Having spent more than 25 years as a consultant designing and developing decision support tools for project selection, which time included founding and running a successful project portfolio management (PPM) software company, I have some opinions about PPM software. This 7-part paper is an expression of those opinions. The paper describes currently available PPM, identifies the critical weaknesses of most tools, explains the decision model that must be included within the tool if it is to make valid project recommendations, suggests criteria for evaluating tools, and provides recommendations for organizations interested in acquiring a PPM tool.

Additional papers on project portfolio management are available at http://www.prioritysystem.com.
Abstract

Project portfolio management is a hot topic, and there is no shortage of advice on how to do it. Consulting companies and software vendors are offering tools for the job. Organizations can benefit considerably from improving the processes used to select and manage projects, but "caveat emptor," let the buyer beware.

Much of the current advice on project portfolio management PPM is incomplete, inexact, or flat-out wrong. Available software typically provides good data management and reporting capabilities, but most current programs lack sound algorithms for identifying optimal project portfolios. Providing the wrong project recommendations is worse than providing no recommendations at all. The weak link for most tools is the lack of a quality decision model for recommending projects.

This 7-part paper identifies available tools, describes the model that must be included within the tool if it is to make accurate project recommendations, suggests criteria for evaluating tools, and provides recommendations for organizations interested in acquiring tools.

Before purchasing a tool, potential buyers are advised to familiarize themselves with established theories for valuing projects and to reject tools that cannot be properly tailored to correctly apply these theories. Armed with understanding, organizations can avoid being "burned" by unsuitable and inadequate tools that are being pushed in the marketplace.
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Part 1: Project Portfolio Management Tools

To survive and prosper in today's competitive, cost-conscious, and risky business environment, organizations must derive greater value from the projects that they conduct. Success requires doing the right projects, not just doing projects right.

As organizations have begun to recognize the need to improve project-selection decisions and to better manage their project "portfolios," consulting companies and software vendors have rushed to offer tools for the job. Most of the relevant products are marketed as tools for project portfolio management (PPM), but they may be alternatively described as tools for project prioritization, capital efficiency, enterprise project management, portfolio analysis, multi-project management, asset management, or resource allocation. The tools being pushed in the marketplace use very different approaches for evaluating projects and recommending project portfolios. Which approach is best?

This paper identifies and evaluates the PPM tools that are currently available. As you will see, "caveat emptor—let the buyer beware. Although many tools are described in marketing materials as being "rigorous" and "quantitative," few incorporate well-established project selection or portfolio optimization methods.

Project Portfolio Management

I define PPM as a tool-supported process for selecting projects and managing the project portfolio for the purpose of creating the greatest possible value. Under PPM, new projects are formally evaluated, prioritized and selected; existing projects may be accelerated, killed or de-prioritized; and resources are allocated and reallocated based on maximizing productivity. PPM does not involve making project-by-project choices based on fixed acceptance criteria. Instead, decisions to add or subtract projects from the portfolio are based on the impact on the total value created for the organization. The idea behind PPM is to apply investment optimization methods similar to those that have proven successful in the world of financial investing to project decisions.
Modern Portfolio Theory

The revolution in financial investing known as “modern portfolio theory” was initiated in the 1950’s by Nobel Prize winner Harry Markowitz. Markowitz showed that investors could obtain significantly greater return at lower risk if, instead of choosing stocks and other financial assets based on their individual potentials, choices were made based on calculating the impact on the risk and return generated by the portfolio as a whole. Certain combinations of investments (portfolios) are efficient (they lie on an “efficient frontier”) in that they create the greatest possible value for the least risk. Inefficient portfolios should be avoided. Which of the various efficient portfolios is best depends on the investor’s willingness to accept risk.

What enabled Markowitz to achieve his breakthrough was a clear understanding of the investor’s goal; namely, to obtain a portfolio of investments that provides the greatest possible (risk-adjusted) value. This perspective led Markowitz to a different and much better strategy for selecting investments. Although Markowitz may not have anticipated it at the time, the same reasoning applies to organizations investing in projects. The organization’s goal is to choose a project portfolio that provides the greatest possible (risk-adjusted) value for the organization. Likewise, this revised perspective produces a much improved project-selection strategy.

Challenges for Optimizing the Project Portfolio

Despite the analogy between financial and project investing, there are some key differences. Organizations conduct projects because they believe those projects will produce consequences that are good for the business. Thus, the value of a project portfolio is determined by the worth, to the organization, of the consequences of conducting those projects. The business consequences of projects may include improved cash flows (e.g., cost savings, increases in revenue), but there are other common project benefits that cannot so readily be expressed in dollars. For example, projects may be conducted for the purpose of improving worker safety, customer service, or organizational capability.

Another key difference relates to uncertainty. The returns from financial investments and projects are both uncertain. However, unlike financial assets, data on past performance is typically not available to help characterize the uncertainties over the returns from candidate projects. Difficulties for measuring project value and quantifying uncertainty posed challenges for applying portfolio theory to projects.

The Remaining Breakthroughs

Since Markowitz’s time, the additional breakthroughs necessary for optimizing project portfolios have been achieved. These advances include business consequence modeling (for estimating or simulating the impact of project decisions on business performance), probability encoding, Monte Carlo analysis, and decision trees (for quantifying uncertainty over the outcomes of alternative project decisions), and multi-attribute utility analysis, real options analysis, and risk tolerance (for quantifying the dollar value of projects and adjusting project value based on organizational willingness to accept risk).
The relevant methodologies still had to wait for improvements in computer technology and software engineering to become fully operational. Government laboratories, the military, research institutes, and others with early access to computing power and understanding of the mathematics involved have been selectively applying the techniques for years. However, only recently have suppliers attempted to create commercial products for PPM.

**PPM Tools**

Tools for PPM are evolving rapidly, and it is impossible to maintain a complete and up-to-date list of suppliers and capabilities. However, the table below provides a recent snapshot (Summer 2011) of advertised products. (There are some additional tools claiming PPM capabilities, but unless they advertise some functionality for project prioritization or portfolio optimization, I do not include them in my list.) The number of tool options is truly staggering. As indicated, there are now more than 100 tools aimed at PPM.

The information in the table is intended only to provide starting points for further inquiry. In the “Focus” column, I’ve attempted to indicate main target industries and application areas, features that the supplier emphasizes, structural characteristics (e.g., modular), and delivery modes. At best, the information is useful for initial screening only. The tools differ in so many dimensions that it is impossible to fairly summarize distinguishing characteristics in just a few words. For example (as explained in Part 2), a tool may address a select few or nearly every task encountered by a large, project-oriented business. It might recommend projects based on sophisticated portfolio optimization routines and industry- and project-specific models. Or, it may simply rank projects based on a simplistic scoring method chosen by the vendor as a lowest-common denominator applicable to the widest possible customer set.

Use the links (see web version of this paper) to obtain up-to-date information about how providers distinguish their tools. Product updates are announced almost weekly, and software capabilities can change significantly as new versions are introduced. Competition is fierce, and suppliers go out of business. Others are being acquired by larger companies. Oracle, for example, has purchased several PPM vendors and has yet to fully integrate the products or provide a comparative roadmap for customers.

**Tool Lifecycle**

For the purpose of evaluating tools, it is helpful to understand the typical lifecycle of a successful tool, as available tools will range from “bleeding edge” to nearly obsolete. Francois Retief [3] provides a helpful characterization, from which the following is derived:

> To compete successfully within the established PPM market, a new tool needs to provide some significant new idea or capability. When first released, the tool will have basic capability and a few defects. If the tool is initially successful, the supplier will gradually add capabilities requested by users. But, not all users will want or need the additional features. Also, the new features will complicate the product and likely produce additional defects. As the

> “[A]mong the most common complaints of PPM tools are that a great deal of the functionality goes unused and that the application is too hard to use.”

> - Lewis Cardin [4]
<table>
<thead>
<tr>
<th>Software for Project Portfolio Management</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product</strong></td>
</tr>
<tr>
<td>1000Minds</td>
</tr>
<tr>
<td>MyProjectManager</td>
</tr>
<tr>
<td>4C Portfolio Manager</td>
</tr>
<tr>
<td>Risk Management</td>
</tr>
<tr>
<td>Powerproject</td>
</tr>
<tr>
<td>Augeo Software</td>
</tr>
<tr>
<td>Bicite</td>
</tr>
<tr>
<td>PM Software</td>
</tr>
<tr>
<td>Clarity PPM</td>
</tr>
<tr>
<td>ProjectManager</td>
</tr>
<tr>
<td>Protrack PPM</td>
</tr>
<tr>
<td>Smart Decisions</td>
</tr>
<tr>
<td>Inventor ePM</td>
</tr>
<tr>
<td>Decision Lens</td>
</tr>
<tr>
<td>Dassault Systèmes PPM</td>
</tr>
<tr>
<td>DecisionLink</td>
</tr>
</tbody>
</table>

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## Project Portfolio Management Tools: Which Approach is Best?

