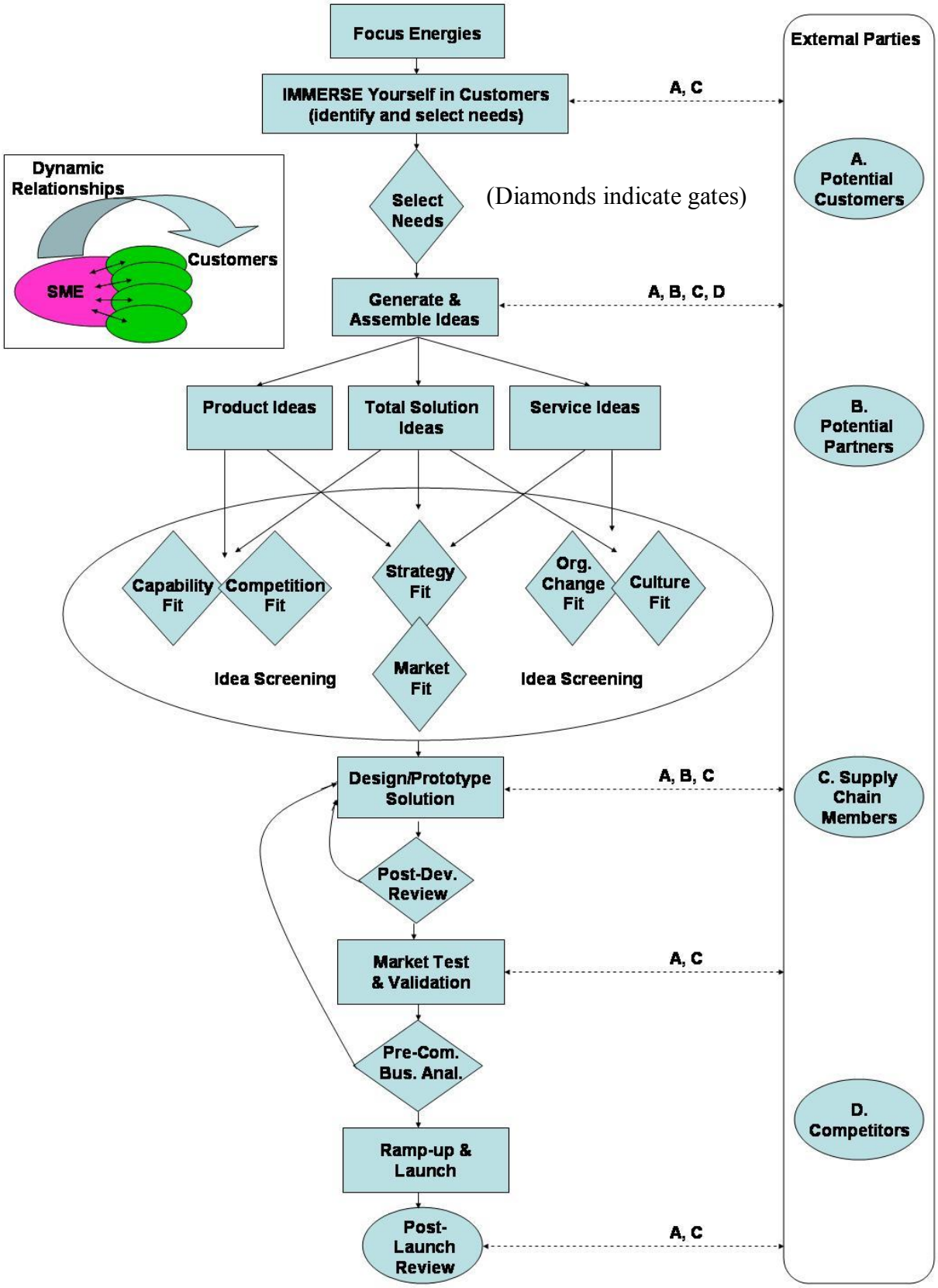
Such an approach will require the firm to engage more completely with external parties (e.g., supply chain members, potential partners, and competitors), and have a *dynamic* rather than *static* interaction with customers. Some companies go as far as having a full-time relationship person on-site to ensure this continual interaction with the customer. We present the TSD model in Figure 4.3.

The TSD model incorporates the key elements of both the stage-gate process and the new service model (e.g., Gustafsson and Johnson). Similar to Gustafsson and Johnson, and unlike stage-gate, it maintains the importance of identifying customer needs as the very first step in innovation. TSD goes even further as it recommends that a firm should segment customer needs prior to selection if possible. It incorporates the key roles of strategic, organizational change and culture fit. However, TSD makes explicit differentiation among new service, new product, and service/product combination, and recognizes the criteria used to select these three different types of ideas differ. Capability and competition are added as part of this gate, but mostly for new product or new product/service combination ideas.

Similar to the stage-gate process, and unlike Gustafsson and Johnson, TSD incorporates multiple gates in the innovation process. It should be noted, however, that different criteria might be used at the same gate; it depends on the nature of the innovation (service, product, or combination), as shown explicitly for the idea screening gate. Market test and launch have been divided into two distinct stages, with one gate between them.

Unlike either of the previous models, TSD explicitly differentiates among new service, new product, and a product/service combination. The combination does not have to be completely new, it could be a new service bundled with an existing product, or a new product added to a service already provided to existing customers. Many SMEs likely already have established products, and they could certainly explore how to add new services to these products to address customer needs that products alone cannot address. TSD espouses a strong and dynamic relationship between the firm and customers (see insert in Figure 4.3). Unlike the static relationship in stage-gate and quasi-static relationship in Gustafsson and Johnson, TSD suggests intimate collaboration with customers with continuous exchange of bi-directional information. External parties, other than customers, are explicitly incorporated into the entire process of innovation. They include potential partners, supply chain members, and competitors. Furthermore, TSD suggests the specific interactions between the firm and various external parties during different stages of innovation development. For the design and prototype solution

Figure 4.3 A Total Solution Development (TSD) Model



stage, for example, TSD recommends that the firm work closely with potential customers, potential partners, and supply chain members -- customers will help assure the new solution does indeed address their needs, partners will help address challenges in developing such solutions (e.g., IT), and supply chain members will help ensure the new solution is in a form that could be delivered to customers in an efficient manner.

TSD dictates innovation should be an iterative and adaptive process; two specific arrows exemplify this process. One arrow goes from the post development review gate back to the design/prototype solutions stage, and the other arrow goes from the pre-commercial business analysis gate back to the design/prototype solution. A stage is not meant to be visited only once during the TSD process. Even idea generation may be revisited if previous new ideas do not appear to be attractive during the following gates. It should also be highly adaptive, conditional on the type of innovation (product, service, and product/service combination).

There are several additional unique features of the TSD model that are not included in Figure 4.3. One is parallel processing. The cycle time must be short to react quickly to changing market conditions and prevent easy copying by competitors. To reduce cycle time, it is essential to engage in some TSD stages in parallel. For example, Alam and Perry (2002) recommend idea screening and business analysis be conducted in parallel as well as personnel training and service testing and pilot run. It should be noted that sometimes parallel processing (and faster development time) leads to higher development cost.

Cross functional teams are a critical component in TSD. They increase the probability of success in new solution development and may avoid costly mistakes. The composition of such teams should reflect the type of innovation (product, service, or combination), and represent all functional departments that will be involved in actually developing, producing, and delivering the innovation. An innovation, if adopted by a firm, will have a different impact on individuals within the firm – some people's careers will be enhanced and compensation increased, while others will have the opposite fate. As a result, it is important for a firm to put the right incentives in place for the people involved, and make sure that it is in the best interest of everybody (at least those involved in the development) to come up with new solutions that serve the firm best. Another aspect of incentives is to encourage risk taking. An individual (or team) should not be punished if the innovation fails, if all due diligence was exercised. A culture of risk-taking is

essential for a successful innovation process. Unlike products, many services are delivered by individual employees and the quality of service can vary greatly depending on the training and experience of employees. As a result, it is critical that personnel training is conducted properly regardless of whether the solution is a product, service or product/service combination.

4.3 Tools to Implement Total Solution Development

We review and suggest some common tools that can be used for each of the stages proposed in the TSD model (Figure 4.3).

Immerse Yourself in Customers (needs identification, segmentation, and selection). Regardless of the source of new solution ideas (inside or outside of the firm), it is essential that a new solution addresses some relevant needs of clients. This could happen *ex ante*, in the sense that a firm actively investigates clients' needs and makes decisions on which needs to target, and what new solutions (service, product, or combination) to develop to achieve such goals. It could also happen *ex post*, in the sense that a firm will investigate, after a new solution concept becomes concrete (either from suppliers or competitors), whether this new concept addresses any substantial needs of its clients and is profitable. Regardless of the sequence, it is essential that a firm understands the needs of its customers and ensures that the new solution addresses their needs.

There are several tools that can be useful, including one-on-one interviews, focus groups, observation, lead users, and even becoming a user. The most commonly used are interviews and focus groups, and it is important to understand the relative strengths and weaknesses of these two approaches. Interviews allow a respondent to open up, but it lacks the stimulation usually present in a focus group. On the other hand, some people are likely to go along with the majority during a focus group. Griffin and Hauser (1993) have indicated that both methods are equivalent in their ability to uncover customer needs, if enough interviews and focus groups are done. Passive observation has gained ground recently as an effective way to uncover customer needs. Passive observation requires a representative from the firm (or a third party) to tag along with the current users of current products (or potential customers), and observe how they initiate and complete various relevant tasks, and try to identify their unmet needs (frustrations).

The objective during customer needs identification is to gather as many needs as possible, without prejudgment. The objective in needs selection/segmentation is to identify the most promising needs to work on, among all those uncovered in the previous stage.

