SUSTAINABLE ENTREPRENEURSHIP PROJECT

Product Development: A Global Survey of Theory and Research

SUSTAINABLE ENTREPRENEURSHIP PROJECT
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Product Development: A Global Survey of Theory and Research

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About the Project

The Sustainable Entrepreneurship Project (www.seproject.org) engages in and promotes research, education and training activities relating to entrepreneurial ventures launched with the aspiration to create sustainable enterprises that achieve significant growth in scale and value creation through the development of innovative products or services which form the basis for a successful international business. In furtherance of its mission the Project is involved in the preparation and distribution of Libraries of Resources for Sustainable Entrepreneurs covering Entrepreneurship, Leadership, Management, Organizational Design, Organizational Culture, Strategic Planning, Governance, Corpoorate Social Responsibility, Compliance and Risk Management, Finance, Human Resources, Product Development and Commercialization, Technology Management, Globalization, and Managing Growth and Change.

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Product Development and Commercialization: A Library of Resources for Sustainable Entrepreneurs

Contents

The Sustainable Entrepreneurship Project (www.seproject.org) also prepares and distributes other Libraries of Resources for Sustainable Entrepreneurs covering Entrepreneurship, Management, Organizational Design, Organizational Culture, Strategic Planning, Governance, Corporate Social Responsibility, Compliance and Risk Management, Finance, Human Resources, Product Development and Commercialization, Technology Management, Globalization, and Managing Growth and Change.

§1:1 Introduction

New product development, or "NPD", includes not only the creation and launch of new products but also modification or updates to existing products and initiatives to introduce changes to the overall development program including quality improvements, reduction of time to market, enhanced collaboration with suppliers, plant modernization and technology updates. Regardless of the focus the goal of the product development process should be to find new and innovative ways to meet customer needs that are not currently being served by the company. Successful product development is essential for launching a company and for ensuring that the company continues to survive and prosper as competitive conditions and customer requirements change over time, and while a good deal of product development efforts focus on building the company's existing product line they can also be used to vault the company into an entirely new set of activities, markets and/or industries. In many industries product development is a core competency that must be acquired and nurtured in order for a company to remain in business and companies have come to realize that they must commit a substantial amount of their investible R&D funds to new product development. No one academic or organizational discipline can claim complete ownership of product innovation and it has attracted the interest of researchers whose primary focus includes economics, engineering, manufacturing, marketing, operations research and organizational behavior.[1]

Innovative activities, including NPD, are influenced by a number of different factors such as the professional and personal characteristics of the founders, owners and top managers; firm characteristics, such as size, organizational structure and degree of internationalization); skills of the workforce, particularly the availability of qualified scientists and engineers; and the external environment (i.e., dynamism and complexity, intensity of competition, environmental change, importance of external barriers and level of networking).[2] Given the importance of NPD to the development and survival of firms and the realization that no one country has a monopoly on product ideas, it is not surprising to see increasing interest in cross-country studies and comparisons of NPD and innovation. Many of these studies have been launched to identify differences between industries and the international aspect of the studies follows from inclusion of firms from multiple countries. Dimensions for comparisons include processes for product concept creation, particularly the level of input from customers; research and development and engineering design practices; influence of internationalization in new product design activities; product portfolio management; supply chain management; project management (i.e., selection and management of product development teams and integration between

[1] For further discussion of new product development, see "Product Development and Commercialization: A Library of Resources for Sustainable Entrepreneurs" prepared and distributed by the Sustainable Entrepreneurship Project (www.seproject.org).

[2] For a full list, including citations to the works referred to in the literature review, see J. De Jong and P. Vermeulen, "Determinants of Product Innovation in Small Firms", International Small Business Journal, 24(6) (2006), 587, 590-591. See also A. Hadjimanolis, "An Investigation of Innovation Antecedents in Small Firms in the Context of a Small Developing Country", R&D Management, 30(3) (2000), 235 and Y. Kim, K. Song and J. Lee, "Determinants of Technological Innovation in the Small Firms of Korea", R&D Management, 23(3) (1993), 215.

those teams and functional departments); formalization of NPD processes and practices; and management of the launch of new products.

Companies conduct their innovation activities, such as NPD, within a broad and continuously evolving external environment and this environment necessarily has a strong influence on the product development process including, of course, the products that companies decide to develop in an effort to satisfy the needs of their external customers and that methods that companies feel comfortable using in identifying, designing and rolling out new products. There are a variety of factors that are part of any company's external environment; however, among the most important in the minds of many researchers are technology, demand, regulatory and legal constraints, patents and other intellectual property rights, suppliers, market conditions, the industry in which the company is operating and societal culture.[3] This list is not intended to be all-inclusive and other factors will certainly be relevant. For example, one survey of differences across countries with respect to the influence of various stakeholders found that employees were considered to be the strongest stakeholders in relation to Japanese firms, with unions being viewed as key partners with management when decisions are made about strategy and productivity improvements; however, for companies in the US and in parts of Europe (i.e., Denmark, Italy and Scotland) the strongest stakeholder influences came from customers.[4]

Regulatory and legal constraints, current and actual as well as projected, may sometimes become significant factors for companies and create both obstacles and opportunities. According to Bloch, regulatory and legal constraints can be considered one of the "less malleable requirements" for successful NPD and examples include safety-oriented rules for products and/or manufacturing processes, requirements that product use and disposal must adhere to environmental protection standards and, of course, the well-known clinical testing regimes that must be completed before new pharmaceutical products are released for public distribution.[5] Regulatory and legal constraints emerge from a variety of sources and pressures. For example, in developed countries environmental groups have long pushed lawmakers and regulators to adopt laws and rules that encourage reduced consumption of energy and natural resources and this movement has spread to many emerging markets. In addition, in recent years the attention of lawmakers in the US and Europe has turned to points farther up the supply chain as they adopt laws and rules that focus on human rights issues and practices in foreign countries that perform manufacturing activities for importers. Companies often proactively respond to

[3] M. Pina e Cunha, Determinants of Product Innovation in Organizations: Practices and Performance in the Portuguese Financial Sector (1998), 12-13. For further discussion of the various listed factors of a company's external environment that will likely influence NPD activities, see "Product Development and Commercialization: A Library of Resources for Sustainable Entrepreneurs" prepared and distributed by the Sustainable Entrepreneurship Project (www.seproject.org).

[4] See W. Tomlinson, S. Paulson, J. Arai and D. Briggs, Company Identity, "Quality Improvement and Labor-Management Relations in Danish, Italian, Japanese, Scottish and U.S. Firms", National Productivity Review (Spring 1991), 129.

[5] M. Pina e Cunha, Determinants of Product Innovation in Organizations: Practices and Performance in the Portuguese Financial Sector (1998), 15 (citing P. Block, "Seeking the Ideal Form: Product Design and Consumer Response", Journal of Marketing, 59(3) (1995), 16).

regulatory and legal issues by implementing internal procedures to improve product performance, safety and reliability and thus reduce the risk of litigation due to accidents occurring during the use of their products. Globalization of competition and the need to develop products that can be launched and marketed in multiple markets around the world has forced new product developers to incorporate regulatory and legal requirements from a variety of countries into their efforts.

Another important and interesting factor from the list explained above is societal culture, which has often been suggested to be a fundamental determinant of product innovation.[6] For example, one researcher has argued that societies that are more accepting of uncertainty tend to be more innovative than societies where uncertainty avoidance is strong[7] and another group of researchers has suggested that differences in societal culture influenced the way in which firms from different countries are likely to approach the processes for concept development and generation of ideas at the earliest stages of product development.[8] Among developed countries there appear to culturally-based approaches to the product innovation process that have been observed on a continuous basis such as high technical standards among German and Japanese firms[9] and the tendency of German firms to focus their product strategies favored by German firms focused on creating well-engineered, high quality products that were delivered on time and supported by extensive and excellent service.[10] Another aspect of new product development that may be influenced by societal culture is planning, which is obviously relevant when new products are being vetted, selected, developed and commercialized. Finally, Ettlie et al. argued that high-tech and low-tech industries had different patterns of cultural influence through the various stages of the product development process and that "[i]n high-tech industries, it could be argued that early stages of product development—like the preconcept and concept development stages—are less likely to show cultural influences because science dominates".[11]

§1:2 Silicon Valley

Product development in Silicon Valley has been characterized by organizational innovations, as illustrated by the experiences in the semiconductor industry. At most of

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[6] For further discussion of the influence of societal culture on product development activities and practices, see "Product Development and Commercialization: A Library of Resources for Sustainable Entrepreneurs" prepared and distributed by the Sustainable Entrepreneurship Project (www.seproject.org).

[7] S. Shane, "Cultural Influences on Rates of Innovation", Journal of Business Venturing, 7 (1993), 29. For discussion of uncertainty avoidance, see the Part on "Cross-Cultural Studies" in "Globalization: A Library of Resources for Sustainable Entrepreneurs" prepared and distributed by the Sustainable Entrepreneurship Project (www.seproject.org).

[8] J. Ettlie, C. Dereher, G. Kovacs and L. Trygg, "Cross-National Comparisons of Product Development in Manufacturing", The Journal of High Technology Management Research, 4(2) (1993), 139, 141, 151.

[9] Id. at 150.

[10] J. Limprecht and R. Hayes, "Germany's World-Class Manufacturers", Harvard Business Review (November/December 1982), 137.

[11] J. Ettlie, C. Dereher, G. Kovacs and L. Trygg, "Cross-National Comparisons of Product Development in Manufacturing", The Journal of High Technology Management Research, 4(2) (1993) 139, 152 (also citing R. Osborn and C. Baughn, "Societal Considerations in Global Technological Development of Economic Institutions: The Role of Strategic Alliances", in Research in the Sociology of Organization (1993), 113).

the earlier Silicon Valley semiconductor companies, such as Fairchild Semiconductor, the product development and manufacturing functions operated separately from one another with new products being developed first by engineers in the research and development ("R&D") department and then being transferred to the product department.[12] At the same time the manufacturing department had its own engineering team in its applications laboratory that focused on developing follow-up products. This type of organization was ultimately seen as terribly inefficient and conducive to turf battles between R&D and manufacturing. In addition, the transfer of technologies from R&D to manufacturing was often difficult due to differences in the equipment and processes used in each of the departments. At the next generation of Silicon Valley semiconductor companies, such as National Semiconductor and Intel, the founders, many of whom has begun their careers at Fairchild, were determined to remove the inefficiencies by tightly integrating the R&D and manufacturing functions and did so by dispensing with separate R&D laboratories and having product and process engineers work together in the manufacturing area using the same equipment and processes. At National Semiconductor the design engineering teams reported directly to plant management and the resulting product development process was described by Lecuyer as follows: "Each team included circuit-design and process engineers, and each focused on a specific product line. Under this scheme, engineers developed new products and processes directly on the manufacturing line, using existing equipment and interacting daily with the people who were going to manufacture their circuits. The design engineering groups were also responsible for a product from its initial design stage through its production. They were expected to solve any problems that might appear over the course of the product's life." This "new" approach allowed National Semiconductor and other companies to bring their products to market much more quickly and efficiently than Fairchild.

Organizational structures in Silicon Valley were notable for their decentralization and this approach was often carried into the product development process. At Hewlett Packard, for example, product divisions were set up as "semi-autonomous business units, with full responsibility for product development, engineering, manufacturing, marketing, and personnel", an organizational structuring strategy that "not only increased the organization's responsiveness but also greatly reduced the decision-making authority of senior management".[13]

Google has received a good deal of attention for its pro-active encourage of new product ideas from employees through its "70/20/10" rule, which Thompson described as the expectation of top management that employees would "devote 70 percent of every work day to whichever projects are assigned by management, 20 percent of each day to new projects or ideas related to their core projects, and 10 percent to any new ideas they want to pursue regardless of what they might be".[14] Obviously such a system became unwieldy as the company's growth exploded and additional steps needed to be taken to

[12] The discussion in this paragraph is adapted from C. Lecuyer, Making Silicon Valley: Innovation and the Growth of High Tech, 1930-1970 (2006), 265-266.
[13] The discussion in this paragraph is adapted from A. Saxenian, Lessons from Silicon Valley, MIT Technology Review (1994).
[14] S. Thompson, Google's Business Leadership and Organizational Culture.

manage the flow of potential innovation including initiating the practice of having employees meet on a regular basis with the founders and other top executives of the company to pitch their new ideas and projects.

