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Technology Assessment—Are You Doing It Right?

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Abstract:

This is the second of a series of articles addressing how the R&D organizations in the US are implementing key elements of the "high performance business model." The HPB model integrates Strategy (S), Processes (P), Resources (R), and Organization (O) to deliver high performance business results.

This second article focuses on "P", Processes, and introduces the analytical framework for a critical business process: Technology Assessment. A robust and reliable method for technology assessment supports decisions regarding launching projects and products; provides a rational basis for evaluating threats from competing technologies; and forms the analytical framework for technology valuation, another critical business process. A good technology asssessment process ensures that your company's technology development and commercialization is consistent with your strategic objectives. Done right, the assessment provides a map of the technical and commercial landscape, defines technical goals and functionality, uncovers promising commercial targets, and describes how to get there.

In this article we outline a framework for technology assessment and identify seven factors that determine high-quality outcomes. Subsequent articles will focus specifically on the two most important processes for technology valuation—the "economic impact" method and the "market comparables" method. This article on technology assessment is the "pre-requisite" to understanding those valuation techniques.

"Should we invest in this technology?"

Most US companies that are involved in technology-based businesses now follow a "stage/gate" type process for technology and product development. The process is characterized by a separation of the innovation process into stages, with each stage addressing key cross-functional activities appropriate and unique to the stage. The output from these cross-functional activities is delivered at pre-agreed upon times (milestones) and is used as the basis for decisions to continue (or kill) the R&D project. These activities are all components of an ongoing and iterative "technology/market" assessment that seeks to answer the fundamental question "Should we (continue to) invest in this technology?"

How are you assessing technologies that are important to your business? How certain are you that your assessments are right? For each technology option there are many possible commercial outcomes. Within a company, the optimists (generally the technical people involved and the product champions) tend to see the upside, while the professional skeptics (generally the business managers) tend to see the downside. Naturally, each group considers itself objective and realistic. What they both need is an independently generated guide to technology assessment. Such a guide can provide a rational, supportable basis for investment decisions, which typically involve not only money but time and human resources.

With such a guide in place, all parties to a technology investment decision know the "rule" of the assessment game, and every candidate technology is subject to the same rules. The ultimate question to be addressed is: How do the expected commercial outcomes measure up against established strategic and financial objectives?

A Framework for Technology Assessment

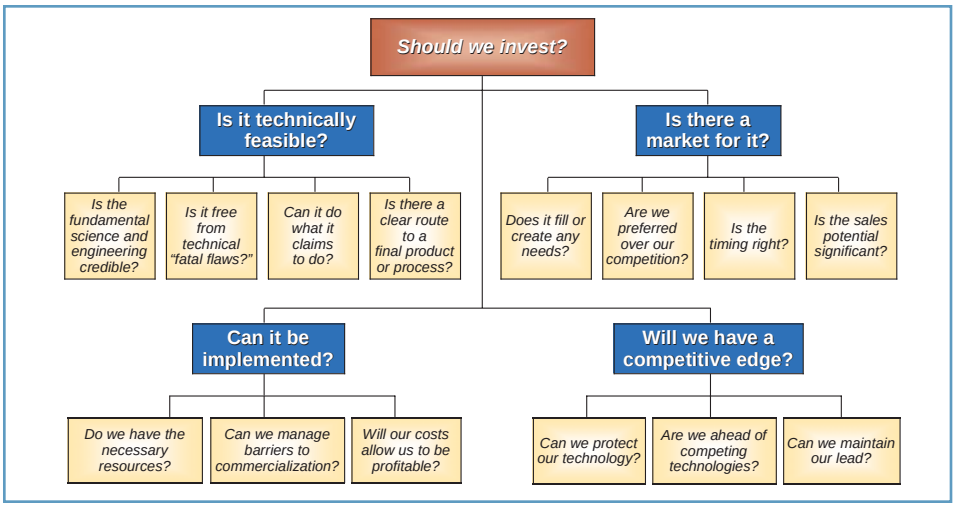
In assessing business-critical technologies, we systematically evaluate the four fundamental attributes that determine commercial success: technical feasibility, implementability, marketability, and competitive edge. The results of our four-part assessment are both qualitative and quantitative. The issues addressed in a complete technology assessment are shown in Figure 1.