The first step is to organize needs. The same need can usually be expressed in many different ways, and it is essential that managers establish the key dimensions of needs. This is normally achieved by affinity diagrams (a sorting process conducted by the firm's employees), or customer sort (ask customers to sort the needs). The objective here is to reduce hundreds of needs statements to 10-20 major dimensions of needs (see Ulrich and Eppinger, 2004 for a very accessible discussion).

The second step is to understand how important these needs are to the firm's (current or potential) customers. This understanding will help the cross-functional team to select the needs that it will target. If the customer base is small, interviews and focus groups will be best. Otherwise, a quantitative approach (e.g., survey) is more appropriate. There are several variations of surveys that can be used for this purpose. First is the compositional approach, which asks direct questions and asks respondents to compare explicitly among different needs. Second is the decompositional approach, including conjoint analysis, which asks respondents to evaluate a combination of needs; their specific valuation for each need is then inferred from their responses.

The third step is to select segments to target. More than likely, the customers' preferences of various needs are heterogeneous. Segmentation allows a firm to do at least two things: (1) identify the most profitable segment; and (2) avoid direct competition. Segmentation can be done qualitatively or quantitatively. Qualitative segmentation usually requires managers to brainstorm, based on the information collected from the previous step, combined with their own judgment. It is important that a cross-functional team should be charged with this task, to bring all perspectives to the table. The quantitative segmentation is best if there are quantitative preference data (e.g., from surveys). Tools such as cluster analysis have been used successfully for this purpose.

Generate and Assemble Ideas. Once the target segment and its core needs are identified, the next task is to generate ideas to address these needs. Sometimes a product is the answer, sometimes a service is the answer, and sometimes a product/service combination is the answer. It is important that managers keep an open mind.

There are several different tools that can be used to facilitate idea generation. Overall, ideas can be obtained from individuals (e.g., employees, lead users), groups (e.g., brainstorming), external search (e.g., patent search, new use of existing products/services, competitors, upstream and/or downstream channel members) or collaboration (e.g., license, alliance, acquisition). A key dimension we included in the TSD model is to draw ideas from three sources – potential partners, supply chain members, and competitors.

One very useful approach to new idea generation is to break down a specific task (associated with the targeted needs) into several components, and then try to come up with new ideas for each component (sometimes borrowing from existing products/services that target a component, but in a different context), and finally explore the combination of ideas (see Ulrich and Eppinger, 2004 for some examples). A firm that is interested in developing a new cell phone, for example, can break down the cell phone into the following components -- receiving signals from tower, transform signals to voice, transform voice to signals, human input/output interface (screen, keypad, etc), and send signals to towers. The firm can decide to generate new ideas for a human input device by searching for all possible human input devices used in other (non-cell phone) products and see which ones can be used for a cell phone (e.g., use the dial mechanism on iPod instead of keypad for inputting numbers).

Once the raw ideas are generated, it is important to categorize and assemble them based on their similarities. This step is essential before moving to the screening stage. It could be done either internally (by the cross-functional team charged with the innovation development), or externally (by focus groups of potential customers or lead users).

Screening Ideas. In most cases, managers will end up with more ideas than they can implement. As a result, it is critical to screen the ideas and identify the best ones. We suggest a combination of non-compensatory and compensatory screening tools. In the non-compensatory approach, an idea will be eliminated if it does not pass the threshold of one criterion. In the compensatory approach (e.g., weighted average), an idea will only be eliminated if the overall score is below the cutoff level (Urban and Hauser, 1993).

We suggest a two-step process for idea screening. In the first step, we recommend mostly non-compensatory rules, and the objective is to quickly eliminate those ideas that clearly will not be able to satisfy the firm's objective. In the second step, we recommend a combination of non-compensatory and compensatory tools, and business analysis should only be done for those ideas that pass the first step of screening.

It is important to recognize market potential, cost, and risk associated with each idea. In most situations, the business analysis should include at least three scenarios: most likely scenario, best case, and worst case. If possible, some types of probabilistic outcomes should be assessed. There are two cautionary notes: (1) business analysis is only as good as the input, and it is critical to vet the input data carefully; (2) the business analysis should only serve as guidelines, and should not be taken literally. In most cases, business analysis should serve to attest whether certain thresholds will be reached for a given idea.

It should be noted that there are three key "soft" dimensions that are equally important in this screening process, compared to the "hard" data (e.g., projected market share, net present value). They are (1) strategy fit; (2) culture fit; and (3) organizational change fit. We suggest non-compensatory rules might be more appropriate for these criteria. For example, if a new solution does not fit the culture, it should not be moved forward, regardless how attractive the solution is otherwise.

Design and Prototype Solution. Unlike product design, service design usually involves intensive customer participation; it also must address perishability, intangibility, and other characteristics of services. A solution involving product and service combinations should also take this into consideration.

Several tools have been suggested and used, including service blueprinting (Shostack, 1984), functional analysis (Berkley, 1996), and structured analysis and design (Congram and Epelman, 1995). More recently (Zhang et al., 2005) have suggested that TRIZ (Theory of Inventive Problem Solving, originally proposed by Altschuller and colleagues in 1946) can be a useful tool for service design.

The proposed solution should be tested at this stage, and the objective is to quickly eliminate losers without spending additional money on further development. In most cases, a firm should have multiple solutions at this stage for testing, with the objective of selecting a final solution to go into the next phase of development. Several methods are commonly used in this stage. Qualitative methods include focus group and lead users. Quantitative methods include surveys.

Market Test and Validation. In many cases, a new solution identified through the TSD process should be tested in the market before full launch. The purposes of test marketing are two fold: (1) identify a loser (if it is indeed a loser) without spending major cost associated with scaling up; (2) obtain feedback to fine-tune the new product/service (e.g., positioning, channel). There are many different tools that can be used for test marketing.

Pseudo-sale involves providing the new product/service to a selected few customers, observing whether they are willing to spend money purchasing the new product/service, and whether they will make repeat purchases after experience with the new product/service.

Controlled sale is more systematic; a specific group is targeted, but the products/services are delivered through (some) regular channels/contacts. This could include direct marketing, mini-market, and informal selling in the business markets.

The full scale test marketing involves delivering a new product/service to a representative segment/location of potential customers, and utilizing all marketing arrangements that are planned for use in scaling up.

If possible, a market test should be designed in a way that certain conclusions can be drawn easily, if possible. For example, if a SME wants to test which of two different segments of customers it should target, it should include a large enough sample (customers) from both segments, and ideally, at geographically separate locations.

When considering various test marketing, managers should keep in mind the cost of such testing, as well as information leaking to potential competitors. This is particularly true in new services, as they are much easier to imitate and subject to less legal protection.

Reviews (pre-commercial business analysis gate) should be conducted after test-marketing. There are several purposes for this: (1) to identify problems that can be corrected, and then go back and revise the solution (product and service) to remedy them; (2) to formulate better marketing strategies; and (3) to learn lessons for future innovation development.

Ramp-up and Launch. Due to the nature of services, managers should be prepared to scale up quickly to preempt potential competitors and realize maximum profit. Standard operation management skills can be used, and various external parties should be involved (e.g., supply chain members, partners).

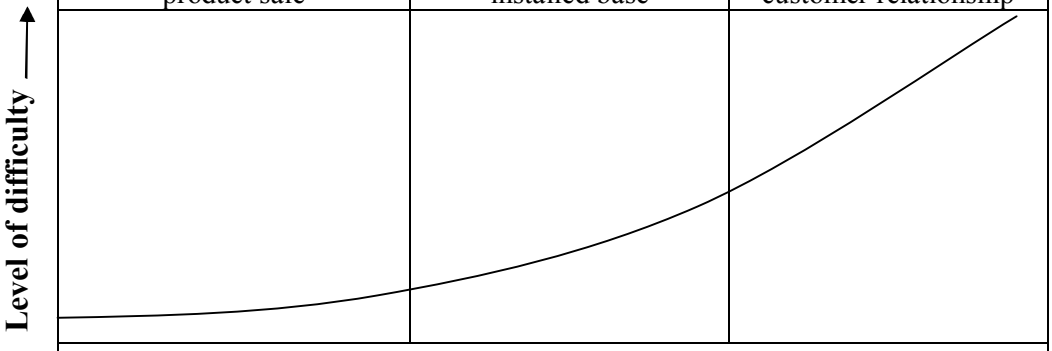
Post Launch Review. This is the place where lessons are drawn.

5.0 TRANSITION STRATEGY

Manufacturing companies find it difficult to enter service-centered businesses, and thus fail to exploit the financial potential that such businesses offer. Nearly all product manufacturing companies that invest heavily in extending their service businesses increase their service offerings and incur higher costs, but do not always get expected corresponding higher returns. This is referred to as the "service paradox" (Gebauer et al., 2005). Effective transition into a service-centered business requires a transition strategy as well as management of employee motivation and supporting organizational structure and culture.

This section suggests potential paths that SMEs may take to increase revenue from selling services. We will start by assuming that SMEs have little initial experience with selling services, so that we can discuss the entire journey that these firms may have to take. SMEs with moderate experience in selling services can start the journey at their current level of capability and take potential paths from that point forward. In all cases, top management motivation and leadership are essential to decide on the path to take, communicate the decision broadly and consistently to all employees, and provide the resources to assure that the path is taken. In addition, each part of the path has its own organizational change challenges that must be overcome (Table 5.1).

