Contesting Functional Specialization: The Case of Ambidextrous Manufacturing

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ABSTRACT

In seeking higher performance, organizations differentiate themselves internally in an attempt to economize on bounded rationality. I argue that for this same reason—bounded rationality—maximal functional specialization is not optimal organizational design from the point of view of exploration. I examine this argument by testing the hypothesis that functional overlap and organizational integration in complement lead to higher operational performance in a sample of 238 manufacturing organizations in eight countries. The empirical results suggest that functional overlap coupled with successful organizational integration has implications to multiple dimensions of performance and indeed promotes both exploration and exploitation capabilities. •

• Acknowledgments to be added.

INTRODUCTION

Choosing the appropriate organizational structure under uncertainty is one of the most established (Burns and Stalker, 1961) yet enduring (e.g., Galbraith, 2002) questions in organizational design. To be sure, we have compelling empirical evidence, dating back over 200 years, on how to organize under certainty: productivity-related benefits of specialization are both well-documented and substantial (Smith, 1991, 1776 original). Managers of Adam Smith's pin factory, however, did not have to worry about bounds on rationality, uncertainty, innovation and strategic renewal. In this paper, I ask: to what extent is it effective organizational design to dedicate organizational sub-units to focus on exploration? My argument is that in contrast with exploitation benefits, there are limits to the benefits of functional specialization when viewed from the point of view of exploration and innovation. I further argue that even from the point of view of efficiency, these limits appear as well as soon as uncertainty and bounded rationality are incorporated into the theoretical argument. The implications to organizational design, in terms of both internal differentiation and organizational integration, are profound. While the limits of specialization argument itself is not theoretically novel (e.g., Simon, 1991; Tyre and Hauptman, 1992; Rivkin and Siggelkow, 2003), in this paper I offer theoretical elaboration and more importantly, systematic empirical evidence to support the hitherto theoretical and simulation- or case-based arguments.

March (1991, p. 71) argued that "[a] central concern of studies of adaptive processes is the relation between the exploration of new possibilities and the exploitation of old certainties." In his treatment, March focused on organizational routines, learning, practices and procedures associated with exploration and exploitation (see also Cohen and Levinthal, 1990; Cohen, 1991). There are volumes of research addressing the strategic and competitive implications of organizational exploration and innovation (e.g., Abernathy and Clark, 1985; Christensen, 1997; Burgelman, Christensen, and Wheelwright, 2003; Miles and Snow, 2003). In contrast, the purpose of this paper is to elaborate the organizational arrangement within which exploration and exploitation occur. In this regard, this paper builds on the classical work on structural contingency theory (Burns and Stalker, 1961; Lawrence and Lorsch, 1967) as well as recent work on exploration, exploitation and organizational design (Rivkin and Siggelkow, 2003; Siggelkow and Rivkin, 2005), which has provided us with important theoretical advancements.

Debate on the Benefits of Functional Differentiation

There are many conventional wisdoms held about organizational designs that seem valid on their face but do not enjoy adequate empirical support. The benefits of functional differentiation is a case in point. Functional division of tasks is a well-established principle in organizational design (Lawrence and Lorsch, 1967; Daft, 2004), which clearly manifests itself in the contemporary business environment as well: even though contemporary organizations are not purely functional organizations, one of the key dimensions of internal differentiation in multidimensional matrix organizations is based on business function (e.g., Galbraith, 2002; Daft, 2004; Galbraith, 2005). Whether or not this leads to higher performance is still an empirically open question: just because functional differentiation is prevalent does not imply its superiority in terms of performance (Meyer and Rowan, 1977). Lawrence and Lorsch's (1967) did argue that high performance arises from a high, indeed maximal degree of functional differentiation coupled with the use of proper integrative mechanisms such as horizontal structures and the use of liaison officers. Lawrence and Lorsch's logic was based on the structural fit hypothesis: each functional sub-organizational unit should adapt to its respective idiosyncratic sub-environment. Their empirical evidence was, however, limited to a small sample.

Functional differentiation as a facilitator of organizational innovation has theoretically been approached from the knowledge point of view: "In complex organizations, coalitions of specialists in differentiated subunits increase the depth of the knowledge base which, in turn, increases the development of new ideas (Aiken and Hage, 1970)" (Damanpour, 1996: 695). Using the very same premises—in-depth knowledge and skill development—, however, Daft (2004: 97) argued that while functional differentiation enables the achievement of functional goals, it may indeed result in less, not more, innovation. Empirical research has not settled the issue: evidence regarding the correlation between functional differentiation and innovation is decidedly mixed (Damanpour, 1991; 1996). One reason could be incommensurability of competing theoretical arguments and use of dissimilar definitions of innovation, however, lack of empirical reliability and validity of measurement is also a concern. Specifically, the empirical measures used to operationalize structural complexity and innovation have been rather crude in the sense that functional differentiation measured as the "total number of units below the chief executive level" (Damanpour, 1996: 701) may not capture the most important aspects of functional differentiation. We need more direct measures of structural complexity and in particular, functional differentiation.

Many theorists tend to assume that organizations know a priori precisely what the demands of the task environment are: Damanpour's argument for functional differentiation builds implicitly on the assumption that the requisite knowledge base can be ex ante specified. Consequently, the task of the organization is to deepen and exploit this knowledge base by the group of specialists belonging to the specific function. Other theorists, in turn, reject the assumption that the requisite knowledge base to meet the demands of the task environment can a priori be known; design scientists in particular have proposed that many problem situations are ill-defined with respect both to means and ends (Simon, 1973; 1996). Burns and Stalker (1961: 91) linked this to organizational design by writing about the “consistent blurring of the definition given to individual positions, [where] the limits of one’s responsibility and authority aren’t defined” (see also Simon, 1991). This argument can also be applied at the level of organizational subunits and development projects: they do not necessarily map onto the existing organizational structure and existing knowledge bases. Leonard-Barton (1992: 119) described the development of the RISC/UNIX workstation at Hewlett-Packard: “[T]he new software base posed an extreme challenge to manufacturing because hundreds of diagnostic and test systems in the factory were based on the corporate proprietary software.” This is an example of the limits of rationality and its relationship with internal differentiation: the problem at HP did not seem to be that the knowledge base was not deep enough, rather, the knowledge base seemed to lack interfunctional breadth. Functionally based “departmental thought worlds” may not provide the necessary cognitive and informational context for innovation to be successful (Dougherty, 1992).

Horizontal Organization and the Integration Challenge

Management of inter-functional relationships has typically been viewed as an integration challenge (Lawrence and Lorsch, 1967; Pinto, Pinto, and Prescott, 1993). Indeed, the concept “interdepartmental relations” (McCann and Galbraith, 1981) connotes well-defined functional sub-units with respect to not only the formal structure but also partitioning of the organizational task. Subunit tasks are equated with functional tasks where task partitioning is taken as given and consequently, the focus in theorizing and empirical research has been on various integrative mechanisms, lateral processes, and the horizontal organization (Lawrence and Lorsch, 1967; Van de Ven, Delbecq, and Koenig, 1976; Galbraith, 1994). While the importance of integration research and organizational integration in general cannot be overstated, focusing on integration tends to overlook the differentiation side of the issue, both in terms of the organizational challenge but also the opportunities it presents. At the same time, if functional boundaries are indeed blurred, functional tasks overlap and organizational charts progressively less meaningful, to what extent can we take task partitioning based on function as a given? In this paper, I will argue that in trying to understand innovation and exploration in the contemporary manufacturing environment, both differentiation and integration must jointly be studied: we must understand integration partly as a function of internal differentiation, indeed, understanding differentiation is logical prerequisite to understanding the integration challenge (Lawrence and Lorsch, 1967).

