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Organizing for Radical Innovation: An Exploratory Study of the Structural Aspects of RI Management Systems in Large Established Firms

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To escape the intense competition of today's global economy, large established organizations seek growth options beyond conventional new product development that leads to incremental changes in current product lines. Radical innovation (RI) is one such pathway, which results in organically driven growth through the creation of whole new lines of business that bring new to the world performance features to the market and may result in the creation of entirely new markets. Yet success is elusive, as many have experienced and scholars have documented. This article reports results of a three-year, longitudinal study of 12 large established firms that have declared a strategic intent to evolve their RI capabilities. In contrast to other academic research that has analyzed specific projects to understand management practices appropriate for RI, the present research reported explores the evolution of management systems for enabling radical innovation to occur repeatedly in large firms and reports on one aspect of this management system: organizational structures for enabling and nurturing RI. To consider organizational structure as a venue for capability development is new in the management of innovation and dynamic capabilities literatures. Conventional wisdom holds that RIs should be incubated outside the company and assimilated once they have gained traction in the marketplace. Numerous experiments with organizational structures were observed that instead work to manage the interfaces between the RI management system and the mother organization. These structures are described here, and insights are drawn out regarding radical innovation competency requirements, transition challenges, senior leadership mandates, and business-unit ambidexterity. The centerpiece of this research is the explication of the Discovery–Incubation–Acceleration framework, which details three sets of necessary, though not sufficient competencies, for building an RI capability.

Introduction

Organizational growth and renewal are fundamental to any firm's long-term survival (Jelinek and Schoonhoven, 1993; Morone, 1993) and can be approached in several ways. One path is to acquire new capabilities via acquisition of or merger with companies that offer technologies or market entrées the focal firm may lack. Another approach is organic, generative growth, meaning growth through the development of new lines of business based primarily on technical competencies nurtured from within the organization. When the promise of the opportunity is very large, and the concomitant

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risk and uncertainty of the opportunity are high, the technology and innovation management literature refers to that phenomenon as *radical innovation* (RI) (Leifer, O'Connor, and Rice, 2000; Morone, 1993).

The difficulty faced by incumbent firms commercializing radical innovation is well documented (Campbell, Newbery, and Reinganum, 2003; Christensen, 1997; Leifer et al., 2000; Morone, 1993). Schumpeter's (1950) early observations of the "process of creative destruction" describing the ability of new companies to commercialize radical technology at the expense of incumbent firms has been validated by many scholars (see, e.g., Rosenbloom and Cusumano, 1987; Utterback, 1994). Evidence suggests that forces operate within such organizations to impede RI success (Cyert and March, 1963; Dougherty, 1992; Dougherty and Heller, 1994; Gilbert, Newbery, and Reinganum, 1984; Hill and Rothaermel, 2003; Leifer et al., 2000; Tushman and Nadler, 1986). Organizations grow by gaining efficiencies of scale and scope in specific core competency areas that, ultimately, become core rigidities (Leonard-Barton, 1992) or core incompetencies (Dougherty, 1995). They lack patience in terms of converting investment of time and resources into profits due to the pressures of equity markets, yet radical innovation can require more than a decade of investment before financial returns are seen (Gilbert, Newbery, and Reinganum, 1984; Quinn, 1985).

Despite the documented challenges associated with commercializing radical innovations, many firms seeking renewal and growth have only a limited number of strategic choices. Downsizing, cost cutting, acquisition, and globalization have presented their own challenges Given the limited options, many firms view the commercialization of radical innovation as an increasingly critical path for growth, renewal, and rejuvenation. Addressing this renewal conundrum, Christensen and Raynor (2003)—reversing an earlier position—urge firms to learn to commercialize radical innovation.

Much of the academic literature focusing on the management processes for radical innovation considers the RI project as the unit of analysis and examines appropriate project management techniques associated with high levels of uncertainty given the constraints of the large established firm (Burgelman and Sayles, 1986; Dougherty and Heller, 1994; Jelinek and Schoonhoven, 1993; Kanter et al., 1991; Leifer et al., 2000; Morone, 1993). The research program on which the present article is based, in comparison, is a longitudinal study of large established firms' attempts to build and evolve a radical innovation capability, meaning the ability to commercialize radical innovations repeatedly. This study reports findings from a three-year longitudinal study on the development of RI management systems in 12 large established firms. Each participating firm has a declared strategic intent to develop capabilities to systematically commercialize radical innovation—not one specific project, but multiple projects. History is replete with cases of firms who have commercialized one or a few such new lines of business. But reliance on a very limited number of RI projects to be successful every 10 years is not enough to fuel organizational renewal that is necessary for the established firm.

The perspective adopted in this article is that radical innovation success is not dependent on any single management element, such as an appropriate process. Rather, it requires a management system whose elements combine to encourage learning, experimentation, and multiple paths to the market. This system must consider issues of culture and leadership, governance and decision making, skills and talent development, processes and tools, metrics, and organizational structure. For a successful RI capability, all elements of the system must be in alignment (O'Connor, 2005). There is a need to understand the approaches firms are taking to each of these elements both systematically and uniquely.

This article focuses on the organizational structure element of a management system designed to promote and enable radical innovations within the established

BIOGRAPHICAL SKETCHES

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firm. Much of the debate in the literature regarding the extent to which radical innovation can happen within the firm at all has centered on the organizational structure issue. Scholars who conclude that radical innovation cannot be effectively managed within the confines of the firm prescribe external incubators or investments in start-up firms and venture funds as the source of organic renewal for large established companies (Campbell et al., 2003). Yet empirical evidence documenting the failure of internally based RI organizations is dated (Fast, 1978, 1979). This article explores the range of organizational structures that the 12 subject firms are employing to support an organic growth and renewal objective through radical innovation.

Building New Capabilities and the Use of Dedicated Organizational Groups

Individual radical innovation projects may succeed or fail for any number of reasons, but factors often cited for success in coping with internal organizational antibodies include strong senior-level patrons and highly motivated, persistent champions (Howell and Higgins, 1990; Madique, 1980; Pinchot, 1985). When the research question focuses not on any single individual project but rather on building a management system to effectively nurture a multitude of RI projects, the theoretical lens shifts to theories devoted to organizational learning and dynamic capability development.

Though dated empirical data suggest that new business divisions or new ventures groups are not sustainable (Fast, 1978, 1979), the literature offers a number of reasons for establishing an identified group to initiate and build a RI capability within the organization. First, organizational capability building is not easy, especially when the capability is foreign to the natural efficiency oriented processes of the company. Transformational experiences (King and Tucci, 2002) are the building blocks of radical innovation. This sort of dynamic capability, in high-uncertainty and high-velocity markets, requires improvisational processes, which if not constantly attended will dissipate (Eisenhardt and Martin, 2000). A clear set of roles and responsibilities is needed to effectively initiate and sustain attention and resources to transformational experience and to RI. Therefore, an identified organizational group is necessary to ensure constant attention.

Second, experience accumulation is described as a critical building block of developing any new dynamic capability (Zollo and Winter, 2002). Prior to the time that a phenomenon is understood well enough to articulate and codify, the most effective outcome is for an identified group of people to share and jointly interpret these experiences. A dedicated organization that accumulates common experiences can compensate for the ease of forgetting that may occur when routines are simple and when there is little structure for managers to grasp (Argote, 1999; Eisenhardt and Martin, 2000). This calls for a consistency of the personnel exposed to the experienced events, which is more likely with a dedicated group responsible for the RI activity.

Third, an identified organization that is measured on results and staffed with individuals responsible for building and shepherding this radical innovation capability is likely to motivate reflection on their progress and reconfiguration of practices to improve. Large established companies offer the slack and room to learn and experiment with new routines that start-ups cannot afford (Floyd and Wooldridge, 1999; Kogut and Zander, 1992). Since organizational elements often display high levels of coherence, changing one element of a system requires changing others (Tushman and Nadler, 1986). An identified organizational entity allows the elements of the system to display internal consistency and logic without impacting the mainstream organization. It can be argued that the inability of firms to manage RI as an internally consistent system due to the lack of organizational identity explains why RIs are so often introduced by new entrants, who have developed appropriate processes that incumbents cannot adopt in mainstream organizations (Utterback, 1994).

Jelinek and Schoonhoven (1993), in fact, find that innovative firms do have institutionalized mechanisms for breakthrough innovation. They argue that the challenge of major innovation cannot be expected to occur in an organic environment, where flexibility, consensus building, and fluidity are the primary managerial mechanisms used to accomplish objectives. Rather, they argue, breakthrough innovation requires structure and clear reporting relationships to ensure there is the opportunity for both discipline and creativity. They do not dismiss the need for unique processes within the subgroup, however, and so are not advocating a mechanistic, hierarchical organization.

Finally, an identifiable organization is needed to allow appropriate competencies to develop without being stamped out by reified rules (Dougherty, 1995; Leonard-Barton, 1992). Much of the dominance of

incompetencies, Dougherty (1995) argues, comes from (1) pressures for reification and abstraction (e.g., codification); (2) pressures against hands-on practice; and (3) pressures against the linkage of technologies and markets. Yet radical innovation takes firms into high-uncertainty technical and market environments (Lynn, Morone, and Paulson, 1996; Meyers and Tucker, 1989; O'Connor, 1998). Hill and Rothaermel (2003) argue, and Rice, Leifer, and O'Connor (2002) demonstrate that a loosely coupled, stand-alone organizational unit should be established to commercialize radical technology so that it can evolve appropriate business models and processes necessary to accelerate rapid growth without the pressures of conforming to current mainstream operating models.