Doing It Right

From years of experience with helping our clients carry out technology assessments leading to important, consequential business decisions, TIAX offers the following suggestions to improve the usefulness of and increase the confidence in the outcome from all technology assessments.

Treat the outcomes as a hypothesis. For example, your assessment results might be something like this: "Yes, this technology is feasible. We plan to implement it because it uniquely serves the needs of our customers, for whom it represents real value. We expect to sustain our advantage over our competitors for at least five years, so that the returns meet our objective of 15-percent-per-year earnings growth."

Figure 1. A Framework for Technology Assessment



Now deliberately try to explode the hypothesis. Create scenarios that would invalidate as many aspects of the hypothesis as possible—scenarios that may seem extreme or implausible—just to test how robust the outcome is. Situations that may seem extreme today could rapidly materialize. Consider the example of chlorofluorocarbons (CFCs) and their virtual "overnight" elimination. Given their pervasiveness and the vast CFC-based infrastructure among suppliers and users, the transition away from CFCs to alternatives was astonishingly rapid. That rapid shift made some companies "winners" (those that had more environmentally acceptable alternatives) and some companies "losers." What could be your industry's next "CFC" scenario? Such extremes provide opportunities for commercially useful technologies while threatening others with extinction.

Ask yourself: Will any of the scenarios constructed render your initial judgment wrong? If so, concentrate on those. Pick out the elements that invalidate your prior conclusion and conduct a risk assessment on them: How likely is the scenario? What needs to happen to make it real? What are your options for responding to it—before and after the fact?

A client asked us to conduct just such a risk assessment. This diversified company, which served industrial and automotive markets, was about to make a commitment to an acquisition in the aerospace industry. It recognized that the technology associated with the target company could "make or break" its long-term attractiveness as an acquisition. Before contacting us, the client had raised and explored several key issues and had concluded that the target company was the leader in its field, enjoyed strong proprietary and differentiating technology, and faced no threat from obsolescence or competitive encroachment.

Our role was to provide an independent assessment. Using their conclusions as our "hypothesis," we searched for facts, trends, leapfrog technologies, and competition that could invalidate that hypothesis. What we found was surprising and valuable to our client:

- Entangled alliances among some industry participants, including the target company, called into question the target's ownership of key patents and know-how.
- One of the alliances implied that a potential competitor had bought access to comparable technology and had made a new and strong financial commitment to market entry.
- A technology "co-leader" existed who could possibly exploit to its advantage any market instability caused by a change in ownership of the target company.

The net result of our risk assessment was a "caution" light. As a consequence of our deliberate probing for real situations that could modify its original, preliminary assessment, the client developed some "before the fact" response options, including some new high-priority action items for the due-diligence phase of its acquisition plan.

Do a best-case, worse-case, most-likely analysis. Any projection of sales volume, price, and cost associated with the commercialization of technology represents a range. Deliberately calculate the boundaries of that range. The estimates should not be guesses, and the "most likely" should not simply be the midpoint between the boundary numbers, but supportable and rational calculations. The range can usually be calculated from the same data used to develop the original estimates.

Such "probabilistic" thinking was at the heart of our assessment of a family of new production technologies for bulk fine chemicals based on nonpetroleum feedstocks. Among the technologies used today for the production of these bulk chemicals, there is no performance differentiation in terms of the end products produced—the products are sold on the basis of purity only. The basis of competition of the new production technologies we assessed was cost—a lower-cost finished product.

The owners of the technologies in question had already proved feasibility and had even gone so far as to set up a pilot plant. Certain that the technologies could produce the products in quantity, the owners had already invested about 40 percent of the time and money needed to take the new technology to the commercial stage. There was still uncertainty about possible problems in scale-up and other hurdles. The question posed to us was whether they should continue to invest in the technologies.

To answer this question we needed to analyze the potential production cost advantage that would be achieved by the new technologies and then determine whether that cost advantage was sustainable. We began by creating a base for evaluating the economics of the problem, then used the base to estimate the savings in terms of capital and operating costs for the technologies being assessed and for competing petrochemical-based processes. We also evaluated levels of technical and economic uncertainties and projected trends in feedstock costs, capacity, and demand over 5, 10, and 15 years through the life of the patents.

