Assessing Technology Risks

R. R. (Ron) Goforth, Ph.D.

Abstract

When presented with an attractive business opportunity that is based on sophisticated new or evolving technology, anyone with less than expert knowledge of that technology will need help to fully appreciate the risks attending that technology and its use in a business venture. Anyone who fails to undertake due diligence that includes a competent assessment of the underlying technology may unsuspectingly invest in a superficially attractive but impossible venture. Those risks will be known only if an objective assessment of the technology is included as a fundamental and integral part of investment due diligence.

Outline of Contents

Assessing Technology Risks

1. Technology and Business

1.1 Defining "Technology"

Why is it important to define such a commonly used word as "technology?" For those not directly involved in technology, at least in any way other than the use of the commonplace, there has been a real loss of precision in the definition of what it means. The word technology is being both overused and inappropriately used - it has become a buzzword to lend an air of currency and of a certain mystique. This misusage compromises the clarity of our communications when we use "technology" unless a careful definition, devoid of unintended connotations, is provided.
"Technology" as used by Beta-Rubicon is carefully defined as applied science, that is, natural science and the scientific method applied to solving practical problems. It usually considers at least the potential for commercial exploitation. Natural sciences, in this context, may include agricultural sciences, biology, chemistry, earth sciences, medical science, mathematics, and all fields of engineering. The social and political sciences are excluded.

We also begin this Technology Brief with this definition to show that it is important to establish and ensure an appropriate level of precision of meaning in the work we do. Precision is necessary if we are to provide credible information for use in making important decisions, be they investment-related or concerned with more general issues such as the management of technology development.

1.2 Characterizing technology-based enterprises

Because technology is evolving so rapidly, it is not possible to identify "technology-based" enterprises by simply providing a list of qualifying tools, resources, or techniques. Today's conventional photocopy machine, now commonplace in virtually every office, was considered by some to be cutting-edge technology as recently as 20 years ago. The typewriter preceded it in a similar way. As a consequence of rapidly changing nature of what we consider to be technology, we must use a more systematic and generic characterization scheme.

We consider technology-based enterprises to be those adopting technologies with the following characteristics:

1. Technologies that represent an effort to improve productivity or efficiency, and reducing cost and resource constraints by relying on tools, practices, and recently introduced materials and resources -- usually with the anticipation of reducing human resource requirements (numbers and skill levels).

2. Technologies that are aggressive today, that are being adopted in anticipation of near-term competitive pressures, or that open new opportunities for commercial exploitation.

3. Technologies that represent a substantive evolutionary progression from the current base.
It is probably a good idea to avoid using terms such as high-tech, cutting edge, or breakthrough, as they are also such overused and misused terms as to be mostly meaningless hype. Complicating matters further, we have no organized system for categorizing or characterizing technology change. However, it is clear that change is the norm and what today is considered technology may soon be either the commonplace (photocopy machines) or largely obsolete (typewriters).

A system for describing, organizing, and showing the relationships in technology change will be the topic of a future Technology Assessment Brief (tentatively titled A Taxonomy for Technology Change).

1.3 The lure of investment in technology

There are a number of recognizable and important trends that point to the need for more well informed investment decision making in technology-based enterprises.

In recent history there have been cyclical investor disappointments and enthusiasms for biotechnology and artificial intelligence (AI). Too much was expected too soon. Both now appear to be settling in on more realistic expectations, but it has been a rocky road for investors in both areas. This situation does show, however, the need to realistically foresee difficulties in development and deployment of new technologies and to plan for realistic development time frames and resource requirements.

There is an increased awareness of the negative impacts of biased science and many scientists are less credible primarily as a result of recent legal actions against the tobacco industry. There are also numerous examples of superior technologies having been displaced by weaker ones due to business and marketing issues (e.g., VHS vs. Beta technology for the videotape industry). We also have numerous examples of technical success that have been commercial failures (e.g. bottle-shaped Coke® cans).