A fascinating window into the product development and management process at Google during the early 2000s comes from notes taken by Rodriguez on a presentation given in 2003 by Google product manager Marissa Mayer, who was later to become CEO of Silicon Valley icon Yahoo.[15] In her presentation Mayer noted that product development at Google was rigorously tied to the company overall mission of organizing the world information to make it universally accessible and useful and that "accessibility" and "utility" were thus key goals in each product development initiative. In fact, Mayer stressed several times that "user-centered design" was extremely important in the product development at Google and that this meant building products that people really wanted based on identifying and understanding user needs and desires. According to the notes prepared by Rodriguez the Google product development process began by accepting ideas from everywhere (i.e., employees and customers)—Google expended a lot of effort to encourage new ideas including sponsoring various forms and mediums for idea-collection and participation—and then prioritizing those ideas on a "Top 100" list based on several factors including utility to users, the likelihood that it would assist user retention, chances for success, the contribution it might make to diversifying revenue stream and, finally, the level of effort required relative to impact.

When a new product idea was selected for further development it was assigned to one of many small, agile engineering teams that were allowed a great deal of autonomy with respect to their internal organization. Google did not have a formal product development department and instead viewed each team, which typically had three engineers, as the relevant business unit for each project. Members of the team were co-located and worked exclusively on the project for three or four months before moving on to a new project. One of the engineers was designated as the "technical lead" for the team and had responsibility for the technical excellence of the project. At this early stage product documentation was very sparse and the team prepared only what was necessary to create a product requirements document that would be analyzed at the end of the initial development process. A Google product manager was continuously involved in the work of each team and product managers generally worked with nine or ten engineers across several teams at the same time. Larger projects were explored using the same methods applied to smaller projects by breaking the tasks into logical modules that could each be addressed by small teams (e.g., a large project might have four units of three people, a total of twelve people, each working on a discrete piece at the same time).

Rodriguez recorded several other interesting characteristics of the Google product development process. First, once the company was satisfied that a new product or service was likely to be seen as useful by users teams were created to create and execute an

[15] The discussion in this paragraph and the following paragraphs regarding Mayer's presentation is adapted from E. Rodriguez, Google Product Development/Management Process: A Presentation by Google Product Manager Marissa Mayer to Silicon Valley Product Management Association on January 8, 2003, http://evelynrodriguez.typepad.com.

explicit "monetization" strategy for the product or service. Second, Google created organizational tools to ensure that the plans for launching each new product, including calendars and current status reports, were readily visible throughout the company. Third, as mentioned above, the focus on user-centered design was continuously reinforced and the product development path included weekly user studies, emphasis on quality and understanding what users really care about, experimentation and iteration. Finally, Google had a bias toward "expedient solutions" and getting new products and services out into the market quickly even if the company knew that further work would be needed to improve performance and the quality of the solution offered to users.

Abbott and Quinn noted that while historically in Silicon Valley product development has typically been driven by engineers they perceived a fundamental shift in the technology industry's approach to product development beginning in the late 2000s toward the fundamental disciplines of design: customer experience, interaction, and visual design.[16] They argued that more and more startups have launched as design-focused and that older firms have been forced to quickly shift from their engineering-centric roots to a new product development paradigm that emphasizes addressing and meeting customer expectations of simplicity and ease-of-use in new products.

Rush et al. have conducted ongoing research to identify best practices of highly successful new product development teams operating among Silicon Valley technology companies.[17] They were particularly interested in exploring the methods used by these companies to get new products to market quickly and efficiently while ensuring that customer requirements are satisfied. Among other things they found that the most successful companies were those that recognized that customer requirements were likely to change continuously during the development process and that it was a mistake to freeze the product specifications early in the process and not engage in regular contract with customers to gather feedback. In fact, the researchers found that the most successful product development teams proactively sought out product requirements from the most suitable and dominant customers in the market segment that the companies had chosen for the new product. Jaruzelski and Le Merle argued that Silicon Valley companies were more successful at innovation than their counterparts in other parts of the world because Silicon Valley companies did a much better job of creating and maintaining strong alignment between their innovation and business strategies and emphasized that the most successful Silicon Valley companies anticipated customer needs, had their top technical executives report directly to the CEO, ensured that innovation strategies were developed and communication from the top throughout the company, and constantly refreshed their product development staffs.[18]

§1:3 United Kingdom

[16] M. Abbott and M. Quinn, Redesigning Product Development in Silicon Valley (2013).
[17] A. Rush, J. Schmook, N. Mitchell and B. Biddinger, Fast-Time-to-Market Best Practices (1992).
[18] B. Jaruzelski and M. Le Merle, "Revealed! Silicon Valley's Secrets to Innovation Success", Forbes (March 27, 2012).

Haake et al. examined differences between UK and German companies operating in the food industry with respect to their organizational processes and structures for new product development.[19] Among other things, the researchers found that the UK respondents typically set and followed a much shorter planning horizon than their German counterparts—no more than three years in the UK compared to five year planning horizons in Germany. The UK companies also assumed much shorter life cycles for their new products, normally no more than 12 months compared to German projections of life cycles of up to 70 months, and had a much higher percentage of sales attributable to products launched in the previous two years than the German firms included in the survey. The preferred organizational structure for new product development activities among the UK firms was "loose" and "flexible" and their activities were focused much more on commercialization rather than research.

Abubaker and Mitra studied the new product development methods used among 52 small technology-focused companies in Silicon Fen by identifying and assessing their reliance on "knowledge spillovers" and "pecuniary knowledge mechanisms".[20] With regard to the key knowledge spillover mechanisms used by the surveyed companies, the researchers found that they relied most heavily on labor mobility (i.e., acquiring knowledge through the recruitment of new labor) and research institute spillovers (i.e., acquiring and using mostly "free" knowledge from universities and research organizations through conversations with academics and researchers in universities and colleges and early and easy access to public research made available to outsiders without restrictions). As for pecuniary knowledge mechanisms, the Silicon Fen companies were most likely to collaborate with, or use paid services of, universities and research institutes traditionally known to be providers of basic research. The researchers found that in Silicon Fen knowledge spillovers had greater explanatory power than pecuniary knowledge externalities on new product development and also found that both "local knowledge" sources and "national and international knowledge" sources were significant influences on new product development. While the later finding regarding the influence of "local knowledge" was consistent with the arguments in favor of "clustering", the researchers noted that companies in Silicon Fen must nonetheless look beyond their local region for resources since shortages of those resources, such as labor, are likely to occur due to the intense competition that comes with high concentrations of like-minded companies. Silicon Fen companies must also look outside their region for expertise in certain phases of the innovation process including manufacturing of products developed in Cambridge.

Abubaker and Mitra actually combined their study of Silicon Fen companies with a simultaneous assessment of new product development methods used by 48 electronics

[19] S. Haake, C. Moore and N. Oliver, Recipes for Success—Product Development Benchmarks in the UK and German Food Industries (2000).

[20] Y. Abubakar and J. Mitra, Small Firm Innovation in Non-Clustered Regions: Comparing High and Low Agglomeration Regions (2011). According to the authors, "[k]nowledge spillovers . . . are transmitted outside the market system and arise when new ideas and knowledge, crucial for enhancing a firm's innovation potential, flows between firms through personal exchanges in the labour market" and "pecuniary or market related externalities are transferred through inter-firm supply and demand linkages, and therefore arise through trade related sources that have impacts on creation of new knowledge and goods".

and software companies in Essex, which was chosen as an example of region lacking a concentration of firms in high technology industries that could be compared to an innovation cluster such as the one that had grown up around Cambridge University.[21] The most popular knowledge spillover mechanism among the Essex-based firms was "imitation", a process that involved reverse engineering products developed by other companies to find new applications. The researchers argued that this approach could be explained, at least in part, by the fact that the companies in Essex had significantly less resources than their counterparts in Silicon Fen to use on internal R&D and imitation required less R&D. When looking at the pecuniary knowledge mechanisms used by the Essex companies the researchers found a tendency to rely on subcontracting relationships as the means for development of innovative products due to a lack of access to universities and large research organizations and the relative cost-effectiveness of subcontracting. As was the case in Silicon Fen, knowledge spillovers had greater explanatory power than pecuniary knowledge externalities on new product development among the companies in the Essex group and "national and international knowledge" sources were significant influences on new product development in Essex; however, in contrast to Silicon Fen, the new product development activities of the Essex companies were not significantly influenced by "local knowledge" sources. Following on the discussion above with respect to Silicon Fen, the researchers noted that shortage of "local knowledge" in Essex was not necessarily a disqualifier in the race to innovate since, based on their analysis, "international knowledge" sources were the most important influence in both "high agglomeration" and "low agglomeration" regions.

Another aspect of new product development that may be influenced by societal culture is planning, which is obviously relevant when new products are being vetted, selected, developed and commercialized, and researchers have found that planning can lead to different types of successful outcomes and that variable patterns can be observed across cultures. For example, Hagerty and Hoffman found that better planning among Anglo firms translated into higher returns on sales.[22]

§1:4 Japan

NPD activities in Japan rely heavily on cross-functional involvement and management. Imai noted that rather than following a sequential approach to NPD that is often punctuated and delayed by functional departmental managers placing priority on the needs and activities of their department, Japanese companies follow a NPD model that requires communication and collaboration among multiple functional departments from the outset in pursuit of three key cross-functional goals for each product: "quality", which

[21] Y. Abubakar and J. Mitra, Small Firm Innovation in Non-Clustered Regions: Comparing High and Low Agglomeration Regions (2011). Abubaker and Mitra were interested in identifying differences between product development activities of small high technology companies in "high agglomeration" and "low agglomeration" regions, with "agglomeration" being determined by the local concentration of firms in high-tech industries as measured in terms of below or above average densities of both firms and their respective workforce in those regions. Abubaker and Mitra selected the Silicon Fen and Essex as "high agglomeration" and "low agglomeration" regions, respectively.

[22] W. Hagarty and R. Hoffman, The Relationship between Strategic Planning and Performance Among Three Cultures, Proceedings, Academy of Management (1990), 106.

is concerned with building better systems for quality assurance; "cost", which is concerned both with building a system for identifying costs factors and with reduction of costs; and "scheduling", which is concerned with building better systems for both delivery and quantity of products.[23] Imai explained that while profitability is obviously a significant goal for every company, Japanese managers believe that this goal can only be obtained by continuous pursuit of improvement in the three goals mentioned above, while Imai referred to as "QCS", since products that are inferior with respect to quality will fail in the face of competition, higher costs will erode profits, and the inability to deliver products on time to customers will cause them to look elsewhere to fulfill their needs.

Matsui et al. collected data that was used to measure and compare practices, processes, strategies and capabilities for new product development in Italian and Japanese companies and found that in both countries technology and marketing capabilities concerning new product development were overwhelmingly important to financial performance.[24] One survey of differences across countries with respect to the influence of various stakeholders found that employees were considered to be the strongest stakeholders in relation to Japanese firms, with unions being viewed as key partners with management when decisions are made about strategy and productivity improvements; however, for companies in the US and in parts of Europe (i.e., Denmark, Italy and Scotland) the strongest stakeholder influences came from customers.[25]

Ettlie et al. were interested in improving knowledge regarding the relatively under-researched activity of "concept development", which included the methods that firms used in order to generate ideas for new products and processes before the better understood period of concurrent engineering (i.e., simultaneous design of products and manufacturing processes) began, and did so by undertaking a rigorous cross-national study of various aspects of the new product development process used by durable goods manufacturers in five dispersed countries, including Japan.[26] Ettlie et al. found that in the Japanese firm included in the survey there was near parity in degreed design and manufacturing engineers at a very higher percentage level (95% and 80%, respectively), a result similar to the German firm in the survey and one that Ettlie et al. explained as consistent with the Japanese cultural predisposition of high concern for technical accuracy.[27] Ettlie et al. also noted that the survey participant from Japan followed what

[23] M. Imai, Kaizen: The Key to Japan's Competitive Success (1986), 125-129.

[24] Y. Matsui, R. Filippinib, H. Kitanakac and O. Satod, "A Comparative Analysis of New Product Development by Italian and Japanese Manufacturing Companies: A Case Study", International Journal of Production Economics, 110 (2007), 16.

[25] See W. Tomlinson, S. Paulson, J. Arai and D. Briggs, "Company Identity, Quality Improvement and Labor-Management Relations in Danish, Italian, Japanese, Scottish and U.S. Firms", National Productivity Review 129 (Spring 1991).