### Part 1: Tool Options

<table>
<thead>
<tr>
<th>Vendor</th>
<th>Product</th>
<th>Key Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>PortfolioEngine</td>
<td>Multi-Project Portfolio Management</td>
<td>Various tools for project management, including prioritization, alignment, and financial analysis.</td>
</tr>
<tr>
<td>Expert Choice®</td>
<td>Risk Analysis</td>
<td>Tools for risk management, portfolio prioritization, and decision-making.</td>
</tr>
<tr>
<td>GenSight</td>
<td>PM/CM</td>
<td>Tools for project and program management, including planning, execution, and control.</td>
</tr>
<tr>
<td>HighImpact Solutions</td>
<td>Portfolio Management</td>
<td>Tools for portfolio management, including strategic planning and resource allocation.</td>
</tr>
<tr>
<td>PlanView</td>
<td>Enterprise</td>
<td>Tools for project management, including risk management, portfolio assessment, and decision support.</td>
</tr>
<tr>
<td>Oracle</td>
<td>PeopleSoft</td>
<td>Tools for human capital management, project planning, and resource allocation.</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Tool Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post Vision Technology</td>
<td>Prof. services / collaboration, multi-project &amp; res. mgmt. / South Africa / SaaS</td>
</tr>
<tr>
<td>PowerPlan</td>
<td>Utilities / asset management, accounting, custom prioritization / USA / onsite</td>
</tr>
<tr>
<td>PowerSteering</td>
<td>IT, new products / proj. management, res. utilization, alignment / USA / SaaS</td>
</tr>
<tr>
<td>Project Insight</td>
<td>General / project management, scorecard prioritization / USA / onsite, SaaS</td>
</tr>
<tr>
<td>Project InVision</td>
<td>IT, prof. serv. / proj. &amp; res. mgmt., alignmnt. / USA, UK, Mexico / onsite, SaaS</td>
</tr>
<tr>
<td>Project.net</td>
<td>General / scorecards, reporting, social networking, open source / USA / web</td>
</tr>
<tr>
<td>Project Objects</td>
<td>IT, new prod. / strat. alignmnt, suite / Ireland, UK, Italy, India, Brazil / web, SaaS</td>
</tr>
<tr>
<td>Projectplace</td>
<td>Gen. / collaboration, proj. planning, doc. mgmt. / Europe, India / SaaS, plug-in</td>
</tr>
<tr>
<td>Project Portfolio Office</td>
<td>Gen. / multi-proj. res. mgmt., planning, time cards, scoring / South Africa / SaaS</td>
</tr>
<tr>
<td>ProModel</td>
<td>General / project management, collaboration, alignment / USA / desktop</td>
</tr>
<tr>
<td>ProSymmetry</td>
<td>General / resource planning, risk minimization / USA / onsite, SaaS</td>
</tr>
<tr>
<td>Psoda Limited</td>
<td>IT, testing, new prod. / proj. mgmt., scoring / modular / New Zealand / SaaS</td>
</tr>
<tr>
<td>PwC</td>
<td>General / optimization, multi-attribute utility analysis, custom models / USA / web</td>
</tr>
<tr>
<td>SAP®</td>
<td>R&amp;D, engineering / lifecycle management, alignment, suite / Int'l / onsite</td>
</tr>
<tr>
<td>Savioi Software</td>
<td>Gen. / program, resource, proj. &amp; time management / Australia, India / onsite</td>
</tr>
<tr>
<td>Sciforma</td>
<td>Gen. / proj. management, scheduling, collaboration / USA / SaaS, onsite</td>
</tr>
<tr>
<td>Siemens</td>
<td>R&amp;D / portfolio &amp; program mgmt., prod. lifecycle, ideation / USA / onsite</td>
</tr>
<tr>
<td>Semanticspace</td>
<td>IT, gen. / proj. &amp; resource mgmt., suite / Int'l / desktop, onsite, SaaS</td>
</tr>
<tr>
<td>Sentient</td>
<td>Airlines, manufacturing / pipeline mgmt., suite / New Zealand / onsite or SaaS</td>
</tr>
<tr>
<td>Serena</td>
<td>IT, gen. / proj. &amp; resource management, alignment / USA, Brazil / SaaS</td>
</tr>
<tr>
<td>ServiceNow</td>
<td>IT / proj. visibility, cost &amp; res. mgmt, custom apps. / USA, Brazil / onsite</td>
</tr>
<tr>
<td>Smart Org</td>
<td>R&amp;D, new prod. / simulation custm. value models, risk anal. / USA, UK / web</td>
</tr>
<tr>
<td>Solution Q</td>
<td>General / risk balancing &amp; reporting / USA / web</td>
</tr>
<tr>
<td>Sophene</td>
<td>New prod. / roadmaping, simulation, strategic alignment / Int'l / web</td>
</tr>
<tr>
<td>Stand by Soft</td>
<td>General, small firms / multi-project &amp; resource management / Romania / SaaS</td>
</tr>
<tr>
<td>Syncopation Software</td>
<td>Gen. / decision trees, influence diagrams, portfolio optimization / USA / desktop</td>
</tr>
<tr>
<td>SumOpti</td>
<td>R&amp;D, contractor proj. / optimization, throughput solns. / USA / onsite or SaaS</td>
</tr>
<tr>
<td>TeamDynamix</td>
<td>Gov., colleges, construction / proj. management / USA / onsite, web</td>
</tr>
<tr>
<td>Tenrox</td>
<td>Gen. / time &amp; cost management, proj. execution, suite / Int'l / SaaS</td>
</tr>
<tr>
<td>Transparent Choice</td>
<td>Gen. / collaborative dec. making, prioritization, AHP / Germany / SaaS</td>
</tr>
<tr>
<td>UMS Group</td>
<td>Utilities / asset mgmt., optimization, custom models / Int'l / spreadsheet apps</td>
</tr>
<tr>
<td>UMT</td>
<td>Gen. / proj. fin., optimization, integrates w/ Microsoft Proj Server / USA / onsite</td>
</tr>
<tr>
<td>Unanet</td>
<td>Prof. servs., schools / proj. time &amp; expense mgmt., suite / USA / onsite, SaaS</td>
</tr>
<tr>
<td>Unit 4</td>
<td>Gen. / res., payroll, proj. &amp; procurement mgmt., suite / Netherlands / web</td>
</tr>
<tr>
<td>Vanguard Software</td>
<td>Gen. / decision modeling, optimization / suite / USA / desktop</td>
</tr>
<tr>
<td>VCSonline</td>
<td>General / project &amp; resource management, scoring / USA / SaaS</td>
</tr>
<tr>
<td>XenLogic</td>
<td>Prof. services / business intelligence, reporting, suite / USA / onsite</td>
</tr>
</tbody>
</table>
design becomes more feature-laden, it will become more complex, contain more defects, and become increasingly difficult to modify in any significant way. Eventually, the feature-rich product will stop selling because it can’t be made to incorporate the next new idea.

Try to ascertain where the tool is within its lifecycle, and be wary of feature-rich tools laden with capabilities that are not very important to you.

**Obtaining Information**

Tool providers are eager to pitch their products. Be prepared to be impressed. Modern PPM tools are graphically rich, with color-coded plots, maps, and charts. But, don’t be persuaded by pretty colors and sexy displays. You will need to do your homework to decide whether there is sufficient content behind the attractive cover.

Be skeptical. Many companies describe themselves as the “leading provider” of PPM software. As one vendor told me, “We would never tell a prospective customer that someone else has a better tool for their application.”

Importantly, it is often difficult to determine from websites and marketing materials (and even proposals submitted in response to RFP’s) what capabilities the tool has for portfolio optimization. Despite what is claimed in marketing materials, many packages advertised as supporting project selection and portfolio management actually have little functionality for identifying value-maximizing project portfolios.

