METHODS REPORT

A Practical Guide to Opportunity Assessment Methods

Peter Liao and Amy Witsil

February 2008

RTI Press

RTI INTERNATIONAL

About the Authors

Peter Liao, MBA, BE, is a technology commercialization manager at RTI International in Research Triangle Park, NC.

Amy Witsil, BS, is also a technology commercialization manager at RTI's headquarters in Research Triangle Park, NC.

RTI Press publication MR-0003-0802

Suggested Citation

Liao, P., and Witsil, A. (2008). A Practical Guide to Opportunity Assessment Methods. RTI Press publication No. MR-0003-0802. Research Triangle Park, NC: RTI International. Retrieved [date] from http://www.rti.org/rtipress.

This publication is part of the RTI Press Methods Report series.

RTI International
3040 Cornwallis Road
PO Box 12194
Research Triangle Park, NC
27709-2194 USA

Tel: +1.919.541.6000
Fax: +1.919.541.5985
E-mail: rtipress@rti.org
Web site: www.rti.org

doi:10.3768/rtipress.2008.mr.0003.0802

www.rti.org/rtipress

A Practical Guide to Opportunity Assessment Methods

Peter Liao and Amy Witsil

Abstract

Based on the authors' experience, a gap is apparent between technology managers' needs and opportunity assessment resources. Many organizations need a tool for evaluating seed funding or small business investment opportunities, but they lack a means for determining what options are available. This research report describes several opportunity assessment methods and matches the methods to user types in public and private sector organizations in analyzing technical, business, and market information for investment and commercialization decisions. Organizations that may benefit from this review share a common goal of seeking to strengthen the viability of a new technology venture or capitalizing on their investment in new technology. These include venture capitalists who choose investments (in early-stage technology companies) that will return the largest return on investment for their client investors, angel investors placing their own money in pet projects, public or quasi-public new or small business-funding agencies, and academic and government research and development agencies. The authors' focus was to evaluate not only the availability of methods but also the associated analysis framework in order to understand which opportunity assessment methods are optimal in supporting various investment objectives and stakeholders. This report should also provide individuals in the technology transfer and commercialization community with a succinct, useful reference for identifying what methods are available to them and which methods work best in various situations.

Contents

RTI INTERNATIONAL

Introduction

Choosing the Right Opportunity

Technology managers are frequently asked to select new technology research projects or companies for investment. Making the right decision can result in a viable technology or company, and improve the return on investment (ROI). Choosing unwisely can squander resources and undermine the momentum of a technology development program. Best practice approaches for choosing technology investments support an organized and systematic assessment of all the options, with the aid of tools such as spreadsheets or scorecards. However, it has been our experience that guidance in choosing appropriate tools to support the decision process is lacking.

The authors reviewed and compared a variety of assessment tools and methods that can be used to perform opportunity assessment in selecting companies or research and development (R&D) projects (or both) for investment. This research report presents a review of the types of tools and suggests a process for choosing tools for particular types of organizations.

The Opportunity Assessment Process

Opportunity assessment refers to the investigation and examination of a new technology investment opportunity. Usually the assessment process begins with candidates submitting some sort of proposal that outlines the technology, justifies the need for the investment funds, and addresses some business planning for commercializing the technology. After the proposals are received, the opportunity assessment process begins. At this point, the technology manager organizes an assessment process and chooses appropriate tools to facilitate the process. Using the tools, the technology manager assesses the strength of the four classic characteristics of a new technology opportunity: (1) the technology, (2) the technical or management team (or both), (3) the market, and (4) the financial opportunity. The technology manager gathers and analyzes the data to rank the opportunities, and makes a selection.

The State of Assessment Tools

An original intent of this report was to simplify the process of choosing a tool for assessment. Our past experience involved adapting several assessment methods and tools that, when combined, provided a holistic assessment of programmatic, technical, market, and business (including financials and management) factors that influence the risk of success/failure and the ROI of early-stage technology investment opportunities.

Convinced that there was an easier way, we set out to validate and catalog easily accessible tools available free or for purchase "off the shelf," such as spreadsheets, rating sheets, and scatter plots, to aid in the assessment process (see Appendix A). However, we were surprised that none of the methods we examined included off-the-shelf tools that could be quickly downloaded and used. Instead, we found that most tools were home-grown or embedded in academic papers as researchers attempted to "build a better mousetrap" for evaluating new business or research opportunities. Very few models were presented publicly in a form complete enough to enable true benchmarking and assessment. Also, on the whole, the tools lacked real-world use. This mirrored our past experience and confirmed that, for now at least, choosing a tool is more of a trial-and-error process.

Goal of This Report

Without a simple catalog solution, we expanded our initial view to investigate the broader assessment process landscape. Our goal for this research report is to discuss opportunity assessment methods with regard to where to look for solutions (i.e., tools) and why developing one's own tool may be the best solution. Another goal is to provide guidance and to point to opportunity assessment tool options for those individuals in the technology transfer and commercialization community responsible for assessing opportunities for investment.

Our review of existing methods yields a diverse collection of tools for implementing the methods—spreadsheets, matrices, scatter plots, etc.—that have been used successfully by various organizations pursuing different technology investment goals. We

do not endorse any specific method or tool; neither do we seek to rate methods and tools against each other. Rather, we provide insight to the layperson in technology management who might be seeking practical, defensible mechanisms for conducting opportunity assessments.

In the Results section, we have listed the tools in a way that highlights the specific features and attributes of each. The figures and tables in this report can help simplify the act of choosing, in the way that an article in *Consumer Reports* magazine may help simplify the act of buying a gas grill. Additionally, we provide suggested steps for the reader to follow when selecting an opportunity assessment tool and a case study of our own experience in selecting a tool.