Some argue that the organizational entity responsible for RI must be physically and culturally separated from the mainstream organization that is pressured to deliver immediate results with great efficiency (Benner and Tushman, 2003; Campbell et al., 2003; Hill and Rothaermel, 2003; Kanter, 1985). Although the need for an internally consistent complete system is a critical aspect of developing a RI dynamic capability, some positive aspects are associated with embedding the activity within the mainstream and attending vigorously to the interfaces (Heller, 1999). Corporate ventures have access to the assets and resources of the organization (Greene, Brush, and Hart, 1999; Pinchot, 1985; Wernerfelt, 1984) and so, theoretically, have a competitive advantage over start-ups. For example, NetActive, a software rental venture funded by Nortel Networks, leveraged its parent company's name to gain access to software game producers they would never have been able to attract as a stand-alone firm (Leifer et al., 2000). Case studies show that physical separation at the project level may work for a time but that complete separation at the system level may not be wise, since the purpose of a RI system is to leverage and stretch current competencies and to simultaneously build new ones. Thus, the interface mechanisms to the mainstream organization become critically important, and physical separation may not be as likely to allow the assimilation of the radical innovation into the mainstream as would an identified group embedded within the organization (Heller, 1999; Sharma, 2002).

Though these theoretical arguments for an identified organizational structure responsible for ensuring that radical innovation occurs in the company seem convincing, what is left unexplored in the literature is what that appropriate organizational structure is, including where it reports in the firm, how concentrated or dispersed it is throughout the company, whether a single organization can handle all aspects of the radical innovation commercialization effort, and why these groups have not been successful over time (Fast, 1978, 1979). These issues are the subject of the current article.

Methodology

Defining Radical Innovation Competency

The research program defines *radical innovations* as products and technologies that have high impact on the market in terms of offering (1) wholly new benefits; (2) significant (i.e., 5 to 10 times) improvement in known benefits; or (3) significant reduction (i.e., 30 to 50%) in cost (Leifer et al., 2000). These impact levels are highly correlated with high risk and high uncertainty, requiring the firm to develop new, situation-specific competencies in technology, market, and organizational domains. A radical innovations competency, then, is the ability for a firm to commercialize radical innovations repeatedly.

Qualifying the Sample

The sample is composed of 12 large multinational firms: Air Products, Albany International, Corning, Dupont, GE, IBM, Johnson & Johnson Consumer Products, Kodak, Mead-Westvaco, Sealed Air, Shell Chemical, and 3M. (This work comes from the second phase of the Radical Innovation Research Program, which the Industrial Research Institute [IRI] has sponsored since 1995. The IRI is a professional organization of research and development [R&D] managers of Fortune 1000 firms.) Annual sales revenues range from just under $1 billion to $130 billion. These companies are market leaders in a variety of mature and emerging industries; they generally have been adept at achieving operational excellence through continuous cost-reduction programs. They were screened for inclusion in the study based on their declared strategic intent to develop an organization-level capability for commercializing radical innovations. In all cases but two there was an identified organizational system, process, and set of people associated with this cause, or senior leadership had declared its intent to initiate one in the very near term. Firms were also qualified into the sample on the basis of (1) obtaining

a sufficiently large variation in levels of system development among firms to allow for a determination of age and time behavior and dynamics; and (2) obtaining at least some pairs of firms in similar industries to allow observation of comparisons within and across industries. Table 1 provides demographic data regarding the sample and their RI systems.

Research Approach

Given the multidisciplinary nature of the research question, the research team is a multidisciplinary group, composed of nine researchers with strengths in entrepreneurship, strategy, marketing, finance, risk management, technology management, organizational behavior, and political science. The present research follows the methodological approach described in O'Connor et al. (2003) for use with multidisciplinary, longitudinal research programs, wherein collecting and interpreting data together is imperative for gleaning insights that any single disciplinary approach may not perceive.

Data Collection

The initial round of data collection involved day-long site visits to each company. The person who ran the RI initiative was interviewed in each case, and then a sampling of those who reported directly to him and those to whom he reported were also interviewed. In 11 of the 12 cases, the chief executive officer (CEO), chief technology officer (CTO), or chief strategy officer (CSO) was interviewed as part of the data collection process. A total of 143 interviews were conducted for the initial round of data collection—between 9 and 14 managers per company (Table 1).

One coauthor was present during each of the interviews to provide consistency of interpretation across each company, as well as at least three additional members of the research team, to provide multiple perspectives on each case (Eisenhardt, 1989). Additional phone interviews were conducted when data required expansion or clarification. The site visits were conducted between February and October 2002. Follow-up calls have been conducted each six months since each site visit, with the RI initiative leader and, in many cases, others the RI leader identified as key players in the initiative at the time of the interview. Four rounds of follow-up interviews had been completed for each company at the time of this article's submission, for a total of 224 interviews (Table 1).

Table 1. Summary Information on Companies and Interviewees[a]

Case	Company Business Description	Age of Initiative at Time of Initial Interviews	Number of Initial Interviewees	Managerial Level of Initial Interviewees	Number of Follow-Up Interviews to Date
1	Diversified Industrial Products Manufacturer	0; just beginning	8	CTO and direct reports	5
2	Producer of Industrial Gases and Chemicals	1 year	18	CTO, BU Leaders, Incubator director and his direct reports	7
3	Paper-Making Machinery Products	0; just beginning	8	CTO and direct reports	4
4	Materials Company	2 years	14	CTO and direct reports	6
5	Chemical Ingredients and Science-Based Products	5 years	10	Executive VP for growth initiatives, R&D directors and staff reports to CTO	9
6	Diversified Industrial Products Manufacturer	7 months	16	CTO, COO of R&D, and RI team leaders	6
7	Computer Systems and Related Goods	2 3/4 years	14	Executive VP of Strategy, Exec. VP of Technology, RI staff and RI team leaders	8
8	Consumer Nondurable Goods, Nonfood	1 year	11	CTO, leader of RI initiative, VPs of platforms	7
9	Diversified Industrial and Consumer Products Manufacturer	8 years	13	CTO, BU leaders, incubator director and his direct reports	10
10	Specialty Paper and Packaging Manufacturer	2 years	9	President of new ventures, his direct reports, and venture team members	7
11	Specialty Packaging Manufacturer	7 years	11	R&D directors and direct reports, members of technology board at corporate level, including VP of strategy	7
12	Chemical and Plastics Manufacturer	3 years	11	Research directors, leadership of RI group and his direct reports	4

[a] CTO, chief technology officer; BU, business unit; VP, vice president; R&D, research and development; RI, radical innovation; COO, chief operations officer.

Interviews were semistructured. One researcher led the questioning, but flexibility was maintained to probe issues arising during the interviews. The interviewees were asked a variety of questions related to their company's radical innovation initiatives and management system. With respect to their organizational structures, particular emphasis was placed on understanding the locations, reporting structure, roles, and governance models associated with initiating, nurturing, and commercializing RIs. In addition, respondents were asked about the competencies required to commercialize radical innovation, to reflect on the extent to which they believed those were present in their current system, and to identify areas for improvement.

Interviews averaged somewhat longer than one hour. Detailed notes were recorded during the interviews by one researcher while others recorded impressions and observations. Immediately following each interview, recorded notes were reviewed by each member of the team present during the interview. Impressions and observations were added, and corrections or clarifications were made. In 11 of the 12 cases, following agreements with the companies, the interviews were taped of the interviews were transcribed. Both the field notes and the transcribed interviews were used in the data analysis.

Data Analysis

Data were analyzed through multicase analysis methods (Eisenhardt, 1989; Yin, 1994). The data were content analyzed according to the processes described in Glaser and Strauss (1967) and Miles and Huberman (1984). In addition, in accordance with the multidisciplinary research team data analysis processes described in O'Connor et al. (2003), data tables and diagrams were verified with other members of the research team and with participating companies to gain confidence that an unbiased interpretation of the data has been achieved.

Annually, the research team holds a three-day meeting for the purpose of forcing a thorough review of the transcripts and field notes. These meetings are tied to preparation for a variety of public deliverables, such as conferences or workshops with the participating companies. In this time-sensitive environment, each team member is assigned a subset of the cases to review for new insights. It is important to impose time pressures for these insights to emerge (O'Connor, 2003), since this requires concentration on the data for purposes of specific output (Gersick and Davis-Sacks, 1990). Insights are then presented from each team member and are validated or debated among the team.