Focusing on Exploration and the Manufacturing (Operations) Function

From the point of view of functional differentiation, it makes intuitive sense to think of the operations function as being responsible for running current operations such as daily production, and marketing and sales as being responsible for their respective tasks. But to what extent is it true that organizational exploration is the task of a separate research and development function? Do new ideas always emerge within a pre-defined organizational sub-unit? Can the relevant knowledge base for exploration be a priori specified, which sounds like a logical prerequisite? Do we have empirical evidence supporting this? There are authors who argue that exploration and exploitation must indeed be separated organizationally and that the managerial challenge is to integrate exploration and exploitation at the senior executive level (O'Reilly and Tushman, 2004: 76-77). This sounds like an appealing argument, but there is a potential counter-proposition, which operates as the main premise in this paper. As a corollary of bounded rationality, “cognitive limitations prohibit individuals from possessing identical stocks of knowledge” (Conner and Prahalad, 1996: 478). Under this premise, anticipating which specific stocks of knowledge will be relevant for exploration and identifying where in the organization they reside may be an impossible task. Further, the argument that emerging ideas, once identified, can be transferred and isolated into the organizationally separate development unit for further refinement can also be challenged by bounded rationality: extracting the idea from the knowledge environment in which it was created may be not only expensive (Teece, 1977) but indeed destructive (Pisano, 1994); knowledge is “sticky” (von Hippel, 1994; Szulanski, 1996; 2000). The reason may also be technological: the refinement of innovations may require a manufacturing environment, resulting in a necessary co-location of R&D and manufacturing (Howells, 1995; Rafii, 1995). All this points to an organizational and knowledge management task that extends far beyond an integration challenge at the level of senior management.

The notion that the R&D function is the only source of new ideas has been squarely rejected in empirical research. Florida (1997), for instance, discovered in a study of 186 organizations that customers, consultants, suppliers, and other organizations external to the firm were important sources of innovation (see also Powell, Koput, and Smith-Doerr, 1996). Particularly relevant in Florida’s work with regard to my argument was the observation that individual manufacturing plants were also seen as important sources of new projects: in the automobile industry, manufacturing plants were a “very important source of new project ideas” for 38 percent of the organizations sampled (Florida, 1997: 97). New ideas emerge in multiple functions of the organization, and the challenge of managing these emergent processes does indeed not sound like just an integration challenge at the senior executive level, rather, it must be understood as a broader organizational challenge.

Implications of bounded rationality raise the question: What is the proper division of exploration tasks within the organization? This is of course a very broad question, and the approach in this paper is empirically to examine a narrowly defined special case of exploration: the role of the manufacturing function in the development of new products. The primary premise in this paper is that while the manufacturing function has traditionally had an exploitation role (e.g., Lawrence and Lorsch, 1967), managers in particular have long since become increasingly conscious of manufacturing’s exploration potential and manufacturing has become functionally ambidextrous. In addition to Florida’s research results, the crucial role of the manufacturing function in such micro-level exploration endeavors as new product development projects has been identified (Clark and Wheelwright, 1993). Conceptually and theoretically this idea is not new (e.g., Skinner, 1985; Nemetz and Fry, 1988), however, systematic empirical evidence is scarce (see also Adler, 1995). This paper provides such systematic evidence by examining internal differentiation, integration and performance using refined and more direct measures of the theoretical constructs.

AMBIDEXTROUS MANUFACTURING

In developing the argument for the performance benefits of ambidextrous manufacturing, a key definitional challenge is the demarcation between exploration and exploitation, incremental versus radical innovation or any similar dichotomy (O'Reilly and Tushman, 2004). In this paper, I try to avoid arbitrary demarcation criteria by talking about different kinds of operational performance relevant in manufacturing organizations; this way, I do not have to resort to arbitrary definitions of demarcation and consequently, somewhat arbitrary operationalizations of exploration and exploitation. Following Adler, Goldoftas and Levine (1999), I define efficiency and flexibility as the two main tasks of the manufacturing organization. Efficiency means productivity, cost efficiency, inventory turnover, cycle time, and other similar measures of internal efficiency. Flexibility in turn is defined as the ability to respond effectively to discontinuities such as production ramp-ups and ramp-downs when new products are introduced to manufacturing. Operations management researchers have found efficiency and flexibility to be not contradictory or mutually exclusive, but clearly separate dimensions, both theoretically and empirically (Ward et al., 1998; Flynn, Schroeder, and Flynn, 1999). An ambidextrous manufacturing organization tries to excel in both. The Toyota-GM joint venture, the NUMMI auto assembly plant, in Fremont, California, is the paradigmatic example (Adler, Goldoftas, and Levine, 1999). NUMMI not only tried but indeed excelled in both productivity as well as model changeover flexibility.

Ambidexterity as Functional Overlap, Functional Integration as the Complement

I define ambidexterity as a specific organization design which emphasizes functional overlap in task partitioning. Ambidexterity is thus a characteristic of the organization's internal differentiation. In contrast with Adler et al. (1999) who examined the role of organizational and operational routines as the foundational content of ambidexterity at NUMMI, my focus is on organizational design, although the view in this paper is not mutually exclusive with routines, it merely directs our attention to organizational differentiation and integration (e.g., Dougherty and Hardy, 1996; Rivkin and Siggelkow, 2003).

The manufacturing function is defined as functionally ambidextrous when it has an important role both in the daily production activities as well as new product development. Because the manufacturing function is, by definition, involved in daily production activities, the measure of ambidexterity becomes simply the extent to which the manufacturing function is involved in activities new product development. The concept is similar to Tyre and Hauptmann's (1992: 309) concept of functional overlap, which is relevant not only for this study but also more generally, because it has recently been used to challenge some of the received wisdoms in organization design. Specifically, Rivkin and Siggelkow (2003) have challenged task division that minimizes the interdependence between organizational sub-units (e.g., Galbraith, 1977; Mintzberg, 1983). Rivkin and Siggelkow argued that functional overlap enhances the balancing of search and stability in that it "can induce subordinates to make creative proposals that pry firms off of low sticking points" (Rivkin and Siggelkow, 2003: 307). This is close to my reasoning: involving manufacturing experts in the new product development projects can lead to creative proposals regarding new product designs, both in terms of functionality as well as manufacturability (e.g., Adler, 1995; Hayes et al., 2005). This is essential because of bounded rationality and idiosyncratic stocks of knowledge: manufacturing people may have valuable knowledge about new product development that the R&D department does not, and that may have an impact on efficiency and flexibility performance. Expertise regarding mechanical engineering aspects of the new products or various "producibility rules" (Adler, 1995: 148) are good examples of such expertise (see also Simon, 1991; Sutton and Hargadon, 1996). Finally, functional ambidexterity enhances the absorptive capacity (Cohen and Levinthal, 1990) of the organization: the enhanced ability to combine ideas facilitates not only knowledge accumulation within the organization but also exploitation of external knowledge.

It is important to note that from an organization design point of view—and in accordance with structural contingency theory—, while ambidexterity is defined strictly in terms of functional overlap, the performance benefits of functional ambidexterity require also successful organizational integration. Both task partitioning and integration must be considered when the performance effects of ambidexterity are examined. Functional ambidexterity is not the same as cross-functional cooperation, which is traditionally viewed as an integrative mechanism (Lawrence and Lorsch, 1967). Instead, functional ambidexterity is a new way of looking task partitioning (cf. von Hippel, 1990; Hoopes and Postrel, 1999; Dougherty, 2001). Producibility rules, for instance, are not necessarily explicitly codifiable and transferable from the manufacturing department to R&D, hence, the challenge is not one of information flow and communication. Instead, applying producibility rules may involve high team interdependence (term used by Van de Ven, Delbecq, and Koenig, 1976), which requires refinement of the rules in the same knowledge context in which they were created; some of this “sticky” expertise may never be transferable to a part of the organization that does not host manufacturing expertise.

As functional overlap increases, the organization becomes internally less goal-differentiated in Lawrence and Lorsch’s (1967: 8) terminology. This is because when internal division of tasks shifts toward ambidexterity, the manufacturing function’s goals begin partly to overlap with the goals of the R&D function, thus lowering the degree of functional differentiation. A lower degree of goal differentiation can in turn facilitate organizational integration due to “greater trans-specialist understanding” (Postrel, 2002: 317); integration in highly differentiated organizations tends to be more difficult (Lawrence and Lorsch, 1967), and ambidexterity facilitates the challenge by reducing the degree of differentiation.