Methods

Our methods incorporated primary and secondary research to identify tools and evaluate their utility and suitability for particular organization types. Primary research included speaking with 5 to 10 organizations that conduct periodic assessments of technology opportunities to gather input on best practices and suggestions for tool types. Secondary research consisted of a literature review and Web searching to identify tools.

It is important to note that we focused primarily on judging a method's ability to assess the overall content of a proposal rather than its ability to verify proposal data. A funding candidate's proposal will likely present data such as estimates of market size and lists of development partners that may or may not be totally accurate. While some organizations spend resources to verify the data, most do not, so we focused on assessing what is provided in the proposal or business plan, and not on fact finding.

Results

Our work reaffirmed the diverse nature of opportunity assessment methods. Some include graphical components to allow simple conveyance of the technology's disposition with regard to ratings of success measures. Others provide more complex weighting calculations to generate scoring totals used in group prioritization, or they stimulate feedback and insight from a reviewer. We suggest that technology managers can select an assessment tool by using a self-evaluation process and breaking this process up into discrete steps. Additionally, we provide a simple case study to show our approach to a situation where we needed to select an assessment tool.

Types of Opportunity Assessment Tools

To provide some context for readers, this section provides samples of assessment tool features. These are drawn from a variety of methods and are merely given as examples, not a comprehensive listing of tools. Figure 1 depicts sample graphical assessment tools. Figure 2 illustrates a short-answer worksheet, and Figure 3 shows a worksheet used during a panel review method. Tool types are described in greater detail later in this section.

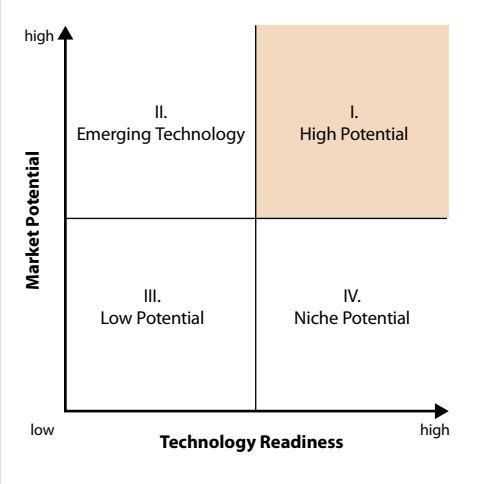
Figure 1 depicts two types of graphical assessment tools. The number of axes reflects the number of evaluation criteria selected by the user. Graphical elements most readily lend themselves to quick comparison of proposal ratings, when multiple proposals are plotted on a common set of axes.

Figure 2 shows a template for evaluating the commercial potential for government-developed technology. The form provides for weighting rankings in each criterion, up to a maximum point value. For example, in the case of Market Potential, a proposal with five potential applications having minimal impact (1 out of 5) would have the same weight as a proposal with one application area but major impact (5 out of 5). Additionally, this form simplifies the amount of feedback the reviewer is asked to prepare.

Figure 3 is a sample format for a reviewer to use as part of a panel review. This form aids the reviewer in guiding his review and focusing on key issues for discussion. While the scores can be tallied and used to create an average rating for proposals, the comments section captures the rationale behind the rating. This perspective is critical for debate and qualitative comparison of proposals.

In the following section, we list tools in a way that highlights specific features and attributes like those just described.

Figure 1. Examples of graphical opportunity assessment tools



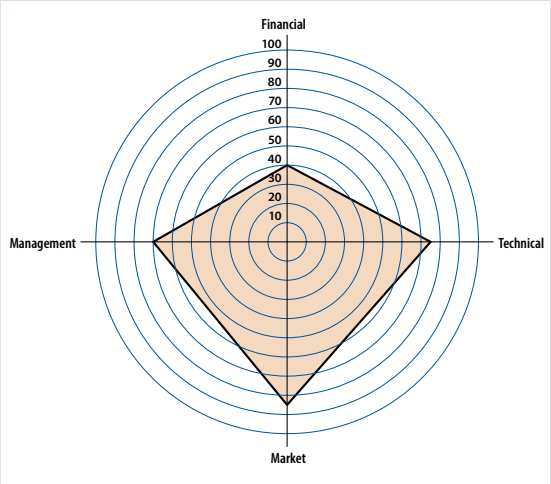


Figure 2. Sample of short-answer worksheet tool

Rating Criteria — **Sub-Score** — **Weight Factor** — **Score**

1. Market Potential (Non-Government only, 25 pts.)

$\sum_{i=1}^{n}(\text{Market}_i \times \text{Impact}_i) \leq 5$, n = Total # Applications Identified

_____x_____ =_____ _____x_____ =_____
_____x_____ =_____ _____x_____ =_____
_____x_____ =_____ _____x_____ =_____
_____x_____ =_____ _____x_____ =_____
_____x_____ =_____ _____x_____ =_____ _____ x 5.0 = ☐

2. Commercial Readiness (15 pts.)
1. 3 yrs. to market
2. 2-3 yrs. to market
3. 1-2 yrs. to market
4. 6 mos.-1 yr. to market
5. <6 mos. to market

_____ x 3.0 = ☐

3. Technology Maturity Level (15 pts.)
1. Concept only
2. Mathematical Model
3. Proof of Concept
4. Functional Prototype
5. Field Applications and/or Performance Test Data

_____ x 3.0 = ☐

4. Intellectual Property Potential (15 pts.)
0 1 2 3 4 5 6 7 8 9 10
(None) (High)

_____ x 1.5 = ☐

5. Societal Impact (10 pts.)
0 1 2 3 4 5 6 7 8 9 10
(None) (High)

_____ x 1.0 = ☐

6. Licensing Potential (10 pts.)
0 1 2 3 4 5 6 7 8 9 10
(None) (High)

_____ x 1.0 = ☐

7. Commercial Partner's Contributed Resources (10 pts.)
0 1 2 3 4 5 6 7 8 9 10
(None) (High)

_____ x 1.0 = ☐

Date of Evaluation_____ **FINAL SCORE:** ☐

Evaluator's Name_____

Mean Score: ☐

Market Size:	**Technology Impact:**
1) < $25 M	**Low .2**
2) $25M - $100M	**Moderate .4**
3) $100M - $250M	**Significant .6**
4) $250M - $500M	**Exceptional .8**
5) > $500M	**Revolutionary 1.0**

Figure 3. Sample of worksheet used in panel review

REVIEW PANEL EVALUATION FORM

Proposal Title:

Reviewer:

Please score the items using a scale of 1 (poor) to 5 (excellent). Use the comment sections to explain, clarify and support your ratings and responses. Please use a pen so that copies will be more legible.