On the other hand, there have been examples of wildly successful high-risk technology introductions (e.g. the Sony Walkman®). There is clear evidence of an increasing scientific and technical sophistication in approaches to the assessment of cost - benefit relationships in health service and medical devices, information technology, and food production (driven in the food processing industry largely by the imposition HACCP -- Hazard Analysis Critical Control Points rules). We are clearly experiencing an ever-faster evolution of new products and shorter product life cycles as seen so dramatically in the new generations of computer microprocessors.

1.4 Pitfalls of investment in technology

Dangerously Misleading Prototypes

Given the widespread familiarity of computer applications, one can provide a rather easily appreciated illustration of the kind of traps that await potential investors in technology-based "opportunities." Anyone who fails to undertake due diligence that includes a competent assessment of the underlying technology may unsuspectingly invest in an attractive but impossible venture.

For example, Professor Hal Berghel of the University of Nevada, Las Vegas has reported, "It is now possible, with few technical skills, to create an interface at a higher conceptual level and with more sophistication than one can produce in the back end application." (Reference: Berghel, 1994) Professor Berghel describes "vacuous prototypes," saying it is easy to create an effective demonstration prototype, but one that is devoid of content and which cannot be implemented with existing technology. He demonstrates this "software surprise" with an example using an application that purports to automatically translate bi-directionally between sets of six languages (throwing Latin into the mix for good measure). "The modern venture-capital prototype is coming to resemble a spaghetti western, all theatrics and no substance." When presented with an attractive and apparently functional software "prototype," how is the non-expert going to know the real risks in investing in its commercialization as a business venture?

1.5 Making it real: An example.

Consider the following abstract taken from the non-confidential disclosure of Company X's "Business Development and Investment Opportunity" descriptive information:

Based on its advanced research and development work, Company X plans to introduce into the market a novel system that provides instantaneous language translations. This system allows the simultaneous translation between five globally important languages and has provisions for both the spoken and written languages. Immediately following the commercial introduction of this system, an on-line service will be established through our subsidiary, CompanyX.Com. The funding investment of $1.625 million will represent a 27.5% ownership of Company X and will yield an average annual rate of return of approximately 40%.

From their statement, it would appear that Company X is either (1) on the verge of making a commercial breakthrough, or (2) promising more than the state of the art will support. We will revisit Company X in section 2.3, "A (simple and hypothetical) case study."

Note: To see a dynamic demonstration of near state of the art, you can check out BabelFish.

2. Due Diligence and Risk

2.1 Defining and examining conventional investor due diligence

Due diligence, in the conventional sense, is an in-depth analysis of the financial and operational conditions of a company targeted for investment, merger, or acquisition. It may be as detailed as an accounting audit but is much broader in scope because the operational condition and efficiency of the target's assets are investigated as well. Due diligence is to ascertain the economic values and results of operations and express them in financial terms. The objective is to find, identify, and estimate the impact of purchase price or investment conditions. (Reference: McLaughlin, 1998)

Due diligence may also be described in terms of investigation of investment potential by consideration of six major areas of concern (Reference: Keely, et.al., 1998):

1. Market structure, competition, and marketing strategy
2. Technology assessment
3. Management team assessment
4. Operating plan (development, operations, marketing, support systems)
5. Financial review
6. Legal review

2.2 The role of technology assessment in due diligence

Although "technology assessment" is sometimes identified as a component of due diligence, we would note that how to actually do the technology assessment has been and largely remains a serious concern. This is primarily a result of very limited resources available to competently do this type of work, particularly without a high risk of introducing bias. Reliance on consultant-salesmen, a common practice, is obviously fraught with such hazards. University scientists and engineers, although possessing in-depth expertise, are more often than not simply too specialized and too remote from the complexities of business and investment decision-making.

This situation begs for a response, and that response is an independent service to do technology assessments. Such an independent service must be done by an agency that possesses systematic analytical abilities, both breadth and depth in technical and management areas, the ability to respond quickly while protecting intellectual property and ensuring objectivity, and the ability to communicate effectively across widely varying disciplines.

2.3 A (simple and hypothetical) case study

If we use the Company X project (refer to Section 1.5 above) coupled with an exploration of BabelFish, as a starting point, we can illustrate some specific concerns that could arise in a technology assessment. Here are a few of the questions that should be considered in determining investment risks that would be present in the Company X project.

