DIAGNOSING RISK IN RADICAL INNOVATION PROJECTS

Both ambiguous and unambiguous risks have been identified from case studies. Here's what you can do about them.

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OVERVIEW: *Radical innovation projects are inherently risky. A number of in-depth case studies have been carried out to identify the kinds of risk that are characteristic of this type of new product development project. Two kinds of risk were identified. The first—unambiguous risk—was high for three basic questions: 1) Will the new product perform according to specifications (balance between the product components and functional product format)? 2) Can we rely on our suppliers (quality and contract arrangements)? 3) Will consumers adopt the new product (fit with standards and demands, and fit with habits and user conditions)? The second kind of risk—ambiguous risk—included risks for which there were strong differences of opinion concerning internal organization and project management. These results provide guidelines that can help industrial R&D managers improve their companies' innovation capabilities.*

KEY CONCEPTS: *risk diagnosis, new product development, radical innovation.*

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Radical innovation is a risky business. The revenues can be huge, but highly uncertain, while the hit rates are low and the costs of failure often very high. Yet, many companies face considerable pressure to engage in radical innovation efforts in order to gain and maintain competitive advantage (*1–4*). Because an innovation strategy based on risk avoidance cannot be an option, proactive risk management is needed in which risks are identified in the early phases of product development when there is still time to influence the course of events (*5,6*).

Radical and incremental innovation projects differ on different project dimensions. Radical innovation life cycles are longer, more unpredictable, have more stops and starts, are more context-dependent in that strategic considerations can accelerate, retard or terminate progress, and more often include cross-functional and or cross-unit teamwork. Incremental projects are more linear and predictable, with fewer resource uncertainties, including simpler collaboration relationships (*3,7,8*).

Radical and incremental innovations also differ with respect to the results they are meant to realize. Radical efforts involve discontinuous development, with which unprecedented improvements or performance features are achieved (*8,9,10*). They also differ with respect to the

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basic assessment criteria applied at the start and at monitoring or review points during the life cycles of the different projects (*11*). The focus of the criteria applied to incremental projects is on the return to the firm within a predetermined timeframe: What is the profit impact? How fast will it grow? How much market share can we expect? In contrast, the key criteria regarding radical projects relate to the return of new value to the market: What impact can this new technology have on the market? What will this new technology enable? Will this technology deliver the benefits that are desired?

Projects of both types can be continued or terminated wrongly if the underlying differences in risk are not recognized. The research reported in this article examines which risks are associated with radical innovations and how these risks can be conceptualized and measured in a managerially and methodologically sound way. Although there is a respectable literature on risk perception, risk behavior and risk-taking propensities, an accepted model of strategic risk-taking that recognizes the contextual interplay among decision makers, organizational processes, and market and industry factors that influence judgments of risk and strategic risk-taking is still lacking (*12*). And while many innovation management studies indicate that radical innovations are highly risky but widely accepted, practical measures of risk in product innovation are also lacking.

The aim of this study was to find out which risks are associated with radical innovation projects if a risk conceptualization is applied that specifically fits the characteristics of such projects. We begin by examining and clarifying the key concepts of radical innovation and risk. Then, we explain the method used in the empirical research and present the results and analyses. Finally, based on our findings, we suggest actions for industrial R&D managers to consider.

Radical Innovation Risks

In radical innovation, unprecedented improvements or performance features are achieved, representing major changes in technology regarding materials and functions, newness to the market, and substantial time and cost (*7,9,10,13*). The "major changes" strongly relate to what we understand as the conceptual basis of risk in radical innovation projects (*14*). Risk can be described as a three-dimensional concept, involving: outcome uncertainty, level of control and perceived impact on the desired project performance.

Outcome uncertainty is associated with gaps between available and required knowledge, skills and experience, whether concerning technological, market, operational, or financial factors (*15*). *Level of control* is involved because of the dynamic process in which managers influence anticipated risk factors that might jeopardize the success of intended radical innovation projects (*16*). The *perceived impact on the desired project performance* has been included in the definition of risk because studies indicate that the performance and aspiration constructs found in the behavioral theory of the firm are central to managers' concepts of risk (*17–19*).

Risk involves outcome uncertainty, level of control and perceived impact on project performance.