The arguments presented above are important, because they explicitly position conventional theories as the counter-hypothesis: a functionally ambidextrous manufacturing function is less differentiated and specialized and, by the classical contingency-theoretic hypothesis (Lawrence and Lorsch, 1967), less efficient than a manufacturing function that specializes exclusively on manufacturing. I argue in contrast, however, that functional ambidexterity in manufacturing—while admittedly compromising some benefits due to specialization—can have beneficial effects on efficiency, especially in the long run. Whitney (1988) in particular hypothesized that smart product design can lead to significant efficiency improvements in production (see also Leonard-Barton et al., 1994; Ulrich, 1995). To be sure, productivity and efficiency benefits in manufacturing are not limited to economies of scale and specialization, in uncertain and rapidly changing environments in particular. Echoing Whitney's (1988) ideas, I hypothesize that the adverse consequences of sub-optimal product design outweigh the benefits that added functional specialization can offer. This is why the manufacturing function is often involved, in one way or another, in new product development projects in a wide array of industries (e.g., Clark and Wheelwright, 1993).

Why Are Efficiency and Flexibility not Mutually Exclusive?

Conventional wisdom has it that the two tasks—efficiency and flexibility, as defined above—are mutually exclusive: organizing for change is different from organizing for stability (Burns and Stalker, 1961). This argument has explicitly been presented in the context of manufacturing as "the productivity dilemma" and "the uneasy alliance" (Abernathy, 1978; Clark, Hayes, and Lorenz, 1985). Many of these arguments are, however, based on marginal analysis: "adding new products or changing the specifications of an existing product through an engineering change order… disrupt the stability of the factory's operation… and have a negative impact on… labor productivity" (Hayes and Clark, 1985: 178). These arguments are difficult to refute, because they are true by definition: disruptions, by definition, lower productivity.

Both the significance and the relevance of marginal analysis have been, however, brought to question. Brush and Karnani (1996) found that benefits due to economies of scale and specialization may not be as significant as they once were. More importantly however, recent theoretical and empirical examinations have challenged not the logic but the very relevance of marginal analysis, directing research attention instead towards the more general and long-term view of balancing between flexibility and efficiency, exploration and exploitation, or search and stability (e.g., Ghemawat and Costa, 1993; Adler, Goldoftas, and Levine, 1999; Rivkin and Siggelkow, 2003; Siggelkow and Rivkin, 2005). The arguments at these levels have a different logic: flexibility and efficiency are not necessarily mutually exclusive, once we shift our attention away from the tactical micro-level to the more strategic long-term aspects of the phenomenon (McKersie, 1985). Further, Adler et al. (1999) showed that if we want to understand the correlation between flexibility and efficiency, we need to understand the drivers of these performance dimensions. I embrace this view in this paper by hypothesizing that ambidextrous organizational designs can lead to both efficiency and flexibility benefits. As far as the bias for marginal analysis is concerned, I rely in my thesis on Williamson's (1994: 85) premise: while there is a time and a place for economizing at the margin, "second-order (marginalist) refinements" may direct our attention away from the issues that really make a difference in terms of performance. In my argument, the issue that is hypothesized to make a difference is—much like in Williamson's argument—the organizational arrangement within which economic action takes place.

Based on the discussion above, I submit the following manufacturing ambidexterity proposition for empirical analysis:

> **Proposition:** Ambidexterity of the manufacturing function combined with successful inter-functional integration at the organizational level leads to ambidextrous operational performance in terms of efficiency, flexibility, and customer satisfaction.

In addition to efficiency and flexibility, the manufacturing function also has to focus on customer satisfaction: exploration is at least in some part an effort to solve customers' problems (e.g., Dougherty, 2001). Customer satisfaction is of course partly a function of efficiency and flexibility, but is obviously also affected by other factors. Incorporating customer satisfaction is important, because both efficiency and flexibility tend to be biased toward internal performance metrics which are not necessarily visible to the market. Because I want to embrace an explicit open systems view (e.g., Thompson, 1967; Scott, 2003) in this paper, I incorporate the customer satisfaction measure as another performance criterion variable. By customer, I mean the immediate customer of the manufacturing organization, which may or may not be the end user.

The proposition is a complementarity argument. I hypothesize an interaction effect between functional ambidexterity and organizational integration. I use the term complementarity in accord with Milgrom and Roberts (1990): the performance effect of functional overlap is higher when the organization is functionally well-integrated. Trying to solve the various engineering problems associated with new product development in the absence of functional integration—under conditions of sub-goal pursuit and local optimization—will likely fail, no matter how smart the task partitioning. This is because a new product development team consisting of representatives of various business functions, each focusing on their own functional interests and sub-goals instead of broader organizational interests, will be subject to political turf battles and local optimization (Dess, 1987). Consequently, the engineering problem will likely not be solved, and even if it is, in the absence of organizational integration the project may not lead to results that are beneficial for the organization as a whole. Instead, in the absence of organizational integration, projects themselves may become the focus of local optimization, where development teams "build local skill but don't tie it to [the] larger system" (Clark and Wheelwright, 1993: 814). In contrast, solving the engineering problem will be facilitated and made organizationally valuable if organizational integration has taken place, sub-goal pursuit has been eliminated, and functional management is cognitively geared toward tackling the overall organizational goal (Wheelwright and Clark, 1992: 185). This does not mean that functional goals in such organizations have been eliminated altogether: the organization is still—in an attempt to benefit from the economies of specialization—functionally differentiated. But the organization is also integrated in the sense that individual functions do not emphasize their own functional sub-goals at the expense of overall organizational priorities (Lawrence and Lorsch, 1967; March and Simon, 1993). When a differentiated organization is integrated, organizational members understand that the local goals and priorities of the organizational sub-units are only means to an end, that is, "shorter-term, more local actions to obtain [the global objectives]" (Hrebiniak and Joyce, 1984: 28).

EMPIRICAL ANALYSIS

The empirical data come from the third round of the High Performance Manufacturing project (see Schroeder and Flynn, 2001, for detailed project description), an international manufacturing survey of mid-sized and large manufacturing organizations in the electronics, machinery and transportation industries. The data were collected in collaboration with several dozen academic researchers around the globe. The third round of data were collected in 2003-2005 in 238 manufacturing organizations in eight countries: Austria, Finland, Germany, Italy, Japan, South Korea, Sweden, and the United States. Data were collected from each organization from 12-24 informants (a grand total of 4268 informants), ranging from the plant manager and SBU-level informants to shop-floor supervisors, team leaders and direct labor employees. Multi-informant research design was used to ensure that the proper expert within the organization was the source of the data. For the majority of the psychometrically scaled data, multiple informants within the organization provided the same data, thus avoiding common methods bias due to informant effects. The research instrument is well-documented in the literature and has been the source of several hundred research articles over the past 12 years (Flynn, Schroeder, and Sakakibara, 1994; Schroeder and Flynn, 2001).

Companies in the pre-specified sampling frame were contacted by telephone and asked to participate. The response rate ranged between 40 and 80 percent from country to country, averaging at around 65 percent. The high response rate was in part achieved by promising each organization an organizational profile, in which the focal organization was compared to the rest of the sample, giving managers an idea of how they stand with respect to their industry and competition in terms of strategy, technology, manufacturing practices, and performance. Because the data were collected at the level of an individual manufacturing organization—not the business unit or the corporation—, full-fledged analysis of potential non-respondent bias is impossible to do; the necessary data for meaningful analyses of non-respondent bias are simply not available. This is why achieving the high response rate was particularly crucial. In terms of demographic variables such as size, the sample is, however, unbiased.

Insert Table 1 about here

The Empirical Context

The data were collected in three different industries: electronics, machinery, and transportation components; the third industry consists primarily of parts and components suppliers in the automotive industry. These are industries where manufacturing has been identified as an important source of innovation. Florida (1997) observed in his sample of 186 industrial firms that in the automotive industry almost 40 percent of the firms considered manufacturing to be a "very significant source of innovation." In the electronics industry, the corresponding percentage was 15 percent. While there are other important sources of innovation—some of which are undoubtedly more important than manufacturing—, the innovation potential of manufacturing in the industries studied is significant to be considered in empirical analyses. Indeed, if one visits contemporary manufacturing plants in these industries, one quickly realizes that they are not as much "factories" as they are "complex technology centers" with scores of resident engineers, product developers, technology professionals, and the like, and where functional boundaries are blurred. That is why studying ambidexterity in the context of these industries is particularly interesting. At the same time, the results of this study should not empirically be generalized to other industries, which is why industries are treated as fixed factors in my models: empirical generalization beyond the three industries is not warranted.