[26] J. Ettlie, C. Dereher, G. Kovacs and L. Trygg, "Cross-National Comparisons of Product Development in Manufacturing", The Journal of High Technology Management Research, 4(2) (1993), 139.

[27] Id. at 150. In a similar vein, Cole noted that Japanese perceptions of relatively small quality differences were much more sensitive than in the US. For example, when studying data on, and reactions to, defects per vehicle in the US and Japanese automobile industries Cole found that Japanese technicians would be very concerned if defect measures rose from 1.0 defects per vehicle to 1.6 defects per vehicle while US technicians would consider such an increase to be, as described in Ettlie et al., "very subtle and, therefore,

was described as a "team approach to concept development" that featured influences from both marketing and technical representatives ("hints from market and technological trends") with respect to the ideas that were reviewed.[28]

Hellwig identified considerable differences between US and Japanese companies with respect to "product genesis", or the "evolution of an idea into a manufactured and marketed product".[29] In the US, for example, there was a strong tendency toward maintaining the process as strictly proprietary, an approach which also extended to applied and basic research. In contrast, Japanese product development was often done on a cooperative basis that extended through prototyping and which was open to foreign participants, an act of inclusion almost never seen in the US. Japanese companies have also been noted as keen learners of technologies originally developed elsewhere, particularly in the US. Cole observed that while US firms tended to carry out technology adoption and development in parallel to manufacturing productivity enhancement and product development Japanese firms incorporated new technology as part of their continuous improvement programs.[30] Mansfield found that the "time-to-market" for new products among Japanese firms was faster than among US firms.[31]

Fujita and Matsuo looked at utilization rates of various tools in Japan in comparison to firms in the UK and New Zealand and found that while the Japanese had a much higher rate of usage for quality function deployment and the "Taguchi method", not necessarily surprising given that those tools both originated in Japan, they lagged behind the UK and New Zealand when it came to using techniques such as design for assembly and design for manufacturing. Moving to a comparison of differences in utilization of tools and methods among industries the researchers found, for example, that companies in both the automotive and information equipment industries in Japan had a much high level of utilization than other industries, a finding that the researchers attributed to the severe competition within those predominantly global industries. They also found differences among industries with respect to which methods were more effective: product planning and conceptual design methods were more effective in the automotive, electric and electronic consumer appliances industries while companies in the machine components industry derived more value from fault tree analysis and design for assembly.

Takeuchi and Nonaka suggested that Japanese companies were able to compete effectively in commercial new product development ("NPD"), and achieve the required speed and flexibility, by substituting the traditional sequential approach to NPD with a "holistic method" that the researchers analogized to rugby (i.e., "the ball gets passed

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less important". Id. at 142 (citing R. Cole, "U.S. Quality Improvement in the Auto Industry: Close But No Cigar", California Management Review 71 (1990)).

[28] Id. at 145 and 148.

[29] H. Hellwig, "Differences in Competitive Strategies Between the United States and Japan", IEEE Transactions on Engineering Management, 39(1) (1992), 77.

[30] R. Cole, "U.S. Quality Improvement in the Auto Industry: Close But No Cigar", California Management Review 71 (1990).

[31] E. Mansfield, "The Speed and Cost of Industrial Innovation in Japan and the United States: External vs. Internal Technology", Management Science, 34 (1988), 1158.

within the team as it moves as a unit up the field").[32] Takeuchi and Nonaka highlighted six important characteristics of the holistic approach, including built-in instability, self-organizing project teams, overlapping development phases, "multi-learning," subtle control, and organizational transfer of learning. They also described the process as being based on the constant interaction a hand-picked, multidisciplinary team whose members worked together from start to finish and continuously engaged in iterative experimentation all the way to the end of the project. In contrast to the sequential model, which required that NPD proceed in defined and highly structured stages, Japanese companies allowed their engineers to begin work on designing products even though feasibility tests had not been completed and the team members were prepared to reconsider decisions made earlier in the project when later information was received. Takeuchi and Nonaka argued that by adopting the holistic method, Japanese companies reduced the time needed to develop new products, stimulated new kinds of learning and thinking within their organizations and identified and developed ideas that challenged the status quo.

Another important, and well-publicized, feature of Japanese NPD is the emphasis on relationships with suppliers. As noted by Kamath and Liker, large world-class Japanese manufacturers, such as Toyota and Nissan, were pioneers in reducing the number of suppliers and focusing on developing and nurturing long-term relationship with the members of the smaller group that included involving key suppliers in the design and development of new products while simultaneously pushing them to continuously improve their own internal business processes.[33] Kamath and Liker cautioned, however, that Japanese manufacturers did not treat all of their suppliers equally and that, in fact, only a handful of suppliers were treated as equal partners and the others were assigned more limited, albeit important, roles. Differentiation among suppliers follows from the recognition that manufacturers are simply unable to devote equal time and attention to relationships with dozens of firms, even after the number of suppliers has been reduced, and the fact that only a few suppliers are able to make the large ongoing investment in personnel, technology, prototyping facilities and research and development capabilities that are needed to qualify as key partners. Kamath and Liker also pointed out that Japanese manufacturers and their suppliers did not work together in free-flowing teams to develop new products and that the reality was that manufacturers retained tight control over their development programs and used targets and prototypes as tools for keeping their suppliers focused and directed.

§1:5 Nordic Europe

In their cross-national study of various aspects of the new product development processes used by durable goods manufacturers in five dispersed countries, including Sweden, Ettlie et al. observed that a much higher percentage of degreed design engineers in relation to degreed manufacturing engineers (90% to 10%, respectively) in the Swedish

[32] H. Takeuchi and I. Nonaka, "The New New Product Development Game", Harvard Business Review (January 1986), 137.

[33] R. Kamath and J. Liker, "A Second Look at Japanese Product Development", Harvard Business Review, 72(6) (November-December 1994), 154.

firm included in the same survey and argued that this was illustrative of how Swedish firms took a more "creative" approach to product development issues in comparison to, for example, German firms.[34]

One survey of differences across countries with respect to the influence of various stakeholders found that for companies in Denmark the strongest stakeholder influences came from customers when decisions are made about strategy and productivity improvements.[35]

Another aspect of new product development that may be influenced by societal culture is planning, which is obviously relevant when new products are being vetted, selected, developed and commercialized, and researchers have found that planning can lead to different types of successful outcomes and that variable patterns can be observed across cultures. For example, Hagerty and Hoffman found that the better planners among Nordic firms enjoyed higher sales growth.[36]

Ettlie et al. found that supplier arrangements and reorganization were the most popular methods among Swedish firms looking for sources of ideas for new products and processes and that the firms were comfortable taking on changes in a number of different areas simultaneously.[37] Ettlie and his colleagues also found that Swedish firms were comparatively eager and willing to implement a wide range of tools for improving design-manufacturing integration in the product development process, including the use of outside training and development in design-for-manufacturing techniques, the adoption of manufacturing sign-off at design review stages, the installation of new organizational structures (e.g., teams) to help with coordination, job rotation between functions and mobility between functions.[38]

§1:6 France

Mazzarol and Reboud studied and compared the innovation management practices of small firms in France and Australia and found that for companies from both countries systematic approaches to the management of innovation (i.e., formal and systematic market assessment, strategic planning, marshalling of resources and protection of intellectual property) were most likely to provide enhanced success than a more random approach, the role of the government in supporting innovation by small firms at both the

[34] J. Ettlie, C. Dereher, G. Kovacs and L. Trygg, "Cross-National Comparisons of Product Development in Manufacturing", The Journal of High Technology Management Research, 4(2) (1993), 139, 150. Ettlie et al. noted that the Swedish firm had the same ratio of design to manufacturing engineers found in the German firm in their survey; however, the ratio when presence or absence of a degree was included varied significantly as 100% of both design and manufacturing engineers in the German firm were degreed. Id.
[35] See W. Tomlinson, S. Paulson, J. Arai and D. Briggs, "Company Identity, Quality Improvement and Labor-Management Relations in Danish, Italian, Japanese, Scottish and U.S. Firms", National Productivity Review (Spring 1991), 129.
[36] W. Hagarty and R. Hoffman, "The Relationship between Strategic Planning and Performance Among Three Cultures", Proceedings, Academy of Management (1990), 106.
[37] J. Ettlie, C. Dereher, G. Kovacs and L. Trygg, "Cross-National Comparisons of Product Development in Manufacturing", The Journal of High Technology Management Research, 4(2) (1993), 139, 143-144.
[38] Id. at 150.

macro and micro levels was important, and leading customers and other strategic alliance partners (i.e., suppliers and research centers) played a central role in influencing decisions as to whether or not to proceed with investing in a particular innovation.[39] Owners of the surveyed French firms reported that it was difficult for them to access a workforce with the necessary skills and education and also had a fairly negative view of the availability of high quality managerial staff. They also complained about the high costs of doing business in France; the difficulties they had accessing venture financing and loans from commercial banks—the overwhelming majority of them admitted that retained profits were the most important source of capital to fund innovation; and the difficulties of building links with local universities and research centers.[40]

Mazzarol and Reboud found that the Australian firms in their study were significantly more likely than the French firms to seek to develop "technological product innovations", which were described as attempts to implement and commercialize a new product with improved performance characteristics that would deliver objectively new or improved services to customers, and that innovation among small French firms was more often focused on "technological process innovations" (i.e., changes in equipment, human resources and/or working methods that would lead to new or significantly improved production or delivery methods).[41] Mazzarol and Reboud commented that the differences in innovation focus between the Australian and French firms might explain why the Australian firms were more concerned than the French with customer acceptance and protection of intellectual property rights. Mazzarol and Reboud also found that the French firms appeared to be much more interested in developing innovations that were compatible with existing products or processes, a finding which contrasted sharply with the emphasis that the Australian firms placed on pursuing innovations that would hopefully lead to the creation or new standards or systems. Finally, French firms were much less likely than the Australian firms to engage customers and suppliers in the new product development process.[42]

Galvez et al. used the "potential innovation index", or "IIP", methodology proposed by Morel and Camargo to evaluate the innovation capabilities of a group of 32 "low-tech" French small- and medium-sized enterprises.[43] According to Galvez et al., IIP evaluates innovation capabilities within companies by looking at six criteria—creativity, new product development, human resources management, strategy, project management and

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[39] T. Mazzarol and S. Reboud, Innovation Management in Small Firms: A Comparison of French and Australian Companies (2007). Mazzarol and Reboud used a multiple case study methodology based on 89 cases—55 from Australia and 34 from France—and compared the characteristics of the firms and their management teams, their perceptions of the innovation climate in their host country, their approaches to strategic decision making and previous success or failure in innovation.

[40] Id. at 12-13.

[41] Id. at 18.

[42] Id. at 25.

[43] D. Galvez, M. Camargo, J. Rodriguez and L. Morel, "PII—Potential Innovation Index: A Tool to Benchmark Innovation Capabilities in International Context", Journal of Technology Management and Innovation, 8(4) (2013). 28% of the surveyed companies were engaged in the carpentry industry, while the rest were fairly evenly distribution of five activity sectors including construction, food, metallurgy, wood and others. See also L. Morel and M. Camargo, Comparison of Multicriteria Analysis Techniques to Improve the Innovation Process Measurement (2006).

knowledge management—and then classifies them into one of the following four categories intended to be descriptive of their strategic vision into its market: Proactive, Preactive, Reactive or Passive.[44] Galvez et al. found that 62.5% of the companies they studied were in the Passive, or low innovative, category, 31.25% were in the Reactive category and none of them could be classified as being Proactive. According to the researchers, Passive companies adopt a defensive attitude in dealing with their environment and are primarily focused on simply surviving, while Reactive companies react to the dynamics of their environment and await concrete demands from their markets before pursuing technological changes. As companies grew beyond 50 employees they were more likely to be Reactive as opposed to Passive. Strategy was the most important influence on the innovation capabilities of the French companies followed by creativity. Innovation practices associated with "strategy" included strategy integrated to favor innovation, network operation, client importance and financing, while the innovation practices associated with creativity included use of tools to increase creativity, integration of clients and supplier in the conception process, and organization and management of information regarding the company's external environment.