This implies that an innovation issue will be defined as "risky" if the perceived:

- *certainty is low;* i.e., probability of a satisfying solution for the innovation issue is low.
- *controllability is low;* i.e., ability of the innovation team to influence the course of action in such a way that a satisfactory solution can be realized within the project's time and resource limits is small ("influenceability").
- *relative importance is high;* i.e., not achieving a satisfactory solution for the innovation issue may jeopardize the desired project performance.

How the Research Was Conducted

Our research consisted of eight in-depth radical innovation case studies in the fast-moving consumer sector. We had the rare opportunity of interviewing the individual members of the respective project teams to get an overview of the risks that participants in such teams perceived. The formal risk assessment process was carried out using the Risk Diagnosing Methodology, *RDM* (*20,21*).

RDM was initiated, developed and tested within a division of a multinational company in the audio, video and lighting industry having 160,000 employees in over 60 countries and 2004 sales of €30.3 billion. More than 8,500 people work on research and development, in which the company invests over US $900 million each year. On the basis of the results, the senior vice president (R&D) decided to include the method in the company's standard innovation procedures. Since then, RDM has been applied to product innovation projects in areas as

diverse as automobile tires, ship propellers, printing equipment, and landing gear systems.

Although our study involved only one company, we believe the findings are applicable to other companies and sectors because they provide a generic method for systematically diagnosing project-specific issues, as well as showing how to move beyond and search for structural weaknesses in a company's innovation process.

Our research was conducted in four successive steps: literature review, interviews, questionnaire, and content analysis.

In the literature review, we identified the competences researchers have identified as critical for the success of radical innovation projects. The critical competences—risky if not sufficiently available—appeared to relate to strategy (technology as well as market strategy), product characteristics and production processes, human capabilities, internal organization, and knowledge. Apart and together these competences constitute the organizational backbone of successful radical innovation.

In the second step, the 114 members of the eight different project teams were interviewed (Table 1). Each interviewee was asked to state, on the basis of his position and responsibility within the project, the intended result and what he considered to be the main gaps in his knowledge, skills and/or experience. After this, the interviewee was invited to look across functional borders at issues in and around the project and the project team as a whole. The interview was completed by presenting a list of potentially critical issues from the literature review carried out in the first step of this research. The respondent was asked to check whether the interview had been complete and, if not, to add the missing pieces.

Next, to evaluate the seriousness of the identified potential risk factors, the interviewees were asked to give their second-thought judgment in a risk questionnaire. Each respondent scored (on a 1–5 point scale) each of the identified potential risk factors of his own project on the three risk dimensions: 1) Certainty that an appropriate solution for a particular technical problem could be found (score 1 = very low certainty, 5 = very high certainty); 2) Controllability or ability to realize a certain solution within time and resource constraints (1 = very low ability, 5 = very high ability); 3) Likely impact of the identified risk factor on the overall success of the business, in general, and the innovation project, in particular (1 = very high impact, 5 = very low impact).

Finally, to enable drawing cross-case conclusions, we carried out a content analysis (*22*) to identify the risks that are characteristic for the totality of radical innovation projects in the study. The risks recorded in the individual interviews were checked against the potential risks drafted on the basis of our literature review. Then, two researchers independently went through all 653 perceived project risks to determine for each risk whether it matched an issue on the list. After this, the researchers compared their outcomes and discussed any differences. In cases where consensus could not be reached, a third researcher knowledgeable about innovation management served as a referee and determined the final coding. The outcome of this process was a list of radical innovation risks in 12 categories with 142 critical innovation issues (Table 2).

Table 1.—Project Teams and Risk Issues

Project Name	Number of Participants	Number of Risk Issues
Sparrow	12	53
Starling	21	179
Gull	19	96
Finch	13	71
Woodpecker	15	120
Blackbird	13	51
Magpie	8	24
Rook	13	59
Totals	**114**	**653**

What We Learned

Inspection revealed that the projects have specific risk profiles. For instance, projects Starling and Woodpecker included several "Manufacturing Technology" risks, while in Magpie not one risk issue within this category was identified.

What Are the Most Frequently Identified Risks Within These Radical Innovation Projects?