Before purchasing PPM software, learn more about how to compare and evaluate PPM tools. In addition to reading the remaining parts of this paper, you might want to take a look at my paper containing detailed criteria for evaluating PPM tools (and the free spreadsheet for doing tool comparisons).

**The Bottom Line**

For those of you who can’t afford the time to read through the remaining parts of this paper, here is the bottom line. There is no one PPM tool that is best for every organization. Available tools differ greatly in what they do and how well they do it. No single tool does everything really well. Also, and most importantly, the right tool depends on you — the nature of your business, your needs, the kinds of projects you conduct, the maturity of your existing processes and associated tools, your culture and politics, and the degree of rigor that you want and can realistically bring to your decision-making processes. I can’t tell you which single tool will work best (or even work at all) for your situation. However, the path to finding that tool is here.
For many vendors, selling PPM software involves a bit of bait and switch. The bait is the ability to make project choices that maximize the value of the project portfolio while accounting for risk, using optimization methods analogous to those employed by financial investment managers. The switch is to a tool that facilitates multi-project management, not portfolio optimization. Such tools are capable of collecting and reporting information conveying the status of all of the projects in the project portfolio, and, quite often, they also provide features to support related tasks such as the tracking and assignment of resources, time and expenditure reporting, and communication and collaboration. However, such tools generally do not offer credible capability for valuing projects or optimizing project portfolios.

In truth, you don't need an expensive, feature-laden piece of software to implement a model that uses best-practice methods for valuing and prioritizing projects (you can do it with Excel). What you do need is a tool that can evaluate project proposals based on estimating the value to the business of the outcomes that would be produced by the decision to conduct those projects. I teach courses on how to do this. You can read about the applicable methods, starting here.

The reality about PPM that most software vendors don't want to hear is that the necessary model for valuing projects needs to be different for different customers because what customers need from their projects to be successful differs, even for similar organizations within the same industry. It is often not profitable or technically feasible for big PPM vendors to deliver large, multi-project management tools with the customer-specific models that would enable organizations to optimize their project portfolios based on value.

The reality about PPM that many PPM customers don't want to hear is that, to obtain a tool that reasonably prioritizes projects, the customer needs to think hard about what the business needs and the specific ways that proposed projects address those needs. The customer must then devote necessary effort to working with the software supplier to obtain a model that is capable of capturing the appropriate sources of project value.

Fortunately, for both PPM vendors and PPM users, it is not essential that a tool include accurate algorithms for valuing projects and optimizing the project portfolio in order for that tool to be useful. Experience shows that collecting and making project information easily accessible can provide considerable benefit to an organization that needs to take better control of the work it is performing. Likewise, a project prioritization tool does not need to provide real-time project reporting and support a broad spectrum of project-related activities to be useful. A focused tool that improves project selection decisions can be of considerable value to an organization that finds it difficult to determine which of too many project proposals ought to be killed or delayed. You
can benefit from acquiring a quality tool that supports multi-project management or from a quality tool that identifies value-maximizing project decisions.

Among the important questions that you must answer in order to choose the best PPM tool is whether your organization needs most urgently to improve its ability to prioritize projects or its ability to collect, manage, and communicate basic information about the projects it conducts and the resources that are utilized. If you need to do both, you can look for a tool that does both, or acquire both types of tools. Just don't make the mistake of choosing projects based on the recommendations of a PPM tool that lacks the analytics for quantifying project value.

The remaining parts of this paper provide more understanding for choosing among the available tools, beginning with, Part 2, which describes the key differences among the currently available PPM tools.

Notes

Part 2: Tool Differences

Part 1 identified tools available for project portfolio management. This part describes key distinctions among the tools.

All tools for project portfolio management (PPM) share a common feature; namely, a database containing information on proposed and/or ongoing projects. Typical project data include the project description, owner, cost estimates, resources required, schedule, anticipated project benefits, and so forth. The tools allow project data to be rolled-up to the portfolio level and then sliced and diced in various ways. The idea is to provide a bird’s eye view of the portfolio, a view that aids decision making by clarifying, among other things, the project mix. Data management features make it easy to add, delete, and edit project data, and to otherwise manage the project database. At minimum, if the tool is advertised as PPM, it will allow you to select and simultaneously view data for multiple projects.

Beyond that, as indicated by the side box, available PPM tools differ in many ways. In this part we explore some of these differences.

**Project Prioritization**

In addition to providing a repository for project data, nearly all PPM tools provide some project prioritization or portfolio optimization capability. The quality of this capability, however, differs dramatically. The simplest tools merely allow users to manually rank and/or select projects. Most tools go at least one step further and provide capability to score projects based on pre-specified or user-defined factors. Some tools have been around for years and show their age. Others are beta versions that may not be fully debugged or have all advertised features. Price tags vary considerably. Expensive products don’t always provide more capability. Inexpensive products are generally low cost for good reason. Some tools represent generic, off-the-shelf software designed to work in most any environment. Others are systems whose parameters are set to better fit a range of situations. Some are custom designs intended for a specific client and application. Tools may be standalone, independent applications or designed to link to other software used by the customer. Some tools for PPM are modules within a "suite" of related tools provided by the tool supplier. Some tools emphasize detailed scheduling, staffing, and reporting data desired by project managers. Others are geared more toward senior executives interested mainly in setting spending levels, resource allocation, and impacts on the bottom line. Some designs are driven by "hard" data, while others are fed entirely by judgments. Most tools adopt a top-down approach to data collection wherein data needs are based on what is required to compute the portfolio measures required by executives, but some tools adopt a bottom-up approach that relies on a social-media-type GUI to capture project data from the natural flow of project and non-project work. Some tools are massive, all-encompassing packages that require considerable cultural changes by user organizations. Others are small-scale, "starter" tools or tools focused on narrow applications.
defined criteria. In many cases, however, project scoring is limited to subjective judgments regarding how well individual projects support corporate objectives and strategies (an approach commonly referred to as strategic alignment). Simple scoring methods are almost always inaccurate or biased and therefore incapable of identifying value maximizing project portfolios.

Tools with more sophisticated analytics evaluate projects based on simulating or otherwise estimating the impacts or consequences of conducting those projects. Some consider the consequences of not-doing the project. Some incorporate Monte Carlo analysis or other techniques for quantifying uncertainty. A very few include methods for determining the dollar value to the organization of the forecast project consequences using rigorous valuation methods. More discussion of these important differences is provided below and in subsequent parts of this paper.

**Target Applications**

As indicated in the tool table, some tools are intended for specific industries and types of project investments, whereas others are general-purpose. Being advertised for a specific industry or type of project may mean that the tool incorporates specialized project evaluation logic appropriate for that industry or project type. Alternatively, it may merely mean that “templates” have been created that make it more convenient or easier to apply the vendor’s generic logic to the specific types of projects common to that industry. Tools that are truly designed for specific industries build their methodology around the business processes, customer segments, and success factors specific to that industry. Specialized tools are more likely to incorporate models for estimating the benefits produced if the project is conducted (since the mechanisms by which projects create benefit will be industry- and project-type specific).

The biggest subset of targeted PPM tools consists of those aimed at information technology (IT) projects. IT is a popular application because it is easy to identify IT needs, costs are high, and IT spending is typically viewed as discretionary (so prioritizing to decide which projects to conduct makes sense). IT projects are often difficult to justify based on financial analysis alone, and the tools make it easy to define various non-financial measures for evaluating and comparing projects. IT PPM tools may include features to support the tracking and management of application assets created as a result of an IT deployment project, referred to as application project management (APM). Examples of providers with tools designed for IT include Artemis, Cardinis, Compuware, Daptiv, IBM, ITM, Planview, and Serena.

Another large category consists of tools for managing projects to develop new products. These tools typically represent product development as a staged decision process. Examples include products from Augio, BOT International, CA, Gensight, Instantis, Smart Org, Sopheon, and Telelogic. Tools for pharmaceutical PPM comprise a special case, as the drug development stages are well-defined, compliance driven, and have other distinguishing characteristics. Examples include the tools from Enrich, Planisware, and Portfolio Decisionware.

Tools for traditional engineering and construction projects, like those for new products and R&D, distinguish themselves based on capabilities for addressing project risk. Examples of providers of PPM tools aimed at the construction industry include Meridian Systems, Skire, and Oracle (Primavera). Another application requiring strong risk management capabilities is oil exploration.
Examples of tools applied to up-stream oil projects include Oracle’s Crystal Ball and Schlumberger’s (now discontinued) Merak Capital Planning.