Table 5.1 Path from Product-Centered to Service-Centered Business

	Phase I Services embedded in product sale	**Phase II** Services provided to the installed base	**Phase III** Services based on customer relationship
			
Transition Issues	• Add product-centered services • Consolidate services into a single unit • Staff and train service sales force • Develop incentives, measures, rewards for selling services • Build a serviced-centered culture	• Base business model on quick response and customization • Shift downtime risk from customer to service supplier • Transition from transactional to relational selling	• Base business model on low cost and convenience over product life • Extend customer relationship deep into value chain • Develop TSD skills

5.1 Phase I: Services Embedded in Product Sale

The journey from product-centered to service-centered offerings usually starts by adding product-centered services to the sale of existing products, e.g., maintenance, spare parts, installation and training. The latter two may be part of the sale price (at or below cost) because the product may not function properly without providing them. Maintenance and spare parts could be part of the initial sale or offered through a one-year warranty. Experience in offering such services allows the firm to develop response capability, reputation and image with customers. It also gives the firm experience in working with customers between sales, which can be a prelude to a shift from transactional to relational selling. At the end of a year warranty, single or multi-year service contracts can be proposed to the customer.

In order to assure that services receive the attention they deserve, firms should consolidate all services into a single department, and give its manager profit and loss responsibility (Gebauer et al., 2005; Oliva and Kallenberg, 2003). Consolidation allows the firm to concentrate on developing a service-centered culture that emphasizes the firm's new values and goals such as responsiveness, speed, customization and customer satisfaction. Consolidation also helps to establish a separate reward structure that rewards employees for culture-supportive behavior. Employees in this unit will need to be motivated to relate to customers differently than those in manufacturing units. Dialogue is essential for success. These employees may need to be trained to relate to customers or selected according to certain criteria. Similarly, it is probable that there will be conflicts between product and service departments, as the firm's priorities shift. It is important that employees understand their function within the company and how it relates to the whole company. Managing any firm is inherently difficult; however, in a hybrid company the management problem is exacerbated as two different modes of operating are actually pulling against each other - the more rigid and disciplined stage-gate approach to new product development and the more flexible, inclusive and relational context in which service innovation flourishes. This is perhaps even more difficult in SMEs as they tend to have more conservative management styles and are motivated to maintain stability and life-style rather than to innovate.

Transitioning from a product- to a service-centered firm requires organizational-based culture adjustments. Culture is defined as a firm's values, norms and beliefs. A service-centered firm values flexibility, variety, responsiveness, speed, customization and customer satisfaction. Its norms, or standards that are accepted as status quo, should reflect a high priority on customer relationships. In contrast, a product-centered firm's norms should show a high priority on new product development and time-to-market. Similarly, a service-centered firm believes in adding value to its customers. Values, norms and beliefs shape the firm and drive employee behavior. Some companies will have a tougher time with the transition to a service-centered culture; however firms wishing to shift from product-centered to a service-centered business should adopt a culture that places a high emphasis on customer satisfaction.

In our earlier study (Warren and Susman, 2004), we examined the cultural factors that separate excellent innovative SMEs from others over a long period of time. Interestingly, many of these had moved from a pure product-centered business model to one where service components played an increasing role. It is worthwhile therefore to recall the attributes that we associated

with such companies as they provide a guideline for SME managers that wish to add services to their business model. These cultural attributes are explained in Table 5.2.

In addition to culture, the goals of a service-centered firm will also be different than those of a product-centered firm. Thus, the firm's management team must set realistic goals with participation from affected personnel in order to achieve its new objectives. These goals should be customer-oriented. For example, goals that a service firm might set include a goal for selling a realistic, but challenging number of services per month as a revenue goal, or socializing with x number of customers x times per month as a customer relationship building goal. Whatever goals the firm decides to implement, it is important that the affected people are included in the goal setting decision process. It is critical that goals are not applied too aggressively as research shows that unrealistic and unattainable goals result in unmotivated and cynical employees (Gebauer et al., 2005). Further, research suggests that goals should be broken down to the individual level as "sub goals" that contribute to the overall "corporate goal", and that those goals should be connected to the reward structure (Gebauer et al., 2005). When employees can see that their task contributes to the overall strategy and goals of the firm, they are more motivated to achieve their objectives (Boswell and Boudreau, 2001).

Management tends to get what it rewards, thus it is essential to link the reward structure to the firm's strategy . This means, that a service-centered firm's reward structure should focus on services and customer relationships. Rewards can be tangible in the form of monetary bonuses, or they can be less tangible in the form of recognition, promotions or empowerment. Regardless of what type of reward is given for a certain behavior, the objective is to make sure that rewards are associated with behaviors that management would like to see increase (Susman et al., 2006).

In addition to goal setting and reward structure, it is imperative that service-centered firms have service-centered performance measures. These performance measures include customer satisfaction, employee satisfaction and business success (Gebauer et al., 2005). In a product-centered firm, customer satisfaction is based on the product, but in a service-centered firm it is based on service delivery, employee friendliness, value-added, flexibility, customization, etc. Thus, customer satisfaction may be more difficult to achieve in service firms. It is imperative that the firm focuses heavily on customer satisfaction because the reputation of a service-centered firm for customer satisfaction is very important. In fact, some firms find their customer satisfaction reputation so important to their firm that they would never consider outsourcing their service responsibilities to others (Simon, 1992). Of course, outsourcing would defeat the purpose of being a service-centered firm, but it exemplifies how important reputation is to such firms.

Once goals are set and a reward structure is in place, management must motivate the employees to reach their goals and be rewarded. Employee motivation can be described in terms of employee-push and -pull (Gebauer et al., 2005). Employee-push refers to management's desire to motivate employees to engage in the service business. On the other hand, employee-pull refers to employees' enthusiasm and self-motivation to commit to the new service initiative, resulting from understanding the benefits and results of pursuing services. Although employee-push might be sufficient initially, the goal in service firms is to stimulate employee-pull in order

Table 5.2 Cultural Attributes of Successful Innovative Enterprises

Alignment	The degree to which the interests and actions of each employee support the clearly stated and communicated key goals of the organization	"We have clear aims and objectives which everyone understands; we build consensus around key objectives; we recognize and reward loyalty"
Communication	The degree to which there is planned and random interaction between functions and divisions at all levels of the organization	"I am kept in the picture on how we are performing; we have excellent formal channels of communications; we use best practice knowledge transfer between departments; we actively manage our intellectual assets"
Empowerment	The degree to which each employee feels empowered by managers and the organization	"As a manager, I am expected to delegate; we have a 'no-blame' culture; we allow staff to make decisions"
Engagement	The degree to which all levels of the organization are engaged with the customer and the operations of the organization	"Management understands the operations of the company; I can share problems with my managers; I know why my job is important"
Freedom	The degree to which self-initiated and unofficial activities are tolerated and approved throughout the organization, not instead of teamwork, but in addition to it.	"I am allowed to do my own thing in addition to working with my team; we encourage people to take initiatives; we recognize the individual"
Honesty	The degree to which each employee has total confidence in the integrity, ability and good character of other employees and the organization, regardless of their role	"I trust the people I work with; I find it easy to be open and honest with people from other departments"
Risk	The degree to which the organization, employees and managers take risk	"I am encouraged to experiment; we take calculated risks; we encourage trial and error"
Stimuli	The degree to which it is understood that unrelated knowledge can impact product, service and operations improvements	"I am encouraged to search externally for information; I obtain data from many different sources; we listen to suggestions from suppliers; we use consultants in focused roles"
Support	The degree to which new ideas are encouraged from all sources and responded to promptly and appropriately	"We encourage fresh ideas and new approaches; we reward innovative individuals; we reward innovative teams"
Teams	The degree to which team performance is emphasized over individual performance	"We promote teamwork and make it the center of everything that we do; there are usually people from other departments in my team; we have both problem-solvers and 'out-of-the-box' thinkers in our teams"

Adapted from Warren and Susman, 2004.

to get employees involved. Internal marketing is one way that firms "sell" the service concept to their employees in order to get them to "buy-in" to the new initiative.

Management should provide excess human resources while service-centered learning is underway so that employees are free to engage in service exploration. Once the change process takes off and employee-pull is set in motion, employees will become the driver of new ideas. During shifts from product-focus to service-focus there are often conflicts between departments because of perceived status, either increased or decreased. For instance, production personnel may feel downgraded because of the new interest in service sales. In addition, service personnel may have inflated egos because of the new interest in their department. Management's assurance of status parity can help to bridge the gap between departments, and unite them for a common purpose (Susman and Dean, 1992).

Once employees are motivated and united to achieve service-centered goals, they will need to be equipped with training that will help them meet their objectives. High expertise refers to the availability of knowledge about the firm's basic technologies, customers and delivery processes. High expertise determines the success of innovative service concepts. Education and training on the job are relevant to improve the firm's expertise, to enlarge the body of knowledge and to increase the creative and problem-solving capacities of employees. In product-centered firms, sales people view products as the main source of revenue and services as add-ons that are obligatory in order to make a sale. However, in a service-centered environment, sales people must view services as the main source of revenue; services can no longer be performed for free, but must be priced according to the value they add to the customer (Oliva and Kallenberg, 2003). Thus, sales people need to be trained to eagerly sell services, not just products (Johne and Storey, 1998).

Firms also may need to hire new personnel to staff the new service department. If the firm chooses to hire new employees it is critical that the new hires fit with the new service-centered culture in order to maintain it, and take the company in the right direction (Kotter and Cohen, 2002). According to Blumentritt (2004), there are three main characteristics to look for when hiring a new person into an increasingly innovative culture: curiosity, talent and motivation. Curiosity is important because people who are curious generally ask a lot of questions and usually have a very creative mentality that helps to stimulate idea generation. Likewise, talent is needed in order to understand how things work and finally motivation is necessary so that new service ideas are not only conceptualized, but also carried out to completion. In addition, the firm should also look for new hires that have diverse work experiences, education, demographics, knowledge, skills and abilities so as to bring new perspectives to the table. Newly hired personnel can also bring excitement, which can help build support and energy for the shift to a service-focus (Susman et al., 2006).