The organizational structures depicted in Figures 1 through 7 were developed by the two coauthors following one of these meetings and were presented to the remaining team members. They were then presented to the participating companies for feedback. Adjustments were made in accordance with the feedback, where necessary. Field notes and transcripts were reviewed once again by the coauthors to strengthen the understanding of issues related to organizational structure. The critical dimensions of corporate RI initiatives gleaned from the team (listed in Table 2) include (1) RI structure, function, and degree of formality; (2) RI group location and reporting relationships; (3) RI group degree of coupling with mainstream organization; (4) RI project management approaches; (5) RI initiative's initial mission and scope; (6) significant challenges RI initiatives faced; and (7) RI organizational changes over time. The transcripts were coded by the two researchers. One author employed NVivo, a computer-aided text analysis software package specifically designed to enable coding (Richards, 1999). The other coded using Microsoft Word. When an issue arose in any single case,

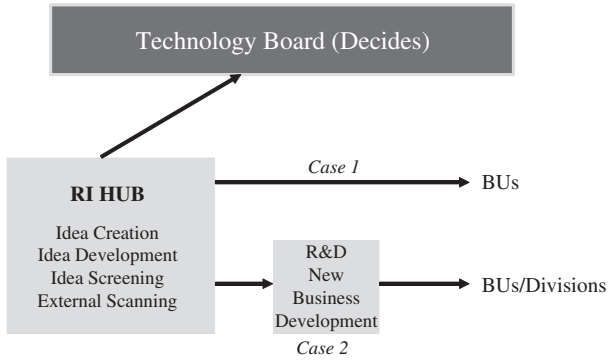

Figure 1.

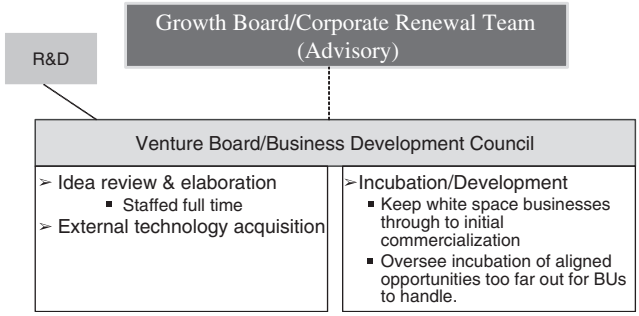

Figure 2. Idea Generator + Incubator

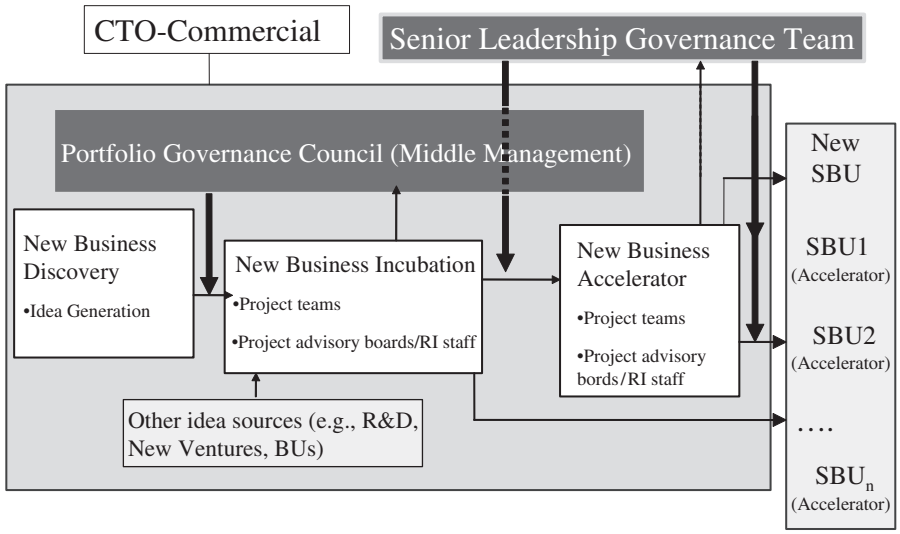

Figure 3. Holistic Sequential Model

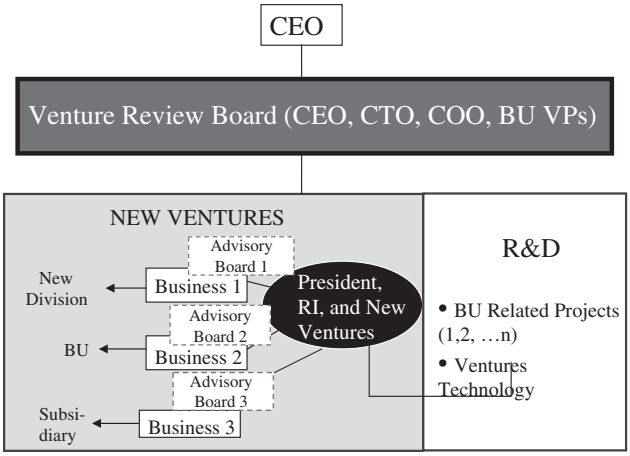

Figure 4. Corporate Venturing Unit

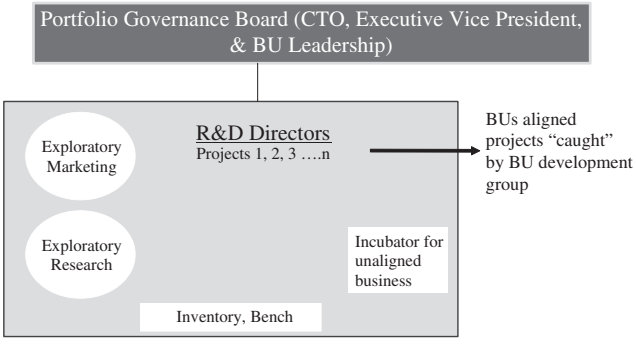

Figure 5. R&D Management System

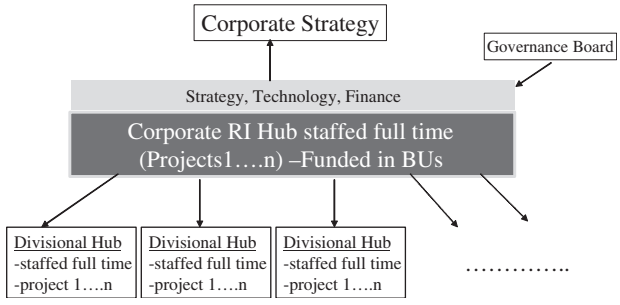

Figure 6. Self-Similar Model

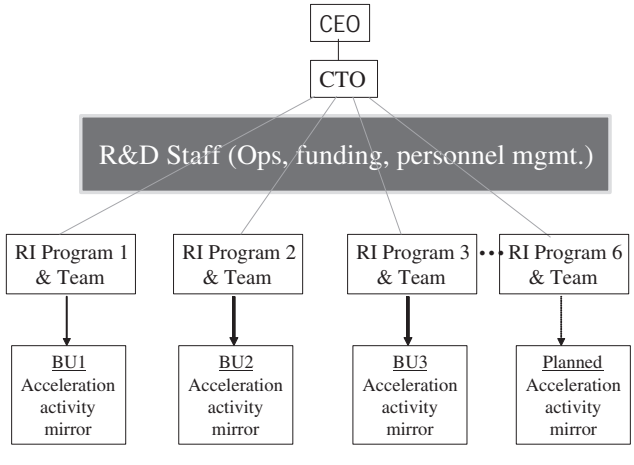

Figure 7. Mirrored Model

the others were reviewed for similarities and differences associated with that issue.

In the following discussion company identities are concealed in accordance with confidentiality agreements between the organizations and the researchers.

Results

Table 2 presents the data that provided a way to map the organizational structures and their changes over time. Results are presented as follows: (1) descriptions and graphical representations of seven organizational

Table 2. Sample Firms Organizational Structure Data[a]