An important part of the assessment involved generating cost probability curves for each of the technologies and competing petroleum-based processes. The curves showed that the process based on the new technology was likely to yield a lower cost than that of the existing

competing technologies. A considerable area of overlap, however, suggested that the new process was not "breakthrough" in its potential cost advantage and therefore would at best share the market with its rival incumbent technology.

Our treatment of the whole array of new production technologies in this probabilistic fashion revealed striking differences among them. Of the original family of new technologies, only a few showed a significant and sustainable cost advantage. The client chose those few for commercialization.

"View the Technology as a Functionality"

Look for the disconnects in the analysis. For example, if the technology appears to offer value-added potential to a broad array of end users and to have little competition—yet the estimated return on investment is low—probe for the reasons. Are economies of scale missing because of scale-up-related issues? Are commercialization costs high because additional people are needed for implementation? What do the answers to these questions tell you about whether or how to proceed? Might the technology be worth more to someone else—someone who has potentially lower production costs, someone who already has a commercial development team in place with ties to the target markets? If so, licensing or partnering may be alternative ways to extract value from the technology.

In some cases, the "disconnect" is less subtle and more fundamental—e.g., you may not have chosen the best possible market. Addressing new markets is always risky to some degree, because they represent unknowns: unknown needs, unknown competition, unknown fit between market needs and what the technology offers. For example, one of our clients came to us with a family of heat transfer fluids. The client's product line was attractive in a number of respects: it was nontoxic, environmentally benign, non-corrosive and was immediately available, with a long track record of successful performance in a number of niche applications. Excited by the vision of a quick leap in sales based on a rapid displacement of existing fluids in high-volume applications, the client invited us to work with them to identify customers. This should have been easy, right? Not quite. A customer-by-customer exploration of the major markets for heat transfer fluids revealed a much different set of "cost/performance" requirements and trade-offs in the high-volume segments. A number of new or improved heat transfer fluids had been introduced into the high-volume segment that simultaneously filled customers' needs for performance, cost, worker health and safety, and environmental safety. Moreover, in most high-volume applications it cost less to use engineering solutions to heat transfer than to use our client's product.

So the targeted market turned out to be inappropriate. Since then, the client has successfully focused on other markets, in which "in kind" and "not in kind" options for the customers are far fewer and in which the client's product represents good value-in-use.

View the technology as a functionality. Don't think of it as a product, process, chemical, material—that is, don't think of your technology solely in terms of its saleable embodiment. Customers buy functionality. A food company, for example, wants powdered soft drinks to remain free-flowing at all times of the year, in all sorts of transportation and storage conditions, and across all its geographic markets. So it buys anticaking agents. Of course, these agents have to satisfy other secondary performance and acceptance requirements, but in a very real sense the food company is indifferent to the chemical composition per se. What it cares about is the anticaking behavior. Similarly, suppliers of noise-control products and services need materials that absorb or reflect sound. The material is immaterial except as it meets the product's primary and secondary functional requirements. The technology being assessed, therefore, must be described and viewed in functional terms to identify the real customers and the relevant competing technologies.

Viewing a technology as a functionality can open up its range of commercial opportunities, as well as more sharply define categories of opportunities. A case in point is a client with a proprietary coated fabric technology whose first commercial success was in reusable surgical gowns. In terms of functionality, this client's technology could be variously described as providing a blood barrier, providing a liquid barrier, resisting viral transmission, and retaining properties after multiple washing/sterilization cycles.

Our mutual objective was to identify new commercial opportunities. Obvious among these were extensions into the medical/health care market, but this market was saturated with competitive materials and approaches, including use of disposable goods purchased at low prices from multiple sources. We identified a new potential market area, however, by linking the technology's functionality of "retains properties after multiple washing cycles" to a newly identified need in the nuclear services industry for improved durability of rental maintenance uniforms. Indeed, the entire textile rental industry could value this client's technology as a service-life-enhancing, cost-saving fabric. The client chose to work with a market leader in services to the nuclear industry to broaden the commercial applications of its technology.

"Know Your Real Competition"

Know your real competition. View the technology from the vantage point of a user, i.e., a customer. That viewpoint will help identify who the competition is. Improperly identifying your competition will lead you down the wrong path.