1. Implicit in the Company X information is the assumption that algorithms for the understanding and translation of natural languages exist or can be developed in the time frame being considered. It this true?

2. Company X projects (speculates) an investment yielding a 40% average annual ROI. Has there been adequate consideration of "maintenance phase" costs for a system that is largely software based? (It is not unusual for maintenance phase costs to be 60% or more of the lifecycle costs for software.)

3. The system is said to work with *spoken* as well as written languages. Has the state of the art in voice recognition and speech synthesis in the target languages been adequately researched? Is this to be developed internally or licensed from third parties? Have the options been adequately researched and appropriate costs included?

4. The translation machine is likely to demand considerable computational resources and a real-time online service to demand significant transmission bandwidth. Have these resource demands been adequately assessed and provisions made to accommodate them in offering an online service? What are the human resource requirements needed to support such a system? Are they adequately planned for in the proposal?

2.4 Analyzing technology risk

From this example, it should be easy to appreciate that a technology assessment includes more than simply ensuring that exploitation of a new or evolving technology does not violate first principles. Although the basic elements of the analysis process can be predetermined, certainly at a functional level, the fact is that each technology assessment must be designed to respond to the nature of the specific project on a carefully constructed and individual basis.

Note: Suggested procedures and practices for analyzing technology risks will be explored in a future Brief in this series. At that time we will identify alternative procedures, multiple levels of analysis, and differing potential outcomes.

3. Technology Assessment

3.1 Identifying criteria for assessing technology risks

These is no single or universal set of the technical criteria that can be used in assessing the vast array of rapidly evolving or newly appearing technologies. There are however, certain general concepts that rather universally apply. For example, the technology must not violate first principles (e.g. the technology does not require a perpetual motion machine or otherwise violate the laws of thermodynamics). The state of the art must be thoroughly examined and adequate research of existing and competitive technologies must be done (i.e., we must be sure that the "not-invented-here" syndrome is not in play).

The nature of competent technology assessment is such that, except in the most simple and straightforward cases, the creation of specific assessment criteria requires consideration from diverse points of view. This being the situation, a team-oriented analytical approach is a necessity.

3.2 Investment risk mitigation

The first and most obvious reason for undertaking a technology risk assessment is to provide information necessary for a balanced and objective investment decision. The nature of competent technology assessment work is such that it is also likely to generate a wealth of information of potential use in the mitigation of any identified risks. A few examples of risks or potential problems will illustrate this point.

A particular risk in technology-driven development proposals, more so than for market-driven ones, is inadequate research of competitive technologies such as for potential patent infringement.

Proponents of technology-based developments all too frequently underestimate the resources required (money, people, and time) to take their project from any early development stage through full commercial introduction. Examination of this problem, perhaps looked at as a failure to fully appreciate the "80/20 rule", may indicate the desirability of adding additional progress check points to the development plan and means for tracking progress against planned resource consumption.

In proposals for updating management information systems (MIS) or information management systems (IMS), there may be a failure to adequately plan for varying organizational impacts. The decision-making process itself may impact on the acceptability of the product to the user, training may need to parallel or precede the technology installation, and so forth. If these factors, which may be considered management issues outside of the area of responsibility of the technology proponent, are not appropriately addressed, these technologies may fail to achieve expected returns no matter what their technical sophistication. Should this appear as a potential problem, plans should be modified accordingly and budgets and schedules adjusted as necessary.

3.3 Where independent technology assessment should be employed

Independent technology assessment should be employed where one or more of the following conditions or circumstances are encountered:

1. Where there is a need for cost-effective systematic analysis of complex technology issues and in-house expertise is limited, or where there is a need to minimize impacts on such internal resources.

2. Where complexity dictates that a team-oriented approach is necessary to assure that both a broad perspective is taken during the assessment and that depth of analysis is provided by discipline specialists.

3. Where a fast response is required and can only be assured through the dedicated efforts of specialists familiar with technology assessment and technology due diligence work.