The countries were chosen based on availability of research colleagues to collect the data, and the data were collected in the native language of the informants. Questionnaires were translated from English to other languages, and then independently back-translated to ensure consistency (Behling and Law, 2000). Because countries, just like industries, were not randomly picked, it is appropriate to treat them as fixed factors in statistical models. Whether generalizing beyond the sample countries is warranted or not is, however, of minor importance, primarily because for the purposes of this study, the country of origin is merely a control variable. Of course, what is important is that the sample contains North American, European and Asian countries, and in particular countries that are major economic players in their respective continents.

Insert Table 2 about here

Operationalization

Efficiency, Flexibility, and Customer Satisfaction. The general manager of the manufacturing organization was asked to evaluate the operational performance of the manufacturing organization with respect to competition in eight dimensions: manufacturing unit costs, inventory turnover, production cycle times, speed of new production ramp-ups, on-time new product launches in manufacturing, product innovativeness and changeover flexibility (the flexibility to change production over from one product to another). These variables were operationalized using 1-5 scales (1=poor, low end of the industry, …, 5=superior). I do recognize that these are perceptual measures of performance, however, their reliability and validity has been examined with multitrait-multimethod analysis (Campbell and Fiske, 1959; Bollen and Paxton, 1998) in earlier empirical work, and deemed in these analyses adequately valid and reliable (see Ketokivi and Schroeder, 2004, for details).

Collecting customer satisfaction data directly from the customers was infeasible, but multi-informant data on the perceptions of customer satisfaction were collected at each organization, operationalized as a four-item seven-point Likert scale (1= strongly disagree, …, 7=strongly agree):

1. Our customers are pleased with the products and services we provide for them
2. Our customers seem happy with our responsiveness to their problems
3. Customer standards are always met by our organization
4. Customers have been well satisfied with the quality of our products over the past three years

Three informants per organization provided data on these variables: the plant superintendent (a business-unit –level manager overseeing the manufacturing operations), plant quality manager, and shop-floor – level informant.

In order to examine validity and reliability of the performance measures, confirmatory factor analysis (CFA) using structural equation modeling (SEM) was conducted (see Figure 1). From the results we can conclude that reliability, measurement unidimensionality, as well as convergent and discriminant validity of the measures are adequate:

1. Reliability is established by calculating composite reliabilities.
2. Unidimensionality is established by the good fit of the classical-test-theory -based CFA model (where unique variances of all the indicators are independent of one another).
3. Convergent validity is established by the fairly high factor loadings in the CFA model (average loading is 0.73; all loadings are statistically significant at $p<0.001$).

4. Discriminant validity is established by a chi-square-difference test, where one inter-construct correlation at a time is fixed at unity (all tests yielded highly significant changes in the chi square statistic, indicating discriminant validity, see Bagozzi, 1980).

Insert Figure 1 about here

Functional Ambidexterity and Organizational Integration. Functional ambidexterity was operationalized using a three-item seven-point Likert scale:

1. Manufacturing is involved at the early stages of new product development
2. The manufacturing function is key in improving new product concepts
3. Manufacturing is given challenging tasks in the development of new product concepts

It should be noted here that, consistent with my theoretical argument, these items do not address cross-functional cooperation (integration), they measure the extent to which it is the task of the manufacturing function to engage in new product development (task partitioning and differentiation). Further, these items are agnostic to performance. In sum, these items only address the ways in which the manufacturing function is functionally ambidextrous. The informant for this scale was a new product development expert. Looking at the distribution of the functional ambidexterity scale (see Table 1 for descriptive statistics), it seems that while there is variance in the extent to which the organizations in the sample emphasize manufacturing ambidexterity, the average functional ambidexterity score in the sample is 5.1 (on a 1-7 scale), meaning that on average, respondents in the sample at least “somewhat agreed” with the three ambidexterity statements; functional ambidexterity in these industries seems to be more the norm that the exception. This is not surprising, given the industrial context of the sample: contemporary manufacturing organizations in machinery, electronics and the auto industry have clearly given up maximal functional specialization. In contrast with Simon's (1991) observation made in the early 1990s, the phenomenon is clearly no longer limited to Japanese manufacturing.

Organizational integration measures the extent to which the various business functions within the organization are integrated (Lawrence and Lorsch, 1967). This is assessed using a four-item seven-point Likert scale:

1. The functions in our organization are well integrated
2. Problems between functions are solved easily
3. Functional coordination works well in our organization
4. Our business strategy is implemented without conflicts between functions

These items assess the extent to which the manufacturing organization is in the state of organizational integration, in Lawrence and Lorsch's (1967) original meaning of the concept. Three informants within each organization submitted data for this scale: the plant superintendent, the general manager of the plant, and a process engineer.

Reliability and validity of the two measurement instruments were again assessed using SEM-based CFA. We conclude that reliability and validity are adequate (Figure 2). The reliability of the functional ambidexterity measure is only mediocre at 0.62 but no major cause for concern: I am estimating tendencies in a large sample, and thus the reliability requirements are not as stringent (Nunnally and Bernstein, 1994: 249). We also make the important observation that functional ambidexterity and organizational integration are clearly two separate empirical constructs; their correlation (.22) is positive and statistically significant, but this correlation is quite low. But this only implies that the functional ambidexterity challenge and organizational integration challenge are two separate issues, both theoretically and empirically.

Insert Figure 2 about here

Control variables. Because of multi-industry-multi-country data, I included country and industry controls as fixed factors into the model. I also controlled for the size of the organization (logarithm of the number of employees) as well as perceived competitive intensity. Perceived competitive intensity is a three-item psychometric scale assessed by three informants: the plant superintendent, the general manager of the plant, and a process engineer. The composite reliability of the scale is 0.87. I forgo the detailed discussion of this scale, because it is merely a control variable.

Competitive business strategy is perhaps the most important control variable. At the business-strategy level, the strategic posture of the business unit guides resource allocations in pre-determined strategic directions and defines the dominant orientation of the firm (Wheelwright, 1984). Dominant orientation is often defined in functional terms: some companies are marketing- or technology- oriented, others are manufacturing- oriented (Wheelwright, 1984). These functional orientations are thus a direct reflection of competitive business strategy, indeed, Wheelwright (1984: 79) regards the dominant orientation as one of the fundamental elements of strategy in manufacturing organizations. Of course, in terms of competitive strategy, it is well-established that some strategies emphasize efficiency, others differentiation and innovation (Porter, 1980; Miles and Snow, 2003); the most fundamental drivers of manufacturing ambidexterity reside at the level of business strategy. This is explicit in, for instance, the Miles and Snow typology, which will be used in this paper: Analyzers and Prospectors are probably more likely than Defenders and Reactors to exhibit ambidexterity, because the former two explicitly emphasize new market opportunities and innovation. Defenders, in turn, concentrate on efficiency considerations (Miles and Snow, 2003: 29). It is therefore downright definitional that certain business strategies may favor ambidexterity more than others: because neither Analyzers nor Prospectors can fully ignore efficiency considerations, they probably tend to emphasize ambidexterity more than others.

To operationalize business-level strategy, three informants in each organization—the plant superintendent, the general manager of the plant, and the quality manager—were given the original descriptions of the four archetypes of the Miles and Snow typology. They were then asked, independently of one another, to classify their own organization into one of the four categories. In 70 percent of the cases, all three informants agreed on the categorization. In the case of disagreement, in the vast majority of cases at least two of the informants agreed with one another; in these cases, the third informant was ignored. The most common disagreement was a scenario where two informants had classified the organization as a Prospector and the third as Analyzer, or vice versa. The business strategy is entered into the statistical model as a fixed factor, but for the purposes of this paper, it is merely a control variable: the focus is on organizational design, not competitive strategy.

Hypothesis Tests

Because there are multiple dependent variables and both categorical (controls) and continuous (theoretical variables and other controls) independent variables, I performed the analyses using a multivariate analysis of covariance (MANCOVA) design. It should be noted, however, that contrary to conventional applications of MANCOVA, the central variables of theoretical interest are the covariates, not the factors; in typical applications of MANCOVA, the continuous covariates are "nuisance variables," indeed controls, and the factors are the variables of theoretical interest, which the experimenter manipulates. In my design, it is just the opposite: all factors are control variables.

