HOW TO MANAGE TECHNICAL RISKS

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Abstract: This paper deals with the concept of technical risk, defined as the likelihood of failure in a technical project. We discuss here about failure and success in terms of objectives: institutional, personal or objectives defined at the level of the project (meaning the objectives of the technical project itself).

Keywords: technical risk, uncertainty, success, failure, objectives, project, development

1. RISK AND UNCERTAINTY IN TECHNICAL PROJECTS

The ability to describe the risk of failure inherent in many technical projects implies some prior experience. It is not possible to talk about a given project having, for example, a 20% probability of success in the absence of some cumulated prior experience. To the extent that a technical team is attempting to overcome a challenge that is truly novel, it is more properly to say to be facing uncertainty rather than risk.

The distinction between risks and uncertainty is not only an academic one. Where probabilities of failure can be reliably calculated, conditional on observable facts, risks can be easily managed. If technical projects were mere spins of the roulette wheel, a few dozen trips to the table would suffcicient to yield a payoff for any given number chosen at random. This is not the case similar to early-stage, high- risk technical projects.

Uncertainty describes the absence of sufficient information to predict the outcome of a project. Uncertainty and risk are quite different. Risks offers great harm; uncertainty offers great opportunity. Where risk is quantification of potential failure, uncertainty is the context for the opportunities that drive innovation from the outset.

The quantification of technical risk is as much of an art as it is a science: the elements of technical risk are not easily characterized, since real technical risk involves

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a forecast of how science will pan out when real people conduct experimentation, interpret results, and apply them in real situation. The elements of technical risk are chaotic, in that they are dependent on people and environment, as well as the laws of science, some of which are known, and some of which are unknown at any point in time. The elements of technical risk are not independent of one another – actions to understand and mitigate risk are interrelated through the laws of science, patterns of rational processes and the personalities of people involved. Risk can be characterized as a probability of success, but it is always a probability given a set of premises, an expected environment, and a pattern of response with a correlated expectation of success.

There are many well-established methodologies for assessing technical risk, but the consensus of the practitioners was that none of the assessing risk methods are very successful, but the effort to understand the sources of risk is very important to risk management.

The difficulty of quantifying the uncertainties associated with early-stage technical projects is only one of the conceptual difficulties with a statistically based definition of technical risk. A second difficulty is that technical projects tend to have binary outcomes: they are either terminated when they encounter severe obstacles or are supported all the way to market introduction.

Risk is the price of doing something that appears to be worthwhile. Risk is not desirable in itself, nor is risk necessarily something to be minimized. An important attribute of risk-taking is that it is deliberately undertaken because the rewards, multiplied by the probability (presumably known or estimable) of achieving those rewards, exceed the cost of taking the risk. We can say that “killing” the project minimizes risk but it also eliminates reward.

2. DEFINING FAILURE AND SUCCESS IN TERMS OF OBJECTIVES

We describe risk as the likelihood of failure in a technical project, so we have to define failure and success in terms of objectives. These objectives may be: institutional, personal or defined at the level of project.

2.1. Institutional objectives

A venture capitalist may define success of a technical project exclusively in terms of the expected return on invested capital, regardless of whether the firm abandons one particular set of specifications for another, or even changes the market objective altogether. Success will depend on the commercial viability of the technology in question.

On the other hand, a government technology project may emphasize specific national security needs, environmental objectives, and/or broad benefits to the economy that may ensue from overcoming a particular technological challenge.

Technical projects with sufficiently ambitious goals almost always produce useful, technical knowledge and experience. We cannot say the same thing in case of investment measured by returns from sales in competitive markets.

A university, in turn, is defined by its own unique mission and objectives. The most important are education and the advancement of knowledge.

2.2. Personal Objectives

The extent to which any institution is able to achieve its mission is dependent in large part on the harmonization of the objectives of the institution as a whole and those of individuals comprising the institution. We discuss here the importance of harmonizing personal and institutional objectives in the context of new firm formation and funding. If new firm raises equity from outside investors, managers have an incentive to engage in wasteful expenditures because they do not bear their full cost; in instead the firm raises debt, managers have an incentive to decrease levels of risk. Even if such problems can be mitigated so that the managers are fully motivated to maximize shareholder value informational asymmetries may complicate efforts to raise capital. The facts that potential investors know less about the inner working of the firms they fund than the managers who run the firms can lead to problems for both groups – managers will have an incentive to only offer new shares in the firm if the stock is overvalued and concerns over informational asymmetries may lead investors to offer funding under less then favourable conditions.

A distinct set of personal objectives define the relationship of technology project managers and the technologists directly responsible for the work of the project team. The information asymmetry is nowhere greater then between the technical expert who champions the project and the financially responsible manager who must commit resources with an inadequate personal mastery of the technical challenges and means for their solution. The nature of the communication and most importantly the degree of trust between these two parts is probably the most critical element in the management of technical uncertainties. Both parts must accept the reality of the uncertainties that can lead to failure. For the innovator they derive from the unpredictability of nature and uncertainty about how long the confidence of the investor can be sustained. For the investor or business executive the uncertainty about whether the innovator will be successful must be based on prior performance and trust.