It is imperative that employees believe the internal marketing before they can get involved in external or interactive marketing. External and interactive marketing are strategies that can help employees to sell services. External marketing is about portraying the firm's image to customers, but before employees can make that portrayal they must be sure of its existence, a

belief that relates back to the firm's internal marketing. Once the employees are assured that the internal marketing is credible (i.e., the firm will be able to keep the promises it makes), they are able to perform external marketing, which includes making promises to customers (Gebauer et al., 2005). Interactive marketing is the how the firm sells its value proposition to customers and begins the transition from transactional to relational selling. The first stage in the transition from transactional to relational selling includes marketing activities, which commonly don't include any personal interaction between the firm and its customers. If the firm is just beginning the transition, it is likely that its customer/employee interaction includes advertising, sales promotions and publicity. It is important to use the relationships that are originally created in this phase to help develop more strong and long-lasting relationships in the future.

One of the most prevalent reasons for failure among firms focusing on developing new services is an inadequate assessment of customer needs and problems (de Brentani, 1995). An inadequate assessment of customer needs can stem from a lack of attention paid to understanding customers and creating value for them. New services cannot be developed effectively in isolation of customers. Front-line employees, the ones who commonly work the most closely with customers, need to be in-tune with customer needs, wants and frustrations, and should be encouraged to have frequent contact with them in order to build relationships (de Jong and Vermeulen, 2003). These employees also need to be committed and able to come up with possible ideas and solutions for customer problems. Sometimes this includes active listening, which entails engaging the customer in serious dialogue where the employee listens intently and asks questions to make sure he or she understands what the customer is trying to articulate. Exceptionally creative employees can listen to customer problems, generate their own ideas and solutions, and share them with others to stimulate maximum problem-solving ability. In any event, there are certain characteristics of company culture that can help to foster idea generation that is relevant to customer needs and wants.

Idea generation is facilitated by company culture. As aforementioned, company culture is a very important piece of the transition from product-centered to service-centered offerings. Cultural attributes that foster a supportive culture for idea generation include openness, management support, autonomy, information sharing, tolerance of mistakes and communication. Senior managers play a key role in stimulating an open culture. It is important that they share their ideas with employees, stimulate communication within the organization, and provide leadership to motivate employees (Johne and Storey, 1998). All too often service firms view their people simply in terms of an approach to deliver the product, i.e., a delivery system. However, because of the inseparable nature of services, front-line employees shape the quality of a customer relationship. de Brentani (2001) concludes that having a highly trained workforce that has an intimate knowledge of the customer plays an important role in the success of new services. Often, new service initiatives do not sufficiently involve input from front-line employees. In this case, the employees who should play a critical role in the process are uninformed and underutilized and will build resentment to the new initiative. As a result, co-workers can be the biggest resistance to innovation efforts, which is another reason to involve them in the process. Accordingly, management must consistently support the innovation process, encouraging employee involvement, and ensuring communication among the different functional areas (e.g.,

production, process design, IT, service delivery and marketing) to drive service innovation (de Brentani, 1995).

In addition, autonomy is another characteristic of an open culture. Autonomy is the extent to which followers are given latitude to carry out their tasks without excessive supervision (Basu and Green, 1997). When workers experience autonomy, they feel less constrained to explore opportunities and to generate ideas. Innovative new services can result from this. Similarly, information sharing among employees should be encouraged so as to generate more ideas to satisfy unmet customer needs (de Jong and Vermeulen, 2003). Additionally, task-rotation (i.e., having employees cross-trained and able to perform other company tasks) also helps to broaden employees' points of view and problem-solving ability, enabling them to generate more ideas (de Jong and Vermeulen, 2003).

An open culture supports idea generation and fairly evaluates each idea that is generated, no matter how outlandish it seems on the surface Further, this type of culture also tolerates errors and even celebrates failures as long as lessons are learned. Thus, if an employee took the initiative to generate ideas for solving a customer problem and failed, the person would still be rewarded for his or her efforts according to the rewards policy, as long as the employee (and the firm) learns from the mistakes. An open culture should value experimentation and should understand that sometimes the firm will need to "fail early and often to succeed sooner" (Kelley, 2001). Employees should understand that learning from failures is often a key to success (Susman et al., 2006).

As always, management needs to ensure that there are open channels for communication, both vertically and horizontally (Susman et al., 2006). Reducing the number of levels in a company will result in a flattened structure. Flat structures allow employees to see "the big picture" and minimize distortion by reducing the levels through which communications must pass. Flat structures also encourage an "open door policy" where employees have easy access to top management. This helps employees to be able to contact people in other functions directly without going through and/or clogging other channels. It should be noted that the individuals with the most formal authority aren't necessarily the most knowledgeable on a certain subject. Employees should be permitted to seek advice from those who have authority based on knowledge as well as position. Information should also be shared with employees at all levels (e.g., service, production, financial, marketing) by publishing newsletters or using other communication channels. Managers should make sure that everyone is on the same page and minimize symbols or signals of status differences so that some employees don't feel less valued than others. In order to encourage teamwork and idea sharing, it is important that employees feel equal with their peers.

5.2 Phase II: Services Provided to the Installed Base

The next step is to extend services from the sale of existing products to providing services to the firm's installed base or even to its competitors' products. The latter is especially opportune if competitors do not offer such services or offer inferior service. Potential service revenue from one's own and competitors' installed bases depends on how many generations of product are in it

(the older the product, the larger the installed base). Enough experience may have accumulated to know what parts wear out most frequently (and how much they cost to replace) and what alternative sources of parts may be available (e.g., after-market). As sophistication of the average product in the installed base is likely to be less than that of currently sold products, service may now include upgrades and refurbishing. One major challenge is to assure that the installed base is not more widely dispersed geographically than the firm can reach easily. Responsiveness is a key to reputation and the firm cannot afford major holdups because technicians cannot be deployed where needed. Contracting such work to outsiders has reputation risks and inhibits feedback and learning opportunities from the field. It is better to overstaff in-house personnel than risk ineffective response (Gebauer et al., 2005). The firm also can start to offer services where its installed base is most dense, but supplement these services elsewhere with a 24/7 help desk and self-diagnostic software where applicable.

Up to this point, the firm's business model need not shift dramatically, but further steps will require a more dramatic shift. The value proposition underlying the Phase II business model is to offer the customer equipment availability, operational uptime, and do it better and/or cheaper than the customer can. The skills of the firm's employees now must extend beyond accurate diagnosis and speedy repairs, but include surveillance, monitoring, information gathering, interpretation, and the firm's willingness to invest in data capture and storage. The move to Phase III should not be made until the firm has thoroughly mastered selling services with current sales or to its installed base. Firms can move from transactional to relational selling by offering their customers a fixed-term contract for services. Customer interaction in this phase should include employees creating a friendly and helpful atmosphere for the customer. In addition, regular contact with customers via opportunities such as newsletters, users' clubs, chat rooms, etc. will help make the transition easier. The move to fixed-term service contracts is prompted and accelerated by the firm's desire to increase capacity utilization of the higher fixed costs of its newly centralized and specialized service unit. The value proposition to customers is equipment availability or up-time. The firm's responsiveness and problem-solving capability underlie its ability to deliver on this proposition. However, responsiveness may not be enough. The firm now has a strong incentive to innovate with methods for preventive or condition-based maintenance. The firm might also consider offering consultation services to help its customers develop their own diagnostic and response capabilities.

5.3 Phase III: Services Based on Customer Relationship

The next step is to shift from sale of individual products to sale of services embedded in products, comprehensive services or integrated solutions (Wise and Baumgartner, 1999). The first option is primarily an engineering solution in which services that the customer previously performed are now embedded in the product or at the interface between simpler and previously isolated product components. The value proposition is that technology can substitute for the customer's current service personnel. The second and third options require understanding the product's context of use and need for ancillary services, and require a more radical transformation in the business model. The firm now offers the customer total solutions to problems that relate to consumption or use of its products. Some of these problems may be known initially and included within the scope of a fixed-term contract, but other problems await

discovery as the firm and its customers deal with problems that emerge over the course of their relationship.

Smaller customers may lack the knowledge or resources that larger customers possess to solve their operational problems or pay for infrastructure and ancillary services that relate to the effective use of their products. This presents an opportunity for market segmentation and focus on customers with the greatest need for the firm's services. Firms can recognize the need for new services by studying how the customer uses or consumes the firm's current product and suggesting that they can perform these activities better than the customer can. It can do this by focusing on mastering these skills. The firm now needs an effective product or service development process with which to generate ideas and transform them into new services (replaces or creates activities up and down the value chain). Firms that already have an effective NPD process in place can make the transition to NSD more easily, especially if they have previously used cross-functional teams. However, there clearly are differences (de Jong and Vermeulen, 2003). For example, customer interaction is higher with NSD and less attention is given to prototype test and launch.

We propose going a step beyond NPD or NSD because of the nature of the type of services that firms and their customers will co-develop and the intensive interaction required to develop them. We described this advanced step as "Total Solution Development" in section 3, and offered more specific details about it in section 4. Cross-functional (and cross-firm) team composition, timing (after need recognition) and location (firm's or customer's premises) are less predictable than with NPD and NSD. The "fit" issues are also more comprehensive, including the need for strategic, organizational and culture fit of solutions to the customer's operations and the seller's delivery capabilities. Firms should encourage employees who are in regular contact with customers to share ideas with other employees concerning optimal use of the product, and observe points of pain and frustration that customers experience in using the product. These ideas and observations, if captured, may help create a proprietary database that can give the firm a competitive advantage over its rivals.

In this phase, employees should be immersed in their customer's business. Employees should be able to see the points of pain (Gustafsson and Johnson, 2003), or frustrations that customers have with existing offerings, and generate ideas for new solutions. Since the employees are very close to the customer, the solutions generated from this type of encounter are often very valuable to the customer.