Summated scales are used for the multi-item constructs, although the summated score is divided by the number of items to preserve the original scale. Individual informant responses were aggregated to the organizational level by averaging. Because the scales were concluded to be unidimensional and adequately reliable, using summated scales is warranted. At the same time, we must acknowledge that in creating the summated scales we are also incorporating measurement error into the composites. For the dependent variables, this is not an issue since any measurement error in the dependent variables is absorbed into the MANCOVA error terms (Neter et al., 1996: 164). However, with respect to the independent variables, measurement error in the scales may cause estimation bias, because MANCOVA, much like regression analysis, assumes that independent variables are measured without error (e.g., Kennedy, 2003). Estimation bias is particularly a cause for concern if the independent variables correlate with the error terms of the dependent variable (Kmenta, 1971: 301). The results of the statistical analyses that follow are hence based on the assumption that the MANCOVA error term is not correlated with the independent variables. The fact that the informants for the independent and dependent variables are only partially overlapping alleviates the problem.

The results of the MANCOVA model are given in Table 3. From the results I concluded that the results provide at least partial support for the ambidexterity hypothesis. With regard to specific conclusions, I must exercise caution in interpreting the functional ambidexterity and organizational integration effects. Because only the estimates of the highest-order parameters are interpretable (Cohen et al., 2003), I can conclude that the results do support the complementarity proposition in general: the effects of functional ambidexterity and organizational integration are complementary for both the efficiency and customer satisfaction variables. Because the idea of a main effect of functional ambidexterity or organizational integration in the presence of an interaction, however, only makes sense if the value zero on the other variable is relevant (it is not in this case), I must interpret the main effect of functional ambidexterity and organizational integration in another manner. I followed the guidelines in Cohen et al. (2003) and constructed simple regression lines for the effect of functional ambidexterity at various levels of the organizational integration variable, and vice versa. In order to reach the proper statistical interpretation of the main effects, I drew both sets (3a&3b and 3c&3d) of simple regression graphs. However, the theoretical argument is that organizational integration specifically complements the effect of functional ambidexterity. Consequently, for theoretical interpretation, only 3a and 3b are relevant. The idea of functional ambidexterity moderating organizational integration (3c and 3d) simply does not make sense substantively. Graphs 3c and 3d can, however, be used to assess the statistical effect of organizational integration at different levels of the functional ambidexterity variable.

The simple regression lines are depicted in Figure 3, with a set of three simple regression lines per dependent variable. The simple regression lines are constructed as follows: one of the interacting variables is set at three different levels, high (sample mean and sample mean ± 2 SD). The control variables are fixed at their sample means. Then, using the parameter estimates from the MANCOVA model, the linear functional relationship between the other interacting variable and the dependent variable is plotted. The scaling on the X and Y axes are chosen so that the end points of the axes match the range of the data so as (a) to get an idea of the magnitude of the interaction effect with respect to the range of the data in the sample, and (b) to avoid extrapolation beyond the range of the data. As far as (a) is concerned, the effects appear to be quite significant from the sample variability point of view: the slopes in Figure 3 are strongly positive, and the differences between slopes of simple regression lines in a given sub-graph (e.g., in Figure 3d) are conspicuous.

Insert Table 3 and Figure 3 about here

The simple regression lines lead to the following conclusions about main effects. First, the main effect of organizational integration is positive in the sense that the simple regression slope is always positive for the customer satisfaction variable, no matter what the level of the functional ambidexterity. Because of the complementary effect, however, the slope is steeper at higher levels of functional ambidexterity. The main effect is more complex for the efficiency variable in that the effect of increasing organizational integration is positive only with average or higher levels of functional ambidexterity; with low functional ambidexterity, organizational integration has a negative effect, although the slope is only slightly negative.

The main effect of functional ambidexterity is quite different. While the effect of organizational integration tends to be positive, or at worst only slightly negative, the effect of functional ambidexterity can be either strong positive or strong negative, depending on the level of integration. This is a theoretically relevant observation. At low levels of organizational integration, functional ambidexterity is useless, downright harmful. Conversely, at high levels of organizational integration, functional ambidexterity has a positive effect on both efficiency and customer satisfaction, efficiency in particular. At the average level of organizational integration, the impact on efficiency is modest and positive, but the effect of customer satisfaction is modest and negative.

The R^2-statistics for the models range from 18 to 30 percent. These percentages are, however, somewhat misleading given that the dependent variables are measured with error; unreliable variance, by definition, cannot be explained. Adjusting the variance explained by the item reliabilities (Table 3), I concluded that the explanatory power of the MANCOVA is satisfactory: the reliability-adjusted R^2 measures the proportion of reliable variance explained.

The “Top 5” Ambidextrous Manufacturers

Extreme-value analysis of the results may produce additional insight. In this case, a look at the top performers in the sample further strengthens the results of this study. Based on the MANCOVA results, I would predict the most likely candidates for high ambidexterity performance to be Prospectors (or perhaps Analyzers) who not only emphasize functional ambidexterity but also do it in a functionally well-integrated organizational context. This is a direct statistical deduction from the model: organizational integration and functional ambidexterity as well as their complementary effect drive efficiency and customer satisfaction, while business-level strategy and the independent effects of organizational integration and functional ambidexterity drive flexibility performance.

Looking at the actual high performers in the sample, this prediction is highly accurate. If high ambidexterity is operationalized as efficiency and flexibility both ≥4 (“better than average or superior” on a 1-5 scale), and customer satisfaction ≥6 (on the 1-7 Likert scale), there are five organizations in the sample that satisfy these performance criteria. This group of five organizations has the following characteristics, all of which are consistent with my theoretical predictions (points 2 and 3 in particular are theoretically relevant):

1. Four are Prospectors, one is Analyzer.
2. The average functional ambidexterity score is extremely high, 6.2 (1-7 scale), which is 1.05 standard deviations above the grand sample mean of 5.1.
3. The average organizational integration score is also high, 5.7 (1-7 scale), which is 0.7 standard deviations above the grand sample mean of 5.0.

These observations square well with the MANCOVA results. I have added to the interaction graphs in Figure 3 the average of the Top 5 further to illustrate the result. Because of confidentiality reasons, I am not at liberty to disclose individual data points (even anonymous ones), but the ovals around the “Top 5 average” data point represent the variance in the Top 5: the ovals are drawn such that all five observations fall within their boundaries. Based on the size of these ovals, I concluded that the Top 5 performers are quite similar to one another. In summary, in this case extreme-value analysis is consistent with the general statistical findings: extreme values in this case are thus not outliers in the conventional sense, on the contrary, they seem to follow rather nicely the predictions of the statistical model.

DISCUSSION

The empirical results suggest that functional ambidexterity and successful organizational integration jointly lead to higher performance in multiple relevant dimensions of operational performance. With regard to efficiency, it is interesting to note that the effects of functional overlap and organizational integration are rather strong (Figure 3c). This result suggests that even from the point of view of manufacturing efficiency, there are clearly limits to functional specialization. This study highlights the argument that the well-established idea of “design for manufacturability” (e.g., Dean and Susman, 1989), for instance, is not just about the product development communicating with manufacturing. Functional overlap embraces the idea that manufacturing engineers are not just communicating with product developers, they become in a manner of speaking product developers themselves (Imai, Nonaka, and Takeuchi, 1985: 354). This is the essence of functional ambidexterity: much like a group of five left-handed and five right-handed people is not an ambidextrous group, a team consisting of five dedicated product developers and five dedicated manufacturing engineers is not an ambidextrous but merely a cross-functional team. “[Product designers and manufacturing engineers] must have a sufficient knowledge and understanding of the others’ problems to be able to communicate effectively about them. Experience shows that these conditions are unlikely to be satisfied unless members of each group (or a sufficient number of members of each group) have had actual experience with the activities and responsibilities of the other group.” (Simon, 1991: 131)

With regard to flexibility, there is no similar complementary effect observed, instead, there are independent positive effects of both ambidexterity and integration on flexibility performance. Because the interaction term in the flexibility equation is not statistically significant, we can interpret the main effect in the traditional manner, and no simple regression lines are required to describe the relationship: ambidexterity and integration have both an additive positive effect on flexibility performance.

With regard to customer satisfaction, the interaction term is again observed: ambidexterity and integration jointly lead to higher performance, although the interaction is not as strong as in the case of efficiency (compare figures 3c and 3d). This is not surprising given that customer satisfaction has a wider array of determinants than internal efficiency. At the same time, the customer satisfaction effect serves as an important criterion validity check, suggesting that functional ambidexterity has implications to other than internal performance measures as well.

