



## Risk Taxonomy

### What is Risk, Anyway?

If we define risk as the occurrence of an adverse or unwanted event, we can classify risk according to the probability and severity of the event occurring. More formally, the “expected cost” of an unwanted event is the product of the cost of the effects of the adverse event times the probability the event will occur.

### Major Risk Categories for Technology Companies

Technology firms generally face the same kinds of risk as other non-technology firms. However, the presence of technology as the driver of a firm’s value affects those generic risks in special ways. These are what we call structural risks in the industry. The essential point is that since technology<sup>1</sup> by its nature is unpredictable in its form and timing, all factors relying upon it have extra uncertainty induced upon them.

We give some important examples below.

#### **Demand risks**

Demand risks are due to actual demand being substantially different from forecasted demand, resulting in adverse impacts. The risk in this case is that demand either exceeds capacity by a large amount, resulting in market share loss or product delays, or that capacity becomes under utilized, inducing unpaid costs. The high-level effects are obvious, but the detailed reasons can be managed and learned from.

#### **Customers Reduce or Cancel Orders**

This is a common business risk, but one that high tech firms may find especially costly due to severe competition and technology surprises in new products. Sometimes cancellations occur because customers would prefer to delay purchases until the next generation product is offered. The most famous example of this occurred in the early 1980s, when Osborne Computer announced its next computer. It was so attractive that customers stopped buying the Osborne on the market and preferred to wait the six months or so for the next generation. We believe this mistake was a turning point in the industry, and marked the beginning of awareness of the dangers of “pre-announcements” of new products. Since then, technology firms rigorously avoid discussing plans for future products except in vague (and of course, very appealing) terms.

Another example comes from Cisco Systems. Cisco wrote off \$2.5B in inventory when the internet bubble burst. Here was another demand shock that was fully predictable (except, of course, for the timing).

#### **Ineffective Strategic Marketing**

Poor strategic marketing results in failure to discover what customers will really pay for, resulting in lower sales. This risk is severe in technology firms due to the rapidly changing customer technology requirements and technology innovations. There are two main forms of this risk: that customers seek new features the firm hasn’t designed-in while rivals have, or customers expect more complete solutions.

Here is a good recent example of the missing features danger. In 2004, Intel was forced to change its announced product road map when rival AMD launched a product with a dual-core processor. AMD used an architectural concept Intel had previously publicly rejected, but AMD’s launch showed wide customer demand and technical success.

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<sup>1</sup> Technology is know-how, and distinct from a product that implements a technology

### **Customer Transparency Risk**

Another form of demand risk stems from factors far up the value chain from the firm's own customer base. For example, semiconductor firms sell directly to OEMs or ODMs, whose demand in turn derives from distributors and ultimately individual consumers. Thus, the "customer's customer's customer" really drives demand, and the chip firm has little or nil visibility into this end user.

### **Disruptive Technologies Emerge in New Products**

Disruptive technologies have been described at great length recently, with the seminal idea being formalized and empirically studied by Clayton. M. Christensen<sup>2</sup>. The risk here is that the firm is surprised by a technology or product that at first was ignored or dismissed until it had grabbed significant market share.

The mechanism of this failure is easy to understand, but not obvious except in hindsight. The incumbent firm's management is focused intently on serving customer requirements. But customers often don't know what they really want or need, and usually have less than total competence in new technologies on their supply side. So a confident third party launches a new product with a new technology that initially has poor performance or high cost, yet addresses a niche market. Over some time, this technology radically improves in both performance and cost, and captures substantial share from incumbents, or opens new markets.

Well-known examples are how the PC surprised the minicomputer makers and how cell phones have taken business from wireline phone companies. Another example is flash memory taking share from certain kinds of magnetic media.

One of the biggest recent examples of disruptive technology is the emergence of the Linux operating system. Linux now is the only serious threat to Microsoft's revenues and product line. This software has generated an entirely new corporate "eco-system" of businesses and alliances, and continues to gain share in a growing number of markets. Not only is the technology disruptive, it also carries with it an entirely new business model called "Open Source Development" (see Business Model section below).

### **R&D Risks**

While the term "R&D" is frequently used, we need to distinguish the "R" from the "D". Research is a process of discovery of new realities, and as applied to technology, research is focused on new ways of doing and making things. Research is quite a different process from product development using new research results, or even well established technologies. The research process by definition faces an unknown path to a large extent, while product development projects have specific goals to achieve. Each category is discussed in turn.

#### **Research Risks**

Two major risks in technology research may be distinguished.