What can we learn about the development of new services from the five mini-cases discussed in section 3? What are they offering of value to customers beyond the sale of a basic product (e.g., bolts, containers, detergent)? Greif Packaging and General Fasteners observed how customers used or consumed their product and believed that they could do this better by specializing in activities that customers currently perform but don't have the skill, time or interest in mastering to the same degree. Taprogge specializes in providing maintenance activities and spare parts. These are traditional services, but a natural offering for a company that sells such sophisticated equipment. ChemStation, DeAngelo Brothers, and Taprogge used IT to capture data about their products' performance in different contexts and developed proprietary databases that allowed them to customize use of their product to meet specific customer needs. All five cases required

their work force to be extensively trained in activities that their customers could not do as well as they could. In all cases, once a firm establishes a foothold inside the customers' operations, they are in a privileged position to offer new ideas to progressively take over more of their customers' current activities or suggest new ones to perform.

6.0 RECOMMENDATIONS FOR THE MEP NETWORK

6.1 Introduction

This report has reviewed the literature on innovation for creating SME growth. In particular, we have researched one specific major growth opportunity for such companies, namely the addition of complementary services around manufactured products. This strategy can provide higher operating margins, greater revenue stability and, most importantly, heightened barriers against competitors, including non-domestic suppliers.

However, the transition to new service-centered business models does not come easy. The admittedly limited research on so-called "hybrid business models" indicates that the value systems, customer interfaces, incentives and innovation processes must be substantially different from purely product-centered firms. Thus the move to these more complex yet more robust business models requires confronting the need for change management. As we have seen, SMEs may have in-built cultures and governance methods that make such changes difficult to execute. They need support in initial analysis of their current and potential business models, development of a transition strategy for changes in operations and structures needed to succeed, and hand-holding throughout the process.

These tasks are an ideal role for the MEP outreach network if the relevant consultant skill set can be tapped. Before suggesting how this might arise, it is necessary to understand the current focus of this network.

6.2 Current Skills within the MEP Network

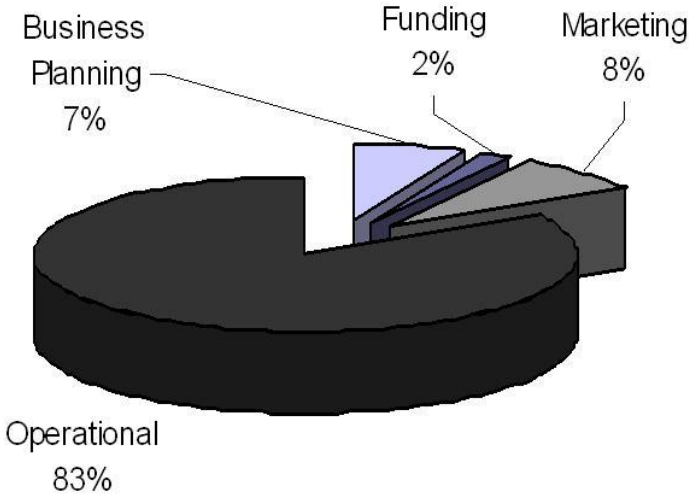
In order to determine the present strengths of the MEP network, we analyzed the MEP database of past success stories coupled with selective interviews.

We reviewed a total of 689 "success stories" from 2002 to 2005 that were posted on the NIST MEP website. All these stories were divided into four broad categories based on the type of consulting services provided by MEP – Operational, Marketing, Funding, and Business Planning. Each story was put into one of the categories based on the following criteria:

1. Operational – six-sigma, lean, ISO, IT implementation, plant/equipment design
2. Marketing – product design, market entry
3. Business Planning – organizational restructuring, change in business models
4. Funding – anything related to finance

Figure 6.1 shows the breakdown of the stories by category. About 83% of the consulting assignments were related to operational issues faced by the SMEs and most of them were related to "lean" implementations. Only 7% of the assignments were related to business planning. Within this 7% (or 45 assignments) MEP had helped the SMEs change their business model only in about 20 assignments, less than 3% of the total support activities.

Figure 6.1 Consultancy Provided



Following this analysis, we conducted random phone interviews with four of the MEP center directors. The interviewees varied greatly in their opinion about the role of MEP in the economy. Many of these directors clearly felt that lean implementation was the most important service offered by MEPs, but some clearly understood the need to move towards "top line consulting" and have been pushing for change. The centers under their supervision have been making strong progress in marketing and business planning related consultancies.

We also found that MEP centers do not interact with one another on a regular basis. Hence there is very little knowledge sharing among the centers. Consultants rarely refer to the success stories posted on the website for information and insight. Most of the collaboration among centers is based on personal relationships among the directors and quarterly national conventions. As a result, national customers usually have to work with many centers and fail to get the desired quality and breadth of service.

6.3 Statement of the Key Problems

Our research has shown that historically there has been very few outreach projects undertaken by the MEP affiliated offices that address the issues of innovation, new business models, change management and revenue enhancement through service additions.

We have also seen that the addition of services around manufacturing products can have major benefits in terms of increased revenues, profits and creating barriers to competitors. Yet, although adding services may seem, at first, a rather easy expansion of current business, many companies have experienced great difficulties in managing these changes. Questions of innovation processes, compensation structures, customer interfaces, management of intellectual property, sales force management etc. all require major changes first in understanding the cultural issues and then adapting the organization shifts that are demanded.

Our assessment of the current resources and experiences of the MEP outreach consultants indicate that, before these changes can be transferred to the SMEs seeking to expand, there needs to be a major shift in the skills and techniques deployed by these consultants. Indeed, they themselves may not be able in most cases to absorb and evangelize these new ways of doing business. Further, in comparison with the current skill sets employed by MEP programs, such as TQM, lean manufacturing, etc. there is a limited supply of consultants who have the appropriate knowledge, skills, and application to affect the sorts of change management and business model innovation that we are addressing here.

It is therefore unlikely that, at least on a local or regional basis, current consultants within the MEP network are sufficiently knowledgeable to engage and excite SME owners and managers of the potential of changing their business model to include services and all that it entails; and even less likely that there are local skills that can effectively help these companies through consulting projects.

A further shortcoming is the static nature of the case histories that reside within the MEP database. We found this database rather difficult to use. However, the more important issues are concerned with both content and format. The content is largely written for the benefit of the current project, i.e., how the work was recorded, rather than specifically as an aid to subsequent remote, future projects. The title of "success stories" in itself can lead to further shortcomings as cases are skewed to show that projects are "successful" where the honest reporting of problems and failures may indeed be more valuable. Many of the reports are sterile in content and it is difficult to relate to them as a model for a new challenge. They are also almost entirely involved with cases that are not relevant to the changes that we are exploring.

6.4 Recommendations

In order to break out of these very major resource and knowledge shortfalls, we need to instigate a *scalable* initiative that meets a number of new demands including:

- Maximizing the use of the scarce consulting resources available to help SMEs
- Adding new skills via focused training of those local consultants who have the propensity to provide outreach services in the field of change management and service addition
- Providing tools to this community
- Leveraging experience across assignments.

The current MEP database may not fulfill the purpose for which it was created, either in content or in user value. Therefore, we make the following recommendations:

Recommendation 1 - Leverage the existing skills between MEP centers

We recommend augmenting the current database with a dynamic knowledge network. (See recommendation 5 for a more detailed discussion of this topic.) NIST would support a secure portal that enables local MEP centers to interact in real time to tap into specific and relevant

know-how tailored to each case. This portal would be used to post "client challenges" which would stimulate consultants nationwide to offer advice, cases, and possibly direct involvement.

Recommendation 2 – Develop new skills

Our analysis shows that there is a major shortage of appropriate skills in the MEP consultant network. In order to increase the availability of growth strategy and change management skills, it is necessary to expand the population of consultants versed in such skills.

We recommend the development and provision of a training program for existing MEP linked consultants to provide them with the skills to excite MEP targeted SMEs in the opportunities for growth, to analyze the existing firm positioning and possible new opportunities, and to guide the client through the change process. The courses would be residential, one week in length and be based on actual cases and examples. The consultants would learn how to use tools specifically designed for tackling the challenges faced by SMEs. This program would be positioned as a re-training program for MEP consultants. The target should be one consultant from each location identified and qualified by the MEP team at that location.

Recommendation 3 - Analyze use of the current MEP database

We recommend a web-survey of existing MEP centers to determine:

- The current use and value of the database
- Research to determine features and expectations of the knowledge portal
- "Market research" for the proposed training courses and content