Roure studied companies in France and Germany to identify potential cultural differences in the characteristics of "product champions" in those countries.[45] Rouse found that in France, a high power distance culture, the chances for an innovation project to be successfully completely were greatly enhanced by having a product champion for that project who was close to top management of the firm and that a "top-down" championing process appeared to be favored in France.[46] In contrast, among the German companies studied the hierarchical level of the product champion appeared to have little significance with respect to whether or not an innovation project was supported by top management and "bottom-up" championing processes seemed to be just as likely as "top-down" initiatives. Roure noted that French product champions emerge out of the same elitist educational system that produces senior managers in that country and are thus more likely to have preexisting links to top management due to their similar backgrounds and educational experiences. In Germany, however, product champions climb gradually up the hierarchies of their firms, a process that provides them with better understanding of the organization and makes them more efficient in carrying out their activities in promoting new innovation projects.

Doring and Feix analyzed the potential influence of cultural determined differences on the supply chain management ("SCM") practices of French and German companies and found that the French companies were more likely than their German counterparts to have a well-defined SCM strategy and that the key success factors for the French companies in working with their suppliers included teamwork, technology and quality.[47] Doring and Feix found argued that the French appeared to be more controlling of their

[44] Galvez et al. used a typology first suggested in M. Godet, Manuel de Prospective Stratégique (1997).
[45] L. Roure, Cultural Differences in Product Champions Characteristics: A Comparison of France and Germany (1999).
[46] Id. at 16.
[47] P. Doring and M. Feix, The Impact of Culturally Determined Differences on the Supply Chain Management of French and German Companies (2004).

supply chain than the Germans and that a majority of the surveyed French companies engaged in a detailed analysis of costs, profit and return on investment. Companies in both France and Germany relied on regular information exchange and meetings with their supply partners and also engaged in joint planning. Doring and Feix found that the French companies seemed to be more interdependent and connected with their suppliers with respect to development of their own products, but less involved than the German firms with respect to the design and development of suppliers' products. As for the comparative strength of relationships with suppliers and customers, Doring and Feix commented that French companies were more customer-oriented than the Germans and survey results showed that the French companies had better relations with their customers than with their suppliers, shared more tactical company data with their customers, and preferred "customer integration" over "supplier integration". The French firms typically assigned responsibility for SCM to one of their senior managers while the German companies delegated responsibility for that activity to a specialized SCM department.

§1:7 Germany

In their cross-national study of various aspects of the new product development processes used by durable goods manufacturers in five dispersed countries, including Germany, Ettlie et al. found that integration of design and manufacturing processes proceeded relatively smoothly among the German respondents, a finding that the researchers attributed to the strong emphasis on technical training in Germany supported by the long-standing national systems of apprenticeship.[48] Ettlie et al. also noted that the parity in the percentage of degreed design and manufacturing engineers at the 100% level in the Germans firm included in their survey was illustrative of what they referred to as the "stereotypical German approach to technical problems—thorough, painstaking, and with high technical standards".[49]

Limprecht and Hayes also identified several different characteristics associated with German firms and their management and human resources practices that would likely influence the way in which they approached and conducted their new product development activities.[50] First of all, senior managers in German firms generally had strong technical backgrounds.[51] Second, the strength of apprenticeship programs in

[48] J. Ettlie, C. Dereher, G. Kovacs and L. Trygg, "Cross-National Comparisons of Product Development in Manufacturing", The Journal of High Technology Management Research, 4(2) (1993), 139, 141, 151. See also L. Lynn, "Technology and Organizations: Cross-National Analysis", in P. Goodman and L. Sproul (Eds.), Technology and Organizations (1990), 174, 189; L. Trygg, Engineering Design: Some Aspects of Product Development Efficiency (1991); and J. Lee and N. Wallbaum, "Apprenticeship Training: The U.S. versus West Germany", Operations Management Review, 8(3/4) (1991), 19.

[49] J. Ettlie, C. Dereher, G. Kovacs and L. Trygg, "Cross-National Comparisons of Product Development in Manufacturing", The Journal of High Technology Management Research, 4(2) (1993), 139, 150.

[50] J. Limprecht and R. Hayes, Germany's World-Class Manufacturers, Harvard Business Review (November/December 1982), 137.

[51] Ettlie et al. also observed that the relative abundance of technically trained managers in Germany was likely to influence the new product development process, particularly the design approach, among firms in that country. See J. Ettlie, C. Dereher, G. Kovacs and L. Trygg, "Cross-National Comparisons of Product Development in Manufacturing", The Journal of High Technology Management Research, 4(2) (1993), 139, 142. With regard to the influence of professional orientation on organizational culture and practices

Germany, and the reliance of German firms on the skills disseminated in those programs, created a workforce that was more qualified to understand and efficiently incorporate manufacturing technologies. Third, product strategies favored by German firms focused on creating well-engineered, high quality products that were delivered on time and supported by extensive and excellent service. Finally, German firms take a more long-term view of product evolution and market competitiveness and thus are willing to accept lower profit margins to secure and maintain market share and long-term stability.

As part of their study, Ettlie et al. analyzed a number of other aspects of the new product development process within the surveyed firms.[52] For example, they found that the German firm, like companies from other countries included in the survey, was continuously interested in improving the quality of their new products and reducing time-to-market and also devoted special efforts to reorganization, doing so in a relatively focused manner by concentrating on just three areas at a time. In addition, at the time of the survey in the early 1990s the German firm was preparing for a shortening of product life cycles which would be accompanied, hopefully, by a reduction in the amount of time required to complete development of new products. As to the efficiency of its product development processes, as measured by compared the ratio of product life cycle to development period, the German firm lagged far behind the US company included in the survey—a ratio of 9.33 for the US firm compared to 2.5 for its German counterpart—but was comparable to the Swedish firm in the survey and more efficient that the participants from Hungary and Japan.

Ettlie et al. also carefully studied similarities and differences among the participants in their survey group regarding concept development processes. They observed that the concept development process in the German electric motors firm could be described as follows: ". . . most ideas come from the design department, which would be expected from the culture's technical and organizational traditions. The sales department gives advice and feedback from customers, but the opinion was that these are immediate, short-term customer needs only. In order to anticipate future, long-term customer needs, more has to be done. Designers typically visit customers or interact with potential buyers at trade shows and fairs. The technical project leader provides vision and direction in this German company."[53] With respect to coordination between functions and disciplines during the product development process, Ettlie et al. found a 2:1 ratio of design to manufacturing engineers within the German firm; however, when the focus of measurement was the proportion of degreed design and manufacturing engineers, Ettlie et al. found the percentages in Germany were 100% for each category, not surprising given that almost all engineers in Germany complete formal training to earn a degree. In addition to engineers, the German firm included specialists from production planning, sales and quality.

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generally, see also J. Van Maanen and S. Barley, "Occupational Communities: Culture and Control in Organizations", in Research in Organizational Behavior (1984), 287.

[52] J. Ettlie, C. Dereher, G. Kovacs and L. Trygg, "Cross-National Comparisons of Product Development in Manufacturing", The Journal of High Technology Management Research, 4(2) (1993), 139, 144-145.

[53] Id. at 147.

In their comparative study of product development benchmarks in the German and UK food industries, Haake et al. found that the German companies they surveyed tended to take a long-term orientation with respect to strategic planning for product development that included planning horizons that were pushed out for five years.[54] The Germans also projected quite lengthy product life cycles of 70 months, which contrasted sharply with the UK companies that were studied and typically expected their new products to be on the market for only 12 months. The validity of these projections was borne out by the fact that product renewal cycles were much lengthier in Germany than in the UK (i.e., 32% of the sales of UK firms came from products launched in the previous two years while the comparable percentage for German companies was just 12%). Haake et al. observed that the German companies preferred tight, task centered organizational structures for their product development activities, tended to focus more on research than on product development and commercialization, and preferred formality over flexibility with respect to organization and execution of product development projects.

Harstatt et al. conducted a comparative study involving German and Japanese companies that focused on how they managed the early stages of new product development projects.[55] While the researchers confirmed the tendency toward formality among the German firms, they noted that the German companies that they studied were somewhat less formal in their approach than the Japanese companies they were compared to. Harstatt et al. also reported that "in German [product development] projects all relevant functions were integrated early in the process, partly already during idea generation, to ensure that all information and points of view were taken into consideration right from the start . . . [and] . . . [r]esponsibilities were assigned during the front end and rarely changed during project execution to reduce deviations and enhance efficiency."[56]

Roure studied companies in France and Germany to identify potential cultural differences in the characteristics of "product champions" in those countries.[57] Rouse found that in France, a high power distance culture, the chances for an innovation project to be successfully completely were greatly enhanced by having a product champion for that project who was close to top management of the firm and that a "top-down" championing process appeared to be favored in France.[58] In contrast, among the German companies studied the hierarchical level of the product champion appeared to have little significance with respect to whether or not an innovation project was supported by top management and "bottom-up" championing processes seemed to be just as likely as "top-down" initiatives. Roure noted that French product champions emerge out of the same elitist educational system that produces senior managers in that country and are thus more likely to have preexisting links to top management due to their similar backgrounds and educational experiences. In Germany, however, product champions climb gradually up

[54] S. Haake, C. Moore and N. Oliver, Recipes for Success—Product Development Benchmarks in the UK and German Food Industries (2000).
[55] C. Harstatt, B. Verworn and A. Nagahira, The "Fuzzy Front End" of Product Development: An Exploratory Study of German and Japanese Innovation Projects (2002), 22.
[56] Id..
[57] L. Roure, Cultural Differences in Product Champions Characteristics: A Comparison of France and Germany (1999).
[58] Id. at 16.

the hierarchies of their firms, a process that provides them with better understanding of the organization and makes them more efficient in carrying out their activities in promoting new innovation projects.

Another aspect of new product development that may be influenced by societal culture is planning, which is obviously relevant when new products are being vetted, selected, developed and commercialized, and researchers have found that planning can lead to different types of successful outcomes and that variable patterns can be observed across cultures. For example, Hagerty and Hoffman found that the better planners among German firms realized the value of planning through higher returns on assets.[59]

§1:8 Switzerland

A description of the Swiss economy published by the country's Federal Department of Foreign Affairs noted that it was not built on mass production, but on high-quality work and well-trained workers, and that many businesses have elected to pursue a "niche strategy" and focus on a small range of high quality products, a choice that has allowed even the smallest Swiss enterprises to become world leaders in their own specialized product areas. Haour also noted that Swiss small- and medium-sized enterprises ("SMEs") compete by selling high value offerings in narrow market segments, providing quality and "demonstrating a strong and *real* customer-orientation".[60] In order for them to be able to compete successfully based on quality, Swiss companies have had to be make substantial investments in R&D and, in fact, the Department of Foreign Affairs reported that a higher percentage of the Swiss workforce is involved in R&D than in other industrialized countries. Switzerland spends a significant percentage of its GNP on R&D; however, a large portion of the investment in R&D comes from the private sector and Haour observed that in Switzerland "[m]arket-oriented innovation is considered to be the realm of the private sector and the government has nothing to do with it, other than by providing a supporting environment".[61]

Haour commented that Swiss SMEs have been slower to engage with local universities than their counterparts in other European countries, such as Germany, and thus may be missing out on opportunities to access new technologies that could lead to new innovative products; however, Haour pointed out that the situation may be changing as the number of technology-based spinouts from universities has been gradually increasing in recent years.[62] In addition, the government has established technology transfer offices in the main public universities staffed with high quality specialists trained in facilitating the transfer of the results of academic research to private firms that can proceed with identifying and exploiting market-based uses of the technologies.

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[59] W. Hagarty and R. Hoffman, "The Relationship between Strategic Planning and Performance Among Three Cultures", Proceedings, Academy of Management (1990), 106.
[60] G. Haour, Innovative Switzerland.
[61] Id. Statistics provided by Haour indicated that as of the mid-2000s Switzerland was, along with the Japan, the country with the lowest percentage of its national investments in R&D financed by the public taxpayers among the OECD countries (approximately 20%, as opposed to 40% - 50% in most other countries).
[62] Id.

§1:9 Brazil

A 2012 report by the Organisation for Economic Co-operation and Development ("OECD") on science, technology and industry around the globe characterized Brazil as "an emerging economy that weathered the global financial crisis well with a continuing upward growth trajectory" and a country that "has some well-known leading innovative firms and is at the forefront in high-technology fields such as deep water oil extraction".[63] The OECD cautioned, however, that while high-quality research is undertaken by a few Brazilian universities research outputs are very low in terms of both articles published in top-quartile scientific journals and patents and trademarks issued to universities and research institutes and noted that innovation "does not spill over to the entire, diversified Brazilian economy" and that, in particular, one sees very little innovation activity among the many small- and medium-sized enterprises that operate within the Brazilian economy.[64] In spite of its recent economic growth and development Brazil continues to suffer from challenging framework conditions and social issues such as poverty, a relatively low ease of entrepreneurship index, weak international innovation-related linkages and poor quality of human capital especially in science areas.