We ranked all risks according to how often they were identified by the interviewees. Table 3 lists the ten most

Table 2.—The 12 Radical Innovation Risk Categories

Risk Category	Critical Innovation Issues per Risk Category
1. Product Family and Brand Positioning	13
2. Product Technology	11
3. Manufacturing Technology	12
4. Intellectual Property	7
5. Supply Chain and Sourcing	11
6. Consumer Acceptance and Marketing	16
7. Trade Customer	10
8. Competitors	9
9. Commercial Viability	17
10. Organization and Project Management	22
11. External	8
12. Screening and Appraisal	6
Total	**142**

frequently identified risks and the categories to which they belong. Obviously, these risks reflect the specific characteristics of the fast-moving consumer goods industry.

What Are the Most Serious Risks in Radical Innovation Projects?

As explained above, for each identified potential risk, interviewees were asked to rank the level of uncertainty, ability to reach a satisfactory solution within time and resource constraints, and impact of the risk factor on project success. Following that, for every risk statement, the scores for the three evaluation parameters were summarized and expressed as a "risk score" in accordance with the distribution of the respondents' scores over the five-point scales. Four possible outcomes can be distinguished for every evaluation parameter by using the following decision rules:

- Consensus on high risk ("+"): At least 50% of the scores are 1 or 2 (1 being "very risky"), and there are no scores of 5.
- Consensus on low risk ("0"): At least 50% of the scores are 4 or 5 and there are no scores of 1.
- Consensus on medium risk ("M"): At least 50% of the scores are 3 and there are no scores of 1 or 5.
- Lack of consensus on risk ("?") For all remaining cases there is a wide distribution of opinions. After discussion with the interviewees, the "?" scores may be changed to one of the other three risk scores.

In the next step, each risk statement was classified into a "risk class" by examining the assigned risk scores on the evaluation parameters. RDM uses five risk classes: S = safe, L = low, M = medium, H = high, F = fatal. For example, a combination of risk scores +,+,+ on a given risk would result in its being viewed as extremely risky, and not lessening this risk would be fatal for the project (which would then be assigned a risk class of F). The combination +,0,+ can be classified as highly risky (risk class H), and the combination 0,0,0 can be classified as safe (risk class S).

The total number of possible combinations of risk scores is 64, all of which are worked out in the RDM manual (*21*). If there is a distribution of opinions, the risk score can be represented by a range between the lowest and highest risk class that can be reached if the respondents achieve consensus (e.g., L–M, H–F and so on).

Across the eight projects, the analysis enabled us to determine, for each of the three dimensions, those issues that respondents overall perceived as most risky. Tables 4–6 present the highest risks on the three dimensions in our project sample. "Highest" means here that they were scored on the respective risk dimensions higher than the mean and median on the five-point scales used in the questionnaire.

Table 4 shows the principal risks measured on the "level of certainty" risk dimension. The lower the certainty, the higher the risk. Issues associated with *performance of the new product* and a *realistic sales perspective* are among the riskiest. In the feasibility phase of a project (the phase in which the interviews were held) these categories are by definition the most difficult to predict.

Table 5 shows the risks on the second dimension of risk: controllability or influenceability. The lower

Table 3.—Ten Most Frequently Identified Risks

Rank	Frequency	Risk Issue	Risk Category
1	26	Ensuring the new product meets target consumers' needs	Consumer Acceptance and Marketing
2	23	Organization and management of the project	Organization and Project Management
3	22	Stability of the product, while in storage in production plant, in shop/warehouse, during transportation, or at home	Product Technology
4	18	Quality and safety requirements of production system (facilities and personnel)	Manufacturing Technology
5	16	Constant and predictable quality of supply by suppliers	Supply Chain
6	15	Possible negative external reactions by key opinion makers or interest groups	External Risks
7	14	Adequate production means (equipment and tools) available when needed	Manufacturing Technology
8	13	New product fulfils intended functions	Product Technology
9	13	New product meets consumer standards and demands	Commercial Viability
10	12	New product's appeal to generally accepted values (health, safety, nature, environmental issues)	Consumer Acceptance

the influenceability, the higher the risk. It is not surprising that issues like *ability to foresee competitors' future challenges* and *easy-to-use advantages compared to competing products* are perceived as risky in terms of influenceability since they are almost completely out of the project team's reach. In this table we also find some issues for which the commitment and combined efforts of several departments within the organization and even outside the company are required: *supplier's readiness to accept modifications if required,* and *strategy to follow with respect to possible sharing of patents.*

Finally, Table 6 presents the highest risks on the impact dimension. The more important bridging a particular gap in knowledge, skills and or experience is for the eventual success of a radical innovation, the riskier the underlying issue is for the project involved. The radical projects cannot be successful if these objectives cannot be realized.