Case	RI Group Structure, Function, Degree of Formality	RI Group Location, Reporting Relationship	Degree of Coupling with Mainstream Organization	RI Project Management Approaches[b]	Group's Initial Mission and Scope (Ability to Handle White-Space Projects)	Challenges Facing RI Initiative	Changes in Organization Structure over Time
1	One group in R&D formally recognized as an early-idea group thought of themselves as responsible for radical innovations. However, RIs could come from anywhere, and no formal recognition of RI is different from any other sort of innovation.	Early-stage idea development efforts located within R&D report to CTO. Unaligned projects incubated in R&D report directly to CTO.	Early central R&D efforts uncoupled	NPD	Small group's mission was to create new technologically based inventions, aligned and unaligned	Only limited RI commercialized, a bias toward incrementally new small businesses, business too small and limited in growth potential, and BUs not taking responsibility for investing in new business opportunities arising from idea development in central R&D	Disassembled the group, created a program to identify big potential projects, a governance board of BU leadership to oversee them, and a market learning group within R&D to investigate potentially big ideas and articulate them as business opportunities. Created new processes to weed out smaller, incremental, less attractive new business.
2	RI managed separately from other innovation. Two groups, formally recognized as responsible for RI, tightly linked to each other. One was to identify opportunities (six people) and the other was to nurture them (one person).	Located in the new business group (with its own VP) that was tightly linked to R&D community. Reported through its VP to the growth board	Initially not coupled but grew more coupled via growth board's influence and lack of independent funding	GRI	To identify and nurture RI opportunities for bigger growth, 80% to be aligned with existing businesses, 20% white-space opportunities.	Ideas were too small. Needed fewer, bigger ideas. Had a hard time getting BU support and funding.	Moved the opportunity incubation function into one or two of the business units and retained idea generation function with added mission to connect to future strategic intent and develop bigger programmatic opportunities.
3	No formal group responsible for RI. In fact, little RI activity at outset of the study. CTO tried to create a senior management innovation council to oversee big projects.	Any RI project activity concentrated in central R&D.	Not coupled, majority of RI projects hidden from mainstream leadership.	EXC	N/A	Limited support from senior managers including the CEO. No understanding that RI requires longer gestation periods, no dedicated RI budget, a short-term orientation in a cost-focused industry.	Innovation council did not materialize. CTO retires. Central R&D focuses even less on RI. After two years, CEO recognizes dearth of RI projects. R&D shifts 15% of people to longer-term technology development, but overall R&D headcount dropped 60% over two years. No business or strategy people involved.
4	No major distinction between RI and II, but R&D considers big innovation to be in its DNA. Two formal councils overseeing all R&D projects: Technology council composed of CTO, and technology community for early-stage projects, and growth council, composed of CTO, company president, and BU presidents to oversee later-stage development of	Early-stage opportunities managed as R&D projects. Exploratory marketing reports to CTO and works tightly with R&D scientists. Later-stage opportunities reside in R&D but report to growth council.	Tightly coupled. Corporate tradition and culture encourages a tight coupling between central R&D and business units. One business unit, however, is structured for the purpose of receiving and growing new unaligned opportunities.	NPD	Exploratory marketing's mission: To find systems level problems in industries the company does not currently serve and solve them. Aligned and unaligned.	Strong technology focus limited by weak market knowledge and business-building ability, limited high potential ideas in pipeline, difficult to fund RI projects during difficult financial times	Technology council and growth council still in place. Exploratory marketing group found that out-of-bounds projects did not get traction, so they began to incubate those opportunities themselves, in conjunction with the technical team, residing in R&D. Now called strategic growth group. Reside within R&D. Mission: create new businesses that are

Table 2. (Contd.)

Case	RI Group Structure, Function, Degree of Formality	RI Group Location, Reporting Relationship	Degree of Coupling with Mainstream Organization	RI Project Management Approaches[b]	Group's Initial Mission and Scope (Ability to Handle White-Space Projects)	Challenges Facing RI Initiative	Changes in Organization Structure over Time
	projects into business opportunities. Also created an exploratory marketing group to identify potential big opportunities given lack of good ideas in pipeline.						unaligned with current businesses.
5	RI formally recognized and managed separately. Central R&D organized by project rather than scientific specialty to enable RI. Exploratory marketing group (six people) reports to RI portfolio manager in R&D with ideas for big hit projects. A ventures organization also resides within R&D to incubate opportunities that do not fit current org. structure and to find external early stage technology opportunities that help build new businesses.	Located within central R&D, reporting to CTO. Corporate growth Council, composed of CTO, BU VPs and VP of Corporate planning, oversees projects. One individual manages RI portfolio and exploratory marketing staff.	Tightly coupled with business units. As projects mature, BUs assume increased funding burden as project mature from early stage to more mature and BU home is clear. Unaligned opportunities are incubated within R&D and are overseen by CTO	GRI for aligned via and EXC for unaligned.	Intended to commercialize opportunities that are adjacent to current businesses, are of high uncertainty and have big payoff potential. Ventures organization nurtures highly unaligned projects.	Lack of marketing expertise in central R&D. Poor linkages with company BUs and strategic intent. Not enough people with business acumen in R&D to coach teams so rely on BUs for this.	Limited organizational changes. Increased emphasis on the marketing–technology interface. Greater emphasis on early-stage BU and platform participation central R&D RI activities. Corporate growth council replaced by technology leadership team (chief marketing officer and BU technology leaders) as primary reviewers of projects as selected projects become increasingly aligned with BUs.
6	RI formally recognized and managed separately from rest of R&D activities. COO of R&D is program manager overseeing 6 major RI programs. Each RI program has a leader and team.	All RI program teams reside in central R&D, report to COO or central R&D and indirectly to CTO. CTO meets with them regularly.	Programs were selected with far future in mind. Some of them have natural homes in the BUs, and others do not. Those that do began immediately to created BU linkages.	GRI	Build technological capabilities in a few focused areas for major future impact. Focus on existing business domains and aligned opportunities.	As programs matured, unaligned opportunities arose that did not have clear BU home.	Added a business building capability in BUs that were identified early on as natural homes for developed opportunities. Unclear yet what they will do with unaligned opportunities.
7	RI formally recognized and managed separately form rest of innovation activities, though less so in early R&D phases and more so in business growth phases. Operates at two levels: corporate and BU. Corporate RI group began as staff of three to four and each division that has an RI initiative also has three to five people. Senior management highly involved in Corporate level identified opportunities	RI is the responsibility of senior VP of corporate strategy. In each division a similar structure exists. Corporate-level RI projects meet monthly with CSO, CTO, and company comptroller.	Tightly coupled. Most RI businesses are funded by the divisions, though overseen by corporate strategy. Those that have cross-divisional benefit are funded by one but have an advisory board composed of members from each.	GRI	To assure investment and commercialization of longer-term high potential projects, aligned or unaligned. Unaligned are funded from corporate money.	Faced challenges in getting new ideas into pipeline. Also, RI groups responsible for division-level RI have not evolved to a high level of competency. But corporate-level projects have been very successful.	Added staff to corporate strategy group to help coach and train new RI leaders, document processes to help institutionalize learning

Table 2. (Contd.)

Case	RI Group Structure, Function, Degree of Formality	RI Group Location, Reporting Relationship	Degree of Coupling with Mainstream Organization	RI Project Management Approaches[b]	Group's Initial Mission and Scope (Ability to Handle White-Space Projects)	Challenges Facing RI Initiative	Changes in Organization Structure over Time
	as enabler, funder and educator.						
8	No formal structure. CTO asked his 12 direct reports to experiment with ways to get RI projects. They agreed to common budget processes and common evaluation criteria. A small new ventures group existed for a short time in R&D as well but moved to a division very quickly.	N/A	Any RI projects that were initiated were tightly coupled with current lines of business.	EXC	Need fewer, bigger hits, though aligned	Nothing was happening. One project was begun and quickly killed. Few of the 12 direct reports responded to CTO.	Formed an R&D board, like a technology council, to review opportunities within the division and an Innovation board to identify opportunities across multiple divisions. Identified biggest within division opportunities in the company and resourced them with dedicated teams. New ventures group disbanded. CTO mentoring junior people to become platform leaders. Division-wide training in RI by external consultant. Replacement of key positions with people from a different division where RI occurs frequently.
9	One highly formal, centralized group. Composed of a leader, a leadership team of 12 people, and 60 additional people in three locations worldwide. The group was divided into discovery and incubation subteams, though group members flowed back and forth between those two activities. Discovery and incubation had different processes and outcomes.	Located within R&D; report to CTO.	Loosely coupled system. RI projects have difficulty transitioning to mainstream business units.	GRI	Intended to commercialize both aligned and nonaligned projects.	Uncertain where mature projects should be housed, since some do not fit in BUs and others may eventually but require investment to grow or solidify the business model. RI organization requires greater credibility with operating units.	Expansion of system to include an accelerator. New accelerator designed to allow new projects and businesses to gain bottom-line self-sufficiency to sustain transition to existing business unit or stand-alone status.
10	One formal organization, composed of director, assistant director, five idea hunters and coaches. Focus on early-stage idea generation and incubation	Located within corporate engineering. Loosely connected to R&D. Dotted line reporting to CEO.	Very loosely coupled. Credibility difficulties with the existing business units, R&D, and all other corporate actors.	GRI	To promote the development of new sustainable businesses, promote the creation of an entrepreneurial culture, and leverage existing core competencies to create growth. White space and aligned opportunities	No standing with business units, contentious relationship with R&D, tepid support from executive management	CEO acted early in the study to hire a president of new ventures from outside the company. Reports directly to CEO. New executive disbanded early-stage RI organization and created new RI organization focusing on later-stage acceleration. Little idea generation and early-stage incubation activity

Table 2. (Contd.)