##### Technology choice

Technologies always offer multiple paths of research to gain a new understanding or competence. But some paths can lead to breakthroughs and others lead to delay or failure and wasted investments. In most technology firms, these are always high risk decisions.

##### Innovations in technology

This is all about being creative, and thus is very difficult to manage. The risk manifests in failure to achieve an intended technology result, or having some result achieved by another firm thereby opening entirely new product or service options.

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<sup>2</sup> Clayton. M. Christensen, *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*, 2<sup>nd</sup> Edition, New York., HarperBusiness 2000

### **Development Risks (Technology Project Management Risks)**

Developing new products that incorporate technologies pose risks obviously unique to technology firms. Every technology project has the risk of failing to achieve the technical goals. But there are also three other interacting risks. A project may

- Be late relative to perceived market timing or feature-set requirements
- Fail to meet competitive requirements at right time within cost target
- Exceed its budget.

### **Intellectual Property (IP) Risks**

Intellectual Property (IP) is ultimately the most important asset of any competitive firm, because any other competence or condition can be matched by rivals to some meaningful extent. The risks associated with IP are especially important, since in some cases, these risks can destroy the firm.

#### **Litigation and negotiation risk**

Major sources of IP risk are the obsolescence, theft or irrelevance of a firm's IP. Further, IP risk entails the possibility of infringement by the firm against another, or being infringed by another firm.

#### **Technology Acquisition Risks associated with IP**

Many industries, such as semiconductors, wireless and biotech rely upon acquiring certain new technology through the licensing of IP in the form of patents or designs, rather than attempting an internal research process or development project. The idea is that with limited resources, the firm prefers to focus resources on its core competencies, and buy other competencies in the form of patent rights or actual designs of subsystems. There is a large number of major risks in this technology outsourcing process for IP, which can be categorized in two main groups.

Failure of the IP to work in the intended application

Failure to sufficiently understand the potential licensable IP in advance can lead to project failures, which is ironically the error expected from an internal project which is to be avoided through licensing.

Failure of product specifications to be satisfied by the IP within performance and cost boundaries

Even with successful technical implementation of the IP in the intended product or process, the acquiring firm may have failed to meet cost or performance goals simply through its inability to fully understand the IP before making the acquisition decision. In this case, failure of understanding affects the actual technology transfer process more than the development process.

Strategic Marketing IP Risk-Stuck in the Middle

Customers occasionally demand that a firm's product use a subsystem to be implemented using a specific external design. If the supplier firm licenses the design and the customer changes its desires, the license was purchased and then gets no use.

### **New Business Model Risk**

Some firms gain competitive advantage simply by adopting an entirely new "business model". For example, one of the earliest business model innovations in the semiconductor industry was made by Cirrus Logic. The firm started under the new idea that a chip firm should not build its own products! Their management's analysis led them to realize that chip manufacturing competencies were so specialized, it would be far more effective and cost much less to outsource manufacturing, while concentrating on product specification and design. Cirrus gained substantial advantage with this move over its rivals. Subsequently, the "fabless" model has now been firmly established throughout the semiconductor industry. Similarly, some chip design firms applied the same reasoning to later circumstances in the chip business and became "chipless chip companies". This means that these firms licensed their chip designs rather than manufacture them. A well-known example of such a firm is Rambus, Inc.

Another example of an entirely new business model is Open Source Development (OSD). OSD has many counterintuitive features, yet has proven wildly successful.

The most notable feature is that OSD is given to customers for free. Of course money is made, but not by the developers. Rather, all the entities in the ecosystem/value chain get paid for necessary services and products. OSD software is like a loss leader.

The Linux operating system is the best example of OSD software. Entire firms now exist, e.g., Red Hat Software, to provide maintenance and consulting services to Linux users.

With OSD, software developers contribute programs in a cooperative effort to a central decision making body which owns and licenses the software. The decision maker accepts or rejects the best code, and states requirements. The programmers are all “volunteers”, in the sense that the decision making body doesn’t pay them, and many work part-time on their own time. For some OSD software like Linux, big firms, e.g., IBM and HP, pay hundreds of programmers to write Linux software, but there is no direct payback for this investment. Rather, these firms gain profits from delivering hardware, like computer servers, with Linux installed for free, thereby saving substantial amounts of money compared to installing, e.g., Microsoft Windows.

In a real sense, the OSD business model has effectively spread development costs for a common and crucial product subsystem across an industry. Industry competition revolves around the applications that run on the “free” software.