4. Where potential conflicts-of-interest must be avoided, and non-competition, objectivity and impartiality must be assured.

5. Where it is necessary that confidentiality can be secured by legally binding agreement and that the assessment product is exclusively the property of the Client and can be released to other parties only with the Client's written instruction to do so.

6. Where obscure or abstract and technologically sophisticated issues must be translated into a form meaningful to investment and management decision-makers.

Even companies or agencies with in-house technical capacities might require such independent services to avoid the potentially negative impacts of hidden agendas or vested interests. Due diligence, for internal technology investment decisions, may be done in differing ways. Frequently these are not even identified as a due diligence process, but the decisions made may be no less critical. While objectivity is always a key factor, it is also true that significant information that is typically difficult to access internally may be more readily made available in the open format provided by an independent agent who observably has no vested interests to maintain or promote.

Consultant-salesmen, though frequently used by default, fail the test of independence. Frequently, if the total financial considerations are carefully considered, their recommendations are not optimally cost effective. Their solutions are naturally conditioned by, and point to, the products they represent and sell. Again, independent specialists can provide the best technology assessments presuming, of course, that they are thoroughly competent in all areas needed to undertake the work.

4. Concluding Comments

4.1 Defining "Technology Assessment" and "Technology Due Diligence"

Technology Assessment includes a detailed review and analysis of the technology development proposal documentation and literature, verification of the representations made by the proponent, and a reviewer's conference. There must be a review of the technology plan; an evaluation of the depth of proponent's in-house expertise, and a search and analysis of state of the art in the proponent's area of technology. Additionally there should be a search and analysis of related and competitive technologies, a detailed analysis of the technology and development plans, schedules, budget, and its management capabilities to respond to the opportunity; and structured interviews with key personnel. Conclusions and recommendations must be formulated, and full details of methodology, sources, and references documented.
Technology Due Diligence, as developed and used by Beta-Rubicon, is analogous to classical due diligence but focused on opportunities that are primarily technology-based, technology-driven, or both. Technology due diligence requires an intimate knowledge of the state-of-the-art in technology, as well as of technology trends, R&D management, and management technology. It requires a high degree of research and scientific sophistication, a well-developed analytical methodology to provide accurate evaluations of the relative risks and potential rewards of the acquisition of, merger with, or investment in technology-based enterprises. It requires extensive data gathering and information extraction capabilities and the ability to translate technical detail into terms that make relative potential risks and rewards meaningful to the investment community.

4.2 Prepared by:

R. R. (Ron) Goforth, Ph.D., President of Beta-Rubicon, Inc., prepared "Assessing Technology Risks".

4.3 Contact Information:

To request further information, offer comments, or express interest in securing the services of Beta-Rubicon, Inc., please contact:

Dr. R. R. (Ron) Goforth, President
Beta-Rubicon, Inc.
21 West Mountain, Suite 123
Fayetteville, AR 72701

Voice: (479)444-8118
FAX: (479)575-7446
e-mail: rgoforth@beta-rubicon.com

References

Berghel, H., New Wave Prototyping: Use and Misuse of Vacuous Prototypes, Interactions, April, 1994, pp 49-54.

Chambers, Donald R., & Lacey, Nelson J., Modern Corporate Finance: Theory and Practice, Harper Collins Publishers, New York, 1994.

Dorf, Richard C., Editor-in-Chief, The Technology Management Handbook, CRC Press, New York, 1999.

Keeley, Robert H., Jeffrey M. Cooper, Gary D. Bloomer, Business Angels: A Guide to Private Investing, Colorado Capital Alliance, Inc., Boulder, CO, 1998.

Marshall, John F., & Bansi, Vipul K., Financial Engineering, Second Editon, Kolb Publishing Co., Miami, Florida, 1993.

McLaughlin, Joseph, Chair, Conducting Due Diligence 1998, Practising Law Institute, New York, 1998.

U.S. Congress, Office of Technology Assessment, Innovation and Commercialization of Emerging Technologies, OTA-BP-ITC-165 (Washington, DC: U.S. Government Printing Office, September, 1995.