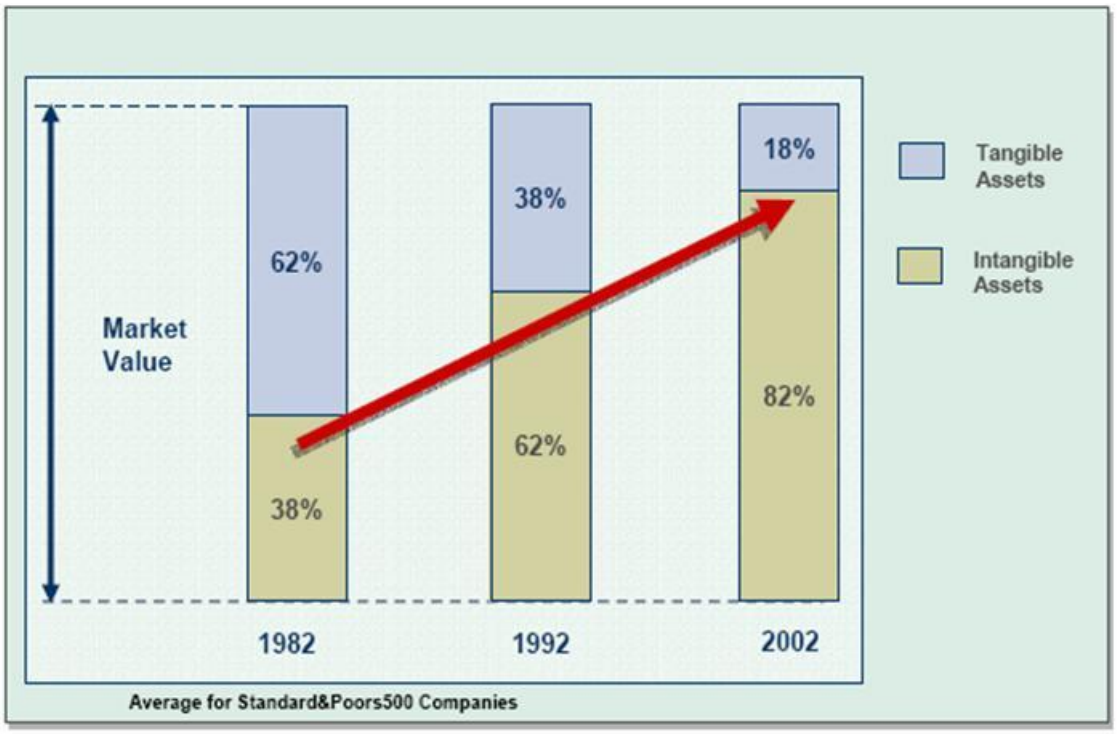
Recommendation 4 - Develop a research agenda

As reported in section 3, there is a paucity of research on service innovation and in particular the additional challenges of innovation in hybrid companies. This is despite the fact that current U.S. economic activity in the private sector based on service revenues exceeds 82% (Rae, 2005). Moreover the research is largely European in content. We recommend that NIST develop an agenda for research in hybrid companies. This would directly benefit SMEs in the U.S.

Recommendation 5 - Develop a dynamic knowledge management portal

Background. One of the shortcomings that we must address is the efficient use of experience and knowledge. Every MEP client project cannot be seen as being entirely unique; we must build on the expertise that is accumulated. We look as this issue in the context of knowledge management. Considerable attention has been given over the last twenty or so years to this field. In Figure 6.2, the shifting market value of enterprises largely from tangible to intangible assets (Hand and Lev, 2003) leads us to believe that knowledge, which is an intangible asset, is becoming more and more important. Attempts have been made to codify and apply the knowledge created by a company for future use and application; knowledge is a firm's primary intangible asset. This should be no different within the MEP network.

Figure 6.2 Market Value of Tangible and Intangible Assets



Source: Hand and Lev, 2003.

A number of researchers recognized that it is useful to consider two categories of knowledge – explicit and tacit (Nonaka and Takeuchi, 1995; Hinds and Pfeffer, 2001). Broadly speaking, explicit knowledge can be structured and recorded for the benefit of future users without any interpretation from the creators of the knowledge. Examples might include maps, recipes, operating manuals, etc. Within this category are the case histories that reside in the MEP database. They are rather sterile reports that are built around standard terms, categories and data, and do not really convey any of the actual "touchy-feely" attributes which are much more important in this case.

Tacit knowledge, on the other hand, is more complex and has personal interpretations embedded within it such that the value for future users requires access to the implied knowledge and experience of the creator. For example, Kraft manufactures a range of processed cheeses that are noted for their quality, and consistency. Yet the raw materials are highly variable coming from a range of farms in which the product quality, flavor, texture etc. may depend on a large number of variables, such as weather, herd management, timing etc. Selection of the mix of raw materials into the manufacturing process is aided by tasters who choose the blend from the warehouse of individual raw materials in order to achieve a consistent output. The selection depends highly on experience, taste, health of the tasters, etc. This knowledge is impossible to codify and has a high tacit content.

These two classes require different methods for transmission between individuals and teams wishing to avail themselves of the intellectual content. For example:

- Explicit-to-explicit is the simplest transfer challenge exemplified best by web-publishing such as the MEP database. There is a wealth of information that is not tailored to the user. If it is structured and codified, then it can be of considerable value. www.webmd.com for example has a wealth of health-related information. Often however, it requires the experience and tacit knowledge of a trained physician to interpret and diagnose complex disease states. Current web-sites and brochures targeting economic development are rich in explicit knowledge.
- Explicit-to-tacit is typified with a learning environment particularly where students are required to experiment with published information and develop tacit knowledge for themselves.
- Tacit-to-explicit has been the Holy Grail for many years spawning the field of expert systems. The aim has been to somehow capture the subtleties of tacit knowledge and use computer systems to codify and interpret them for particular future instances – replacing the cheese taster above with a computer program. Apart from very limited domains, this approach has been largely unfruitful.
- Tacit-to-tacit is still the most powerful method of knowledge transfer using such techniques as story-telling. Fortunately, now that the Internet has developed, we can deploy systems that allow tacit knowledge application without the necessity for direct one-on-one contact. This is included in the solutions we are proposing.

Dynamic knowledge management. Many large enterprises have invested millions in creating knowledge management systems based on attempts to catalog knowledge to be searched and applied later. It is now generally accepted that these investments have been largely unsuccessful. There are several reasons for this. The first set of barriers is considered to be a result of the way that humans assimilate cognition:

- Expert knowledge creators, when asked to codify their knowledge, embed significant tacit information using more abstract concepts than novices can comprehend.
- Experts do not remember how they learned and hence set expectations too high – novices may then just give up.
- Experts tend to emphasize their most recent experiences to the detriment of the earlier supporting knowledge and experience.
- Tacit knowledge is inherently difficult to verbalize. (How do you learn to swim or ride a bike?)
- Tacit knowledge is difficult to generalize to other situations. (Is cheese making similar to chocolate blending?)
- There is little incentive for someone to take the time to codify his or her knowledge for others' later benefit. Even if an appropriate incentive system is there, it is difficult to codify knowledge for yet to be defined problems.

The second group of barriers is related to motivational limitations:

- Competition can be a disincentive, with participants believing that their personal promotion, status, raises, etc. may be lost if they teach others. They believe they must "look better" than their peers.
- Team cohesion forces may prevent open exchange of valuable knowledge.
- The belief that "knowledge is power". (If I am the only one who can blend cheese, then my job is secure forever.)
- There can be hierarchical and status barriers to open knowledge exchange.
- Reward and incentive systems can counter openness.
- Organizational trust can be a barrier, (Do I trust others *not* to use this knowledge against me?).

It is this second group that we must be cognizant of as we develop a cooperative innovation network.

Over the last few years there have been some developments based on the evolution of the Internet that are successful at overcoming the inherent shortcomings of static knowledge management. These are generically referred to as "dynamic KM systems". They work as follows:

Knowledge is not preemptively codified, but is only requested when there is a need. "Challengers" create a web-request which is then responded to, based on the knowledge and experience of the network. Experts do not work in isolation and, responding to a specific need, they are more likely to offer tacit information as well as tapping into their own extended expert networks. The challenge therefore becomes alive as each contributor builds on the knowledge of the others. The environment is collaborative, active, dynamic, and innovative.

Portal Features and Operation. Based on the above concepts, we propose a secure knowledge management portal for the MEP network. Access to this portal will be only for local MEP offices *and* approved and relevant consultants who are able to address the new issues confronting SMEs. We refer to the MEP offices as "gateways".

The portal will also have resources and tools for the local offices to help them determine when it would be appropriate for them to "post" a request on the portal for help. These resources and tools could include such topics as:

- Analysis tools to determine whether the company in question is ready and accepting for considering changes in its business model.
- Techniques for judging the cultural attributes (see section 5) that can help determine how open the company may be to change.
- Access to "stories" that illustrate clear cases that show how moving into services has been accomplished – not only the successful parts but also the difficulties encountered. We suggest rich media materials for these to add "mapping" of the example to the new case.
- Bios and contact information for the consultants.

The aim of these tools and support data is to prime the outreach function at the MEP offices on which types of companies to approach with materials to provide discussion topics.

When an office identifies and engages with a company seeking to change its business model, for example, the "challenge" will be compiled in a standard format on the portal. The posting office can remain anonymous together with the target company. The posting person can select which consultants and experts may be able to help.

The "case" is then posted and all the selected possible experts are e-mailed with a password to access that case and invited to comment, suggest help, guide to materials, etc. This dialog is open to the selected community as well as the company executives so that they can also participate in the knowledge exchange and thereby become engaged and encouraged to continue.

The most appropriate contributors can then be approached by the local MEP office together with the company and an appropriate project designed with the most relevant resources.

Upon the completion of the project, a case will be constructed again in standard format with links to the participants and thereby become part of an ongoing and active database for future projects as the links can be used to tie in the experts for future cases.

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Compares US large enterprises (LEs) vs. US and Canadian SMEs on 14 sources of innovation. LEs rated only suppliers as more importance sources than did SMEs. SMEs rated customers, co-workers, marketing and professional journals as more important.

Booz, Allen, and Hamilton (1982). New Product Management for the 1980's. New York: Booz, Allen, and Hamilton, Inc.
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Boswell, W. R. and J. W. Boudreau (2001). "How leading companies create, measure and achieve strategic results through "line of sight"." Management Decision **39**(10): 851-859.
Discusses the advantages to having employees understand their function in the company and how it relates to the rest of the company. Employees that understand their part in the firm are more likely to engage in behaviors that support the firm's strategy.