1. The extent to which the proposed project is appropriate and is adequately explained:
   - relationship of the project to present state of knowledge in the field
   - general plan of work, including measureable milestones
   - description of experimental methods, procedures, and objectives

   Comments: **Score** _____

2. The ability of the company to commercialize this product or process:
   a. Previous success in commercializing a product or process
   Comments: **Score** _____

   b. Relationship of potential product or process to current product line
   Comments: **Score** _____

   c. Competitive advantage of the company in commercializing the product or process
   Comments: **Score** _____

3. Evidence of Commitment:
   a. Institutional commitment to this project
   Comments: **Score** _____

   b. Business commitment to this project (amount of "real" collaboration)
   Comments: **Score** _____

   c. Competencies of proposed research and development personnel
   Comments: **Score** _____

   d. Adequacy of research facilities to support this project
   Comments: **Score** _____

4. The intrinsic merit of proposed project:
   Comments: **Score** _____

5. Appropriate budgets:
   a. Is requested budget appropriate? yes ___ no ____
   b. Does the requested budget require additional justification? yes ___ no ____
   Comments:

   c. Is the company contribution appropriate and clearly described? yes____ no ____
   Comments:

Does this project merit funding? yes___ no___ possibly ____
Comments:

Selecting an Opportunity Assessment Method

Before accessing specific methods or tools, the users must assess their own needs by considering their individual priorities. Like *Consumer Reports* articles, the charts in this report serve as a companion to, rather than a replacement for, thoughtful consideration. Unlike the process that *Consumer Reports* employs when it compares products, the authors did not benchmark various methods against one another, and no performance data are available for the tools.

Based on the authors' knowledge of various methods to evaluate technology investments, the act of choosing a method and tool may be thought of as a subjective three-step process:

1. Review high-level needs.
2. Determine preferred tool characteristics.
3. Generate tool options lists for decision.

The first step involves high-level review of the basic needs and limits of the particular assessment circumstance to establish the parameters of the situation. The first step also discusses the overarching factors that the user will establish for each situation. The second step discusses tool characteristics, with checklist-type questions prompting the user to define their preferred characteristics. The output of the second step is a list of preferred characteristics of the tool. Last, the first two steps can generate a short list of acceptable tool options, from which the user chooses the best match.

To illustrate steps 1 and 2, the following sections include tables that

- Depict characteristics of different user types and tasks and provide suggested classes of tools and methods.
- Associate characteristics with each general class of tool and provide a sample of each type of tool.

Based on the information in the following two sections, the reader will be able to complete the third step of the process—generating a short list and making a decision.

Step 1. Review High-Level Needs/Overarching Factors

As no single assessment tool is appropriate for all situations, a user will need a thorough grasp of the goals and resources available for his situation. A strong understanding of these high-level factors will help the user select an appropriate assessment tool. Some factors that the user may consider to establish the parameters or framework of the assessment include the following:

- Resources required in using each tool: The tools vary in the amount of time required to use them, the number of evaluators and associated coordination costs, and the funds required to buy software or hire facilitators or consultants.
- Evaluator perspective: Some tools require technical review, business review, management review, or some combination thereof.
- Reviewer experience: Most reviewers will have knowledge of only technical or business aspects, though some might have insight into both areas. The individual reviewer's capability, as well as the composition of the entire review team (if a panel is used), plays a significant role in achieving a thorough, accurate assessment. Other reviewer factors include the following:
  - number of reviewers
  - diversity of reviewers (including both managerial and technical personnel)
  - geographic location of reviewers
- Content evaluated: In most cases, a proposal or business plan is submitted by a researcher or start-up business as input into the assessment process. Some assessments are made solely on the information supplied by the proposal. Others expand consideration to information that reviewers can infer based on their own experience. Best practices discourage judging solely on the proposal information as it may skew certain attributes, such as the following:
  - Market size vs. market share: Some tools award points based on market size, but business plans do not always provide reasonable estimates. For example, a company may cite published market research that estimates the total market for visual simulation tools at $1.4 billion, but the

immediately addressable sub-segment of that market may be limited to the display systems segment, which is valued at closer to $100 million for the same time frame.

  - Team: Many venture capital firms (VCs) weigh the strength of the team as the most important success indicator, so effort on the part of the reviewer to research or confirm the capability of the proposal's development or management team is warranted.

- Objective: This issue raises the question, "Why are we evaluating?" Most assessments are done to narrow the field of options for investing in technologies that can complement existing products and processes or be the basis for new business ventures. The person choosing the tool needs to determine the best fit—either a tool that filters out unpromising options, perhaps by employing a minimum requirements filter, or a tool that prioritizes alternatives.
- Balance: In most cases, tools support a balanced emphasis on technology, team, market, and financial aspects of an opportunity. Some situations may require prioritized consideration of one or more of those aspects.

Different types of organizations or agencies considering an investment will establish a framework that suits their particular characteristics. To illustrate, we have provided three examples of organizational assessments employing the different parameters that must be accommodated.

NASA Seed Fund. The National Aeronautics and Space Administration (NASA) invests in early R&D of revolutionary new technology that is crucial to meeting its mission goals. The seed fund program issues regular requests for proposals and conducts opportunity assessment to narrow the field of proposals to a few that will receive funding.