Providers of tools for professional services (e.g., Innotas, Oracle, OpenAir, HP, XenLogic) emphasize project staffing and billing. Electric, gas, and water utilities are asset-intensive businesses, and the tools designed for such industries often evaluate projects in terms of their impacts on asset performance (e.g., tools from Copperleaf, Davies Consulting, Folio Technologies, and UMS).

Tools aimed at government and government contractors often include functionality designed to satisfy federal project management requirements such as the Clinger-Cohen [1] and Sarbanes-Oxley Acts [2]. BOT International, Compuware, Daptiv, Innotas, VCSonline, for example, advertise features designed to ensure compliance with government mandates.

**Tool Sources**

Tools can also be distinguishing based on the types of organizations that provide them. Consulting companies, software vendors, and service providers all offer PPM tools. In terms of market share, software vendors and software service providers deliver the most tools. Suppliers range from large companies with international sales forces to tiny niche players.

Operations research consultants and academics have been delivering customized, portfolio optimization tools for at least two decades, often using Microsoft Excel to create their applications. The industry-specific PPM tools offered by some consulting companies are generalized versions of custom tools created and paid for by previous clients. Software vendors began providing commercial PPM tools in earnest beginning around the mid 1990s. Many of the early entrants were start-up’s, pioneers who mainly focused on tracking projects and displaying portfolio-level data.

Software vendors with established products for project management quickly recognized the opportunity to add portfolio capability to their products. In essence, they up-sized their project management tools—whereas their original tools were designed to provide support for the planning and control of individual projects, the portfolio versions added features for multi-project management, including multi-user access (through providing a client-server environment), cross-project resource loading, and cross-project data roll-up and reporting. Examples of long-time project management vendors who early on introduced portfolio versions to their product line include Artemis, Niku (now Computer Associates), Planview, and Welcom (now Deltek).

More recently, software giants, including SAP, Microsoft, HP, and Oracle, have entered the PPM space, mostly by acquiring niche players and integrating the products into their offerings. Generally, the larger software houses offer PPM modularly as a component of an enterprise project management (EPM) or an enterprise resource planning (ERP) “solution”—a software suite intended to address a wide-range of needs faced by a project-based enterprise. For example,
Microsoft’s Project Portfolio Server is a software platform that allows organizations to create and manage project portfolios on a central server accessed via its web client, Project Portfolio Web Access. Various modules of Portfolio Server can be activated, including Portfolio Builder, Portfolio Optimizer, and Portfolio Dashboard. The product can be used independently or integrated with Microsoft Project Server and Project Professional, collectively marketed as an Enterprise Project Management Solution.

**Tool Types**

Another way to distinguish tools is based on the features provided, in particular, whether the tool emphasizes features to support project prioritization and selection (the central theme of portfolio management) or more traditional needs of large, project-based organizations.

**Tools Focused on Analysis and Optimization**

As noted previously, a relatively small fraction of PPM tools provide well-established prioritization and portfolio optimization algorithms. To do so requires incorporating superior analytic capabilities. The sidebox provides a summary of the characteristics often present in tools with this focus. Features provided that are typically not available from other tools include capability to optimize under multiple constraints, compute project value in dollar units, display the efficient frontier, re-optimize with some projects being forced into or out of the portfolio, identify optimal multi-period strategies (e.g., multi-year project decisions), select project versions based on total portfolio funding level, compute risk-adjusted project value, and optimize the portfolio subject to achieving portfolio performance targets.

Most tools focused on prioritization are provided by organizations specializing in operations research and decision analysis, or from industry consultants or software vendors with strong capabilities in these areas. The tools are almost always configured to be industry and/or problem-context specific and employ special models and methods of analysis deemed appropriate for the application area. For example, Copperleaf's PPM tool for utilities uses mixed integer programming to allow for multi-year budget constraints. Schlumberger's tool for oil and gas exploration generates and analyzes portfolios of exploration projects (oil wells) using a genetic search algorithm.

Some PPM tools focused on project selection and prioritization are custom applications created using general-purpose tools for modeling and analysis. Examples of tools used for this purpose include (in addition to Excel) @Risk, Analytica, Criterium DecisionPlus, Crystal Ball, and DPL Portfolio. Some ERP suites contain modules that provide portfolio optimization capability (e.g., Microsoft's Portfolio Optimizer). A few companies (e.g., Enrich Consulting and SmartOrg) have
developed web-based PPM tools with strong portfolio optimization capabilities that may be customized for specific industry applications. SumOpti delivers customized tools to support portfolio and resource decisions based on a very efficient optimization engine.

**Tools Focused on Project Management**

Because, as stated above, many vendors entered the portfolio space by augmenting their existing project management tools, it is not surprising that so many PPM tools provide strong project management features even though they may lack portfolio optimization capability. An industry insider put it this way, “As interpreted by the software industry today, PPM is about managing the execution of project work after the decision is made to do the work.”

PPM tools focused on project management typically include features to support project planning (e.g., PERT charts, Gantt charts, milestones, critical workpaths, work breakdown structures, financial analysis), communication and collaboration (e.g., bulletin boards, automated email), document management (e.g., for project plans, charters, regulatory compliance requirements documents), project status tracking (e.g., progress reporting, earned value management, schedule and cost variance analysis), and post project analysis (e.g., benefits monitoring, surveys, lessons learned). Examples of tools with strong project management features include Pacific Edge, Planview, and Sciforma, as well as giants Microsoft, Oracle, and HP.

**Tools Focused on Resource Balancing**

Many tools with strong project management features also include capability to support the assignment of people and other resources to projects. Such tools track the resource needs of new and existing projects and the skills and availability of people. The concept, often referred to as resource balancing, is to help the organization improve efficiency through maximizing the utilization of available resources.

The sidebox summarizes characteristics of tools with this focus. Typically, the tools include features for resource management (e.g., resource pools, people scheduling tools, skill-matching tools) and accounting (e.g., timesheets, expense reporting, billing). PPM tools with strong resource balancing features generally include those provided as modules available within ERP suites, so-called business intelligence tools (such as that provided by XenLogic), and PPM tools designed for professional services firms.

**Multi-Project Management Tools:**

Emphasize project execution and workflow support. Typically, they provide capabilities to:

- Support planning, including defining project schedules and work breakdown structures.
- Generate project cost estimates.
- Monitor project status, including schedule and cost.
- Establish alerts.
- Support team communication and collaboration.

**Resource Balancing Tools:**

Help the organization understand project resource demands and resource availability. Typically, they provide capabilities to:

- Track the skills, experiences and interests of skilled staff.
- Manage work requests.
- Document resource allocations and track utilization.
- Determine the need for additional internal and external resources.
- Spot bottle necks and underutilized resources.
It should be noted that, although resource balancing tools support project staffing, such tools do not automate staff assignments. Even PPM tools with the best analytics for portfolio optimization rarely address the mathematical problem of identifying value-maximizing staff assignments. The difficulty is not just mathematical, but the challenge of knowing or estimating the many relationships that would be required before a solution could be computed, such as how the number of people assigned, fraction of time allocated, and phasing affects team performance. Rather than optimize the allocation of people resources, nearly all PPM tools with resource balancing capability simply support the traditional 3-step process for resource assignment: (1) identify the projects that you’d like to do given the constraints on costs (wherein project costs include labor costs), (2) attempt to phase and stage the desired projects to accommodate people and resource availability, and (3) iterate as necessary.

**Delivery Options**

Suppliers make PPM tools available to customers in several ways. The tool may be provided as a standalone application installed on a single computer, or each user may obtain a copy with project data being written to a central database. Alternatively, the application may be installed on the customer's client server so as to provide access to multiple users over the local network. Even if the application is installed on your server, users' computers may still need software installed to access it. Web-based tools are a form of server-based applications wherein the user's web browser serves as the client software—no software need be installed on the machines of individual users. A growing percentage of providers make PPM tools available "on-demand," also referred to as Software as a Service (SaaS). The tool supplier or application service provider (ASP) hosts the application, typically, making it available to the customer over the internet. Providers of SaaS tools include @task, Daptiv, Clarizen, and Project Insight. Also, many vendors with web-based tools designed for in-house deployment are now offering to host the applications for their customers, thereby including a SaaS option.