The Brazil government has identified innovation as a focal point of the country's overall economic strategies for the coming years and has frequently floated ambitious plans for making significant changes in the legal framework. Specific objectives included in Brazil's National Strategy in Science, Technology and Innovation included closing the technological gap with developed economies; supporting Brazil's leadership in the nature-related knowledge economy (i.e., green innovation, agribusiness and other nature-resource-based activities); strengthening the international links of the country's research systems; and addressing social and regional inequalities.[65] Other efforts have focused on improving coordination and communication among key stakeholders such as federal and state agencies involved in supporting innovation, private businesses, industry and labor union representatives and universities. The OECD observed that Brazil's innovation policy has been moving from focusing mainly on the science base to stronger support for business research and development and product development through a wide range of financing programs and fiscal and tax incentives.[66] In particular, the Brazilian Innovation Law that went into effect in 2004 permitted direct funding of business through competitive grants and offered facilities and incubation services for product-based research projects. Innovation has also been encouraged through creation of venture

[63] OECD Science, Technology and Industry Outlook 2012, Science and Innovation: Brazil (2012), 252.
[64] OECD Science, Technology and Industry Outlook 2012, Science and Innovation: Brazil (2012), 252. While there may be issues with the quality of scientific research in Brazil the quantity of output is increasing according to the 2012 Thompson Reuters ranking of scientific published articles by country which placed Brazil in 13th position ahead of countries such as the Netherlands and Russia. See Brasil passa Holanda e Rússia e vira o 13º em produção de artigos científicos no mundo - UOL Educação.
[65] OECD Science, Technology and Industry Outlook 2012, Science and Innovation: Brazil (2012), 252.
[66] Id. at 254. In addition to providing support for research leading to commercially viable products funding agencies have also encouraged the development of low-cost, easy-to-use applications that address social challenges such as underwriting the search for innovations in housing technology. Id.

capital pools and reduced interest loan programs and schemes designed to enhance distribution of information support for innovation.

§1:10 China

When discussing the skills of Chinese manufacturing firms, Anjoran observed that while Chinese factories are generally quite good at reproducing a physical sample they often have difficulties in developing products or simply following a blueprint or a set of written specifications.[67] Anjoran went on to identify and describe three different types of Chinese factories in terms of how they managed design, prototyping and new product development ("NPD")[68]:

- "Only good at copying": According to Anjoran the vast majority of Chinese exporters, including both manufacturers and traders, would fall into this category and are typically only interested in being told "what to do" and either working off of samples provided by the buyer or with standardized solutions that the buyer selects from the exporter's showroom or catalog. The Chinese firms in this category will usually be able to handle small changes from the standardized product, such as customized logo/labeling/packing, but implementing substantial changes is difficult since the Chinese firms rarely provide any guidance and, if anything, slow the process by asking a lot of questions.
- "Good understanding of drawings, specs or intended function(s)": As Chinese exporters begin to add more skilled technicians to their staff they are increasing able to collaborate with foreign buyers in increasing sophisticated product development activities including participation in small focused teams that are able to drastically reduce the time needed to bring product from concept to production. Obviously this allows foreign buyers to achieve a competitive advantage by moving into the market more quickly and also facilitates reductions in cost.
- "Capable of proposing new-to-the-world features": Some very large Chinese companies have made a significant leap beyond simply serving as basic product assemblers to providing sophisticated engineering and technological development services that complement the research and development efforts of their foreign customers. Foxconn, for example, has its own extensive portfolio of patents covering technologies that facilitate dynamic execution of orders from foreign customers yet which are in areas that those customers consider to be non-strategic from their own perspective (i.e., they do not need to have a proprietary advantage in the area but do need to have partners like Foxconn that have such an advantage).

One of the most interesting and comprehensive studies of NPD in China was conducted and reported on by Ozer, who collected responses from 122 firms listed on the Hong Kong stock exchange to a questionnaire that inquired about their reason(s) for engaging

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[67] R. Anjoran, Product Development with Chinese Factories, Quantity Inspection Tips (June 24, 2010), http://www.qualityinspection.org/product-development-with-chinese-factories/.

[68] The summary of the three categories below is adapted from R. Anjoran, Product Development with Chinese Factories, Quantity Inspection Tips (June 24, 2010), http://www.qualityinspection.org/product-development-with-chinese-factories/.

in NPD, the level of top management support for NPD, the organizational structures they used to manage NPD, the range of NPD activities they engaged in and whether or not they used various NPD tools.[69] Ozer compared the results of the survey of Chinese NPD practices with practices among Western firms and found a number of interesting and important differences:

- The main goal among the Chinese firms for NPD was to increase market penetration. In contrast, Ozer had observed that successful Western firms engaged in NPD for a wider variety of reasons and typically had a broad portfolio of NPD projects with varying time horizons, target markets and resources.
- Only a quarter of the managers from the Chinese firms confirmed strong top management support for NPD efforts and activities. Among Western firms the percentage was much higher with about 80% of respondents reporting discernible commitment to NPD from the top of the organizational hierarchy.
- Only a quarter of the Chinese respondents used cross-functional NPD teams that included members drawn from different functional units. Among Western firms, however, 70% used cross-functional NPD teams, a practice that has become widely recommended as a means for ensuring that the viewpoints and skills of multiple functions are incorporated into the NPD process from the very beginning. Other organizational structures that were frequently used by the Chinese respondents for NPD included new product committees, task force venture teams and separate NPD groups and some of the Chinese firms simply assigned NPD responsibilities to traditional functional units such as research and development or marketing.
- The most critical activities for the Chinese respondents during their NPD process were business and financial analysis; product development; commercialization; customer testing and market launch planning. Ozer found that Chinese companies paid relatively little attention to various early-stage activities popular among Western firms such as pre-market volume forecasting using prototypes; detailed market study for market identification, positioning, and strategy; detailed market testing for concept development; market testing/trial selling; new product idea generation and new product concept screening.
- While Western companies have embraced a wide array of tools for use when making NPD decisions the Chinese respondents generally relied on just one or two techniques, with brainstorming and focus groups being the most popular. Less emphasis was placed on alternatives such as attitude and usage studies, concept testing, conjoint analysis, Delphi methods and in-house use testing.

Ozer suggested that there were several reasons for the observed differences between Chinese and Western companies with respect to the way in which they approached and carried out NPD. First of all, Ozer pointed out that while research on NPD and innovation has a long history in the US and other Western countries, which means that information regarding NPD practices and techniques is widely available in those

[69] The discussion of Ozer's study in this section is based on a summary that appeared as M. Ozer, New Product Development Practices of Chinese Firms (2013). The complete citation to the actual article is M. Ozer, "Strategic, Organizational, and Operational Challenges of Product Innovation in China", Research–Technology Management, 54(4) (July-August 2011), 46.

countries, formal NPD is a relatively new topic in China and access to NPD information and research in China is much more limited. Second, since the primary strategic path of an overwhelming percentage of the Chinese respondents was brand building and market expansion through exporting into Western markets Ozer suggested that it could be expected that those firms were less interested in product innovation than on simply enhancing the quality of their existing products in order to attract more Western customers and build market share and positive brand recognition. Ozer argued that "[t]heir reliance on a single function such as R&D or marketing for NPD, their emphasis on business and financial analysis as well as product development, and their use of such techniques as brainstorming and focus groups are all consistent with a brand building". Finally, Ozer speculated that the range of NPD activities used by Chinese firms, and their speed of adoption of new techniques, might be culturally influenced and noted that Chinese managers may choose to pursue a single NPD objective (and use only the NPD activities directly relevant to that objective) due to higher risk aversion than their Western counterparts and that the Chinese cultural predisposition toward harmony and conformity may cause Chinese managers to follow slowly developing industry norms rather than quickly and unilaterally adopted new NPD practices.

Ozer concluded with several recommendations to Chinese managers about changes they might consider making in their NPD practices, organizational structures and techniques. For example, while the intense interest among Chinese companies to increase market penetration in large Western markets such as the US, and introduce customers in those markets to previously unknown Chinese brands, is understandable, long-term success in those markets were ultimately depend on expanding the objectives of NPD programs and creating a formal pipeline for developing different types of new products. In order to effectively expand their NPD activities and select the right targets for creating and commercializing new products Chinese companies should consider balancing their traditional reliance on business and financial analysis with other activities that can and should provide more insight into the needs and preferences of their target markets such as new product concept screening and market testing/trial selling. Finally, certain organizational changes within Chinese companies should be considered including stronger support for NPD among top management, greater cross-functional integration (i.e., cross-functional NPD teams) and adoption of a wider range of sophisticated tools and techniques to improve product design and positioning.

§1:11 India

Since liberalization of the Indian economy in 1991, there has been increased interest in product development in a wide range of Indian companies driven, at least in part, by an awareness that India must offer more than services in order to fully participate in the global economy.[70] A variety of factors would appear to nicely position India as a country that would have a formidable competitive advantage with respect to product development: economic size and growth; a multilingual, pluralist and tolerant society;

[70] N. Forbes, "Technology and the Indian Industry: What is Liberalisation Changing?", Technovation, 19 (1999), 403-412; R. Krishnan and G. Prabhu, "Creating Successful New Products: Challenges for Indian Industry", Economic & Political Weekly, 34(31) (July 31-August 6, 1999), M114-M120.

and a heavy emphasis on education.[71] However, the development of the Indian software industry provides evidence of a reluctance to maximize potential advantages. For example, Arora has observed that Indian software companies took a very different path from their counterparts in the US and chose to focus on services rather than the development of new programs.[72] While India has clearly reaped benefits from this strategy—many companies from outside of India now outsource their entire data center operations to Indian firms resulting in larger revenues for those firms and impressive enlargement of the local labor pool—Indian software companies have gradually and consistently abandoned formerly ambitious targets for new product revenues.[73]

There are several reasons why Indian firms have limited their development of products.[74] For one thing, India has become well established as a source of software services and large firms draw away investment funds from other sectors and then serve as role model which newer, smaller firms seek to emulate.[75] Focusing on software services has enabled Indian companies to be highly profitable with relatively low risks and ensure regular immediate cash flows, in contrast to betting on product development projects that involve large initial investments and future, uncertain cash flows. The major software services firms have high valuations and generate high expectations from investors and analysts who expect these firms to "de-risk" their ventures. As a result, the software industry has been characterized by low physical capital intensity and high human capital intensity.[76] The steady supply of qualified software professionals who can generate revenue immediately through services has probably added to the inertia of success among software service firms as their business model is not seriously threatened. All of this has made services the dominant logic among Indian software firms.