In this case both parts must face the possibility of failure. It matters very much how that failure occurs. The technologist has at least two ways to fail. If nature proves unyielding, despite a well-organized and managed technical effort and good communications with investors, failure is honourable. But, if the team is ill-prepared, the effort poorly staffed, the knowledge of the state of the art or of the competition is inadequate and management feels deceived, then failure is dishonourable.

University professors may define their own success or failure in terms of any subset of an exceptionally large and varied set of professional objectives, including pedagogy, research productivity, administrative effectiveness, ability to raise funds for research and public service. Even in the absence of explicitly commercial incentives within the academic settings, there is an entrepreneurial aspect of the academic culture. The system forces the professors to be very entrepreneurial because everything is driven by financing a research group. Incentive structures in university research laboratories have by both design and necessity become increasingly similar to those found in either corporate research laboratories or start-up firms.

2.3. The Project Level

We discuss here about the objectives of the technical project itself. Before the market delivers its judgement on the value of a new technology, it must pass through a number of stages of development.

Any temporal partition of the innovation process is bound to be arbitrary and imperfect. A distinction that has the benefit of being often employed by practitioners is that between proof of principle and reduction to practice.

- Proof of principle means that a project team has demonstrated its ability, within a research setting, to meet a well-defined technological challenge; it involves the successful application of basic scientific principles to the solution of a specific problem.
- Reduction to practice means that a working model of a product has been developed in the context of well-defined and unchanging specifications; product design and production processes can be defined that have sufficient windows for variability as to constitute a reliable product, made through a high yield, stable process.

Failure at either of these stages may involve an unexpected technical problem that available skills and knowledge cannot solve.

While there is value to clearly defining project success and failure as a prerequisite to evaluating incumbent risks, some technical managers in private firms may choose to leave the question of success or failure in suspension for a considerable period of time. A manager may stop the flow of funds to a project whose progress is blocked by an unsolvable technical difficulty, but retain both the technical knowledge and the awareness of market potential, pending a new idea that would justify resurrecting the project. The ability to quantify risk is dependent on how far the project is from the market – the more that is known and understood about the total market area, the higher the probability of correctly assessing and dealing with the specific issue of technical risk.

Since failure is an outcome of the uncertainties associated with risk taking, failure is to be expected in an innovative organization. A persistent team can even turn a technical failure in terms of original objectives into an ex-post market success. There exist many cases in which the final success is not the use originally intended. Value in failure, for established firms, may be found in residual technology values that are later used in as-yet-unforeseen markets or the market and business learning from a failed project may contribute to success on the next venture. The extent to which failures are useful in this sense depends on firm size. Start-up companies whose big projects fail are likely to just go out of business, in which case technology and business learning is preserved and transferred only by former employees who go to work elsewhere, but big companies may be able to place failures into the portfolio for the future.

3. COMPETENCE

Technical risk is not inherent to the technical processes being explored. Managing and understanding the risk is really relative to how much we know. The more familiar we are with the market requirements (even though the technology may be very difficult) our ability to put a risk factor on it, deal with it, and make the early decisions before we are well down the road, is much better.

4. MODELLING RISK IN DEVELOPMENT PROCESS

Technical risk is manifest across three stages in the product development process:

1. Basic concept
2. Achievement of market requirements
3. Robust commercialization

The first of these stages describes the type of work undertaken in a corporate or university research laboratory. This stage ends with a laboratory demonstration of phenomena that, if commercialized, might offer attractive business opportunities.

The second stage begins when a firm takes up the concept and begins to reduce it to practice in order to demonstrate the designs and processes necessary to achieve the assumed requirements of the market that make up the business case.

The third phase encompasses the firm's response to a well-understood market opportunity with a full product line at competitive costs and quality.

These three stages are not intended to imply a linear model of innovation. For example, research activity in the first stage may be trigged by a stage three market discontinuity that signals potential opportunity.

In the event of technical difficulties that could not be foreseen, a project can be stopped at a time when only a fraction of the planned expense has been committed. This fact reduces the barrier that technical dimensions of risk otherwise pose. The largest elements of business risk are referred to collectively as market risks: uncertainties attributable to competitors and consumer responses and by all the other factors that together determine business outcome.

4. CONCLUSIONS

The failure and/or success of a technical project must be defined in terms of objectives. Therefore, multiple objectives in a project directly imply multiple categories of failure and success. There are many methodologies for assessing technical risk, but the most important task in risk management process is the effort to understand the sources of risk. We need to emphasize the vital importance of knowledge of the technology and understanding of the market. Where market knowledge is deep, technical risk is easier to manage, because one has confidence in one's understanding of the requirements of the market. Halting a project that is doomed to disappointment is a key element of risk management. Failing to pursue a project whose requirements are as yet undefined and are a function of both technical and market uncertainties is to fail in technical risk management.

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