Bowers, M. R. (1987). "Developing new services for hospitals: A suggested model." Journal of Health Care Marketing **7**(2): 35-44.
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Bowers, M. R. (1989). "Developing New Services: Improving the Process Makes It Better." The Journal of Services Marketing **3**(1): 15.
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Brouwer, E. and A. Kleinknecht (1997). "Measuring the unmeasurable: A country's non-R&D expenditure on product and service innovation." Research Policy **25**(8): 1235-1243.
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Camp, R. C. (1989). Benchmarking: The Search for Industry Best Practices that Lead to Superior Performance. Milwaukee: ASCQ Quality Press.
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Carland, J. W., F. Hoy, W.R. Boulton, J.C. Carland (1984). "Differentiating entrepreneurs from small business owners: A conceptualization." The Academy of Management Review **9**(2): 354-359.
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Chesbrough, H. and R. S. Rosenbloom (2002). "The role of the business model in capturing value from innovation: Evidence from Xerox Corporation's technology spin-off companies." Industrial and Corporate Change **11**(3): 529-555.
Discusses using a business model to successfully determine the value of technology.

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Discusses how customer demands shape the allocation of resources in innovation. Also discusses innovation differences in innovating to meet existing customer needs vs. innovation in new markets.

Clark, K. B. and T. Fujimoto (1991). Product Development Performance: Strategy, Organization, and Management in the World Auto Industry. Boston: Harvard Business School Press.

Discusses alternative approaches to supplier-OEM design relationships.

Congram, C. and M. Epelman (1995). "How to describe your service: An invitation to the structured analysis and design technique." International Journal of Service Industry Management **6**(2): 6-24.

Discusses the use of structured analysis and design to better describe service processes.

Cooper, R. G. (1984). "How new product strategies impact on performance." The Journal of Product Innovation Management **1**(1): 5-19.

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Cooper, R. G. (1994). "Perspective: Third-generation new product processes." The Journal of Product Innovation Management **11**(1): 3-15.

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Discusses how and why NPD projects continue to fail and suggests approaches for NPD success.

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Discusses the application of new product development techniques to the service industry.

Crosetto, P. (2004). Competition and cooperation: Italian SMEs go international, CIRPET-University of Turin.

Discusses internationalization, and specifically the weaknesses of SMEs.

de Brentani, U. (2001). "Innovative versus incremental new business services: Different keys for achieving success." The Journal of Product Innovation Management **18**(3): 169-187.

Discusses the differences and similarities in NPD and NSD and outlines success factors for new service ventures.

de Brentani, U. (1995). "New Industrial Service Development: Scenarios for Success Failure : Ulrike de Brentani, Journal of Business Research (February 1995), pp. 93-103.

Describes the types of new service development situations that typically lead to success and those that lead to failure.

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Eisenhardt, K. M. and J. A. Martin (2000). "Dynamic capabilities: What are they?" Strategic Management Journal **21**(10/11): 1105-1121.
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Fine, C. H. (1998). Clockspeed: Winning Industry Control in the Age of Temporary Advantage. New York: Perseus Books
Shows how supply-chain design choices can drive company evolution. Analyzes product, process and innovation cycles in fast moving industries.

Freel, M. (forthcoming). Exploring the Reach of Innovation-Related Cooperation in Small Firms. Small and Medium-Sized Enterprises and the Global Economy. G. I. Susman. Northampton: Edward Elgar.
Describes small firm collaboration and networking.

Froehle, C. M., A. V. Roth, R.B. Chase, C.A. Voss (2000). "Antecedents of new service development effectiveness: An exploratory examination." Journal of Service Research **3**(1): 3-17.
Found that organizational structure influences the effectiveness of NSD, formal processes increase NSD speed and IT affects the speed and effectiveness of NSD. No support for cross-functional teams and NSD speed.

Frost (2003). "The use of strategic tools by small and medium-sized enterprises: An Australasian study." Strategic Change **12**(1): 49-62.
Discusses the tools and techniques that can be used by companies in order to aid strategic planning. Studies 36 small and medium-sized manufacturing firms. The article heavily highlights the importance of environmental scanning.

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Discusses service innovation in the insurance industry.

Gallouj, F. and O. Weinstein (1997). "Innovation in services." Research Policy **26**(4/5): 537-557.
Describes innovation in the service sector.

Garud, R. and P. Tuertscher (2006). Mapping the field of innovation, The Pennsylvania State University- Smeal College of Business.

Discusses the evolution of innovation research.

Gebauer, H., E. Fleisch, T. Friedli (2005). "Overcoming the service paradox in manufacturing companies." European Management Journal **23**(1): 14-26.

Discusses the implementation of change and obstacles for manufacturing firms to overcome when offering services.

Gordon, G. L., P. F. Kaminski, R.J. Catalone C.A. di Benedetto. (1993). "Linking customer knowledge with successful service innovation." Journal of Applied Business Research **9**(2): 129-140.

Discusses the activities and knowledge needed to develop and market services that create customer value.

Gray, C. (2002). "Entrepreneurship, resistance to change and growth in small firms." Journal of Small Business and Enterprise Development **9**(1): 61-72.

Discusses small firms and their attitudes towards change.

Griffin, A. (1997). "PDMA research on new product development practices: Updating trends and benchmarking best practices." The Journal of Product Innovation Management **14**(6): 429-458.

Highlights NPD best practices as well as industry differences. "Best practice" firms use cross-functional teams and measure NPD outcomes.

Griffin, A. and J. R. Hauser (1993). "The voice of the customer." Marketing Science **12**(1): 1-27.

Discusses using customer input in business processes.

Gustafsson, A. and M. D. Johnson (2003). Competing in a Service Economy: How to Create a Competitive Advantage Through Service Development and Innovation. San Francisco: Jossey-Bass.

Describes how to gain a competitive advantage by strategically pursuing service innovation.

Hand, J. and B. Lev (2003). Intangible Assets (Oxford Management Readers). Oxford: Oxford University Press.

Discusses the emerging importance of intangible assets in today's business.

Hinds, P. and J. Pfeffer (2001). Why organizations don't 'know what they know': Cognitive and motivational factors affecting the transfer of expertise, Stanford University Graduate School of Business.

Describes the complexities of tacit and explicit knowledge.

Huang, X., G. N. Soutar, A. Brown (2002). "New product development processes in small and medium-sized enterprises: Some Australian evidence." Journal of Small Business Management **40**(1): 27-42.

Discusses marketing-related and technical activities and their frequency, execution and success in the NPD process.

ISI (2006). Web of Knowledge, http://portal.isiknowledge.com/portal.cgi.

Johne, A. and C. Storey (1998). "New service development: A review of the literature and annotated bibliography." European Journal of Marketing **32**(3/4): 184-251.

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Kelley, T. (2001). The Art of Innovation. New York: Doubleday.

Discusses innovation and ways to make it happen.

Kelly, D. and C. Storey (2000). "New service development: Initiation strategies." International Journal of Service Industry Management **11**(1): 45-62.

Discusses the initiation of new service development projects, including strategy, idea generation and screening.

Khan, A. M. and V. Manopichetwattana (1989). "Innovative and noninnovative small firms: Types and characteristics." Management Science **35**(5): 597-606.

Found a positive relationship between scanning and innovation. Discusses environmental dynamism and heterogeneity. Found that an abundance of resources encouraged proactiveness.

Kogut, B. and U. Zander (1992). "Knowledge of the firm, combinative capabilities and the replication of technology." Organization Science **3**(3): 383-397.

Builds a dynamic perspective on how firms create knowledge. Discusses path dependency. Cumulative firm knowledge provides options in uncertain markets.

Kotter, J. P. and D. S. Cohen (2002). The Heart of Change. Boston: Harvard Business School Press.

Discusses eight steps for successful organizational change.

Kupper, C. (2001). Service innovation- A review of the state of the art, The University of Munich, Institute for Innovation Research and Technology Management**:** 1-46.

Discusses the history and current state of service innovation in industry and literature.

Ledwith, A. (2000). "Management of new product development in small electronics firms." Journal of European Industrial Training **24**(2/3/4): 137-148.

Studies small Irish electronics firms and compares them to larger ones. SMEs had high percent of R&D and R&D employees per sale. They also had fewer patents than large firms and interacted less with outside firms.

Leonard-Barton, D. and I. Deschamps (1988). "Managerial influence in the implementation of new technology." Management Science **34**(10): 1252-1265.

Discusses the effect of managerial influence on employees' willingness to adopt innovation.

Lindman, M. T. (2002). "Open or closed strategy in developing new products? A case study of industrial NPD in SMEs." European Journal of Innovation Management **5**(4): 224-236.

Reports on the quality of NPD in 5 SMEs in the Finnish metal industry. Describes SMEs' lack of proactive innovation and the danger in only reacting.

March-Chorda, I., A. Gunasekaran, B. Lloria-Aramburo (2002). "Product development process in Spanish SMEs: an empirical research." Technovation **22**(5): 301-312.

Looks at 65 SMEs in Spain and discusses critical success factors and product development processes. Major determinants that confront NDP are cost of NPD projects and uncertainty about market acceptance. Contrary to common theory average NPD time is approximately six months.

Martin, C. R. J. and D. A. Horne (1993). "Services innovation: Successful versus unsuccessful firms." International Journal of Service Industry Management **4**(1): 49-65.

Compares firms that are successful against those that are unsuccessful in new service development.

Menor, L. J., M. V. Tatikonda, S.S. Sampson (2002). "New service development: Areas for exploitation and exploration." Journal of Operations Management **20**(2): 135-157.

Identifies areas of the NSD literature that need further exploration.

Meyer, M. H. and E. B. Roberts (1986). "New product strategy in small technology-based firms: A pilot study." Management Science **32**(7): 706-821.

Creates a "newness index" to describe a firm's new products.

Monitor Group (2004). Industrial services strategies: The quest for faster growth and higher margins.

Provides an in-depth discussion of industrial services.

Moore, G. (2004). "Darwin and the demon: Innovating within established enterprises." Harvard Business Review **82**(7/8): 86-91.

Discusses choosing between radical and incremental innovation on the basis of market life-span.