In addition, software industry insiders attribute the lack of a product orientation to factors in the larger innovation system outside the software companies and argue that innovation is not a feature of Indian society. Desai believes that "innovation can flourish only in an ecosystem that has the elements of market, money, university, cluster of companies, attitudes, culture and the appropriate regulatory and legal environment",[77] while Mehta emphasizes that software product development requires "an R&D culture, market

[71] A. Chakrabarti (Ed.), The Future of Product Development in India (2007), 691.
[72] J. Dann, "Duke Prof Reveals India's Technology Management Secrets", CBS News, December 16, 2009, http://www.cbsnews.com/8301-505125_162-31041610/duke-prof-reveals-indias-technology-management-secrets/.
[73] R. Krishnan and G. Prabhu, Software Product Development in India: Lessons from Six Cases, http://www.iimb.ernet.in/~rishi/softwareproducts1Jan2003.pdf.
[74] R. Krishnan and G. Prabhu, Software Product Development in India: Lessons from Six Cases, http://www.iimb.ernet.in/~rishi/softwareproducts1Jan2003.pdf [Accessed September 15, 2012].
[75] S. Karampuri, Why No Product Companies in India, Mechanical Engineering Technology (March 3, 2007), http://www.sramanamitra.com/2007/03/03/why-no-product-companies-in-india/ [Accessed September 15, 2012].
[76] D. Mowery, "The Computer Software Industry", in D. Mowery and R. Nelson (Eds.), Sources of Industrial Leadership: Studies of Seven Industries (1999), 156.
[77] A. Desai, Presentation at the Workshop on "The Context of Innovation in India: The Case of the Information Technology Industry", New Delhi (July 24, 1998).

intelligence, skills to develop user friendly software and documentation, availability of funds and special marketing skills.[78]

Various commentators have noted that a lack of product innovation can be found across all sectors of the Indian economy, not just software, and argue that these problems can be traced to the legacy of a protected economy where innovation was unnecessary and, in fact, was often thwarted by government policy.[79] For example, government requirements regarding the content of technology licensing agreements effectively restricted the ability of Indian manufacturers to make even the most modest physical modifications or improvements and import restrictions made it difficult for Indian companies to source particular components or skills and capabilities they lacked in order to engage in product development initiatives. Other constraints to product development in India that have been identified include a scarcity of design skills and experience, lack of qualified vendors and appropriate engineering resources, lack of a strong market orientation, centralized control by business family heads, poor awareness of and regard for intellectual property rights and pressures to change on a number of fronts as the competitive environment in India has been transformed by liberalization.[80]

Krishnan and Prabhu began their discussion of the challenges associated with product development in India by noting that until 1991 the country operated as a highly protected and tightly regulated economy in which competition was restricted by a complex licensing system that generally caused management to focus on obtaining licenses and preventing others from doing rather than on developing new products.[81] Krishnan and Prabhu explained that since competition was low Indian companies did not feel any pressure to engage in product innovation and even if they did the risks associated with developing new products were simply too high given that capital in India was so scarce and difficult to obtain. They also argued, as mentioned above, that import restrictions made it difficult for Indian companies to source components and knowledge from foreign sources, each of which would presumably be important ingredients for any new product development effort. However, the liberalization that began in the early 1990s and continued steadily, albeit with some bumps, since then thrust Indian firms into a new environment of global competition that required the development of new skills to manage growth, achieve cost-competitiveness and harness knowledge and innovation in order to develop and maintain dynamic product portfolios. According to Krishnan and Prabhu, some of the unique challenges that arose in India included the following[82]:

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[78] D. Mehta, "A Time for Consolidation", Information Systems Computer World, 3(17) (1998), 44.

[79] N. Forbes, "Technology and the Indian Industry: What is Liberalisation Changing?" Technovation, 19 (1999), 403; B. Bowonder and P. K. Richardson, "Liberalisation and the Growth of Business Lead R&D: The Case of India", R&D Management, 30(4) (2000), 279.

[80] R. T. Krishnan and G.N. Prabhu, "Creating Successful New Products: Challenges for Indian Industry", Economic & Political Weekly, 34(31) (July 31-August 6, 1999), M114.

[81] Id.

[82] The discussion below, including quotes, is adapted from R. T. Krishnan and G.N. Prabhu, "Creating Successful New Products: Challenges for Indian Industry", Economic & Political Weekly, 34(31) (July 31-August 6, 1999), M114.

- Indian companies suffered from a lack of strong vendor support and the vendor relationships that did exist were generally limited to what Krishnan and Prabhu described as the "ancillary approach" under which the role of the vendor was limited to manufacturing sub-assemblies and components conforming to designs and specifications supplied by the purchaser. While good manufacturing capabilities are important, the ancillary approach failed to incorporate the interactive design and development collaboration necessary for improving the performance and reliability of products and/or lowering costs of production. As a result Indian companies were forced, according to Krishman and Prabhu, "to either develop products almost completely on their own or work with foreign design houses and suppliers", each of which had a negative impact on the cost of development and the time required to bring a new product to market.
- Access to appropriate manpower has been a significant problem with respect to new product development in India. The Indian software industry has been discussed extensively above and one of the issues for other parts of the economy has been that many of the best engineers are attracted to work for software firms that are able to offer attractive locations and compensation packages. This left non-software enterprises scrambling to compete for a limited pool of talent. Other human resources issues more directly related to new product development have included inadequate training in key skills such as design theory and practice by Indian engineering institutions and difficulties in identifying employees with both the technical and managerial skills that are needed in order for them to act as project managers for new product development projects.
- Krishnan and Prabhu noted that many Indian companies struggled to overcome "functional chimneys" that retarded the cross-functional communication and integration that is generally thought to be necessary for efficient and successful new product development. In addition, Indian firms have also often been disadvantaged by a lack of depth in the expertise of each functional area which meant that functional departments "[took] longer than they should to solve problems and that they sometimes [did] not resolve problems completely, thereby necessitating rework at a subsequent stage". Lack of functional expertise also inhibited the ability of Indian firms to absorb new technologies sourced from outside the company and Krishnan and Prabhu advised Indian companies "to consider using focused training programs to improve functional expertise".
- While the size of the domestic market in India appears to be quite large when measured in terms of raw numbers the reality is that actual market for many new products is much smaller due to limited purchasing power and high price sensitivity. Krishnan and Prabhu argued that this made investing in molds and dies a risk proposition and also inhibited Indian companies from purchasing costly computer-based design tools out of fear that they would be unable to recover the cost of such equipment. According to Krishnan and Prabhu: "There was earlier a tendency to make do with less sophisticated design and production methods with lower investments. However that is now proving to be a major stumbling block."
- Krishnan and Prabhu argued that the need to make the large investments associated with new product development required a substantial change in the mindset of top management and that top managers needed to become proactive and get heavily

involved in the planning for a new product at the early stages of development. At the same time, top management needs to be able to defer to the expertise of front-line managers who probably understand the market and the relevant technology better; however, deference of this type is new and different for both the top manager and the subordinate who are used to a hierarchical relationship based on decisions being made at the top of the pyramid. The situation is complicated further by the general lack of project management skills among Indian managers mentioned above.

- In addition to the challenges of managing individual new product development projects Indian companies have struggled with managing the entire R&D and new product development process. Krishnan and Prabhu noted Indian companies had traditionally been low investors in R&D, particularly with respect to internal R&D, but that the situation has changed as Indian companies have been forced to expand their in-house capabilities and aggressively seek, acquire and absorb new technologies from outside. In order to cope with these changes Indian companies have needed to identify and hire people who can actually manage an R&D function and help select the appropriate technologies to develop and acquire and conduct sophisticated technological forecasting. This process has proven to be difficult since persons with the necessary skills are hard to find in India. Moreover, while there has been growing recognition of the importance of R&D the reality has been that R&D has long lacked status within Indian organizations and Indian companies have been slow to grant board-level recognition to the R&D function.

§1:12 Indonesia

Larso explored the practices of new product development in Indonesia's manufacturing industry by conducting a study that focused on the type of new products developed, the processes and organization of new product development and the perceived performance of new products both internally within the organization and externally in the market.[83] The results of the study provided an indication that the level of new product introduction in Indonesia was low since Larso found that 53% of the companies reported less than four new products per year and only 21% of the companies introduced between 5-14 new products per year. The companies that Larso surveyed tended to focus their new product development on more derivative products rather than on radical changes, and the typical scenario was to make relatively minor modifications to existing products primarily in response to specific customer needs and requests. In fact, outside parties, as well as top management, were the primary drivers of new product development initiatives as opposed to forces within the organization. While 61% of the companies that Larso surveyed had some type of formal procedure for new product development in general the companies did not have separate new product development units and, in fact, 74% of the companies reported that the new product development activities are conducted by other

[83] The discussion in this paragraph of Lardo's research and conclusions regarding various new product development practices among manufacturing firms in Indonesia is adapted from D. Larso, "New Product Development Process In Indonesia's Manufacturing Industry", Journal Management Teknologi, 5(2) (2006), http://journal.sbm.itb.ac.id/index.php/mantek/article/view/57. Data was collected from various sizes of business consisting of 43% small, 36% medium and 21 % large-size businesses; and 5% of the businesses were owned by state or local government, 65% were private with full domestic ownership and 30% were private companies owned partly by foreigners. Id.

functional units such as research and development, production or marketing. In general, the budgets allocated for new product development activities as a percentage of total sales were limited; however, those new products that were launched were generally perceived internally and externally as successful. Larso argued that there was a high potential for success among Indonesian firms with respect to new product development and urged Indonesian manufacturers to create and maintain separate new product development units and pursue collaborations with external research and development institutions (i.e., universities and governmental institutions) as a means for acquiring much need knowledge regarding basic and applied research.

§1:13 Korea

Reports prepared by the Organisation for Economic Co-operation and Development ("OECD") on science, technology and industry around the globe have noted that Korean manufacturers have been making a conscious effort to increase their research and development activities since the beginning of the 1990s in an attempt to shift their production towards high-technology industries and compete based on skilled labor and capital intensive goods rather than on low-cost labor.[84] At the time this initiative was first planned government officials, scholars and business leaders in Korea focused on new materials, mechatronics (including, industrial robotics), bioengineering, microelectronics, fine chemistry and aerospace; however, manufacturers continued the work they had successfully been doing in heavy industries such as automobile and ship production. Korea's R&D intensity (R&D expenditures as a percentage of GDP) was among the highest in the world over the next 20 years and this helped the country to achieve success in internal development of new products that allowed Korean manufacturers to successfully enter high-tech markets, particularly those involving consumer products.[85] Most of the R&D, nearly 80%, was funded by the Korean business sector and while the government was not a significant provider of R&D in Korea it provided assistance through its efforts to facilitate economic recovery. Within Korea, as in many developed countries, there was considerable variation in R&D intensity among the various geographic regions around the country.

In their investigation of the differences between firms in Korea and the US with respect to the organizational characteristics of their new product development ("NPD") processes Lee et al. found that several factors were essential for successful NPD in each country including a high degree of participation in decision making, R&D-marketing integration, top management support, the skill of the project manager and his/her motivating ability, the authority given to the project manager from top management and the influence of a

[84] The discussion in this paragraph is adapted from OECD Science, Technology and Industry Scoreboard 2011: R&D Expenditure (2011) and OECD Science, Technology and Industry Scoreboard 2012: R&D Expenditure (2012).

[85] As of 2011 the OECD average for R&D intensity was 2.3%; however, Korea was well above the average at 3.2% and thus ranked fourth in the world after Israel (in excess of 4%), Finland and Sweden and before Japan, China and the US. OECD Science, Technology and Industry Scoreboard 2011: R&D Expenditure (2011).

product champion.[86] However, Lee et al. also found differences between companies from the two countries with respect to the use of venture teams, authority concentration, organizational organicity, project manager's participative style and the existence of the product champion. Another group of researchers conducted a cross-cultural NPD study comparing firms in Korea and Japan and found in both countries initiation and implementation were important determinants of the success of NPD and that performance in both countries was strengthened by customer orientation, cross-functional integration and NPD team proficiency but that there were a few differences between the two countries with respect to these factors.[87] Song et al. analyzed the role of marketing in the development of 372 new products by Korean firms and found that merely processing large quantities of market resources was not sufficient to guarantee new product success but that it was also necessary for firms to develop marketing skills and proficiently conduct marketing activities.[88]

§1:14 Mexico

While Mexico has attempted to improve the performance of its national innovation system, reports prepared by the Organisation for Economic Co-operation and Development ("OECD") indicate that significant weaknesses remain and that Mexico continues to lag significantly behind the OECD median with respect to almost all of the key performance indicators including the share of the federal science and technology budget in GDP, both public and private R&D expenditures as a proportion of GDP and scientific and innovation outcomes (as measured by number of scientific publications and triadic patents per GDP).[89] The OECD reported that R&D performed by the business sector, measured in constant prices and as a share of GDP, decreased between 2006 and 2009 (after a significant rise from 2000 through 2006) and was concentrated in large enterprises in medium-high- to low-technology manufacturing and to a lesser extent in innovative small- and medium-sized enterprises. Patent filings by universities and research institutes in Mexico have been disappointingly low and industry has failed to increase its level of investment in the activities of research institutes in spite of efforts to encourage and increase linkages between industry and the national science community.

Mexico has attempted to remove legal and regulatory barriers to the launch of innovative companies; however, these initiatives have not had the desired impact and the OECD noted that the measures implemented to target business R&D and innovation have not fully succeeded in curbing Mexican firms' preference for imported technologies over the development of domestic capacity. It should be noted though that there is some reason for optimism regarding development of innovation in Mexico particularly in the manufacturing sectors. For example, in 2013 Bloomberg Businessweek offered four

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[86] J. Lee, J. Lee and W. Souder, "Differences of Organizational Characteristics in New Product Development: Cross-Cultural Comparison of Korea and US", Technovation, 20(9) (2000), 497.