In sum, my analysis provides systematic empirical multi-industry-multi-country evidence for the proposition that if the goal of a manufacturer is ambidextrous performance, maximal functional specialization is not optimal organizational design. On the contrary, manufacturers in the industries studied, on average, emphasize functional ambidexterity and functional overlap in their manufacturing function. The benefits of this are explained by the statistical results: functional ambidexterity can enhance efficiency, flexibility and customer satisfaction. This is an important finding, given that conventional wisdom has it that efficiency and flexibility in particular are mutually exclusive goals. My empirical results thus complement, and are fully consistent with, both Adler et al's (1999) in-depth case study of the NUMMI plant as well as Rivkin and Siggelkow's (2003) simulation-based arguments.

Ambidexterity Performance

Emphasizing ambidexterity is one thing, achieving high ambidexterity performance is quite another. While dozens of companies in the sample have achieved at least moderate ambidexterity performance success—48 companies, 20 percent, are above sample mean in all three performance dimensions—, only a handful of companies in my sample of 238 organizations have clearly excelled in all dimensions of performance. The primary reason for this, I submit, is the complex multi-level nature of the causal mechanism at play. Successful ambidextrous performance is not just a matter of setting up the cross-functional product development team to tackle engineering problems at the level of individual projects. This result echoes Tyre and Hauptmann's (1992) conclusions: the general prescription of cross-functional involvement in development projects partly misses the point, because it tends to frame the problem solely as an integration problem. My empirical results suggest that high ambidexterity performance arises from the complementary effect of simultaneously managing both the differentiation and integration challenges. The moderating effect of the level of organizational integration is surprisingly strong in the efficiency dimension in particular (Figure 3). At the same time, the theoretical argument is equally potent: sub-goal pursuit within business functions and the resultant turf battles can have devastating consequences in terms of being able to solve the engineering problem in a cross-functional product development team. Indeed, at very low levels of organizational integration, the effect of functional ambidexterity on performance is negative. The interpretation for this negative effect is that in the case of unsuccessful organization-level integration, emphasizing functional ambidexterity is simply a waste of time and effort for the manufacturing function: in becoming ambidextrous the manufacturing function trades off some of the benefits of functional specialization, but because of lack of organizational integration, the organization as a whole gets nothing in return. What is worse, this waste of time and effort can be so detrimental that it becomes visible even to the customer, as the negative slope for the customer satisfaction measure at low levels of organizational integration indicates. Another extreme-value analysis reveals that while this does not seem to be a widespread phenomenon in the sample, there are indeed a few organizations in the sample consistent with this proposition: strong emphasis on functional ambidexterity, low level of organizational integration, and a low customer satisfaction score.

Positioning the Results vis-à-vis Equifinality Arguments

Both my arguments and empirical results seem to contradict arguments for equifinality (e.g., Van de Ven and Drazin, 1985; Gresov, 1989; Doty, Glick, and Huber, 1993; Payne, 2006). Strictly speaking, this study has not disproved the equifinality proposition, since statistical analysis uncovers only tendencies. At the same time, that the Top 5 performers are all highly ambidextrous suggests that ambidexterity might be more optimal than other alternatives in the context studied. This observation prompted me to conduct a more systematic analysis of the top performers, the results of which indeed present an empirical challenge to the equifinality argument (figure 4):

1. Companies that are in the Top 50 of the sample in both efficiency and flexibility performance (22 companies) clearly emphasize ambidexterity: 17 out of these 22 companies (77 percent) have an ambidexterity score of greater than 5.0 on the 7.0 scale; the corresponding percentage in the entire sample is only 48 percent. Only one company in this high-efficiency-high-flexibility quadrant is clearly not ambidextrous.
2. Highly functionally specialized companies following conventional wisdom are most often found in the quadrant where neither flexibility nor efficiency performance is in the Top 50.
3. Even among the Top 50 efficiency performers, ambidexterity is prevalent: the most efficient companies in the sample clearly prefer ambidexterity over conventional organizational designs: 38 of the Top 50 efficiency performers (76 percent) have an ambidexterity score of greater than 5.0 on the 7.0 scale; again, compared to the 48 percent the difference is conspicuous.

Insert Figure 4 about here

Limitations and Directions for Future Research

One of the challenges associated with empirical analysis of both contingency-theoretic and equifinality arguments is that they often adopt a causally distant dependent variable, such as financial performance. This is theoretically problematic, because organizational design does not operate causally on financial performance, there are multiple intervening variables through which the effect propagates. I have examined three of these intervening variables. The implications to organization design and ambidexterity depend largely on whether these variables are exogenous to firm strategy or not. While the conclusion that "ambidexterity is a must" would be an overstatement, I find it safe to conclude that if the operational performance goal entails both efficiency and flexibility, there are limits to the discretionary range that managers have in designing their organization (Hambrick and Abrahamson, 1995): my results clearly suggest that strong functional specialization is outside this discretionary range. If efficiency and flexibility are, however, endogenous to decision-making, the firm might be able choose a strategy where the simultaneous requirement of high efficiency and flexibility can be avoided and consequently, equifinality with regard to financial performance may obtain. But if this is not the case, the contingency argument has in turn merit: "the limited range of structures available to managers restricts the ways with which the organization can meet the *environmentally determined* demands" (Payne, 2006: 767, my italics). Because I have chosen to study these proximate measures of performance instead of financial performance, drawing conclusions about equifinality with regard to financial performance cannot be done.

To be sure, functional ambidexterity is more valuable to some firms than others. In future research, our understanding of the topic could be enhanced by turning ambidexterity into an endogenous variable, effectively turning the MANCOVA models into path models with both direct and indirect effects. Various contingency factors, such as business-level strategy and task uncertainty could also be used as moderators in statistical models when examining the performance implications of ambidexterity: ambidexterity might be more beneficial for Prospectors and Analyzers than Defenders and Reactors. Such research designs might also shed more light on whether the determinants of organization design are external contingencies or strategic decision variables. This would, however, lead to highly complex statistical models with three-way interactions, which would require even larger samples and likely more accurate measurement. This is particularly important, because the reliability of a three-way interaction is approximately the product of the reliabilities of the interacting variables; high-order interactions are very difficult to estimate in a reliable manner. This was one of the reasons I chose to estimate simpler two-way interaction models in this paper instead. Of course, there is also the longstanding question of when and where interaction terms will capture a moderation effect (Rogers, 2002); in my analyses, at least two of these moderating effects were captured by the interaction model.

More generally, examinations of the interactions between internal differentiation and integration deserve more empirical attention. In many studies, operationalizations of internal differentiation in particular do not capture the theoretically important aspects of differentiation. Reliance on proxy variables is understandable, but the limitations must be acknowledged. In this paper, I have tried to overcome some of these limitations by measuring differentiation more directly, but obviously, measures of functional overlap could clearly be developed further. In developing these measures, we could learn a lot from the operationalizations in the classical study by

Lawrence and Lorsch (1967), which still remains one of the most rigorous empirical treatments of functional differentiation.

Conclusion

Building an understanding of performance, even that of internal efficiency, is a theoretically and in particular, an empirically challenging task once we incorporate bounded rationality. I have in this paper tried to build an understanding of operational performance from the point of view of organizational design, specifically, by examining the hypothesized joint benefits of functional overlap and organizational integration. The results suggest that once we abandon marginal analysis of productivity in favor of focusing on the performance challenge in a broader context, conventional wisdoms regarding organizational differentiation and specialization start to lose their explanatory power. This is not a novel phenomenon, but the empirical evidence is still scarce. This study, however, provides systematic evidence of the benefits of ambidexterity.

Organizations facing uncertainty need not necessarily adopt informal and organic structures as conventional wisdom (e.g., Burns and Stalker, 1961) would suggest. On the contrary, ambidextrous organizations can be highly formalized. The primary difference compared to conventional organization designs is not in the degree of formalization but in the degree of functional specialization, and the link between organizational structure and business functions. In the conventional wisdom, organizational sub-units specialize based on function, making the link between structure and function strong. Ambidexterity in turn is an example of “structure not equating to the function“(Gresov and Drazin, 1997: 406).