Each approach has advantages and disadvantages. Desktop applications tend to be relatively inexpensive, and continue to work even if the local network is down. Server-based tools allow multiple, simultaneous user access and offer centralized control over the application (but users not connected to the network won’t have access). Web-based applications allow users to access the tool from almost any computer, including machines on which you can’t install client software (e.g., PDA’s and iPhones).

The major advantage to customers of SaaS is little or no initial capital outlay is required to purchase software. Instead, the tools are paid for based on monthly or usage-based fees (see discussion of tool costs below). Also, a SaaS deployment may eliminate the need to involve your organization’s IT department in the purchase decision. A goal for providers of SaaS tools is to make their products attractive to a broad spectrum of potential clients and to make the incremental costs of each sale as low as possible. Thus, SaaS tools tend to be simple and easy to use, but they generally lack models and analytic capability that are specific to the customer’s industry and business situation. SaaS tools almost always include basic features to support collaboration, project management, and resource balancing. Of concern to some organizations are data security issues and the risk that a supplier outage will cut users off the application. In addition, providers...
of on-demand tools are challenged to integrate their tools with their customers’ other tools and data sources.

Notes

1. A U.S. federal law passed in 1996 that requires federal agencies to apply more rigorous processes to IT spending decisions.
2. A U.S. federal law passed in 2002 that establishes more rigorous accounting standards and business practices for publicly-held companies.
Part 3: Tool Costs and Risks

Part 1 identified tools available for project portfolio management and Part 2 described key tool differences. This part provides information on tool costs and purchase risks, and offers advice for preparing for a tool purchase.

As with other investment choices, the selection of a PPM tool should be based on tool costs, anticipated tool benefits, and the risks involved.

**Costs**

You don’t need to spend much to purchase a tool advertised for PPM. In fact, there are open source tools like Redmine and OpenPPM that are free (not listed on my tools page because they appear to offer no functionality to support project selection).

Purchase prices for mid-market solutions with robust PPM features range from about $5,000 to $50,000. High-end, feature-rich systems aimed at larger organizations typically have six-figure price tags.

Software purchase price, however, is only one cost component of the total cost of ownership. Other cost components impacted by tool choice include software support and maintenance fees, costs associated with software customization and implementation, hardware and infrastructure costs, data transfer costs, and training and change-management costs.

**Software License and Subscription Costs.** For standalone and in-house server applications, vendors typically charge a one-time fee to grant a perpetual license for the software. The price may be fixed, dependent on the features or modules that are “unlocked,” or based on the number of stations or users accommodated. Some vendors charge a separate fee for a database license. Tools with more features, that support more activities related to project and resource management, or that provide greater analytic power tend to cost more, but the more expensive tools are not always more capable. License fees range from less than one hundred dollars (for the simplest desk-top applications) to half a million or more for some comprehensive, large-scale, enterprise-level solutions.

With SaaS, most vendor costs are bundled into subscription fees, but fees may increase based on extra features like mobile and offline access, industry-specific functionality, storage capacity.

“In general, PPM solutions are not an inexpensive proposition. The costs of a typical solution start around $200,000 and can easily grow to over $1,000,000 based on the size of your company, the number of users, and the level of implementation services required.”

- Jeff Monteforte [1]
beyond some limit, and premium help desk support. SaaS fees are mostly priced under $100 per user per month and may vary depending on each user’s level of use. Like license fees, subscription fees are set to enable the provider to earn a profit—although the upfront costs for SaaS are lower than for a comparable in-house deployment, customer contracts may be required and payments in out years are likely to be higher.

Software Support and Maintenance Costs. In-house applications also typically include an annual support and maintenance fee (usually 15-25% of the net license fee) that provides the customer with ongoing vendor support and normal software upgrades. Although the fee may be described as “optional,” few organizations would be wise to do without vendor support. In addition, of course, in-house applications generate in-house costs, including time from a software administrator.

Software Customization and Implementation Costs. Vendors typically provide consultants to design or configure the tool, conduct tests, assist in the design of PPM governance and process, and otherwise support the implementation of their products, all of which can add to what the vendor charges. Although software configuration is typically included within the license fee, asking the supplier to customize computation algorithms, interface with other software, or provide special displays or reports can add significantly to the price tag. Internally, there is the cost of resource effort to work with the vendor and to manage the implementation. Since you will want to engage your PPM stakeholders in the process design and tool configuration, internal time commitments can be substantial. Internal implementation costs are likely to be the single, largest cost component.

Hardware Costs. In some cases, hardware upgrades (e.g., additional servers) may be needed to run the software. This is most likely to be the case for enterprise or suite applications wherein PPM is just one part of the capability being acquired.

Training Costs. The amount of training required depends on how many people are involved in the process, their current level PPM understanding and skills, the PPM approach that you select, and the complexity of your PPM software. In addition, your training costs will depend on the training...
delivery mode (e.g., train the trainers). As you’d expect, training costs are significant initially (e.g., 5-10% of the total), but should decline significantly after the first application cycle.

**Tool Risks**

There are two main risks associated with the acquisition of PPM tools: adoption risk and productivity risk. Adoption risk refers to the possibility that the organization will end up not fully utilizing the software—there may be a prolonged implementation delay, scope of use may be less than expected, and the software might be abandoned. Choosing a tool that does not really address the needs of the organization and inadequate executive support along with stakeholder resistance are the main sources of adoption risk. Productivity risk refers to the risk that the benefit per dollar of cost incurred will not be as high as it should be. If the software does not provide useful or accurate information and recommendations, if it doesn’t provide functionality that is needed, or if it ends up costing more or is more difficult to use than expected, the software will be much less productive than it should be.

“So for some, the first step toward PPM is a determined effort to buy and install “the best PPM tool available.” Then reality sets in. They don’t have the data it needs and no process for getting it. They meet widespread resistance to changing processes to suit the tool’s needs. The tool is better at reporting past project activity than delivering insights about what remains to be accomplished. Ultimately, they find themselves little better at managing the array of costly projects than they were before.”[5]

Poor productivity, of course, can and often does lead to abandoning PPM tools. Experience shows that many organizations replace or make major upgrades to their PPM software within a few years of initial implementation. This may not be so bad as long as the tool payback period is short and tool replacements do not lead to the need for wholesale process redesign, large data transfer costs, and major retraining. Take care in the initial decision to avoid having the repeat the cost cycle later.

A key consideration for assessing adoption and productivity risk is tool flexibility. Flexibility refers to the ability to adjust and modify the solution. Tool flexibility reduces adoption and productivity risk because the solution can be modified and refined over time and as information and needs change. Aspects of flexibility that are relevant include technical flexibility (ability to integrate with other systems), scalability (ability to handle more projects, more users), and analytic flexibility (ability to change and refine models and algorithms to accommodate new project types, changing business conditions, and learning). Flexibility is a key virtue, especially for organizations in fast changing, uncertain, and dynamic environments. A flexible solution helps defend against unforeseen risks (e.g., the imposition of regulations or other external requirements for project valuation or prioritization) and enables the organization to realize opportunities (e.g., by answering new questions) that may not yet be recognized.

**Stand-Alone versus Tool Suites**

On the question of stand-alone tools versus tool suites, the major advantage of a suite is avoidance of data transfer problems—creating interfaces for integrating products from different vendors can significantly complicate installations. Another plus—tool suites support a “big-bang” approach to tool implementation. If the organization can afford it, a suite can enable the fastest path to achieving significant return for the PPM investment. Also, the more you spend with a vendor, the more opportunity you may have to negotiate price discounts, training, and software customization.
Focused PPM tools, on the other hand, generally lend themselves better to phased implementations. If the interest in portfolio management is localized within a particular business unit, then it may be far easier to generate the needed internal support if the PPM tool is selected to meet the specific, limited needs of that unit. Also, the price of buying into a suite may not be affordable, and you may not want to replace all your legacy software. Acquiring focused tools enables a “best-of-breed” approach. Vendors that focus have the opportunity to excel in their respective specialties. Furthermore, small vendors often provide better business-partner service and attention, and their tight-knit user groups ensure that bugs are identified and fixed quickly.

Understand Your Needs

Choosing the right PPM tool requires not just knowing what tools do well and not so well, but, also, knowing what you want. Do a readiness assessment, and ask yourself these questions (and do it before you begin your search for a PPM tool):

- **Organizational maturity level.** How mature are we currently with regard to the foundation of practices and capabilities needed to support PPM? What level of PPM advancement is it reasonable at this time to aim to achieve?