Case	RI Group Structure, Function, Degree of Formality	RI Group Location, Reporting Relationship	Degree of Coupling with Mainstream Organization	RI Project Management Approaches[b]	Group's Initial Mission and Scope (Ability to Handle White-Space Projects)	Challenges Facing RI Initiative	Changes in Organization Structure over Time
							remain. Link with R&D loosens and tightens periodically. A focus on building new businesses that will diversify the company. R&D supports the ideas.
11	Two committees. One focuses on idea generation at the divisional level, initiating projects and funding them through early discovery and elaboration of the opportunity via the normal R&D management process. Composed of R&D directors. Second board, at the corporate level, focuses on evaluating and funding promising RI initiatives the division cannot support, identifying additional corporate-level opportunities, and sharing information across the other divisions.	The first committee reports to the divisional CTO; the second is run by the corporate CEO.	Initially, loosely coupled, but evolved to get more support from the existing business units. Incubation occurs in existing business lines.	NPD for aligned opportunities, EXC for unaligned that are funded by the higher-level board.	Mission is to commercialize blockbuster products and to identify trends that could impact the core business five years out. No consideration of aligned versus unaligned opportunities	Initially technology focused. Had no business help to nurture the opportunities beyond the technical dimension. Requires more market and business development expertise. Requires mechanism to incubate and accelerate RI projects.	At divisional level, began to involve people from the new business development group on the committee and now consider themselves as identifying new business opportunities rather than technical ideas. Over time, began to transition ideas into new business development group for incubation before they were sent into the businesses. At corporate level, hired VP of global business development, responsible for innovation and added her to the corporate-level board. Added two similar positions at the divisional level to identify and nurture growth opportunities. Greater buy-in from existing business units. Integration of BU business development attributes with idea generation and early-stage corporate funding.
12	One formal organization focusing on early-stage idea collection and generation. Organization also focuses on RI education within the corporation. One leader and six dedicated staff, plus others on a part-time basis.	Located within R&D; reports to the VP of technology.	Began as a loosely coupled system, without much interaction with the BUs.	GRI	Change technology culture within corporation and promote innovation in general. Intended to commercialize only aligned projects, though group wanted to go beyond that.	Difficulty transitioning ideas to existing business units. Difficulty managing senior leaders' expectations and in agreeing on mission of the group in terms of aligned or white-space opportunities.	RI effort severely diminished but linked very tightly to Strategy organization. No additional incubation capabilities added as of now.

[a] RI, radical innovation; R&D, research and development; CTO, chief technology officer; NPD, new product development; BU, business unit; VP, vice president; CEO, chief executive officer; COO, chief operations officer.
[b] EXC (managed on an exception basis), GRI (grouped with other RI projects), or NPD (grouped with all NPD projects and not differentiated.

structures that illustrate how the 12 firms organized for RI; (2) the introduction of the Discovery–Incubation–Acceleration (DIA) model of RI competencies that emerged from the study of changes in the companies' organizational structures over time; and (3) a series of insights beyond the DIA that reveal reasons for specific organizational structures to be more appealing than others given different organizational contexts and RI missions.

Seven Organizational Structure Models for RI

The interviews reveal a set of alternative radical innovation organizational systems whose scope, intent, and functions differ. During the data collection period, a number of companies changed their organizational structures to encompass competencies lacking in their earlier organizational systems. Figures 1 through 7 provide visual representation of these organizational models.

Idea generator (Figure 1). The RI organizational structure shown in Figure 1 is designed to identify RI opportunities and to stimulate others to develop RI ideas. Five sample companies (cases 2, 9, 10, 11, 12) began their RI initiatives as idea generators, though only two (cases 11, 12) continue with this model; the other three have evolved to alternative structures. Though the idea generators in the sample were initially established with the mandate of overseeing the development of radical innovation projects, a number of these groups realized that the quantity and quality of potential radical innovation opportunities coming into their system were insufficient, that is, that big ideas were sorely lacking in their companies. Hence, much of their early effort was spent educating company members about the firm's new mission to think big and to assist appropriate skill development throughout the organization by conducting workshops and ideation sessions. In addition, these groups send internal staff members searching outside the firm for new ideas and to refine their own skills at evaluating, elaborating, and developing raw ideas into bigger concepts.

Idea generator organizations report to the CTO and are tightly linked to the technology community. Though some have the implicit or stated support of senior executive officers, this support was typically passive, meaning that senior leadership was uninvolved in idea generation or screening. Potential RI projects are typically selected by a board composed of leaders in the technology community. Ideas are aligned with divisions' markets and business models and are transferred there in a fairly raw state, although the unaligned ideas would be kept longer within the protective environment of R&D. There was little business strategy expertise applied to these ideas, as they remained within the R&D and idea generation purview.

Incubator (Figure 2). The structure in Figure 2 serves to identify RI opportunities, as in the earlier model just described, but nurtures them along the business creation path as well. This means experimenting with potential market applications, developing the concomitant technology necessary to allow market representatives to interact with the technology, and exploring potential partnership arrangements and business models for the ultimate venture. In all the sample cases, these structures evolved from idea generator structures (cases 2, 9, 10). With the passage of time idea-generating groups engaged in more incubation activity as they encountered a lack of divisional investment in their initial ideas. Innovation leaders found that divisions would not invest in developing ideas that were transitioned in too raw a form and that divisions would ignore aspects of the innovation that stretched their strategy or business processes.

Incubators, like idea generators, were linked with the technology community but required greater senior management support, because of the increased costs associated with incubation. Additionally, incubators increased the scope of their RI projects over those considered by idea generators—advancing RI opportunities that were not necessarily aligned with business-unit (BU) markets and business models since they could experiment with new markets and new application spaces that business units were not prepared to develop.

One mechanism by which incubator organizations gained senior-management support was through their participation on review and evaluation boards. Whereas the idea generator model was primarily overseen by the technical community, this model's evaluation boards were composed of senior business-unit leadership, and, in some cases, senior corporate leadership. Because these organizational forms focused on generating a large number of project ideas, however, several firms adopting this governance model quickly inserted a middle-management review board, as there were just too many projects for the senior leadership to review. Thus, the Venture Board/

Business Development Council in Figure 2 is composed of new business development managers from the respective operating units, who then pass along the most promising projects for the more senior-level growth board to review.

Holistic sequential model (Figure 3). The scope of the RI structure in Figure 3 includes (1) uncovering and incubating RI opportunities; and (2) providing the protection and coaching necessary to evolve these businesses toward commercial self-sufficiency to the point where they can compete for resources with other product lines in the operating units that will become their eventual home. It is referred to as the holistic sequential model because the system is structured so that a project will pass from one group to another as it matures, but the system covers all of challenges that radical innovations face in terms of transitioning through the corporate system (Rice et al., 2002; Roberts, 1977).

Both examples of this structure (cases 2, 9) evolved from an incubator model. Their evolutions were responses to challenges that the incubator structures faced when attempting to advance RI projects. After incubation, nascent projects—with elaborated business plans—would graduate into operating units. The projects, however, generally failed to gain the interests of existing businesses who viewed them as too immature and uncertain to provide short- to medium-term returns and that, in many cases, required adjustments to the business unit's processes, distribution channels, or revenue models. In addition, the timing of the transition was not typically appropriate given the business unit's budget and planning cycles. BU leadership identified new product development programs for investment at the beginning of the budget cycle, which did not always track to specific RI projects' maturation cycles.

Unaligned projects, or those not destined for integration with existing operating units, faced even more daunting problems. Existing operating units possessed even fewer incentives to commercialize these projects. To alleviate these transitional difficulties, one firm (case 9) created an independent business accelerator whose objective is to advance RI projects to self-sufficiency for eventual transfer to a business unit or new organizational entity. The accelerator remains tightly connected to R&D and reports through the CTO but has a governance board that consists of all of the senior corporate officers so that decisions regarding the fledgling businesses—in terms of, for example, ultimate organizational home, ongoing investment, or necessary partnership arrangements—can be made at a very strategic level. In case 2, accelerators are located within each of the operating units that have been designated as growth platforms and are being held to different performance metrics than the ongoing operations part of the business. However, over time, the focus on incubation has diminished. The result is that projects were forced to adopt more aligned opportunities, and projects that were potentially game changing but did not fit the company's current infrastructure were underresourced.

The holistic sequential model employs two governance organizations to oversee the process. After RI ideas are generated, a board of middle-level managers filters and selects promising RI projects to enter the incubation stage. This board's objective is to create a unique portfolio of promising initiatives from numerous potential opportunities. A more senior board, including the chief operating officer, selects RI initiatives that will enter the new business acceleration structure. This very senior board also decides whether and when the accelerated new businesses can exit the business accelerator and move into an established line of business or will be set up as their own division.

Corporate venturing init (Figure 4). The RI model in Figure 4 focuses on nurturing separate internal ventures, with the objective that each could ultimately become a subsidiary or a new division of the company. Only one company in the sample (case 10) established the corporate venturing model. Originally, this initiative was established as an idea generator, linked closely with central R&D, and later added incubation capabilities. It ultimately evolved into a more separated organizational structure when the CEO hired a president of radical innovation and new ventures. The new ventures model focused on driving the projects that were furthest along toward commercial reality and did not retain the idea-generation and early-incubation capabilities the original group had developed. For each venture, the leader structured advisory boards of mid- and upper-level managers in the company for purposes of ensuring their fit with the company's strategy and educating the operating management about growth businesses. The corporate venturing unit's initial mandate was to grow white-space businesses but evolved to a focus on filling the gaps in the product portfolios of the existing businesses. Ultimately the group's mandate expanded once again to

grow businesses that are outside the company's core businesses. These are typically set up as wholly owned subsidiaries rather than integrated in to the mainstream businesses. The initiatives and businesses were acquired from both internal and external sources and are nurtured until they can stand on their own in comparison to the company's other lines of business.

R&D management system (Figure 5). Though central R&D plays a major role in most of the sample cases, there were three cases in the sample for which central R&D was the sole organization in the company responsible for RI. In two cases (cases 1, 5), the corporation's central R&D function is principally dedicated to advancing radical innovation as opposed to most R&D functions who allocate the majority of their efforts to serving immediate and near-term needs of the business units. In the third case (case 4), R&D leadership does not differentiate the management processes they apply to radical and incremental innovation, and so radical innovation is not treated separately from any other R&D activity.