Related to this, my results suggest that contrary to conventional wisdom, successful organizational exploration and successful long-term exploitation are from a cognitive point of view (Simon, 1991) subject to similar organizational design challenges: both exploration and exploitation require an organizational design that enables the organization to take advantage of its complex knowledge base. Because of bounded rationality and sticky knowledge, maximal functional differentiation is not the proper organization design answer to the challenge. The reason is not that the integration of differentiated organization is challenging (Lawrence and Lorsch, 1967), instead, the primary problem lies in the highly differentiated organization's potential inability to harness the relevant exploration expertise residing in different parts of the organization. The solution to the problem is functional overlap complemented by successful integration: functional ambidexterity coupled with successful organizational integration has a positive effect on both exploration and exploitation performance. I have concentrated in this paper on the micro-level exploration of new product development; it would be interesting to examine whether the same conclusion applies to macro-level exploration efforts of strategic renewal as well.

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Table 1

Stratification of the Sample

	Electronics	Machinery	Transportation	Total
Austria	10	7	4	21
Finland	14	6	10	30
Germany	9	13	19	41
Italy	10	10	7	27
Japan	10	12	13	35
Korea	10	10	11	31
Sweden	7	10	7	24
USA	9	11	9	29
Total	79	79	80	238

Table 2

Sample Descriptives (composite reliabilities on the boldface diagonal)

	Mean	SD	1	2	3	4	5	6	7
1. Efficiency[c]	3.35	0.68	**0.73**						
2. Flexibility[c]	3.56	0.68	0.47	**0.78**					
3. Customer satisfaction	5.25	0.58	0.17	0.23	**0.88**				
4. Number of employees[a]	601[b]	771[b]	0.13	0.10	-0.11	**N/A**			
5. Competitive intensity[c]	4.65	1.48	0.16	0.09	-0.11	0.22	**0.87**		
6. Functional ambidexterity[c]	5.10	0.93	0.17	0.20	0.09	0.06	-0.07	**0.61**	
7. Functional integration[c]	5.04	0.67	0.26	0.23	0.35	0.11	0.12	0.16	**0.84**

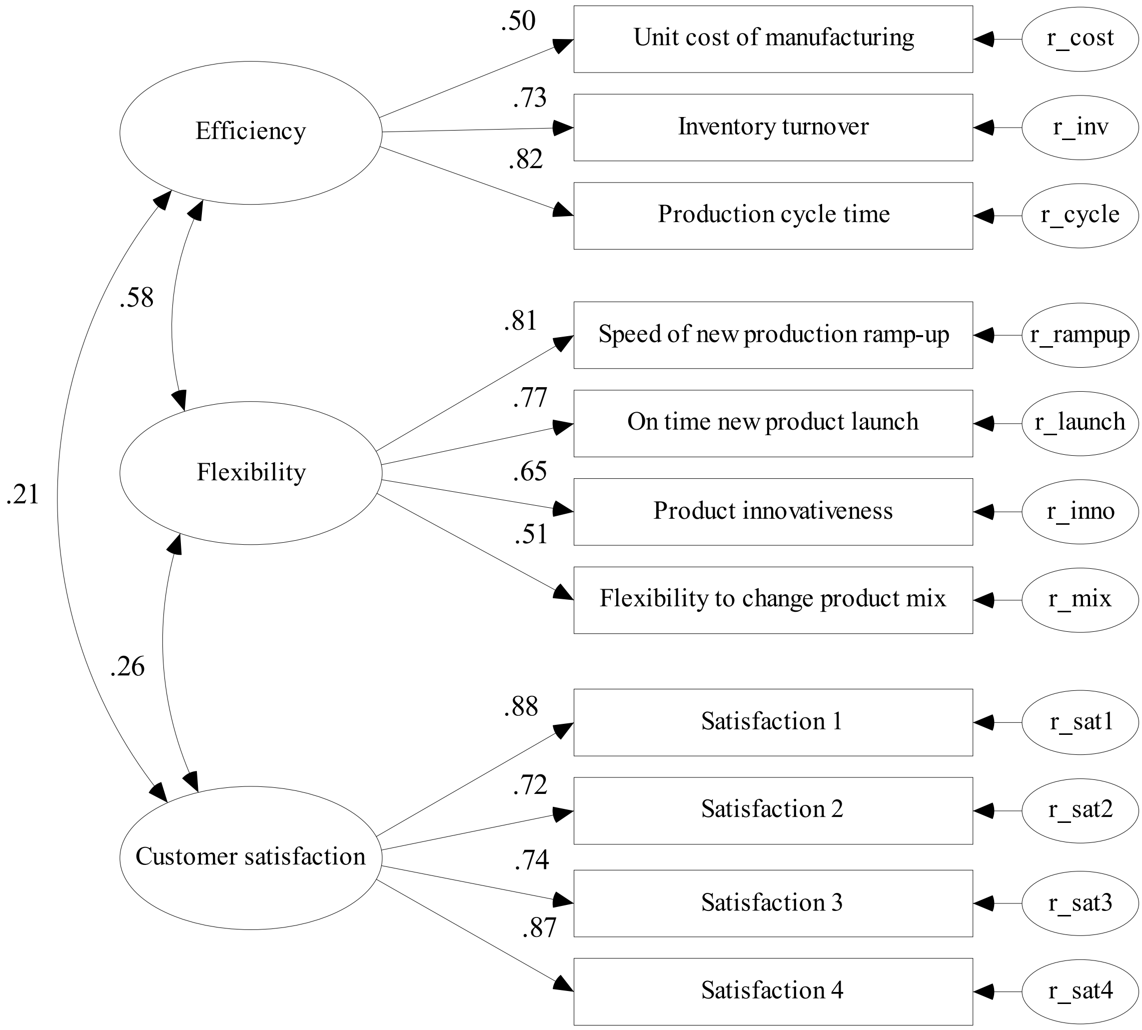
* p<.10; ** p<0.05; *** p<0.01, **** p<0.001

a. Units are #employees for mean and SD, log(#employees) for correlations

b. Five outliers (extremely large organizations) are removed before calculating the mean and SD

c. Summated scales. The correlations here do not match with inter-construct correlations in Figures 1 and 2, because correlations reported here are attenuated by measurement error.

Figure 1. Confirmatory Factor Analysis of the Performance Constructs



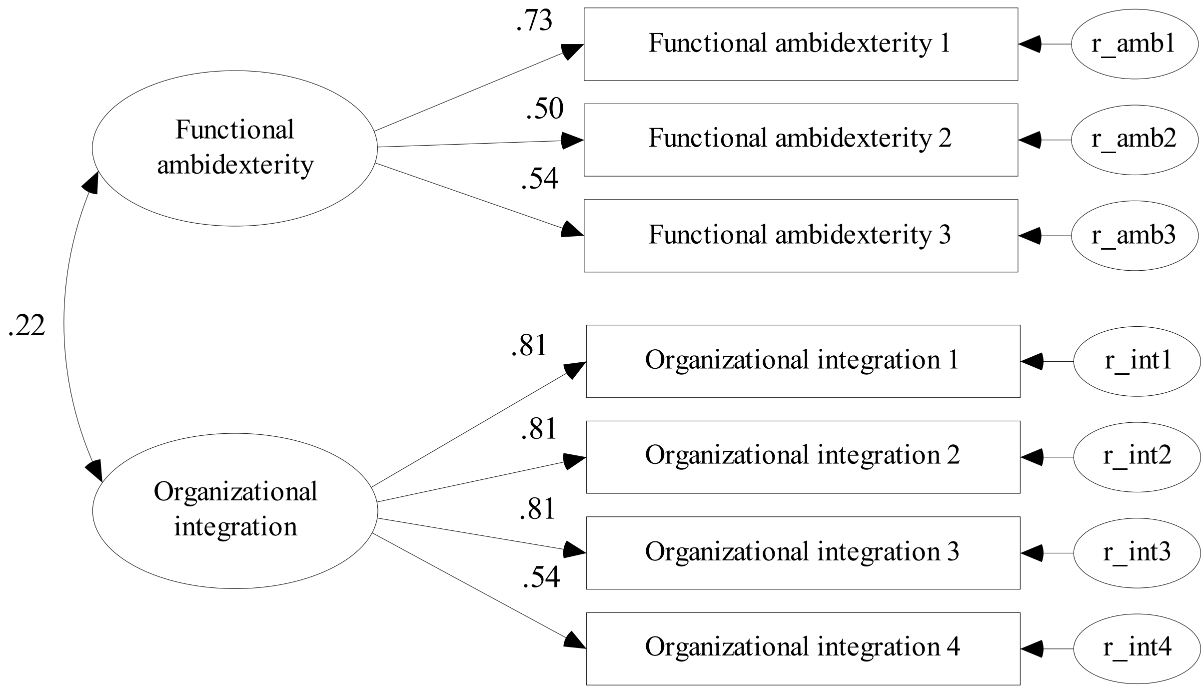
Model fit: χ^2=47.1 on 41 df (p=.237); RMSEA [.000, .053]; CFI .993