- **PPM understanding.** Do we have a reasonable understanding of PPM and the steps for building PPM capability? Do we need training from internal or external PPM experts?

- **Executive buy-in.** Am I going to get necessary executive support to implement PPM? What level of funding, people and time can I expect?

- **Project and process management.** What are our current project and portfolio management processes? What tools do we currently use to support these processes? What works well and what doesn’t?

- **Business needs.** Do we need formal project prioritization (because we seem to be conducting too many or the wrong projects or because projects aren’t generating their promised benefits)? Do we need help with budget allocation (because the allocation across activities or business areas is wrong)? Do we need better project oversight and issues tracking (because projects frequently fail or go over budget)? Do we need resource balancing (because people are poorly utilized)? Do we need improved communication and collaboration?

According to a 2010 survey of PPM users:
The main reason for not investing in PPM tools is insufficient maturity to benefit from the features made available by the tools. [3]

From “Making Sense of PPM Software”

“[E]ach of the software vendors infuses their preferences and business rules for performing PPM into their software products. In other words, if you start by selecting a PPM software product then you inherently are choosing a specific PPM methodology.” [2]

According to Gartner:

“End user organizations seeking improved project and portfolio management (PPM) should primarily spend effort identifying needed changes in roles, skills and processes before exploring which tools can best support—and enhance—PPM capabilities.” [4]
- **Governance.** Do we have roles and responsibilities identified and defined (including executive, portfolio manager, project managers, software administrator, etc.)?

- **Prioritization framework.** Have we defined the framework for evaluating and prioritizing project proposals and for measuring the value derived from projects? For instance, what types of benefits are created by the kinds of projects that we conduct? What metrics and models should be used to quantify these benefits? Is project risk or project-deferral risk important? How should project value be adjusted based on risk and our organization’s risk tolerance?

According to Gantthead:

“Most companies using PPM spend a large portion of their investment in applications customizing off-the-shelf PPM solutions to fit their business processes. These propriety applications force customers to accept a compromise solution with limited customization, or require the purchase of an expensive source code license to ensure useful levels of customization.” [5]

- **Scope.** What is the appropriate scope for PPM rollout? Will I pursue a phased approach, or a one-time, large-scale change? What parts of the organization will be initially covered? What type of work will be included?

- **Organizational culture.** How prepared are we to adopt PPM principles and processes? How flexible is the staff? How much capacity do we have to change? Will senior executives accept priorities based on logic, and how will they react to an environment wherein they will be expected to justify deviations from tool recommendations?

- **Automation.** What part of the PPM process must be automated? Draw a box around it and create a clear statement of what the software must do.

- **Technical.** What are our technical requirements? Do I have the required network, hardware, and related software to implement the technological base needed for a PPM tool? What import and export capabilities are needed to communicate with the data in your other systems? Are there special requirements, for example, does the tool need to accommodate the Japanese language?

- **Selection criteria.** Have we established appropriate, realistic, measurable criteria for evaluating candidate tools?

Before shopping for a tool, design your PPM process. Then test it. Make sure it works for your projects and your organization. If that means delaying the purchase of a tool for a bit, so be it. It is better to manually manage a good process than to automate a bad one.

**Do Your Homework**

Having a clear idea of your requirements is the first step. It is also important to understand what the key weaknesses are of current generation of PPM tools, particularly with regard to being able to accomplish the fundamental goal of identifying the project portfolio that creates the most value for your organization. This is the topic of Part 4 of this paper.
Notes

4. Reported by CA Inc., “CA PPM Project Health Check” a research study conducted by Loudhouse Research, February, 2010
Part 4: The Weak Link for Most Tools

Part 1 identified available tools for project portfolio management, Part 2 described key differences, and Part 3 summarized implementation costs and risks. This part identifies the weak link in the design of most tools.

A significant difference among available project portfolio management (PPM) tools is the capability to make sound project recommendations. Quantitative methods exist for optimizing project portfolios, but few tools use the best of the available techniques. For most tools, the logic used to recommend projects and project portfolios is a weak link.

As noted previously, nearly all PPM tools allow users to define and enter their own measures for ranking projects. In addition, PPM tools typically allow users to rank projects based on any criterion defined by weighting and adding measures that have been assigned to projects. However, the ability to define and create weighted combinations of measures is not as helpful as it might at first seem.

Weighting Project Measures Doesn’t Enable Prioritization

Take the simple case of projects that produce financial benefits (e.g., incremental revenue and cost savings). You could evaluate each project by computing its net present value (NPV). However, the formula for computing NPV is not linear and additive, so if the PPM tool only allows weight and add equations it can’t be used to compute NPV’s. You could compute each project’s NPV externally and enter it into the tool. However, this approach makes it hard to ensure consistency in the way that NPV’s are calculated and impossible to conduct sensitivity analysis to see the impact on

Tools Use Different Logics to Recommend Projects

The logic used to make project recommendations is crucial. A tool incapable of providing reliable recommendations will not be of much help in enabling the organization to generate more value from its projects.

- Tools give users flexibility for defining prioritization criteria, but often provide no real guidance for how such criteria should be defined. Frequently, tool limitations make it impossible to implement logically sound evaluation criteria.
- Some tools rank projects based on scoring algorithms, some based on alignment with strategy, and some based on some measure claimed to represent project value. Some tools don’t rank projects, they identify project sets that maximize some performance measure subject to specified constraints. Some tools look for project sets that achieve some definition of portfolio balance.
- Some tools use checklist, yes/no questions for rating projects. Others use scoring models wherein projects are rated on 1-5, 0-10, or similar scales. Still others measure all project values in terms of dollars.
- Tools are variously advertised as using algorithms based on decision trees, Monte Carlo analysis, linear programming, fuzzy logic, the analytical hierarchical process (AHP), genetic search algorithms, etc. Measures of project value include economic value added (EVA), expected commercial value (ECV), and net present value (NPV).
rankings of changing assumptions (e.g., What if we assumed a lower discount rate?). Thus, a tool limited to weight and add evaluations can’t reasonably handle financial benefits.

Recognizing the importance of measuring financial benefits, nearly all PPM tools include at least a simple financial model for computing project NPV and other common financial measures. However, what about capability for quantifying other project benefits (benefits other than financial)? As with financial benefits, the equations for quantifying non-financial benefits do not generally comply with the restrictive linear, additive, “weight-and-add” form. For example, like cashflows, benefit streams over time ought to be summed and discounted. If the model for evaluating candidate projects is limited to weight and rate, it can’t be used to estimate project value.

What’s needed is a tool that contains all of the models needed to compute the types of benefits that accrue from the types of projects that your organization conducts. However, the types of benefits differ from industry to industry, as does the project information available for use as inputs for the models. This is why it is nearly impossible for general purpose tools to provide the analytics to properly value and prioritize projects.

**Valuing Projects**

The goal for selecting projects is to obtain the project portfolio that, subject to applicable resource constraints, creates the greatest possible (risk-adjusted) value for the organization. This, of course, requires the capability to compute project value. Although many tools are advertised as having the capability to compute measures of project value, few actually define value in a way that makes sense for PPM. In effect, most tools confuse the issue of value maximization with less appropriate (but easier-to-implement) concepts such balance, strategic alignment, maximizing points, etc.

Webster's Dictionary lists several definitions for the word "value." Near the top is, "the monetary worth of something." This is a reasonable and appropriate definition to use as a basis for evaluating projects. However, quantifying the equivalent monetary worth of a project that includes non-financial as well as financial benefits requires sophisticated analysis (using techniques such as multi-attribute utility analysis and real options analysis, see Part 4). Due to restrictions on the analytics that can be incorporated, most tools are incapable of applying these types of analyses. Webster's alternative definitions for “value” include "a numerical quantity assigned or computed" and a "degree of excellence." Although easier to implement, these definitions do not reflect the fundamental objectives of organizations (to create value) and do not provide a sound basis for finding optimum project portfolios.

**Project Value must be Expressed in Dollars**

To be most useful for PPM, value must be measured in dollars. Unless all project benefits are expressed in common dollar units, you can't correctly combine financial and non-financial project benefits. Also, you can't determine whether benefits justify costs. Furthermore, without a common unit for measuring benefit, you can’t determine how best to allocate a budget across organizational units responsible for different project portfolios.

Unlike the imprecise definitions of project value implicitly assumed by most PPM tools, defining value as monetary worth ensures that there is an objective basis for validating the numbers.
computed or assigned using the tool. If someone claims that something is worth X dollars, then he or she should be willing to buy it if it costs less than X dollars, but not if it costs more. A tool that can only assign points to projects doesn’t allow such checks (What basis is there for validating the assignment, say, of 870 points to a project?)