Tables 4–6 show how the risks measured across the three dimensions differ. Issues that are perceived as risky on one dimension are not necessarily perceived as risky on the other two risk dimensions.

Table 4.—Radical Innovation Project Issues Perceived as Highly Uncertain (based on scale of 1 = no certainty, 2 = low certainty, 3 = moderate certainty, 4 = high certainty, 5 = very high certainty)

Risk Category	Specific Risks	Mean (St. Dev.)	Median
Product Technology	Performance compared to other products	1.67 (0.70)	2.00
Commercial Viability	Clear and reliable volume estimates	2.11 (1.20)	1.50
Commercial Viability	Realistic sales perspective	2.17 (1.17)	2.00
Supply Chain and Sourcing	Contingency options for each selected supplier	2.37 (1.12)	2.00
Intellectual Property	Knowledge of relevant patent issues	2.44 (0.79)	2.00
Intellectual Property	Patent-sharing potential	2.56 (0.90)	3.00
Organization and Project Management	Project mission and goals clearly specified and feasible	2.57 (1.38)	2.50
Competitors	New product enabling creation of potential barriers for competitors	2.63 (1.29)	2.00
Intellectual Property	Trademark registration potential	2.67 (1.09)	3.00
Supply Chain and Sourcing	Appropriate contract arrangements with suppliers	2.67 (1.13)	2.50

Table 5.—Radical Innovation Project Issues Perceived as Minimally Controllable (1 = none, 2 = low controllability, 3 = moderate, 4 = high, 5 = very high)

Risk Category	Specific Risks	Mean (St. Dev.)	Median
Supply Chain and Sourcing	Supplier's readiness to accept modifications if required	1.83 (0.69)	2.00
Competitors	New product enabling creation of potential barriers for competitors	2.28 (0.66)	2.50
Intellectual Property	Patent-sharing potential	2.27 (1.01)	2.50
Product Family and Brand Positioning	Contribution to project portfolio	2.32 (1.17)	2.00
Competitors	Ability to foresee competitor's future challenges	2.35 (1.15)	2.00
Consumer Acceptance and Marketing	New product offering easy-in-use advantages compared to competitive products	2.61 (0.95)	2.50
External Risks	Relevant environmental issues identified	2.61 (1.06)	3.00
Commercial Viability	New product's commercial viability in light of required repeat sales	2.67 (1.07)	2.00

Table 6.—Radical Innovation Project Issues Perceived as Having the Highest Impact on Project Success (1 = very high, 2 = high, 3 = moderate, 4 = low, 5 = none)

Risk Category	Specific Risks	Mean (St. Dev.)	Median
Customer Acceptance and Marketing	Meeting consumer needs	1.30 (0.46)	1.00
Commercial Viability	Product viability due to repeat sales	1.33 (0.60)	1.00
Commercial Viability	Realistic sales perspective	1.37 (0.58)	1.00
Consumer Acceptance and Marketing	Efficacy of advertising	1.40 (0.49)	1.00
Intellectual Property	Availability of required external licenses	1.55 (0.66)	1.00
Product Technology	Product format meeting requirements	1.57 (0.94)	1.00
Intellectual Property	Knowledge of relevant patent issues	1.63 (0.70)	1.50
Supply Chain and Sourcing	Appropriate contract arrangements with suppliers	1.66 (0.67)	2.00
Intellectual Property	Dependency on third-party development	1.66 (0.87)	2.00
Commercial Viability	Long-term market potential	1.75 (0.83)	2.00

Which issues were perceived as highly risky in all projects and which issues got a mixed reception from the members of the different innovation teams? The data allow us to draw some conclusions across the three risk dimensions implied in our risk definition. A distinction can be made between unambiguous risks (risks unanimously scored high on the three dimensions in all projects) and ambiguous risks (risks scored high by some and low by others).

Table 7 shows the unambiguous risks as well as the risks on which respondents diverged the most (ambiguous).

Table 7 makes clear that across the eight projects, only a limited number of risks can be considered as generic radical innovation project risks. This means that even different projects within one company, where projects may be assumed to have some convergence in technology, organization and markets, share only a limited number of high risks.