Mosey, S. (2005). "Understanding new-to-market product development in SMEs." International Journal of Operations and Production Management **25**(2): 114-130.

Discusses applying NPD to new customers using existing technologies. There is a need to empower cross-functional teams and involve larger number of partners. Also discusses systematizing learning across projects.

Nonaka, I. and H. Takeuchi (1995). The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation. New York: Oxford University Press.
Describes how Japanese firms do business, and particularly how they handle knowledge.

Nooteboom, B. (1994). "Innovation and diffusion in small firms: Theory and evidence." Small Business Economics **6**(5): 327-347.
Describes small businesses compared to large ones on the basis of strengths and weaknesses. Those strengths and weaknesses influence innovation. The study examines innovation diffusion.

Oliva, R. and R. Kallenberg (2003). "Managing the transition from products to services." International Journal of Service Industry Management **14**(2): 160-172.
Describes the extent of integration that is desirable for products and services. Also discusses implementation issues in transitioning from a product-only to a product/service firm.

Paloheimo, K.-S., I. Miettinen, S. Brax (2004). Customer oriented industrial services, Helsinki University of Technology, BIT Research Centre.
Discusses the creation of industrial service innovations that add value to the customer.

Pavitt, K. (1984). "Sectoral patterns of technical change: Towards a taxonomy and a theory." Research Policy **13**(6): 343-373.
Discusses how variations in sectoral patterns of change can be classified into a three-part taxonomy, including supplier dominated, production intensive and science-based firms.

Prahalad, C. K. and G. Hamel (1990). "The core competence of the corporation." Harvard Business Review **68**(3): 79-91.
Describes core competencies and management's need to develop them for competitive advantage.

Quinn, J. B., T. L. Doorley, P.C. Paquette (1990). "Beyond products: Services-based strategy." Harvard Business Review **68**(2): 58-64.
Discusses the need for services as well as strategy. There needs to be a change in mindset from just manufacturing to manufacturing and services.

Quinn, J. B. and T. L. Doorley (1988). "Key policy issues posed by services." Technological Forecasting and Social Change **34**: 405-423.
Describes the issues relating to services and policy formation.

Rae, J. M. (2005). Analysis of data from the U.S. Bureau of Economic Analysis. A. Warren, Personal Correspondence.
Ratio of 82.5 is taken at Q1 in 2005. The 50% tipping point was 1987.

Reinartz, W. and W. Ulaga (2006). "Growth beyond the core." Financial Times (31 March 2006): 10.

Explains how manufacturers can stabilize cash flows and develop new revenue streams by developing service offerings to complement their products.

Roth, A. V., R. B. Chase, C.A. Voss (1997). Service in the US: Progress Towards Global Service Leadership. London Business School, University of North Carolina and University of Southern California Research Monograph.

Discusses progress towards global service leadership in the US service industry.

Rothwell, R. and M. Dodgson (1991). "External linkages and innovation in small and medium-sized enterprises." R & D Management **21**(2): 125-137.

SMEs have some advantages (flexibility) and disadvantages (unable to spread risk across projects, can't afford to fund log-term R&D). One area that would help is how to link internal and external technical knowledge.

Salavou, H. (2005). "Do customer and technology orientations influence product innovativeness in SMEs? Some new evidence from Greece." Journal of Marketing Management **21**(3): 307-338.

Studied 150 Greek SMEs. Found that innovation is based on product newness to customers and product uniqueness. Found that technology-focused firms are likely to introduce products that are new and unique to their customers.

Scheuing, E. E. and E. M. Johnson (1989). "New product development and management in financial institutions." The International Journal of Bank Marketing **7**(2): 17-21.

Discusses the management of new product development in service businesses other than financial institutions.

Shostack, G. L. (1984). "Designing services that deliver." Harvard Business Review **62**(1): 133-139.

Discusses characteristics of services. The reason that services fail is that there is a lack of systematic method for design and control.

Simon, H. (1992). "Lessons from Germany's midsize giants." Harvard Business Review **70**(2): 115-123.

Discusses the factors that have led to the success of the Mittelstand, i.e. Germany's SMEs.

Simon, H. (1996). Hidden Champions: Lessons from 500 of the World's Best Unknown Companies. Boston: Harvard Business School Press

Discusses the attributes and strategies of hidden champions (worldwide market leading SMEs).

Siu, W., T. Lin, W. Fang and Z-C. Liu (2006). "An institutional analysis of the new product development process of small and medium enterprises (SMEs) in China, Hong Kong and Taiwan." Industrial Marketing Management **35**(3): 323-335.

Examines the impact of governmental intervention on NPD processes in China, Hong Kong and Taiwan. Includes a study of 97 SMEs.

Sundbo, J. (1997). "Management of innovation in services." The Service Industries Journal **17**(3): 432-455.

Discusses organizational learning and the organization of innovation from the perspective of Danish service firms.

Susman, G. I. and J. W. Dean Jr (1992). "Development of a model for predicting design for manufacturability effectiveness". In G. I. Susman (Ed.) Integrating Design and Manufacturing for Competitive Advantage. New York: Oxford University Press.

Discusses factors that lead to effective communication between design and manufacturing personnel.

Susman, G. I., K. Jansen, and J. Michael (2006). Innovation and Change Management in Small and Medium-Sized Manufacturing Companies, The Pennsylvania State University- Smeal College of Business.

Sponsored Research for The National Institute of Standards and Technology Manufacturing Extension Partnership. Discusses the processes of innovation and change in manufacturing SMEs.

Takeuchi, H. and J. A. Quelch (1983). "Quality is more than making a good product." Harvard Business Review **61**(4): 139-146.

Discusses the importance of service quality in addition to product quality.

Tether, B.S. (2005) "Do services innovate (differently)? Insights from the European Innobarometer Survey", Industry and Innovation, **12**, (2), 153-184.

Discusses that "innovation in services brings to the fore 'softer' aspects of innovation based in skills and inter-organizational co-operation practices."

Thomke, S. and E. von Hippel (2002). "Customers as innovators: A new way to create value." Harvard Business Review **80**(4): 74-81.

Discusses the use of "customer tool kits" to transfer some of the innovation process (i.e. design) into the customer's hands.

Tidd, J. and F. Hull (2002). The organization of new service development in the USA and UK, SPRU Science and Technology Policy Research - University of Sussex**:** 1-31.

Introduces and tests a framework for new service development in the US and UK.

Ulrich, K. T. and S. D. Eppinger (2004). Product Design and Development. Boston: McGraw-Hill.

Discusses integrated methods for managing new product development.

Ulwick, A. W. (2002). "Turn customer input into innovation." Harvard Business Review **80**(1): 5-11.

Ask customers for desired outcomes, not solutions; use ideas for innovation. There are dangers in listening to customers. Presents 5 steps and a mathematical formula for deciding what innovations are most promising.

Urban, G. L. and J. R. Hauser (1993). Design and Marketing of New Products. Englewood Cliffs: Prentice Hall.
Discusses the new product development process.

U.S. Census Bureau (2003). Statistics of U.S. Businesses, U.S. Census Bureau**:** http://www.census.gov/csd/susb/usst03.xls and http://www.census.gov/epcd/susb/introusb.htm#size.
Shows that SMEs accounted for 99.7% of all firms in the US in 2003.

van der Aa, W. and T. Elfring (2002). "Realizing innovation in services." Scandinavian Journal of Management **18**(2): 155-171.
Describes innovation in the service industry.

von Hippel, E. (1988). The Sources of Innovation. New York: Oxford University Press.
Discusses "unconventional" sources of innovation, such as end-users.

von Hippel, E., S. Thomke, M. Sonnack (1999). "Creating breakthroughs at 3M." Harvard Business Review **77**(5): 47-57.
Discusses the "lead-user process", e.g. innovation with the help of lead-users.

Vossen, R. W. (1998). Combining small and large firm advantages in innovation: Theory and examples. University of Groningen Research Institute SOM.
Discusses possible innovation advantages of small and large firms. Suggests networking for leverage. Found that relationships seem to determine innovative success for smaller firms.

Warren, A. and G. I. Susman (2004). Review of Innovation Practices in Small Manufacturing Companies, The Pennsylvania State University-Smeal College of Business-for NIST.
Reviews the innovation activities of SMEs.
http://www.smeal.psu.edu/fcfe/more/white/innovation.pdf

Wise, R. and P. Baumgartner (1999). "Go downstream: The new profit imperative in manufacturing." Harvard Business Review **77**(5): 133-141.
Discusses innovation via going deeper into your customer's value chain and going downstream to make more sustainable profits via servicing a high installed base.

Woodcock, D. J., S. P. Mosey, T.B.W. Wood (2000). "New product development in British SMEs." European Journal of Innovation Management **3**(4): 212-222.
The research finds that SMEs companies often neglect NPD in the face of other short-term pressures. Also discusses other short-comings of SMEs having to do with the NPD process.

Wright, R. E., J. C. Palmer, D. Perkins (2005). "Types of product innovations and small business performance in hostile and benign environments." Journal of Small Business Strategy **15**(2): 33-44.

Based on small firm surveys, found that the strategy of innovation through development of more new product lines may be preferable to developing dramatic innovations for small businesses in a hostile external environment.

Yap, C.-M., K-H. Chai, P. Lemaire (2005). "An empirical study on functional diversity and innovation in SMEs." Creativity and Innovation Management **14**(2): 176-190.

Advantages of SMEs: Intrapersonal function diversity (measures the range of function experience within each individual in the management team) has a positive impact on innovation moreso for SMEs than larger companies.

Zhang, J., K-H. Chai, K-C Tan (2005). "Applying TRIZ to service conceptual design: An exploratory study." Creativity and Innovation Management **14**(1): 34-42.

Discusses TRIZ (the theory of inventive problem solving) and its use in developing new services.