[87] S. Im, C. Nakata, H. Park and Y-W. Ha, "Determinants of Korean and Japanese New Product Performance: An Interrelational and Process View", Journal of International Marketing, 1(1) (2003), 81.

[88] X. Song, M. Montoya-Weiss and J. Schmidt, "The Role of Marketing in Developing Successful New Products in South Korea and Taiwan", Journal of International Marketing, 5(3) (1997), 47.

[89] The discussion in this paragraph is adapted from OECD Science, Technology and Industry Scoreboard 2012: Mexico (2012).

reasons why Mexico may be on the way to become a global manufacturing power: manufacturing wages, adjusted for Mexico's superior worker productivity, are likely to be significant lower than in China by 2015; Mexico has more free-trade agreements than any other country; Mexican manufacturing has a significant advantage in energy costs; and Mexico has been developing a national expertise in certain industries supported by the growing use of industry clusters in areas such as auto parts and appliances.[90]

Frias and O'Brien studied industrial design, innovation and new product development ("NPD") among a survey group of small- and medium sized Mexican manufacturing enterprises ("SMEs").[91] Among other things they found that industrial design was a relative new discipline in Mexico and that lack of knowledge, understanding and experience in this area among managers and directors Mexican companies was a major impediment to integrating industrial designers into the NPD process. With respect to the key factors driving firms in the survey to undertaken NPD activity Frias and O'Brien found that the most important seemed to be expanding existing product portfolios, responding to actions of competitors to protect market share and the need to replace obsolete or unprofitable products. Of lesser important to the respondents was research and development activity and marketing strategy and demand and, in fact, a significant number of the companies surveyed did not have a particular trigger for developing new products. Two-thirds of the respondents claimed that they had implemented some form of strategy for NPD as a means for identifying market and product opportunities; however, the impact of these strategies remains questionable given that product design lags far behind quality and price as the main bases for competition in the eyes of the managers of Mexican SMEs. Finally, the respondents identified several barriers to improving their NPD processes and activities including a lack of financial resources, particularly loans from local banks, lack of skilled managers due to poor management education in Mexico and the lack of creative staff.

§1:15 Russia

Writing in 2006 Kyrki and Kortelainen argued that "[a]s a country, Russia has a lot of potential for product development" and noted that even though Russia was generally a poor country, natural resources aside, after it emerged from the Cold War it nonetheless had a technology potential that was disproportionally well-endowed due to the large investments in innovative activities that had been made during the socialist period, particularly in an educational system strongly tilted toward natural and technical sciences, that had enabled the Soviet Union to achieve excellent achievements in several scientific areas.[92] Kyrki and Kortelainen specifically mentioned optical and mathematical

[90] P. Coy, Four Reasons Mexico Is Becoming a Global Manufacturing Power (June 27, 2013).

[91] The discussion in this paragraph is based on J. Frias-Pena and C. O'Brien, Designing Innovative Products in Mexican SMEs, http://www.ub.edu/5ead/PDF/14/Frias.pdf

[92] A. Kyrki and S. Kortelainen, The Key Success Factors in Distributed Product Development—Case Russia, Frontiers of E-Business Research 2006, http://iceb.nccu.edu.tw/proceedings/2006/defevent/papers/cr1053.pdf (citing J. Hagedoorn and J. Sedaitis, "Partnerships in Transition Economies: International Strategic Technology Alliances in Russia", Research Policy, 27(2) (1998), 177; I. Dezhina and L. Graham, "Russia Taking First Steps Toward Commercial

processing, aviation, space, atomic energy, biology, pharmacy and nanotechnology as areas where Russian firms could presumably be able to identify and develop new product ideas as the country's market-based economy evolved.[93] Unfortunately, however, the Russian innovation system has struggled since the collapse of communism for a variety of reasons. For example, investments in research and development ("R&D") activities declined significantly in Russia during the 1990s, although the level of innovative activities did begin to improve during the early 2000s.[94] In addition, while post-Cold War Russian education continued to focus on technology and science, with a high percentage of students specializing in those areas, Kyrki and Kortelainen noted that 'high intellectual potential is often combined with minor experience in business and serious lack of marketing skills".[95]

Kyrki and Kortelainen expressed particular concerns about what they characterized as "an imbalance in the innovation environment, especially relations among the main actors: R&D institutions, universities and enterprises".[96] They explained that during the Soviet period each of these actors had distinct and well-defined responsibilities: "Universities were responsible for basic education. Research and product development were mostly conducted in large research institutes in a highly centralized manner. The state provided the main share of financing."[97] Kryki and Kortelainen noted that "fundamental research and applied development were commonly conducted in isolation from each other" and that, not surprisingly, emphasis was placed on either basic research or applied research primarily for military purposes and little, if any, interest was shown in market applications of research output.[98] All of this changed, however, with the collapse of the communist regime that "scattered the pieces of the puzzle and forced the players to

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Culture for Technology", Research Technology Management, 44(2) (2001), 6; and M. Cervantes and D. Malkin, "Russia's Innovation Gap", OECD Observer, 229 (November 2001), 10).

[93] A. Kyrki and S. Kortelainen, The Key Success Factors in Distributed Product Development—Case Russia, Frontiers of E-Business Research 2006, http://iceb.nccu.edu.tw/proceedings/2006/defevent/papers/cr1053.pdf (citing H. Yashiro, "Knowledge Identification, Utilization and Transfer in Offshore R&D: The Case of Russia and Japan", Proceedings of Engineering Management Conference, IEEE International, 2 (2005), 725).

[94] Ministry of Education and Science of Russian Federation, Стратегия Российской Федерации в области развития науки и инноваций на период до 2010 г. (Strategy for development of science and innovations till 2010) (2005); and S. Boltramovich, P. Filippov and H. Hernesniemi, Innovation System and Business Environment of Northwest Russia, 953 Discussion Paper, ETLA (2004).

[95] A. Kyrki and S. Kortelainen, The Key Success Factors in Distributed Product Development—Case Russia, Frontiers of E-Business Research 2006, http://iceb.nccu.edu.tw/proceedings/2006/defevent/papers/cr1053.pdf (citing H. Yashiro, "Knowledge Identification, Utilization and Transfer in Offshore R&D: The Case of Russia and Japan", Proceedings of Engineering Management Conference, IEEE International, 2 (2005), 725; and Russoft, IT Outsourcing Destination: Russia, Whitepaper, November 2005, http://w3.russoft.ru/whitepaper/whitepaper2-rev.0.6-secured-EU.pdf).

[96] A. Kyrki and S. Kortelainen, The Key Success Factors in Distributed Product Development—Case Russia, Frontiers of E-Business Research 2006, http://iceb.nccu.edu.tw/proceedings/2006/defevent/papers/cr1053.pdf.

[97] Id.

[98] Id. (citing S. Boltramovich, P. Filippov and H. Hernesniemi, Innovation System and Business Environment of Northwest Russia, 953 Discussion Paper, ETLA, 2004).

regroup in order to find new sources of financing"[99] and also created an array of new challenges for launching an effective program of commercial-based R&D. For example, state financing for R&D activities declined substantially since the end of the Cold War, a development that created concerns about the potential adverse impact of continuing large-scale neglect of basic R&D projects. Universities and research institutes, lacking the historical guidance from the state, scrambled to figure out how to improve self-financing and shift their focus to applied research and commercialization activities.[100] Linkages between the private sector and universities performing public R&D were fragile and complicated by governmental insistence on retention of intellectual property rights associated with technology and products developed using public funds.[101]

Kyrki and Kortelainen noted that while the Soviet economy was generally dominated by a small number of large enterprises the transition to a market-based economy has been accompanied by the growing importance of small- and medium-sized enterprises ("SMEs"), including a large number of entrepreneurial firms established by former personnel of the state research laboratories.[102] Unfortunately, these companies have encountered several difficult barriers to progress including a lack of retained earnings, lack of state support in form of tax and social payment discounts, lack of subsidized credits and high interest rates of bank credits.[103] At the same time, according to Kyrki and Kortelainen, innovative Russian SMEs have "face[d] limited domestic demand because there is little interest in new technology beyond what could be used in traditional manufacturing and natural resource industries" and, since these sectors account for two-thirds of Russian industrial investment in R&D, "innovative firms in other sectors must rely on export markets to generate sufficient demand for their products".[104] Kyrki and Kortelainen also commented that large Russian companies remain reluctant to get involved with modernization of equipment or technology development and "tend to dislike long-term, science-intensive and innovative projects"; however, increased demand

[99] A. Kyrki and S. Kortelainen, The Key Success Factors in Distributed Product Development—Case Russia, Frontiers of E-Business Research 2006, http://iceb.nccu.edu.tw/proceedings/2006/defevent/papers/cr1053.pdf.
[100] Finpro, Innovation Centre in Russia, Research Report, March 2006, unpublished.
[101] A. Kyrki and S. Kortelainen, The Key Success Factors in Distributed Product Development—Case Russia, Frontiers of E-Business Research 2006, http://iceb.nccu.edu.tw/proceedings/2006/defevent/papers/cr1053.pdf (citing OECD, Seminar on Innovation Policy and the Valorisation of Science and Technology in Russia (2001); and S. Boltramovich, P. Filippov and H. Hernesniemi, Innovation System and Business Environment of Northwest Russia, 953 Discussion Paper, ETLA (2004)).
[102] A. Kyrki and S. Kortelainen, The Key Success Factors in Distributed Product Development—Case Russia, Frontiers of E-Business Research 2006, http://iceb.nccu.edu.tw/proceedings/2006/defevent/papers/cr1053.pdf (citing K. Liuhto, "Ex-Soviet Enterprises and Their Managers Facing the Challenges of the 21st Century", Lappeenranta University of Technology, Studies in Industrial Engineering and Management, 12 (2001)).
[103] A. Kyrki and S. Kortelainen, The Key Success Factors in Distributed Product Development—Case Russia, Frontiers of E-Business Research 2006, http://iceb.nccu.edu.tw/proceedings/2006/defevent/papers/cr1053.pdf (citing Finpro, Innovation Centre in Russia, Research Report, March 2006, unpublished).
[104] OECD, Seminar on Innovation Policy and the Valorisation of Science and Technology in Russia (2001).

for innovation may be expected in the future as the economy continues to grow and competition stiffens.[105]

The Russian government and business community have long been aware of the impediments to innovation and the need to take steps to remedy the problems described above. Announced governmental strategies for development of science and innovation in Russia have focused on financing new scientific development; development of infrastructure for innovation and R&D commercialization, including infrastructure in science and information business; internationalization of innovation; and implementation of effective intellectual property rights.[106] Some of the specific initiatives designed to accelerate innovative activities in Russia have included the establishment of technology parks, incubators and innovation centers.[107]

A survey of 100 large companies operating in Russia conducted in May 2010 by PricewaterhouseCoopers, the New Economic School, the Russian Venture Company and the Russian Corporation of Nanotechnologies provided evidence that the largest ones, especially those companies—both Russian and foreign—active in global markets, are the most prolific innovators in terms of launching new products and implementing new technologies and business processes.[108] While a significant amount of the innovative activity was focused on products, technologies and processes that were "new to global markets" most of the time and effort among the respondents was concentrated on innovation that was "new to the company" (i.e., implementing and adapting existing innovative products, technologies and processes as a means for rapidly improving internal efficiencies in order to become and remain more competitive). Active innovation was more likely among large private companies operating inside and outside of Russia than among companies that remained fully or partially owned by the government and the level and intensity of innovation was positively correlated to the degree of globalization (i.e., international companies operating in Russia were more active innovators than Russian companies and Russian companies engaged in global markets were more innovative than Russian companies that limited their activities to the domestic market).

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[105] A. Kyrki and S. Kortelainen, The Key Success Factors in Distributed Product Development—Case Russia, Frontiers of E-Business Research 2006, http://iceb.nccu.edu.tw/proceedings/2006/defevent/papers/cr1053.pdf (citing M. V. Šehovcev, "Венчурные фонды, крупные корпорации и малые инновационные предприятия (venture funds, large corporations and small innovative firms)" ЭКО, no. 2 58 (2006)).

[106] A. Kyrki and S. Kortelainen, The Key Success Factors in Distributed Product Development—Case Russia, Frontiers of E-Business Research 2006, http://iceb.nccu.edu.tw/proceedings/2006/defevent/papers/cr1053.pdf (citing Ministry of Education and Science of Russian Federation, Стратегия Российской Федерации в области развития науки и инноваций на период до 2010 г. (Strategy for development of science and innovations till 2010) (2005); and Finpro, Innovation Centre in Russia, Research Report, March 2006, unpublished).