Composite reliabilities:
Efficiency 0.73; Flexibility 0.78; Customer satisfaction 0.88

Discriminant validity:

Efficiency – Flexibility	$\Delta\chi^2$=72.0 on 1 df, p<0.001
Efficiency – Customer satisfaction	$\Delta\chi^2$=131.1 on 1 df, p<0.001
Flexibility – Customer satisfaction	$\Delta\chi^2$=203.4 on 1 df, p<0.001

Figure 2. Confirmatory Factor Analysis of the Ambidexterity and Integration Constructs



Model fit: χ^2=17.3 on 13 df (p=.184); RMSEA [.000, .079]; CFI .990

Composite reliabilities:
Functional ambidexterity 0.62; Organizational integration 0.84

Discriminant validity: $\Delta\chi^2$=63.6 on 1 df, p<0.001

Table 3

General Linear Model Results (N=238)*

Parameter	Efficiency	Flexibility	Customer satisfaction	Wilks' Lambda
	Dependent Variable			
Intercept	2.556 ****	2.719 ****	5.663 ****	0.376 ***
Country				0.822 **
Austria	0.135	-0.109	-0.015	
Finland	-0.019	-0.161	-0.273 *	
Germany	0.219	0.058	-0.135	
Italy	0.271	-0.177	-0.322 **	
Japan	0.183	0.009	-0.680 ****	
Korea	0.184	-0.177	-0.422 **	
Sweden	-0.130	-0.323	-0.119	
USA	0[a]	0[a]	0[a]	
Industry				0.978
Electronics	-0.115	0.007	-0.054	
Machinery	0.076	0.098	-0.046	
Transportation	0[a]	0[a]	0[a]	
Business strategy				0.907 **
Defender	0.339	0.612 **	-0.080	
Prospector	0.542 *	0.955 ***	0.017	
Analyzer	0.347	0.773 ***	-0.002	
Reactor	0[a]	0[a]	0[a]	
Size	0.036	0.032	-0.020	0.995
Competitive intensity	0.012	-0.018	0.005	0.999
Functional overlap	0.106 *	0.076 *	-0.036	0.970
Organizational integration	0.245 ***	0.182 ***	0.335 ****	0.809 ****
Overlap x integration	0.154 **	0.022	0.074 *	0.969 *
Total R^2	21%	18%	30%	
Theory[b] R^2	14%	13%	14%	
Reliability-adjusted R^2	29%	23%	34%	
Theory[b] Reliability-adjusted R^2	19%	17%	16%	

* p<.10; ** p<.05; *** p<.01; **** p<.001

a. Parameter is set to zero by design (the baseline group)

b. The R^2 contribution, in percentage points, of the ambidexterity and integration variables. This is calculated as the difference in R^2 between this MANCOVA model and the model where only control variables are included in the model.

Figure 3. Simple Regression Lines

Figure 3a

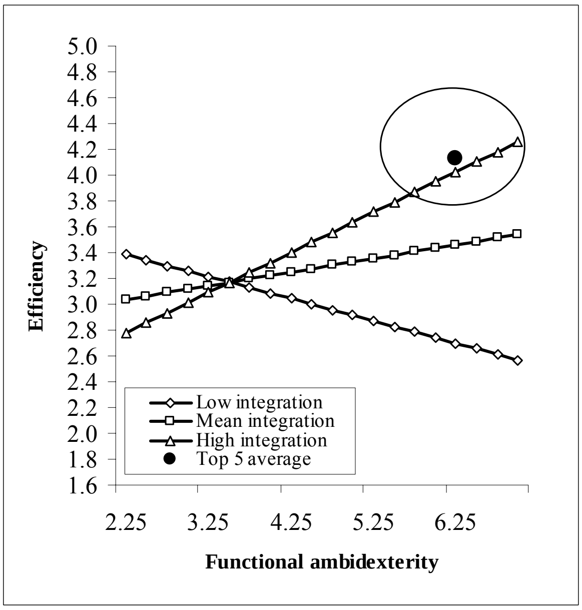


Figure 3b

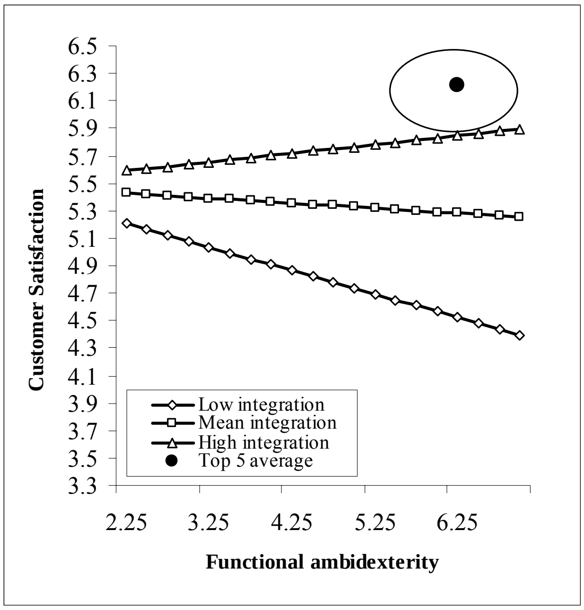


Figure3c

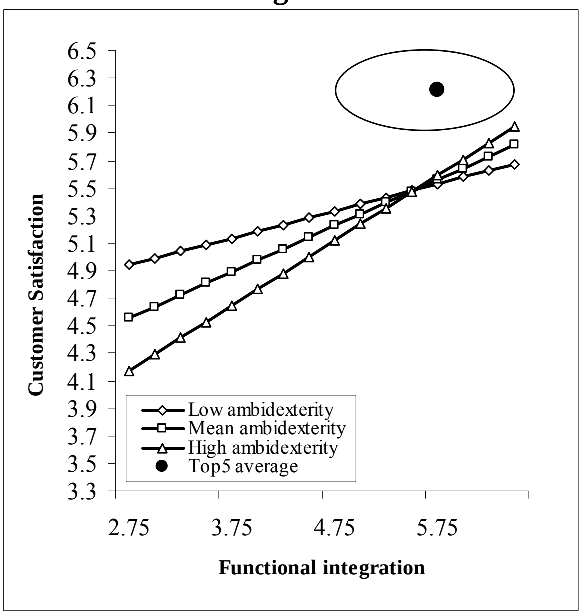


Figure 3d

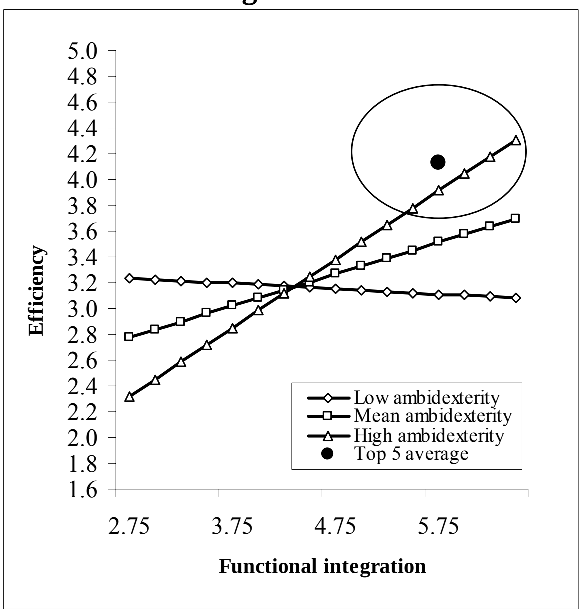


Figure 4. Ambidexterity and Performance Further Analyzed