Companies 1 and 5 are both large organizations. Individual business units, which are large in their own right, possessed significant divisional R&D assets that were expected to support projects aligned completely with the divisions' immediate, near-term, and even further-term needs. This left central research with the responsibility for the radical innovations that would ultimately renew the company, whether or not they were aligned with a division, applied to multiple divisions, or required an entirely new organization to be formed. In case 4, the company simply does not differentiate their management processes for radical and incremental innovation, so all efforts were treated the same, and all development projects were handled within R&D rather than in the business units.

Because these systems possess a technology bias, the firms have created a number of mechanisms to increase market learning. One of the most interesting aspects of this structure is the emergence of an exploratory marketing group within central research. Companies 1, 4, and 5 are all experimenting with this model. Exploratory marketing's role is to learn about markets with which the firm is not familiar and to develop proposals for potential new businesses in those domains based on their knowledge of the R&D lab's technical richness.

Senior managers, including the CTO, play an extensive role in overseeing and evaluating ongoing progress of RI projects. Though R&D management models may identify and incubate both aligned and nonaligned projects, they develop close linkages with existing operating units to transfer moderately matured but aligned RI projects. In addition, in each of the three cases individuals were identified as responsible for incubating novel businesses that did not fit within the company's current organizational structure whereas the firm continued to explore and experiment not just with the technology but with a business proposition as well. All of this was done within the confines of the central research and development organization.

Self-similar model (Figure 6). In the model in Figure 6, a corporate-level RI organization is created and then mimicked with similar smaller-scale organizations throughout the firm. The term *self-similar* comes from the discipline of fractal geometry, which describes phenomena in nature that repeat themselves at different levels, as, for example, a snowflake's pattern that repeats itself at each more detailed level of observation within the snowflake itself. Only one case of a self-similar structure was observed (case 4). This structure requires a high level of senior-management involvement and company-wide investment in radical innovation. In case 4, a senior leadership team composed of the CTO, the CSO, and the controller of the company spend a combined 60 hours per month coaching, advising, and problem solving with a set of 10 to 15 RI fledgling businesses that appear to have the potential to impact multiple divisions across the company. They are accompanied by a staff of three or four coaches who help train the RI teams in market-learning, economic-modeling, and project-management approaches that are appropriate for RI. At the same time, a similar structure is set up within each division for projects that appear to have potential impact within that division specifically. Each division has an RI portfolio leader and small staff and also devotes the senior leaders' time to work with the division-level project teams. If a project within a division begins to exhibit opportunities that could be more broadly leveraged across the firm, it is identified as a corporate-level RI project and gets handled by the corporate-level group. Advisory boards for each project are composed with the necessary senior leaders on the board, depending on which divisions might benefit from the business opportunity.

The focus of this model is not on generating new ideas into the pipeline so much as on gaining clarity of strategy about how the business might be grown to

impact the company's growth rate significantly and on executing to those plans. Thus, the early ideas and high-uncertainty projects are not even considered in this system until they have attained some level of technical and market promise. More than other approaches, the self-similar model promotes radical innovation activities at both the corporate and divisional levels. Divisional senior executives are responsible for the creation of both incremental and radical innovations and are expected to be able to manage ambidextrously.

Mirrored model (Figure 7). In the model in Figure 7, observed in case 6, projects are identified, selected, and incubated within the R&D organization. But simultaneously, in whichever division that appears to be the appropriate receiving unit for a particular RI project, a complementary capability is developed, even before there is necessarily anything close to a marketable product. This complementary activity might be appropriately called an acceleration capability. A general manager is hired or appointed to begin building the infrastructure of the business, including searching for potential acquisition candidates, value-chain partners, and appropriate talent to bring into the organization. In case 6, as the advanced technology programs began to take shape and as one in particular became more clearly directed in terms of the types of businesses that the technology would enable, a general manager was hired from a well-known firm in the industry into which the new technology would take the company. Over a seven-month period, he negotiated the acquisition of a very large firm with complementary capabilities in distribution infrastructure and regulatory protocol for the highly regulated industry the firm would be entering. The business is taking shape so rapidly and is deviating so much from the receiving unit originally considered to be the best fit that the company has now formed an entirely new division within that operating unit. There are still no commercializable products or revenue streams from the research program housed in R&D, but their efforts are rather tightly focused on a suite of offerings.

The mirrored model is contrasted to the holistic sequential model (Figure 3) because whereas the former is designed to stimulate the development of complementary aspects of the commercial activity in the BU even as technology development is occurring, the holistic sequential model is paced more linearly. That is, little consideration is given to building the business prior to the time the technology has been developed into a product and tested in the marketplace.

What is clear from the descriptions of each of these models is that they vary rather widely given that all firms had the same declared strategic intent, that is, to develop a mature radical innovation capability. Each company in the sample evolved its organizational structure over time as it encountered challenges in commercializing its projects or changes in the company's mandate for the radical innovation initiative. As Chandler (1969) demonstrated, organizational structures evolve to fit company strategy. The present article now elaborates insights derived from tracing these organizational structures and their evolution over time.

Three Competencies for Radical Innovation

Tracing the organizational structures of the 12 cases and their evolution as they confronted particular challenges provides insight into the competencies required to develop a mature radical innovation capability. Three competencies were identified: discovery, incubation, and acceleration, each of which requires distinctive types of expertise and processes.

Discovery. A discovery capability involves activities that create, recognize, elaborate, and articulate RI opportunities. The skills needed are exploratory, conceptualization skills, both in terms of technical, scientific discovery and external hunting for opportunities. Discovery activities can include invention but need not always, according to the sample companies. Though the vast majority of companies in the sample invested in internally focused laboratory research, most also embrace the open-innovation concept promoted in recent literature (Chesbrough, 2004), including hunting inside and outside the company for ideas and opportunities and licensing technologies or placing equity investments in small firms that hold promise. Ten of the twelve participating companies are involved in each of these activities simultaneously to increase the opportunity space for radical innovation. Nine of the twelve firms noted external programs to locate outside opportunities through universities, venture capital investments, or strategic alliances.

A number of formal organizational roles and structures for creating, recognizing, and elaborating radical innovation opportunities within the discovery phase were observed. One company (case 9) employed a dedicated research staff responsible for developing radically innovative ideas. This alpha team

of idea generators was the oldest mechanism identified in the sample and had the lowest level of employee turnover. Other firms (cases 2, 4, 5, 10, 12) employed dedicated radical innovation hunters responsible for identifying radical innovations within internal or external environments. In case 10, for example, the RI group became the home for the founders of small companies the larger organization had acquired. The RI group found these people very valuable as idea hunters because (1) they had rich external networks due to their stature and previous activities as the founder of an organization; and (2) their skill at opportunity recognition given their entrepreneurial experience in starting up and running a company. One company, case 12, formed an externalization team devoted to the development of future trend analyses based on visits to universities and built a hunters' network of creative individuals throughout the company as well. In case 11, a permanent team of technical and business development middle managers comprised the technology identification process (TIP) team, challenged with finding new opportunities to help fuel R&D projects. As noted previously in the description of R&D management systems, three companies (cases 1, 4, 5) are experimenting with exploratory marketing groups, which serve as a mechanism to proactively discover radical innovation opportunities at the technology and market nexus. Finally, case 12 relied on an informal network of external contractors to generate and develop wild ideas and inventions. This network was maintained and funded by a senior executive who elected not to bring them within the company for fear that their creativity would be stifled.

Ideas come not just from the scientist's bench but also from groups of creative people within the organization, from idea hunters who uncover ideas inside and outside the organization, and from single creative individuals who may be maintained outside the organization but whose efforts are dedicated to the organization's needs. A broad spectrum of structural mechanisms exists to ensure a rich discovery competency for the company.

Incubation. The analysis also suggests that an incubation capability is necessary for radical innovation. Whereas discovery competencies generate or recognize RI opportunities, the incubation competency involves activity that matures radical opportunities into business proposals. A business proposal is a working hypothesis about what the technology platform could enable in the market, what the market space will ultimately look like, and what the business model will be. Incubation is not complete until that proposal—or, more likely, a number of proposals, based on the initial discovery—has been tested in the market, with a working prototype.

The skills needed for incubation are experimentation skills. Experiments are conducted not only on the technical front but also for market learning, market creation, and testing the business proposal's match with the company's strategic intent. In most sample companies, the vast majority of projects entering into the incubation phase were filtered out when the experiments failed for one reason or another, due to the high uncertainty associated with what initially appeared to be a promising opportunity. One RI portfolio manager described his frustration at the churn rate in the portfolio at the early phases of the projects, when they were moving from the idea phase to early technical and market experimentation. Still, he admitted how that was to be expected given the high level of innovativeness, and therefore risk, of the ideas.

Incubation was not systematically engaged in across the companies. Of the 12 companies, only one had a mature incubation capability at the outset of their RI initiative. Throughout the observation period, nine companies recognized the need for this activity and attempted to build it in some way. Some of them then deresourced incubation as their RI mandates evolved toward more aligned projects or as the RI group experienced financial pressure, indicating that incubation appears to be the most fragile and least understood of the three competencies.