[107] A. Kyrki and S. Kortelainen, The Key Success Factors in Distributed Product Development—Case Russia, Frontiers of E-Business Research 2006, http://iceb.nccu.edu.tw/proceedings/2006/defevent/papers/cr1053.pdf (citing N. Berzon, "Формирование инвестиционного климата в экономике (Formation of investment climate in economy)" Вопросы экономики (Economic questions), Issue 7 104 (2001)).

[108] The discussion in this paragraph is adapted from PricewaterhouseCoopers, Innovation by Large Companies in Russia: Mechanisms, Barriers and Perspectives (June 2010).

Most of the actively innovative companies relied on internal development, as opposed to seeking assistance from external Russian and foreign contractors, and development projects were typically funded with the company's own capital. Financing new product development initiatives, as well as bureaucratic restrictions, were the most commonly mentioned impediments to innovation and respondents commented that the state could assist innovation by making improvements to higher education, increasing state financing for R&D and providing tax incentives for innovative activities.

§1:16 South Africa

A 2007 report by the Organisation for Economic Co-operation and Development ("OECD") on science, technology and innovation policy in South Africa included an extensive analysis and discussion of the strengths, weaknesses, opportunities and threats ("SWOT") associated with South Africa's science and technology landscape and national innovation system.[109] Strengths that were noted included resource-based industries and related knowledge-based services; the existence of a knowledge infrastructure, albeit small in relation to the size of the population; a high proportion of business enterprise expenditure on research and development ("R&D")[110]; a tradition of linkages between major industries and the knowledge infrastructure; international industrial and academic networks; political awareness of the importance of science, technology and innovation for sustainable growth; and open participative governance with mechanisms in place for cross-departmental coordination. Ideally these strengths could be applied in capitalizing on various opportunities identified in the OECD Report such as raising economic performance by building on the existing innovation system strengths in industry—including large firms—and the knowledge infrastructure; capitalizing on growing investment interest in South Africa to enhance technology development, increase absorptive capacities and acquire new knowledge; exploiting the lateral talents of the majority; building on industry-research sector interactions as "focusing devices" for developing the knowledge infrastructure; revising mental models of how the innovation system operates to put producers in the center; and further modernizing the state's role in the innovation system via "agencification" and the creation of a national policy arena.

Some of the impediments to progress in the positive evolution of the South African innovation system can be gleaned from the various weaknesses and threats highlighted in the OECD Report including the poor quality schooling for many citizens and the human resources shortages at all levels in mathematics, science and technology; the lack of design, engineering, entrepreneurial and management actors and R&D capacity leading to an "engineering gap"; the ageing, white, male dominance of industrial and academic R&D; mental models of how the innovation system operates that were overly focused on the role of the state; the existence of a large "second economy" with insufficient

[109] OECD Reviews of Innovation Policy: South Africa 2007 (2007), 11.

[110] Kaplan reported that South Africa has seen a substantial rise in gross expenditure of R&D between 1993 and 2004 and that the share of business enterprises in R&D as of the mid-2000s was 56.3% of total R&D in South Africa, which represented a larger share of R&D than in most comparator countries. D. Kaplan, Science and Technology Policy in South Africa: A Critical Assessment of Past Performance and of Proposed Future Directions (2008), 3.

entrepreneurial and technological skills; inconsistencies between immigration policies and the human resource needs of the innovation system; the persistent risk of social unrest if the pace of development falters; and demographic pressures on education, research and innovation systems caused by a large increase in the cohort of people born in the 1990s.[111] In a separate article Kaplan provided evidence of other indicators of weaknesses within the South African innovation system including stagnant or declining performance with respect to scientific publications, patents (local, US and PCT); royalty receipts and payments on technology licenses; shares of global trade and the World Bank's Knowledge Economy Index that takes into account economic incentives, institutional regime, education and human resources, the innovation system and ICT.[112] Kaplan also mentioned the widespread consensus that South Africa's efforts to improve and expand innovation are severely constrained by skills shortages: the "engineering gap" referred to above that follows from large shortfalls of design, engineering and related managerial and technical capabilities.[113]

The OECD Report included a variety of policy recommendations for improving the South African innovation system--orienting away from dependence on resource-based industries to more knowledge-intensive production, reducing the gap between the formal and informal/second economy and enhancing the country's knowledge infrastructure capacity including expanding the research capacity in higher education and in the public research institutes and ensuring closer linkage between them as well as between them and the business sector; emphasized the need to stop neglecting the role that larger firms can and should play in technological development and recommended that policymakers adopt a broad approach to innovation, including non-R&D based activities that draw on creativity.[114] Kaplan noted that in addition to the OECD Report policymakers in South Africa were being encouraged to focus the country's research agenda on specific sectors such as biotechnology, space science and technology, energy, climate change and human and social dynamics.[115]

§1:17 Turkey

A report released in 2012 by the Organisation for Economic Co-operation and Development ("OECD") on science, technology and industry in Turkey noted a sharp and rapid shift in that country from an economy based on agriculture and labor intensive industries such as textiles which took advantage of low-skilled labor towards an industrial economy with specialized product development and world-class skills in sectors such as automobile production, shipbuilding and manufacturing of electronics and home

[111] OECD Reviews of Innovation Policy: South Africa 2007 (2007), 11.
[112] D. Kaplan, Science and Technology Policy in South Africa: A Critical Assessment of Past Performance and of Proposed Future Directions (2008), 6-9.
[113] Id. at 9-10.
[114] Id. at 12-14 (2008) (summarizing actual recommendations appearing at OECD Reviews of Innovation Policy: South Africa 2007 (2007), 18).
[115] D. Kaplan, Science and Technology Policy in South Africa: A Critical Assessment of Past Performance and of Proposed Future Directions (2008), 17 (citing South African Department of Science and Technology, Innovation towards a Knowledge-Based Economy: Ten-Year Plan for South Africa (2008-2018) (2007), 34).

appliances.[116] However, the OECD Report cautioned that Turkey's science and technology innovation and product development system, including the number of researchers, remained small and that research and development expenditures by the business sector as a percentage of GDP was below the OECD median and concentrated in just a few medium-high-technology manufacturing industries and knowledge services. Other issues likely to create impediments to expanding innovation in Turkey included weak links to international research networks, weak skills in information communication technologies, a small number of top performers in the sciences and few graduates at the doctoral level focusing on science or engineering, poor entrepreneurship conditions and excessive product market regulations, particularly employment protection legislation, that the OECD believed hindered competition and product development.

One recent study of Turkish product development focused on medium- and large-scale automotive companies in Gebze and found that the most common methods used by Turkish firms to accelerate their product development processes and increase their product development performance were accelerating operations, involving lead users and suppliers, using concurrent engineering, simplifying operations and eliminating delays.[117] A study conducted among 28 Turkish companies representing 74% of the total sales of the electronic industry in that country provided evidence that the profitability of new products introduced by those companies was positively influenced by selecting growing markets; having sufficient financial resources to conduct activities (e.g., laboratory tests, customer tests and trial sales) that can reduce the risk of failure in the market; proficient business, market and competitive analysis; using a "follower" strategy and launching new products with major innovations into new markets (i.e., markets that were new to the company).[118] The results of the study also indicated that profitability of new product was negatively influenced by longer development times, deviations from planned project duration and budgets and attempting to launch new products with major innovations into current markets. With respect to new product development project performance the researchers found that the most successful projects occurred when firms established a computer-based collaborative work environment, product design was proficient, adequate attention was given to development and project management training; sufficient financial resources were available; core project teams were established and overseen by an identifiable and accountable project manager and development proceeded on the basis of a clear product definition that took into account customer needs, expectations and other market inputs and included specific product functions, features and specifications.

§1:18 Vietnam

Nguyen observed the capacities of Vietnamese firms with respect to product development have traditionally been limited but that they have increasingly recognized that product

[116] The discussion in this paragraph is adapted from OECD Science, Technology and Industry Scoreboard 2012: Turkey (2012).

[117] A. Yayla and A. Yildiz, "How Product Development Accelerating Approaches Influence Product Development Performance—An Empirical Study of Turkish Automotive Sub-Industry", European Journal of Social Sciences, 18(2) (2010), 268.

[118] B. Akova, G. Ulusoy, E. Payzın and A. Kaylan, An Integrated New Product Development Model for the Turkish Electronics Industry (2001).

research and development ("R&D") is an indispensable element of effective international marketing and necessary for satisfying the requirements of international customers and differentiating their products from rivals with which they are competing in export-driven sectors.[119] According to Nguyen several factors have contribute to weaknesses in product development among Vietnamese enterprises including inadequate levels of scientific and technical knowledge and training in Vietnam and a preference for relying on low-cost labor and goods as the sources of their competitive advantage. In the future, however, it is expected that more companies in Vietnam will be begin investing in product R&D and establishing dedicated departments or centers for R&D on products that will allow them to move up the product chain by creating and marketing products with more distinguishing features, better quality, higher prices and larger margins.

Tran et al. commented on indicators of innovativeness among small- and medium-sized enterprises ("SMEs") in Vietnam and noted characterized the overall situation as being "basically at the first stage" with facilities for knowledge-intensive activities such as research and development ("R&D") remaining very limited in Vietnam.[120] In fact, as of the mid-2000s the percentage of revenues allocated to research and development by state-owned enterprises in Vietnam was just 0.25%, much less than the 5%-10% seen in developed countries, and private sector investment in R&D was virtually non-existent. Tran et al. offered several reasons for the lack of technology-creating capabilities in the Vietnamese private sector including poor, largely theoretical training, in the university curriculum; inadequate attention to formal training of human resources among private firms and poor vocational training overall; weak linkages among Vietnamese research institutions, universities, and enterprises; and inadequate availability of technology that has contributed to low absorptive capacity. Tran et al. noted, however, the Vietnamese firms have been able to gradually update their equipment and technology. In addition, Tran et al. reported that during the three years leading up to the release of their report a little over 40% of Vietnamese SMEs had introduced some new products, although only 30% of those firms were able to introduce a new technology in their processes. The main reasons for introducing new products were to satisfy the requirements of customers and address competition from domestic competitors and adoption of new technologies was generally triggered by the need to upgrade to face competition and buyer's requirements. According to Tran et al. various measures have been implemented to assist Vietnamese SMEs including eased restrictions on technology transfer and financial and other support for technology-related R&D and training to improve human capital.

In addition to the general advice regarding encouragement of innovation in Vietnam, researchers have focused on specific technologies and industries such as software. One researcher argued that the Vietnamese government should provide support for good vocational training for IT professionals, including advanced specialized training and re-

[119] The discussion in this paragraph is adapted from H. Nguyen, "International Marketing Capacities and Export Performance: An Empirical Study of Indochinese Exporting Enterprises", International Journal of Marketing Studies, 4-4 (2012), 51.

[120] The discussion in this paragraph is adapted from T. Tran, X. Le and K. Nguyen, "Vietnam's Small and Medium Sized Enterprises Development: Characteristics, Constraints and Policy Recommendations", in H. Lim (Ed.), SME in Asia and Globalization, ERIA Research Project Report (2007), 323, 339-340.

training for programmers and systems analysts; increase investment in IT faculty at Vietnamese universities; encourage and support relations with foreign enterprises to transfer their knowledge and experience to Vietnamese entrepreneurs; and provide training in project management in order to increase the country's capacity to successfully executive new software product development projects.[121] Government action is also required to improve and modernize the relevant legal environment for software development activities including copyright protections, enforcement of laws prohibiting piracy and a recognized system for measuring and controlling software quality. Finally, the government has a role to playing in building the necessary telecommunication technology infrastructure required by the software industry and in providing opportunities for local software developers to test their products and demonstrate their quality so that potential domestic and international customers will have greater comfort in considering Vietnamese software products. At the enterprise level, Vietnamese software companies were urged to focus on improving both product quality and the quantity and quality of human capital focusing on product development, marketing and after-sales supports. It was also suggested that due to the small scale of the Vietnamese software industry consideration should be given to cooperative arrangements among multiple enterprises to share and use information and knowledge regarding technology and markets more efficiently and launch joint promotion activities to showcase Vietnamese software expertise to domestic and international customers.

[121] *The discussion in this paragraph is adapted from Rights, Prospects and Recommendations to Develop Vietnam Software Industry, http://hoanamy.bizhat.com/thesis/sw_part3.htm.*