Viewing the technology as a potential customer could is the other side of the coin to viewing the technology as a functionality. The case of the proprietary coated fabric technology illustrates this point as well. A customer of barrier textiles in the health care industry has two choices: disposables or reusables. The client's technology was just one more offering in the reusable category, competing against other washable items and against a vast sea of disposable barrier materials. For a customer in the textile rental industry, however, the only fabric category that meets his or her basic need is reusables—disposables aren't an acceptable competitive offering. So by targeting this segment, the client shifts and narrows the relevant competitive issues to those that differentiate his technology from the other available reusables, e.g., durability and comfort. Our client's technology held out the

promise of greater durability, providing the prospective new customer with reduced costs and improved margins.

Increase your fact-to-opinion ratio. Whatever the outcome of a given technology assessment, if it rests largely on "guesstimates," opinions, judgments, and/or extrapolated trends, revisit the input. Which of your guesstimates or opinions can be converted into facts? It may be necessary to run more experiments, to perform field surveys of potential customers, or to pull in new and complementary intellectual resources to improve the fact-to-opinion ratio in the assessment.

"Increase Your Fact-to-Opinion Ratio"

A commodity chemicals producer came to us looking for a way to deal with what was for them a waste stream. Like many other firms, this company hoped to reduce or avoid disposal costs and possibly even increase revenues by figuring out how its waste stream could be "upgraded" to saleable products. Our client's initial exploratory work suggested that commercial outlets could be developed for its waste product once it was transformed into an inexpensive mineral-based extender—a product used by manufacturers of paints, coatings, sealants, plastics, and tires and other rubber products. For some companies, this initial and general assessment would have prompted a broad-based sales effort designed to drum up inquiries and eventual orders. Instead, our client recognized that more facts could provide more focus, not only for its commercial development efforts but also for its plans to technically modify its waste stream processing operations. Side by side with our client, we systematically identified the needs, both qualitative and quantitative, of the target market segments and the extent to which our client's transformed product could meet those needs. This process revealed the most attractive target market: sealants It also resulted in projections of the sales volume our client could expect over the next several years—information used by the client to make decisions regarding production plant modification and marketing.

View the assessment as a whole. In this article we have discussed our framework for technology assessment in terms of its discrete segments, and we have chosen "slices" of case work as illustrative examples. But a step-by-step treatment of the technology assessment process should not obscure the reality that, in any given assessment, issues of feasibility, implementation, market potential, and competitive advantage are concurrent. Feedback loops inherent in the general framework can provide direction for transforming a technology that initially may seem to have limited market potential into one with substantial potential.

For example, a client asked us to identify the most promising industrial applications for a new acoustic material. The overall market is quite large (sound reduction is a good thing), and our client's material could fill some specific needs and wants among prospective users. However, the market for our client's material "as is" was small because of the material's limited flame retardancy, a key attribute in most end-use applications. Prompted by these results to do a "what if" iteration, we were able to segment the markets into distinct categories on the basis of need for flame retardant performance. We then linked each of these categories to a potential sales volume. In the process, we transformed a performance disadvantage that could have been a "show-stopper" into the basis for short-medium-, and long-range plans to develop products for larger market segments. Through aggressive use of the feedback loops inherent in technology assessment, a challenge led to an exciting set of technical and commercial development goals that our client started to realize immediately.

This example illustrates the almost constant interplay between the technical aspects of a technology and the market response to it. The assessment process needs to recognize this interplay and use market data to provide direction and targets for technology modifications. Within the technical component of an assessment, there is an analogous interplay between feasibility and implementability, e.g., you may need to modify the technology you plan to deliver to your customer in order to be able to produce it economically on a production scale. There is also an interplay between the market opportunity and competitive issues, e.g., a technology with fewer competitors should have larger market potential than one with many. Here the issue becomes one of building a fence around your technology to limit competition.

Conclusion

The final test of a good assessment is linked to its purpose: providing a course of action for technology development and commercialization that is consistent with your strategic objectives. Your assessment serves that purpose if it provides you with a "map" of both the technical and commercial landscape, uncovers promising commercial targets, defines supporting technical goals, and describes how to get there from here, both qualitatively and quantitatively.

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