**Optimizing the Project Portfolio**

Most tools that recommend project portfolios use a simple optimization method—they rank projects (based on, as indicated above, individual criteria or on weighted sums of those criteria). At best, ranking is an approximate technique that can only work if neither the costs nor benefits of projects depend on the other projects that are conducted (see the paper on this website on mathematical theory). Most tools do not consider dependencies when ranking projects. Note that tools that claim to handle dependencies usually only allow the user to record yes/no dependencies among projects (and account for bundling requirements, e.g., “You can’t do Project A unless you also do Project B”). Very few tools account for dependencies in project value or cost (e.g., Project A will be worth more if Project B is conducted as well).

Also, be aware that some tools can’t easily handle different versions of the same project (e.g., a lower cost, reduced scope approach to accomplishing the same needs). Instead, these tools assume the only decision allowed for each project is go versus no go. A no-go choice may be unacceptable in some applications, for example, evaluating maintenance projects where the option of eliminating maintenance altogether is unreasonable.

Another common limitation relates to the types of constraints that can be specified. Most tools only allow for one type of constraint; namely, a constraint on total funding. It is rarer to find tools that allow for different types of dollar constraints (e.g., choose the optimal set of projects with out-year costs less than or equal to Y) or multiple constraints on different types of resources (e.g., choose a portfolio that can be conducted given our current workers and skill sets).

**False Claims**

Unfortunately, as competition has heightened, tool providers have tended to put more effort into improving their marketing claims than into improving the way that their tools recommend projects. If you visit the websites of the major providers, you’ll often see the following self-conflicting claims:

1. That their tools are based on “unique” approaches that address risk, uncertainty, project interdependencies, timing, and virtually every other consideration that can be imagined.
2. That their tools provide “flexibility” for defining and using whatever prioritizing criteria that the client organization wants.
3. That their tools correctly identify value-maximizing project portfolios.

In truth, most portfolio management tools fail to employ even the most basic portfolio optimization techniques. Portfolio optimization is mathematically complex, especially when projects produce non-financial as well as financial benefits, when risks are important, and when project costs or benefits depend on when the project is initiated or on what other projects are conducted. Although

According to Wikipedia: 
“..most PPM methods and tools opt for various subjective weighted scoring methods, not quantitatively rigorous methods.” [1]
the necessary algorithms are well-known and can often be obtained as “plug ins” for software, most tools ignore such issues and cannot be configured or otherwise adjusted to obtain even a rough approximation to a mathematically correct solution.

Thus, although many tools are strong on project execution, most are very weak on project selection. While it is true that a well-designed priority system can provide a consistent, logical way to evaluate and compare project proposals, a poorly designed tool or one that doesn't fit the need can distort decisions, increase costs, and create considerable frustration. This is one of the primary reasons that many organizations are disappointed based on their first experiences using PPM tools.

So, how can an organization interested in project prioritization ensure that it obtains a tool that makes sound recommendations? Understanding decision models and how they work is the first step. Part 5 describes in more detail how tools use models to evaluate projects and aid project-selection decisions.

**Notes**

Part 5: Decision Models

Before purchasing or developing a project portfolio management (PPM) tool, it is helpful to understand tool components. A PPM tool should include three components:

1. A data management component for collecting, storing, and retrieving the information that serves as the foundation for decision making.

2. A decision model that manipulates the data and translates the information into intelligence by providing insights into the consequences of making alternative choices and the value of those consequences.

3. A reporting component that displays the results graphically and communicates them to the relevant parties.

Components 1 and 3 are within the domain of computer science, and software providers typically do a good job in these areas. Component 2 is the subject of decision analysis, a topic less familiar to most tool providers. Lack of a quality decision model is the critical weakness of most tools. Bubble diagrams, charts, and other graphic displays are great for displaying information, but they are not by themselves decision models.

Buying a tool that provides great data management and reporting capability won’t necessarily improve decisions. It may just promote information overload. To provide an analogy, if you are captaining a boat, you’ve got instruments that can tell you the barometric

Most Tool Evaluation Guides Pay Scant Attention to Models

Despite the importance of the model used to evaluate and prioritize projects, most guides for selecting project portfolio management tools focus mainly on data management and reporting capabilities. For example, one guide urges potential buyers to consider whether the tool “allows users to easily update forms,” “annotate assumptions,” “drill down,” “collaborate with other team members,” “retain historic information for trend analysis,” “change the axis, bubble size, and color of displays,” etc.

With regard to the decision model, the guide suggests only that tools should “allow the user to specify their own company-specific formulas for computing priority...[based on] ROI, EVA, NPV or RONA.” The guide fails to indicate, however, that using any of these to prioritize projects would be a serious mistake, since none of mentioned metrics provides a correct basis for prioritizing projects. Thus, a tool providing only capability to apply such metrics won’t enable you to accomplish the fundamental goal of maximizing the value of the project portfolio.

Why Models Work

Models are useful because they address fundamental limitations of human problem solving. Research [1] shows that humans have limited information processing skills, can be biased, and are often inconsistent when making choices. People are good at creative tasks like generating alternatives. They are also good at recognizing structure and at making the sort of “small”, well-defined judgments that are required in order to provide inputs to models.

Models work because they break a complex problem into pieces, allowing people to do what they do best while enabling computers to do the calculations.
pressure, the wind direction, and the temperature, but what you may really want is a weather forecast. You need a model to give you that, so to get it, you go to a weather forecaster (who obtains the forecast from a weather model). Likewise, to obtain a forecast of the value to be produced if a project is accepted you need a model, not just a bunch of data about that project.

A good tool is one that is sufficiently good in all three components: data management, decision model, and reporting. As the old saying asks, “If you needed surgery, would you rather be operated on by a surgeon with a butcher knife, or by a butcher with a scalpel?” Using a data intensive tool with impressive graphics is risky if the tool does not include a quality decision model.

### Modeling

An analytic model is a mathematical construct, typically implemented as a computer program, that describes the behavior of some system of interest. In the case of a decision model, the system of interest is the problem of choosing projects that will create maximum value. An appropriate decision model for PPM provides predictions about how effective the various project alternatives will be in creating value. If the model is a good one, an alternative that the model says will create value is likely to do so in the real world.

The key in constructing any model is to abstract from the real-world situation the basic elements and relationships needed to describe the behavior of the whole without losing or obscuring important effects. Advances in the art and science of modeling – mathematical, symbolic, graphic, etc. – provide the means for exploring the structure, dynamics, and interactions that make up the decision problem that we wish to understand. The model builder represents these interactions, as they are identified, in a model. The model captures and makes explicit essential beliefs about “how things work.”

If you have understanding, you can create an analytic model. You can’t manage what you can’t understand. Therefore, you can create a model for any situation that you can hope to be able to manage better. Creating the model is the feasible and necessary step that allows for much more effective project portfolio management.

### Project Selection Decisions May Require Sophisticated Model

Because a successful decision model must capture every critical aspect of the decision, more complex decisions typically require more sophisticated models. “There is a simple solution to every complex problem; unfortunately, it is wrong” [2]. This reality creates a major challenge for tool designers. Project decisions are often high-stakes, dynamic decisions with complex technical issues—precisely the kinds of decisions that are most difficult to model:

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**Types of Decision Models**

Decision models can be categorized in various ways. One taxonomy separates deterministic models from probabilistic models and static models from dynamic models. In a deterministic model, all relevant data are assumed to be known with certainty. Probabilistic models incorporate uncertainty via probabilities. Static models ignore time; while dynamic models represent the time sequence with which changes occur.

Deterministic models can more easily handle situations where there are many decisions that must be made simultaneously and where there are many constraints on what options can be chosen. Examples of deterministic models include difference equations, typical cost-benefit analysis and linear programming. Examples of probabilistic models include decision trees and Markov models. Often times, a deterministic model can be made probabilistic via Monte Carlo analysis.
Project selection decisions are high-stakes because of their strategic implications. The projects a company chooses can define the products it supplies, the work it does, and the direction it takes in the marketplace. Thus, project decisions can impact every business stakeholder, including customers, employees, partners, regulators, and shareholders. A sophisticated model may be needed to capture the strategic implications of project choices.