Driven by the due dates of the proposal award cycle, NASA's resources for opportunity assessment are constrained by time. NASA has an ample number of evaluators on staff that can provide both technical and business perspective to inform the assessments. NASA's evaluators are likely to be geographically diverse because NASA technology may be relevant to several of NASA's 10 centers. The NASA program priority is developing technology; thus, technical merit may be the highest priority for NASA's assessments.

State Technology Investment Fund. A state may invest in developing technology that becomes the basis for new products and new business to create wealth and jobs in the state. Typically, the objective of the assessment is to rank the opportunities and to fund as many as the budget allows.

A state's time resources for assessment are constrained by proposal award schedules, and the amount of funds for assessment is often proportional to the amount of money being invested. For example, an award under $10,000 may warrant fewer than five hours of assessment, whereas a six-figure award will justify more in-depth assessment, including multiple reviewers addressing both technical and market reviews and perhaps a multi-phase process.

In cases in which an in-depth assessment is warranted, a state agency may need a tool to accommodate outside technical reviews. With a focus on job growth, the program and tool priorities may be the team and financial strengths of proposals. When a state technology investment fund is self-supporting, ROI is critical.

Venture Capitalists. VCs fund promising new technology with the potential for large growth and ROI. The objective of their assessments is to filter out opportunities to identify the best. Very few opportunities may be chosen in a given opportunity assessment cycle.

In our observation, VCs rely on their own experience in judging an opportunity, with particular emphasis on the strength of the team; they usually give strength of the financial, market, and technical aspects lower priority. Additionally, we believe that VCs more often evaluate presentations from entrepreneurs than use tools to evaluate a business plan, relying instead on their own background research, judgment, and experience. We see a significant difference between public and private sector investment decisions in this regard—public entities (e.g., federal agencies or

state institutions) generally require a much higher level of transparency and paperwork to support their decision making, where groups like venture capital can be more informal in their process.

In addition to the overarching themes seen in the preceding three examples, each assessment requires the user to consider other unique tool characteristics that may be priorities for the specific situation, as described in the next section. However, every assessment requires judicious application of the factors above when selecting a tool. These factors are important—they serve as the backdrop against which the user will weigh preferences for tool characteristics in Step 2. For example, if an organization realizes in the course of determining its assessment objectives that the budget for the assessment process is severely limited, a tool that features multiple reviews may not be appropriate.

Step 2. Determine Preferred Tool Characteristics

Consideration of the preceding overarching factors allows the user to perform a high-level review of objectives and establish basic operating requirements for their assessment method. Next, users need to consider specific, preferred characteristics of methods and tools, discussed in this section. To facilitate ultimate selection, the next section (Step 3) will provide in tabular form the tools discussed here.

Is this a one-time or regular process?
Technology assessment may be needed for a one-time opportunity, such as when a university or government technology transfer office (TTO) must justify investing funds to further the development of a particular technology. By contrast, opportunity assessment can be a regular process, with scheduled proposals and awards on a regular basis. A regular process warrants an investment in methods and tools that lend themselves to comparing several options simultaneously and that provide recordkeeping so that future opportunities can be compared with past opportunities.

Is this an individual process or a group process?
Our findings support leveraging multiple inputs (e.g., panel review) for optimal review. A tool that facilitates a group process must be judiciously applied; for example, a decision must be made whether "one person, one vote" in the review process is the best approach. The option to use multiple inputs depends on the range of resources and time available for the review; panel involvement can be an intensive, time-consuming process.

Is this a staged (multi-level) process?
Some tools facilitate staged methods that include several reviews from different sources. Examples of staged methods may include the following scenarios:

- Request multiple proposals from each team, increasing the level of detail requested at subsequent stages. For example, request brief initial proposals; filter them; then request full presentations from top candidate teams only.
- Apply a minimum requirements filter to all proposals at the first stage and then perform a second stage of review for those passing the filter.
- Use separate technical and business reviews because sometimes one informs the other; for instance, a technical team may evaluate the proposal for technical merit and then make its review available for the next stage of review by the business team. Separate technical and business reviews are considered a "best process," but such a staged process requires more resources. Generally, a staged process is used when the investments are significant (approaching six figures) and/or when the assessment process is integrated into the normal business practices of an organization that has in-house technical and business reviewers.

Is a software-enabled tool preferred?
Some tools are simple worksheet or questionnaire documents that may be e-mailed among the review team. Software-enabled tools accept, compile, and display data from multiple reviews and allow for easier sharing of review data. Although a software-enabled tool can add expense, it can also benefit an assessment process that leverages multiple reviews. Software-enabled tools also lend themselves to long-term historical recording.

Should the process be transparent?
Those conducting opportunity assessments may need to document clearly the selection method, either for purposes of recordkeeping or for demonstrating fairness. The latter is a particular concern of certain

entities (or agencies) such as public sector technology offices. Some tools employ numerical ranking to build a score. Other tools rely more on the experience and instincts of the reviewers. They may suit private sector organizations that may not be required to make decisions (or priorities or methods) public and in fact may deliberately wish not to.

Is a qualitative view or a quantitative view most appropriate?
Some tools facilitate a *qualitative* review method, capturing input in narrative form. Other tools prompt numerical ratings to facilitate *quantitative* review methods. In our experience, extremely simplified quantitative reviews (e.g., yes/no questionnaires) provide little comparative value for the reviewer or the proposer. Quantitative reviews may be enhanced by using scaled ratings that can impose numerical rankings on vague estimates in areas like market size. Other tools have the flexibility to account for both subjective and objective criteria, and they may be able to assign categorical and numerical ratings to subjective criteria.