Six of twelve companies (cases 2, 7, 9, 10, 11, 12) provided RI staff to help coach the project teams regarding business strategy as they evolved their business proposal, though the degree of coaches' involvement and their expertise varied widely across the cases. In addition, nine of the twelve firms formed formal governance or review panels to evaluate project progress. The sheer volume of proposals influences the nature and composition of these panels. Projects entering the incubation stage are numerous, and their evaluation and supervision require significant amounts of time and energy. The evaluation boards in cases 5 and 11 were initially composed of senior level executives, but these boards quickly realized that the project review time was just too great. They each instituted middle-manager review panels, composed of technical and sometimes business development personnel, to oversee the early selection and

incubation of these projects, electing to get involved only as projects gaining momentum required attention. Evaluation and review is different from incubation. Though most of the boards provided some oversight and helped break down barriers as needed, the competency to coach projects through the incubation period was a rare one in the observed cases. Table 3 indicates that only a small proportion of the cases ever achieved a high level of incubation competency, though, as shown in Table 2, many of the companies expressed lack of business acumen and inability to build businesses linked to the company's strategic intent as challenges they faced.

Acceleration. Acceleration activities ramp up the fledgling business to a point where it can stand on its own relative to other business platforms in the ultimate receiving unit. Whereas incubation reduces market and technical uncertainty through experimentation and learning, acceleration focuses on building a business to a level of some predictability in terms of sales and operations. As one radical innovation director noted, "I need a landing zone for projects that the business unit does not feel comfortable with. If I transfer these projects too early, the business unit leadership lets them die. I need a place to grow them until they can compete with ongoing businesses in the current operating units for resources and attention."

The skills needed are those required for managing high-growth businesses. Acceleration involves exploitation rather than either exploration, which discovery requires, or experimentation, which incubation requires. The activities of acceleration include investing to build the business and its necessary infrastructure, focusing and responding to market leads and opportunities, and beginning to institute repeatable processes for typical business processes such as manufacturing and order delivery, customer contact, and support. Acceleration involves turning early customer leads into a set of qualified customers and predictable sales forecasts. Similar to an independent start-up firm in first stage of growth, acceleration pursues top-line revenue rather than bottom-line profitability. In fact, in two cases (cases 2, 9) acceleration managers negotiated their performance metrics with senior leadership such that they are measured on sales growth rather than profitability, but in most other cases this negotiation has not taken place.

Once a radical innovation program is generating profitable returns, it can be integrated into an existing business unit with less chance of neglect, or it may become a stand-alone business unit or spin-out with profit and loss responsibilities. In the sample cases, some business accelerators (i.e., structures or groups devoted to growing small but highly promising opportunities) were permanent (cases 2, 4, 7, 9, 10, 11), and others were established to handle a single project on an exception basis (cases 1, 5, 6). The permanent operations divided into two subsets: (1) those located outside of the business units (cases 9, 10) to handle projects not aligned with any current business unit's operating model or market infrastructure; and (2)

Table 3. Discovery, Incubation, and Acceleration Competencies and Interface Management[a]

	Beginning of Observation Period				End of Observation Period			
Case	Discovery	Incubation	Acceleration	Interface	Discovery	Incubation	Acceleration	Interface
1	M	L	L	L	M	M	L	M
2	M	H	L	H	M	L	H	H
3	L	L	L	L	M	L	L	L
4	H	L	M	M	H	M	M	M
5	H	L	M	H	H	L	M	H
6	H	M	L	H	H	M	H	H
7	H	H	H	L	H	H	H	M
8	L	L	L	M	M	L	H	L
9	M	L	L	L	H	H	M	H
10	M	M	L	L	L	M	H	M
11	H	L	H	M	H	M	H	H
12	H	L	L	M	M	L	M	M
Summary								
Total High	5	2	2	3	5	2	6	5
Total Medium	5	2	2	4	6	5	4	5
Total Low	2	8	8	5	1	4	2	2

[a] H, high level of capability; M, medium level of capability; L, low level of capability.

those located within the operating unit (cases 2, 4, 7, 11) but managed separately and differently within the mainstream operations. Case 4, in fact, had a business unit solely devoted to new-growth businesses. Finally, cases 1, 5, and 6 managed each project as a unique initiative. They were nurtured through to substantial commercial revenues and remained in R&D for a part of that revenue-producing time. Some of the companies used a combination of these approaches over time as they encountered challenges in the high-investment, early-growth phase of their radical innovation initiatives. Cases 1 and 5, for example, initiated an acceleration program within the BUs but also had ad hoc, exception projects that represented distinct departures from the firm's current businesses.

Discovery, Incubation, and Acceleration Interfaces

Discovery, incubation, and acceleration competencies are difficult to develop. In addition, they do not ensure a successful RI capability. Table 3 lists the authors' evaluation of each company's capabilities for discovery, incubation, and acceleration and how those evolved over the three-year observation period. Firms were evaluated as having a high degree of competency in the area if they had evolved some processes and invested resources into that competency's development and were having success in that area. A medium level of competency was noted for firms where either (1) some success was occurring in the area despite a formal recognition or investment in the activity; or (2) investment in the activity was occurring so that a competency and infrastructure were being built. A low level of competency was noted for firms not engaged in the activity at all. These evaluations were presented to members of the larger research team for validation and were debated until discrepancies were resolved.

One insight emerging from the debate was that in addition to the criticality of the three competency sets for enabling radical innovation, managing the interfaces across those competency domains and activities is crucial. This is particularly important for firms that do not incorporate all three competencies under the same organizational umbrella. Therefore, an evaluation of how the firms managed those interfaces is incorporated into the analysis.

Case 7 represents the single case rating high on each of the three competencies, but the links between the discovery and incubation functions are weak. In follow-up interviews they noted that the pipeline for new ideas had not been developed, and they eventually hired an additional team member to work with R&D and other organizational units to help strengthen the flow of ideas into the RI management system.

It is clear from Table 3 that incubation is the biggest challenge for the firms as a whole, with only two firms rated as highly capable throughout the observation period, although several more improved this capability over time. The summary table indicates an overall improvement in the three capabilities among the firms over time, indicating that firms are attending to the development of these competencies as they encounter the challenges associated with commercializing RI.

Patterns were also observed in the links between competency weaknesses shown in Table 3 and the challenges firms noted in Table 2. Firms rated low on the discovery capability typically complained of not having big enough ideas. Firms with low incubation ratings complained of a lack of marketing expertise and business acumen. And firms with a weak acceleration capability complained of poor connectedness and lack of credibility with the BUs. These grew frustrated when promising projects did not receive appropriate investment and fell off the radar screen due to the pressures BUs experienced to deliver high current-period profits. A number of firms moved projects from discovery to acceleration while ignoring the experimental business activity of incubation that could expand the opportunity space. Projects that may have grown into entirely new businesses were narrowly focused into a product line that fit neatly within a current business.

RI's Mandate Influences Its Organizational Structure

The strategic importance of white space, or unaligned, innovations strongly impacts the organizational structure adopted for the radical innovation initiative. As documented in the literature (Meyers and Tucker, 1989), companies must determine the scope of their RI strategies. Strategies may be narrowly bounded by existing business spaces, with appropriate RI projects fitting within existing operating units. Narrowly bounded strategies tend to ignore peripheral opportunities that emerge in the uncertain, unpredictable project-maturation process. By comparison, the mandate for the RI initiative may require the pursuit of unaligned opportunities to build businesses in arenas that leverage some of the firm's capabilities but may require it to develop many new ones and to move into

unknown territory. These projects may fit within the strategic intent of the company but may lead to the commercialization of projects that do not fit nicely into existing operating units and that challenge current business models. Two of the twelve firms expressly limited their radical innovation initiatives to existing aligned opportunities (cases 6, 12). In these cases, radical innovation projects were screened to remove nonaligned, or white-space, projects from the overall portfolio.

Firms with a strategic intent to only pursue aligned projects developed the most limited organizational systems. Given the narrow scope of their selected projects, senior executives were unwilling to invest in substantial organizational capabilities. Radical innovation discovery efforts tended to be conducted by a limited numbers of individuals. These firms relied exclusively on existing business units to lead acceleration efforts, regardless, in one case, of the BU's lack of new business creation expertise and near-term priorities. Managers from each of these companies expressed reservations about relying on exiting business units because of their tendencies to starve nascent businesses of resources and talent to focus on their mature existing operations. One company expressed an interest in keeping aligned projects outside existing business unit until they were self-sufficient, profit-making businesses.

Firms with a strategic intent to pursue unaligned projects developed more elaborate organizational structures and systems over the observation period. Acceleration, in particular, became important as the systems matured. This is no surprise since the transition of RI projects outside the firm's current markets and familiar business models are the greatest challenge. As noted previously, multiple organizational forms for acceleration were observed including an accelerator within R&D reporting to the CTO and senior leadership team, a single division responsible for growing businesses initiated within the RI system, and acceleration activities within one or more BUs, with senior-leader governance. This latter option poses specific challenges. In case 2, for example, the company established accelerators within the operating units, but at this time only one of them is managed by a person with enough new business creation sophistication to gain the RI incubator leader's attention. The incubator leader is therefore transitioning opportunities to this person to accelerate that do not fit that business unit and may, in fact, fit other business units better. Thus, in this case the structure being used for acceleration may not make sense from an organizational design perspective but, from a practical matter, may be the best way for the RI management team to demonstrate the imperative for a highly developed acceleration function.