The *unambiguous risks* relate to three basic questions: 1) Will the new product perform according to specifications (balance between the product components and functional product format)? 2) Can we rely on our suppliers (quality and contract arrangements)? and 3) Will consumers adopt the new product (fit with standards and demands, and fit with habits and user conditions)? Within our sample of projects, these issues are seen as highly risky.

The short list of *ambiguous risks* contains risks for which there were strong differences of opinion. Some project team members perceived them as highly risky while others saw them as not risky at all. Among these risks we find four that relate to internal organization and project management. None of these internal risks is found among the unambiguous risks. Apparently, people have different opinions about the effectiveness of their own organization and project management, whose strengths and weaknesses they know. Together with the other ambiguous risks—contingency options, fulfilling customer needs, etc.—these risks relate to qualities and requirements for which it is difficult to decide whether they will be fully met during the project life cycle.

Issues associated with performance of the new product and realistic sales perspective are among the riskiest.

Implications for Industrial R&D Managers

Our application of a systematic risk diagnosing method to radical innovation projects suggests several actions R&D managers could take.

1. *Be Conscious of Ambiguous Risks.*
In general, the unambiguous risks will be no surprise. The revelation is that there are also ambiguous risks that one or more team members perceive as highly relevant while others do not. These ambiguous risks could be truly threatening. The literature on group dynamics like escalation of commitment and group think reveals that

Table 7.—Ambiguous and Unambiguous Risks Across Eight Radical Innovation Projects

Ambiguous Risks		Unambiguous Risks	
Category	**Risk**	**Category**	**Risk**
Supply Chain and Sourcing	• Contingency options for each of the selected suppliers	Product Technology	• Correct balance between different product components • Product format meets functional requirements
Consumer Acceptance and Marketing	• Meeting needs of target consumers	Supply Chain and Sourcing	• Constant and predictable quality guaranteed • Appropriate contract arrangements with suppliers
Organization and Project Management	• Roles, tasks and responsibilities well defined within the team • Team organization and management • Communication between members of the team • Reliable estimates of required resources	Consumer Acceptance and Marketing	• Product specifications in accordance with consumer standards and demands • Product requires changes in consumer habits and/or user conditions

project failures often relate to the unwillingness or inability of organization members to communicate about the issues that eventually jeopardize project success. R&D managers should anticipate this behavior by encouraging the use of a risk-diagnostic approach in which people feel stimulated to bring forward what they perceive as risky, irrespective of what others think. The individual interviews applied in the RDM provide such an approach.

2. *Take an Integrated Perspective.*
This study also shows that risks in radical innovation projects are not only of a technical nature. Market, Finance and Operations appear to be comparably threatening. A comprehensive RDM addresses these types of project risks equally. We advise R&D managers to take a cross-functional perspective by assigning risk assessment to teams that include these diverse types of functional expertise.

3. *Take a Systematic Rather Than Impulsive Approach.*
Risk methods differ in the way risks are identified. In RDM, each interviewee is asked to reflect about the project as a whole as well as its parts and to indicate which issues might endanger the project in question. Respondents are asked to prepare for the interview by studying a company-specific risk reference list as well as their own project plan. This interview outline has deliberately been chosen to stay away from "shooting from the hip" brainstorming sessions in which people only record what they think of spontaneously.

4. *Make Use of Risk Facilitators.*
Our study made clear that it is useful to have a risk diagnosing facilitator who may be either a trained internal person who is not a member of the project team and has no direct stake in the project, or an outside consultant with state-of-the art knowledge of product innovation. Some companies have process support specialists available for this task; others invite a project manager to be facilitator for a related project. The key issue appears to be that individual interviews should not be taken by the project manager. Any suggestion that individuals are being judged should be avoided.

5. *Learn From Experience.*
The value of a single risk diagnosis is that it discloses the weaknesses of the project in question. The outcomes can be useful in developing creative and effective risk management actions that can still make the project a success. The application of a risk diagnosis on different projects within one company provides insight into the structural weaknesses of that company with respect to breakthrough projects but also to projects of a less radical nature. This accumulated knowledge is an extremely useful input to starting future projects. This will yield the necessary data to accelerate learning, to increase a company's innovation capabilities and hence its innovation success.

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