Are long-term considerations and synergy with core competencies important?
Or, is this for a short-term project not related to core competencies?
A technology investment may be considered as either a stand-alone product or part of a company's collection of core competencies. An assessment may need to account for how well a new technology aligns with technical core competencies or business strategies over the long term since core competencies are sustained over time (Torkkeli and Tuominen, 2002). For example, a window company may evaluate an option for a new transparent, insulating material for window glass to see how it aligns with the company's core competency of introducing novel window materials into traditional products.

Evaluating technology options for the short term versus the long term affects tool selection. Tools that support methods addressing short-term objectives may focus on ROI and solid business planning. By contrast, longer-term tools have mechanisms to quantify the higher risks of earlier-stage R&D.

Is this assessment method for basic or applied R&D?
Many methods are suited to evaluating technology that can be considered basic R&D, where basic R&D might be discovering a new material and applied R&D might be using a new material to improve an existing product. The tools that support these methods often account for testing and development cycles and may take into consideration the higher value of establishing a completely new technical advance compared to refining an existing area. Extensive proposal information requirements (e.g., a full business plan) are not conducive to evaluating early-stage technology. Tools for technologies that are more mature and closer to introduction into actual markets focus on the practical aspects of addressable market size, distribution channels, and the strength of the business case and the team.

Step 3. Generate Tool Options Lists for Decision

As one can see from the discussion of overarching factors and preferred characteristics in the two previous sections on tool characteristics, users need to identify several data points and decisions in selecting an opportunity assessment method or tool. We believe presenting data in tabular form is useful in discriminating among options. Such a format allows users to compare and contrast the various methods and tools. In this section, Tables 1, 2, and 3 provide a mapping of tool characteristics to organizational characteristics and tool types, respectively.

In Tables 1 and 2, the tool characteristics are listed across the top of the table and the organization or user type is listed down the left stub column. Based on our review of existing methods and related tools and literature, we identify tool characteristics (detailed in Step 2 above) likely to be important to each user group. We list, for each organization or user type, representative tools or references in the far right column (see References for detail on publicly available tools or, for proprietary tools, the owning organization). Important tool characteristics are indicated by a dot in the corresponding cell; empty cells indicate that those characteristics are not usually critical for that user organization or task.

Table 1. Tool characteristics—importance by user organization

User Organization	Tool Characteristics												Suggested Tools or References
	One-time process	Individual process	Group process	Staged process	Software-enabled	Transparency	Qualitative review	Quantitative review	Long-term/core venture	Short-term/ non-core venture	Basic R&D	Applied R&D	
University TTO	✔		✔			✔	✔				✔	✔	• ProGrid[a]
Local or regional government			✔		✔	✔		✔	✔			✔	• Yankee Ingenuity[b] • Technology Tree[c]
Various corporate managerial levels			✔	✔	✔			✔	✔	✔	✔	✔	• ProGrid[a] • Torkkeli[d]
Federal government research labs			✔	✔	✔	✔	✔		✔		✔	✔	• ProGrid[a] • Technology Business Finance Program[e]
Angel investors & VCs		✔					✔			✔		✔	• ProGrid[a]
Banks	✔	✔					✔			✔		✔	• Technology Tree[c] • Csaszar[f]

[a] ProGrid Evaluation Solutions, 2008
[b] Connecticut Innovations, 2008
[c] Technology Tree Group, 2008
[d] Torkkeli and Tuominen, 2002
[e] Oklahoma Center for the Advancement of Science & Technology (OCAST), 2008
[f] Csaszar, Nussbaum, and Sepulveda, 2006

Table 2. Tool characteristics—importance by user task

User Task	Tool Characteristics												Suggested Tools or References
	One-time process	Individual process	Group process	Staged process	Software-enabled	Transparency	Qualitative review	Quantitative review	Long-term/core venture	Short-term/ non-core venture	Basic R&D	Applied R&D	
Investment justification	✔	✔			✔	✔	✔			✔			• Yankee Ingenuity[a] • Technology Business Finance Program[b]
R&D project selection			✔	✔	✔				✔		✔		• ProGrid[c] • NASA Commercial Technology Development Program[d]
New venture selection	✔	✔			✔				✔			✔	• Technology Tree[e]
After-the-fact program analysis	✔		✔		✔	✔						✔	• ProGrid[c]

[a] Connecticut Innovations, 2008
[b] Oklahoma Center for the Advancement of Science & Technology (OCAST), 2008
[c] ProGrid Evaluation Solutions, 2008
[d] NASA Goddard's Technology Transfer Program, 2008
[e] Technology Tree Group, 2008

In Table 3, the tool characteristics are listed across the top of the table, and the tool type is listed along the left side stub. Based on the authors' literature and tool review, we identify tool characteristics associated with each tool type and list sample tools or references in the far right column of the table.

Table 3 illustrates a variety of different tool types. Brief definitions of each tool type are as follows:

- Short-answer worksheet—a tool usually intended to guide a single reviewer through assessment of a case and to capture key rankings of parameters.
- Matrix class tools (grid, table, scatter plot)—a means for graphically depicting the strengths and weaknesses of a given case, usually seeking to achieve some balance of grades across topic areas or to identify extremes that require additional attention.
- Weighted score sheet—quantitative methods for placing emphasis on specific topic areas (e.g., management team) in relation to other areas.