Operating Units' Mandates Influence RI Organizational Structure

Senior management's perceptions of the appropriate degree of business unit ambidexterity—the ability of business unit managers to simultaneously advance radical innovation initiatives while conducting daily operational functions—impacts the RI system's organizational structure. Case 7, specifically, represents the self-similar model, wherein each division has a radical innovation infrastructure of its own and is therefore responsible for investing in high-risk, high-uncertainty projects that most operating units in most large established firms ignore. Senior leadership commented that any individual in the company identified as having the potential to move into general management, either at the divisional or corporate level, is expected to manage ambidextrously—that is, both for today and the future. The company has invested heavily in training all general managers to develop the language distinctions for incremental, near-term versus more radical innovation and has put in place a management system that supports this behavior. In every other sample company, interviewees declare their belief that some individuals are suited for the higher-uncertainty activities associated with radical innovation and that others are better suited for operational challenges. This is reflected in the fact that the vast majority of the other companies in the sample have a single identified organizational group responsible for making radical innovation happen in the company or a set of groups responsible for discovery, incubation, and acceleration rather than expecting each group to handle all of these activities.

Discussion

The seven organizational structure models identified can be viewed in terms of their strengths and weaknesses with respect to coverage of the discovery, incubation, and acceleration competencies. The idea generation model focuses exclusively on discovery competencies. Firms in the sample using this model were seeking to develop and upgrade the firm's abilities

to generate RI opportunities. These organizations possessed no incubation or acceleration competencies within the RI management systems and struggled to transition their most promising initiatives to existing operating units or central R&D. Hence, an effective idea generator could improve the number and quality of RI ideas evaluated by the company, but the ability of the firm to incubate and then to grow these initiatives depended on successful interfaces between the idea-generating capability and existing operating units, thereby confining the idea generator to promote opportunities that were aligned with current business units' markets and business models.

The incubation model focuses on competencies related to both discovery and incubation. It does not provide for acceleration, and in fact, sample firms employing an incubator model and pursuing unaligned radical innovation opportunities were seeking to develop acceleration organizational mechanisms to increase competencies for RI commercialization.

The holistic sequential model focuses on all three competencies of discovery, incubation, and acceleration, but the process it is structured to handle is one in which a project passes through the groups as a phased activity. The ability of this structure to successfully commercialize RI projects depends on successfully interfacing the groups responsible for discovery, incubation, and acceleration and on a corporate commitment to fund and enable unaligned white-space opportunities.

The corporate venture model focuses on acceleration. This organizational structure's deemphasis of discovery and, to a lesser degree, incubation, limits a company's selection of promising radical innovation opportunities. It tends to select the most obvious, mature initiatives, which may not be radical at all but are growth opportunities in existent markets with known technologies. The respondent in this case noted at the end of the observation period that she believed the firm was going to shut down the corporate venturing unit because it had served the purpose of growing two new businesses for the company that, while related, could not be assimilated into the company. No pipeline of projects or business opportunities had been established given the focus on growing the two initially placed there.

The R&D management model focuses on discovery primarily and adds some incubation activity within the R&D department. It is employed by companies who organize their R&D groups specifically around the management of radical innovation and do not view the role of central R&D as serving the BU's immediate engineering development needs. To accomplish this, R&D operations expand beyond their traditional strengths in discovery. They develop incubation competencies, which require greater business development skills, and also seek to keep relationships tight with BUs so that transitioned projects are not dropped. In both of the sample cases of this model, the RI governance board was composed of senior leaders from the BUs so that long-term strategic planning at the BU level could incorporate the new radical innovations R&D was nurturing. Acceleration of unaligned projects, however, proves challenging. In one case (case 4), an entire business unit is dedicated to the task of growing new unaligned fledgling businesses. Both firms were developing mechanisms to improve their incubation competencies, principally by increasing business development expertise.

The self-similar model focuses on incubation and acceleration competencies, which are distributed throughout the organization. The firm employing this model enhanced its linkages with the discovery arm of the company to increase the quantity and quality of ideas coming into the system because of a perceived weakness in that linkage. Finally, the mirrored model is unique in that it simultaneously develops both discovery and acceleration. High-level executives identify technology and market platforms in which the company should compete. Central R&D immediately focuses on these platforms, and the operating units create the infrastructure for the future business, as described earlier. The incubation capability is important to consider proactively in this model, given the proclivity to transition projects immediately into a clear identifiable home without necessary exploration of alternative business opportunities that may arise as a consequence.

Conclusions, Implications, and Future Research

To consider organizational structure as a venue for capability development is new in the management of innovation and dynamic capabilities literatures. However, marketing was once handled as an art and then as a process and eventually became its own function in the firm. Corporate strategy is similarly becoming a function in many companies today, evolving from an art of leadership and then from a planning process. Innovation—meaning scope-changing innovation—

may be moving in a similar direction. As more and more firms increase the investment they make in developing an innovation capability via formal structures and roles, it appears that innovation may be evolving as a function unto itself.

In the last 10 years, there has been an increased emphasis on the part of large, established firms to build a sustainable capability for breakthrough innovation. Due to its chaotic, highly uncertain nature, clarifying only processes for managing RI is not adequate. Firms identified a group responsible for making RI happen and struggling with identifying appropriate talent, metrics, and governance systems for the group. Fast's (1979) observation that new venture divisions last, on average, four years is being revisited. Whether separate divisions are the appropriate structure is an issue raised herein. One question firms who seek high levels of innovation face is how they might benefit from those investments by managing the balance between protection from the operational mainstream and interaction with it. Location in the firm, reporting relationships, roles and responsibilities, and size of the portfolio are issues that the firms in this sample struggled with over the observation period, and the organizational forms reported herein represent the approaches taken to strengthen their RI capabilities.

This analysis explores both the organizational structure mechanisms and required competencies necessary to develop a mature RI capability. The data suggest that three competencies are required to develop a mature radical innovation capability. The vast majority of sample firms did establish identifiable organizational groups to enable the repeated commercialization of radical innovation. Most of these firms' approaches, however, do not incorporate each of the three competencies. From a dynamics perspective, individual firms in the sample have improved their competencies through the enrichment of their organizational structures or, in some cases, their evolution to new ones that allowed for incubation and acceleration.

Previous literature notes the great difficulty of large established firms' success in developing radical innovations within their boundaries (Campbell et al., 2003; Zollo and Winter, 2000). In fact, much of the literature calls for separate divisions, external incubators, or investments in small start-up firms as the source of organizational rejuvenation (Benner and Tushman, 2003; Burgelman and Sayles, 1986; Campbell et al., 2003). The literature is replete with anecdotes about the failure of these options, however, in terms of their ability to impact the mother company's strategic business domains (Burgelman, 1985; Kanter, 1985), yet authors continue to propose models and call for more work into how these interfaces can be appropriately managed (Heller, 1999; Jelinek and Schoonhoven, 1993; Leifer et al., 2001; Sharma, 2002). This study explores one dimension of a management system: organizational structures employed to assist firms toward this goal. Though previous research has explored the importance of organizational structures in commercializing radical innovation, particularly whether radical innovations should be developed outside or inside the corporate mainstream, none have linked the organizational structure choice firms make to capability development, which has emerged from these data.

The findings from the article, then, contribute to theories of innovation management by identifying the discovery, incubation, and acceleration capabilities and demonstrating firms' processes for maturing those capabilities. Most firms in the sample could not consider incubation at the outset. They needed to hone discovery. It is through frustration with a lack of commercial success that the additional competencies are developed and that organizational legitimacy, through the formation of a new identified group (i.e., an incubation or acceleration function), is granted.

This work also contributes to dynamic capability theory in high-uncertainty environments. Eisenhardt and Martin (2000) note that elaborate processes are not appropriate for high-velocity and high-uncertainty domains. They mention simple rules as an important way to begin. This research suggests, in addition, that organizational structures that legitimize transformational experiences (King and Tucci, 2002), situation-specific learning (Eisenhardt and Martin, 2000), experience accumulation (Argote, 1999) and simple, appropriate rules (Dougherty, 1995) help build a capability that is not lost from one radical innovation champion to the next. The reflective aspect of learning (Kogut and Zander, 1992) was enabled because dedicated people were accountable for making their organizational unit, the radical innovation unit, successful. As Jelinek and Schoonhoven (1993) proposed, innovation cannot happen without both discipline and creativity. Accountability, driven by organizational ownership, enables the discipline, and organizational ownership allows the independence necessary to develop appropriate processes to enable creativity.

The Discovery–Incubation–Acceleration framework, including both competencies and competency transitions, represents a unique dimension for future theoretical and applied research into the effective development of radical innovation capabilities. The link between organizational structures and the RI competencies opens a new area of research. There is much to be learned about the transience of these structures, the different capabilities required for each, and, probably more importantly, the interfaces among them and between them and the mainstream organization. Finally, as noted in the previous literature review, organizational structures represent one means for companies to develop RI capabilities. Future research should develop insights into alternative levers that interact with the RI organization to develop the complete array of RI competencies.

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