Table 3. Tool characteristics—provided by tool type

Tool Type	Tool Characteristics												Suggested Tools or References
	One-time process	Individual process	Group process	Staged process	Software-enabled	Transparency	Qualitative review	Quantitative review	Long-term/core venture	Short-term/ non-core venture	Basic R&D	Applied R&D	
Short-answer worksheet	✔	✔	✔	✔	✔	✔	✔			✔	✔	✔	• Technology Business Finance Program[a] • Center for Innovative Technology[b] • NASA Commercial Technology Development Program[c] • Al-Mazidi[d] • Technology Tree[e]
Matrix class tools (grid, table, scatter plot)				✔	✔			✔	✔		✔		Phaal[f]
Weighted score sheet		✔	✔	✔	✔	✔		✔	✔	✔	✔	✔	• Lawson[g] • Technology Tree[e]
Score sheets using linguistic ladder	✔	✔	✔	✔	✔		✔			✔	✔	✔	• ProGrid[h] • DeCoster[i] • Csaszar[j] • Cormican[k]
Filter		✔		✔	✔			✔	✔			✔	• Cormican[k]
Technical input feed forward		✔			✔	✔	✔		✔		✔		• Yankee Ingenuity[l] • Torkkeli[m]

[a] Oklahoma Center for the Advancement of Science & Technology (OCAST), 2008
[b] Virginia's Center for Innovative Technology, 2008
[c] NASA Goddard's Technology Transfer Program, 2008
[d] Al-Mazidi and Ghosm, 1997
[e] Technology Tree Group, 2008
[f] Phaal, Farrukh, and Probert, 2006
[g] Lawson, Longhurst, and Ivey, 2006
[h] ProGrid Evaluation Solutions, 2008
[i] DeCoster and Butler, 2005
[j] Csaszar, Nussbaum, and Sepulveda, 2006
[k] Cormican and O'Sullivan, 2004
[l] Connecticut Innovations, 2008
[m] Torkkeli and Tuominen, 2002

- Score sheets using linguistic ladder—assessment tools that guide a user into rating different parameters using textual statements instead of quantitative ratings. For example, a reviewer might determine that an aspect of the proposal
  1. fails to provide information,
  2. provides a basic level of information,
  3. provides a high level of information, or
  4. provides an exhaustive level of information.
- Filter—typically a one-page, checklist format, used primarily to confirm that certain data points have been gathered or meet minimum criteria.
- Technical input feed forward—a two-stage process in which an initial review focuses on the technical or product facets of a case before "feeding" that report to a later-stage business or commercial reviewer.

Tools included in Tables 1, 2, and 3 have a track record of use and are well structured. The literature reflects an abundance of tools that are academic in nature but are not included since they did not appear to have been "road-tested."

In general, by employing the tables, users can have a short list of acceptable tool options as a starting point for the tool search. In practice, by using the overarching factors information in Step 1, users can first perform a high-level review of objectives to establish the parameters of the situation—i.e., their basic needs and limits of the particular assessment circumstance. Then, considering the points on characteristic preferences in Step 2, users can determine the preferred characteristics of the tool.

Case Study

In 2005, RTI International worked with a client to select an opportunity assessment process for use in a new funding program. The selection process focused on identifying and adapting opportunity assessment methods and tools that provide a holistic assessment of programmatic, technical, market, and business (including financials and management) factors. Those factors influence the risk/return of early-stage technology investment opportunities. The client expressed a preference for an opportunity assessment method with an established track record of use in a similar application.

RTI worked with the client to determine the attributes or specifications that this client judged to be important, much like the process of Step 1 described in this report. In this particular case, the Step 1 criteria included the overarching factors listed below.

Overarching Factors

- Resources—A multistage review was deemed appropriate.
- Perspective of the evaluators—Both technical and business perspectives were needed.
- Experience of the reviewers—Multiple reviewers were necessary and geographic diversity needed to be accommodated.
- Content evaluated—Not defined, but expected to include a business plan-type document.
- Objective—Identify new technology projects for funding that would help meet both programmatic goals and commercial goals to provide a return on investment.
- Balance—Client's focus was on support of programmatic goals in addition to commercialization goals (i.e., provide value to the client's mission, not just provide a rate of return on the investment).

Considering the preceding overarching factors allowed us to perform a high-level review of objectives and establish basic operating requirements for the assessment method. Next, we considered the following specific, preferred characteristics of methods and tools, much like Step 2, discussed in the previous section.

Specific Tool Characteristics

- Is this a one-time process?—No, this program would fund early-stage technology development projects on a yearly basis.
- Is this an individual or group process?—Likely to be a group process with multiple stakeholders (both technical program managers and commercialization managers).
- Is this a staged (multi-level) process?—Yes.

- Is a software-enabled tool preferred?—Not necessarily, although, at a minimum, electronic documents were needed to facilitate multiple reviews.
- Is a transparent process required?—Client was constrained by the need to provide a complete record of its opportunity assessment process.
- Is a qualitative view or a quantitative view most appropriate?—Likely both: a qualitative review to inform quantitative rankings that help in making the process transparent.
- Are long-term considerations and synergy with core competencies important?—Yes, since the technologies will impact the mission of the agency.
- Is this for basic R&D or applied?—Basic R&D.

RTI culled a list of opportunity assessment tools from its network of industry contacts and experience base. These tools could be assigned to different general categories, for example, research/seed funding tools versus small business investing tools, or public funding agencies versus private funding firms.

Some tools were useful as summary tools in that they collected key points from the business plan or other information and presented those points to the reviewer. Other tools were strictly ratings tools that compute a score, which can then be used to rank other reviewed plans. Put another way, summary tools tend to provide more feedback and assistance for small businesses, whereas ratings tools tend to focus explicitly on making funding decisions.

Ultimately, for the purposes and needs outlined just above, RTI recommended use of a modified version of the Yankee Ingenuity evaluation tool available from Connecticut Innovations, a public R&D funding organization. That organization had used the tool for 20 years to support almost $50 million in investments. The main reasons for selecting this particular opportunity assessment method included its proven effectiveness in managing risk, its reliance on the input of a group of commercialization professionals, and its ability to provide a balance between time-consuming and thorough review practices.

Discussion

The process of choosing a tool to facilitate technology investment decisions can be overwhelming. Many methods and tools are available; some are more practical than others, whereas others are more theoretical. Selecting and applying these tools depends on their suitability to evaluate, for example, early- versus late-stage technology or individual versus group assessment processes.

Selecting a method and tool becomes an exercise in determining assessment objectives: What do I really need to know? Who should be involved in the assessment? What information needs to be conveyed and to whom?

Our goal for this research report was to create an accessible resource and overview for the novice technology transfer/management professional. While performing this research, we identified a large base of academic methods and tools. Although indentifying the pool of potential tools was instructive, it did not clarify which tools were truly practical for implementation at a company or university technology transfer office. We had intended to benchmark or evaluate commercial or off-the-shelf opportunity assessment tools, but we could not identify a suitable base of commercial, off-the-shelf tools.

During the course of our research, we learned several lessons that we summarize here as guidelines for those performing opportunity assessment. Users should apply these guidelines within the scope of their resources and needs, of course, and each organization should consider periodic review of assessment objectives to evaluate how well their opportunity assessment process is working in support of their program. Additionally, we suggest several "quick picks" that provide methods a beginning user might find instructive.

An organization looking to implement a new opportunity assessment process simply needs to follow the following guidelines:

1. Keep it simple—Use only as many questions and reviewers as your situation calls for. Provide specific proposal requirements that support your assessment tool/process.

2. Make it relevant—Ensure that the questions you are asking and the parameters you are measuring all contribute to what you would consider a successful choice.
3. Avoid getting too deep in the theory—With hundreds of techniques and approaches, if you try to research even 80% of them, you may become overwhelmed.
4. Take referrals—Explore your networks for opportunity assessment approaches used by others; this could help reduce the risk of trying something new. Public organizations might be more willing than private entities to share their approaches.
5. Customize—Mold a third-party approach to fit your needs rather than just using it "as is"; irrelevant questions can skew your results or frustrate reviewers.

Quick Picks

ProGrid (www.progrid.info)—a simple yet sophisticated software package that facilitates decision making; especially useful for a large organization with a diverse reviewer base and multiple cases to evaluate over several years

Decision Aid for Evaluation of Start-ups (Csaszar, 2005)—a method designed to improve analysis reliability through evaluating cognitive criteria

New Technology Venture Assessment (De Coster, 2006)—a method for evaluating business proposals when in-depth due diligence is not an option

References

Al-Mazidi, S., & Ghosm, A. A. (1997). A management model for technology and R&D selection. *International Journal of Technology Management, 13*(5/6): 525–541.

Chifos, C., & Jain, R. K. (1997) A comprehensive methodology for evaluation of the commercial potential of technologies: The strategic technology evaluation method, 1997. *International Journal of Industrial Engineering 4*(4): 220–235.

Coldrick, S., Lawson, C. P., Ivey, P. C., & Lockwood, C. (2002). A decision framework for R&D project selection. *Engineering Management Conference, 2002. IEMC '02. 2002 IEEE International, 1*: 413– 418.

Connecticut Innovations. (2008). Yankee Ingenuity Competition. Retrieved February 15, 2008, from http://www.ctinnovations.com/funding/ccef/yankee.php

Copeland, T. E., Koller, T., & Murrin, J. (2000). *Valuation: Measuring and Managing the Value of Companies* (3rd ed.). McKinsey and Company.

Cormican, K., & O'Sullivan, D. (2004). Auditing best practice for effective product innovation management. *Technovation, 24*(10): 819–829.

Csaszar, F., Nussbaum, M., & Sepulveda, M. (2006). Strategic and cognitive criteria for the selection of startups. *Technovation, 26*(2): 151–161.

De Coster, R., & Butler, C. (2005). Assessment of proposals for new technology ventures in the UK: characteristics of university spin-off companies. *Technovation, 25*(5): 535–543.

Doctor, R. N., Newton, D. P., & Person, A. (2001). Managing uncertainty in research and development. Manchester, UK: Manchester Business School.

Greene, W. H. (1997). *Econometric Analysis* (3rd ed.). New York: Macmillan Publishing Co.

Heslop, L. A., McGregor, E., & Griffith, M. (2001). Development of a technology readiness assessment measure: The cloverleaf model of technology transfer. *Journal of Technology Transfer 26*(4): 369–384.

Lawson, C. P., Longhurst, P. J., & Ivey P. C. (2006). The application of a new research and development project selection model in SMEs. *Technovation, 26*(2): 242–250.

NASA Goddard's Technology Transfer Program. (2008). Commercial Technology Development (CTD) Program. Retrieved February 15, 2008, from http://ipp.gsfc.nasa.gov

Oklahoma Center for the Advancement of Science & Technology (OCAST). (2008). OCAST Technology Business Finance Program. Retrieved February 15, 2008, from http://old.i2e.org/DesktopDefault.aspx?T0=186&TM=10

Phaal, R., Farrukh, C. J. P., & Probert, D. R. (2006). Technology management tools: Concept, development and application. *Technovation, 26*(3): 336–344.

ProGrid Evaluation Solutions. (2008). Software & software services. Retrieved February 15, 2008, from http://www.progrid.info/Software.html

Saaty, T.L. (1980). *The Analytic Hierarchy Process,* New York: McGraw Hill.

Shehabuddeen, N., Probert, D., & Phaal, R. (2006). From theory to practice: Challenges in operationalising a technology selection framework. *Technovation, 26*(3): 324–335.

Technology Tree Group. (2008). Tomorrow's technologies grown today. Retrieved February 15, 2008, from http://www.technology-tree.com/index.html

Timmons, J. A., Muzyka, D. F., Stevenson, H. H., & Bygrave, W. D. (1987). Opportunity Recognition: The Core of Entrepreneurship. In Churchill, N.C. et al. (Eds.), *Frontiers of Entrepreneurship Research.* Wellesley, MA: Babson College Center.

Torkkeli, M., & Tuominen, M. (2002). The contribution of technology selection to core competencies. *International Journal of Production Economics, 77*, 271–284.

Virginia's Center for Innovative Technology. (2008) Commonwealth Technology Research Fund. Retrieved February 15, 2008, from http://www.cit.org/programs/r_and_d.html

Additional Resources

The amount of literature available on the topic of decision making and opportunity assessment is extensive. These additional selections were also instructive to us.

Alireza, L. (2004). Application of AHP model for selection of technology licensor. *International Journal of Technology Transfer and Commercialisation, 3*(4): 353–368.

Auerswald, P., Branscomb, L. M., Demos, N., & Min, B. K. (2005). Understanding private-sector decision making for early-stage technology development. Advanced Technology Program. Washington, DC: US Department of Commerce, National Institute of Standards and Technology.

Chan, F. T. S., Chan, M. H., & Tang, N. K. H. (2000). Evaluation methodologies for technology selection. *Journal of Materials Processing Technology, 107:* 330–337.

Coates, J. F., & Coates, V. T. (2001). From my perspective/next stages in technology assessment: Topics and tools. *Technological Forecasting & Social Change, 70:* 187–192.

Cooper, R. G. (1993). *Winning at New Products,* 2nd ed. Addison-Wesley.

Drejer, A. (2002). Towards a model for contingency of management of technology. *Technovation, 22:* 363–370.

Farrukh, C. J. P., Phaal, R., Probert, D. R., Gregory, M., & Wright, J. (2000). Developing a process for the relative valuation of R&D programmes. *R&D Management, 30*(1): 43–53.

Farrukh, C. J. P., Phaal, R., & Probert, D. R. (2000). T*echnology management assessment procedure—A guide for supporting technology management in business.* Stevenage, UK: Institution of Electrical Engineers.

Gimenez, G. (2006). Investment in new technology: Modelling the decision process. *Technovation, 26*(3): 345–350.

Giorghiou, L., & Roessner, D. (2000). Evaluation technology programs: Tools and methods. *Research Policy, 29:* 657–678.

Liao, S. (2005). Technology management methodologies and applications: A literature review from 1995 to 2003. *Technovation, 25*(4): 381–393.

Link, A. N., & Scott, J. T. (2005). Evaluating public sector R&D programs: The Advanced Technology Program's investment in wavelength references for optical fiber communications. *Journal of Technology Transfer, 30*(1–2): 241–251.

Newton, D. P., Doctor, R., & Pearson, A. (2001). Managing uncertainty in research and development. *Technovation, 21*(2): 79–90.

Peretz, J., Das, S., & Tonn, B. (2005). Evaluation of the short-run benefits of six Department of Energy R&D projects. *Journal of Technology Transfer, 30:* 287–301.

Phaal, R., Farrukh, C. J. P., & Probert, D. R. (2000). Tools for technology management—Structure, organisation and integration. IEEE International Conference, Management of Innovation and Technology (ICMIT), 12–15 November, 2000.

Phaal, R., Farrukh, C. J. P., & Probert, D. R. (2001a). A framework for supporting the management of technological innovation. In *Proceedings of the Eindhoven Centre for Innovation Studies (ECIS) conference "The Future of Innovation Studies,"* Eindhoven, The Netherlands, 20–23 September 2001.

Phaal, R., Farrukh, C. J. P., & Probert, D. R. (2001b). *T-Plan: Fast-start technology roadmapping—A practical guide for supporting technology and product planning.* Institute for Manufacturing, University of Cambridge.

Ragavan, P., & Punniyamoorthy, M. (2003). A strategic decision model for the justification of technology selection. *The International Journal of Advanced Manufacturing Technology, 21*(1): 72–78.

Appendix

Sampling of Tools

Models Considered for Tables 1 and 2

(Contact the authors for additional detail.)

- Bootstrapping (Greene, 1997)
- Center for Innovative Technology (embedded scored questions and weighted worksheet)
- Cognitive criteria (Csaszar et al., 2006)
- NASA GSFC Commercial Technology Development (embedded one-page worksheet with points and impact ratio for evaluating proposals)
- NASA Industry-Led Partnerships (embedded panel review with technical reviewer input)
- NASA Small Business Innovation Research (embedded electronic review form with multiple reviewers)
- NASA Valu8 (embedded valuation spreadsheet supporting the licensing process)
- OCAST Technology Business Finance Program (embedded evaluation assessment worksheets supporting the award process)
- ProGrid (ProGrid Evaluation Solutions, 2008)
- RTI International (embedded technology investment questionnaire and horizontal bar graph)
- Technology Tree Group (embedded worksheet on strengths-weaknesses-opportunities-threats [SWOT], additional factors; Technology Tree Group, 2008)
- USAF Dual Use Science and Technology (embedded technical program assessment and project manager review)
- Yankee Ingenuity Technology Competition (embedded multi-input forms for technical/ individual/ group review; Connecticut Innovations, 2008)

Other Existing Models

The following list indicates other existing models; those marked with an asterisk have a tangible tool to support opportunity assessment.

- Analytical hierarchy process (Saaty, 1980)
- Cloverleaf model (Heslop, McGregor, & Griffith, 2001)*
- Comprehensive with triage (Chifos & Jain, 1997)
- Decision tree combined with financial models (Doctor, Newton, & Person, 2001)
- Filter based on outcome of normal group technique (Lawson, Longhurst, & Ivey, 2006)
- Framework to software (Shehabuddeen et al., 2006)
- Hybrid project selection model (Coldrick et al., 2002)
- Opportunity, equipment, resources (Timmons et al., 1987)*
- Simple eight weighted factors (Butler, 2005)
- Strategic, team, financial (Csaszar et al., 2006)*
- Structured decision-making model (De Coster & Butler., 2005)*
- Technology and management staged process (Al-Mazidi & Ghosm, 1997)
- Valuation (Copeland, Koller, & Murrin, 2000)*

Funding Source

Funding for the Research Report was provided through a Professional Development Award grant from RTI International.

www.rti.org/rtipress **RTI Press publication MR-0003-0802**