Project decisions are dynamic because a project may be conducted over several budgeting cycles, with repeated opportunities to slow, accelerate, re-scale, or terminate the project. Also, a successful project may produce new assets or products that create time-varying financial returns and other impacts lasting many years. A more sophisticated model is needed to address dynamics.

Project decisions typically produce many different types of impacts on the organization. For example, a project might increase revenue or reduce future costs. A project might impact how customers or investors perceive the organization; that is, whether or not a project is conducted might affect corporate image. A project might provide new capability or learning important to future success. Making good choices requires not just estimating the financial return on investment; it requires capturing all of the ways that projects add value. A larger and more sophisticated model is needed to account for all of the different types of potential impacts that project selection decisions can create.

Project decisions often entail risk and uncertainty. The significance of project risk and project-deferral risk depends on the nature of that risk and on the other risks that the organization is taking. A more sophisticated model is needed to correctly deal with risk and uncertainty.

Benefits of Decision Models

A well-designed model can provide three general types of benefits. First, a model can produce better choices. One way it does this is by reducing errors, biases, and inconsistencies in human judgments. A model that measures the value derived from projects can help the organization to make value-maximizing choices. A model can also create better choices by providing insights that suggest new alternatives and by controlling the role of politics.

Second, a model can improve the decision process. A model levels the playing field for the competition for resources by providing consistent rules for evaluating proposals. A model clarifies what information is needed and shows how it can be incorporated into decisions. A model can be used to involve stakeholders, for example, by allowing them to contribute to the design of the model or provide selected model inputs. A model tends to promote consensus, since it is often easier to get people to agree on the rules for making a decision than on the decision itself. A decision model can also serve as a catalyst for action by providing a way to redirect and end unproductive and unfocused debate.

Finally, a model can increase the defensibility of decisions. It documents underlying assumptions and provides a transparent logic for choice. A model also allows “what if” analysis wherein inputs are varied to see if recommendations change. This is often useful for demonstrating that a decision (e.g., “Should be conduct the project?”) is not sensitive to a specific unresolved issue or disagreement.

Though project selection decision models are necessarily sophisticated, they need not (and shouldn’t be) be complex. What matters is that the critical considerations for choice be captured and properly incorporated into the decision making logic. Though a great many factors may be relevant, it is nearly always the case that only a few factors produce the biggest impacts on choice. So long as the decision model correctly identifies the “decision drivers” and incorporates the proper mathematics, then a relative small, compact model can provide project recommendations and other outputs with surprising accuracy.
A Two-Stage Decision Model

Decision models come in a variety of forms. For project prioritization, a very useful form, illustrated below, is a decision model composed of two distinct but integrated components (sub models).

The first component is a simulation model that provides predictions of the consequences of conducting projects, based on, among other things, the characteristics of those projects, the needs they address, and the effectiveness of the projects in addressing those needs. For example, a simulation model might estimate the improvements to products or customer service that might result from a project, as well as the anticipated increases in revenue or reductions in cost, and other changes relevant to objectives that are important to the organization. If project and portfolio risk are important, it may be desirable to use a probabilistic model that provides a description of the uncertainty over project consequences.

The second component of the decision model is a value model. The value model translates the estimated consequences of conducting projects, produced by the simulation model, into measures of the value of those consequences to the organization. The value model needs to account for the relative importance of the various financial and non-financial objectives impacted by projects, the organization’s willingness to accept risk, and the organization’s time preference (the natural desire to postpone undesired outcomes and speed up desired outcomes).

Advantages of Separating the Two Stages

Structuring the decision model as a simulation model linked to a value model provides two important advantages. First, it enables individuals to contribute to the development of the decision model appropriately according to their knowledge, roles, and responsibilities. For example, technical experts can ensure that the simulation model captures best-understanding about how projects impact business outcomes—the organization’s financial experts can verify that logic for generating financial estimates is correct, marketing experts can ensure that logic for estimating impacts on sales is reasonable, safety experts can ensure that the logic for estimating impacts on public or worker safety make sense, etc. Conversely, the organization’s senior executives, those responsible for setting policy and direction, can provide the judgments needed to specify the value model, including the weights that specify the relative worth of the various types of consequences to the organization.

Second, the two-part structure means that the evaluation of projects is explicitly based on forecasts of what the consequences of doing those projects will be. This ensures that predictions are grounded in reality. Over time, forecasts produced or provided for projects that are funded can be
compared with the actual outcomes that occur. Based on the results, the organization has the opportunity to learn and improve the decision model over time.

**Evaluating Tools Requires Evaluating Decision Models**

I hope I’ve convinced you that the quality of a PPM tool depends critically on the quality of the tool’s decision model. A tool with an inadequate decision model can mislead decision makers, potentially producing poorer and less defensible decisions than would be made without it.

Part 6 provides criteria for evaluating tools and their underlying decision models.
Part 6: Evaluating Tools

How can we determine whether a decision model/tool is adequate? Six criteria are relevant: (1) accuracy, (2) logical soundness, (3) completeness, (4) practicality, (5) effectiveness, and (6) acceptability [1]. The subsections below clarify these considerations.

The Tool Must Be Accurate

The value of a PPM tool depends, most obviously, on its ability to produce accurate outputs, including recommendations. Important questions include: Can the tool be counted on to produce reliable estimates? Is it biased toward or against certain projects, interests, or considerations? Are results highly sensitive to untested or untestable assumptions? Does the tool produce outputs with an acceptable level of confidence and precision? Does the tool indicate the confidence level or precision associated with outputs?

Flaws and omissions in decision models can produce large errors in recommendations. As evidence, see the examples in the boxes below.

Intuitive and Reasonable-Sounding Tools Can Be Inaccurate

The Los Alamos National Laboratory (LANL) was seeking a tool for prioritizing equipment purchases, seismic upgrades, and other high-cost investments. The lab reviewed a half dozen prioritizing models used in industry and by government agencies, noting that each involved a very different approach.

A team consisting of the author plus experts from LANL, two other national laboratories and a university, was formed to develop an improved prioritization model, called the Laboratory Integration and Priority System (LIPS) [2]. Unlike the other models, LIPS was based on multi-attribute utility analysis, a formal theory for valuing projects [3]. A test was conducted to compare project rankings produced by LIPS with those produced by other models. The results surprised many. Even though the other models seemed intuitive and reasonable, projects that ranked the highest using LIPS were often ranked low by other models.

Being Well-Established Is No Guarantee that a Tool Is Accurate

As another example, in the late 1980’s Congress ordered the Environmental Protection Agency to evaluate whether its Hazard Ranking System (HRS), used to place contaminated sites on the National Priorities List for accelerated clean up, was the best-available site-ranking model. The analysis consisted of comparing site rankings produced by the HRS and other models (used by various states and other government agencies) with a ranking produced by an expert panel. The analysis also included developing a model based on multi-attribute analysis (MUA).

Once again, the results were surprising. Although the expert and MUA model rankings were nearly identical, none of the site-ranking models produced rankings that correlated with the ranking provided by the expert panel or with each other. Several models, in fact, produced rankings that were negatively correlated with the expert ranking [4].
Unfortunately, inaccuracies in recommendations often only surface after many applications of a tool. It is difficult to collect empirical data for validating a tool’s recommendations (few organizations are willing to fund recommended and not-recommended projects for the purpose of testing a tool!). Tool providers may have some evidence of their tool’s accuracy, but they will naturally emphasize the positive and minimize (or ignore) the negative. The data they have may not be representative of the particular tool configuration or types of projects relevant to your organization.

Conducting a pilot test before fully committing to a tool is essential. Choose a variety of projects with different characteristics and see what recommendations the tool makes. Be skeptical of any odd patterns, such as projects with certain characteristics consistently being ranked either high or low. Resist the natural temptation to rationalize the results (“garbage in, gospel out”). Drill down to fully understand why the results come out the way they do.

Since extensive tool testing is usually impossible, assessments of accuracy must, at least in part, be based on a detailed evaluation of how the tool’s decision model works. In this regard, two other considerations are useful. As described below, the tool must be logically sound and it must be complete.

**The Tool Must Be Logically Sound**

From a practical standpoint, the logical defensibility of a tool is primarily a function of the degree to which it can be justified by accepted and proven theory. If a model can be shown to faithfully implement accepted theory, more confidence can be attributed to the predictions made by that model. Conversely, if a model is not grounded in theory, it will almost certainly not consistently produce reliable predictions.

What exactly is a theory? A theory is a logic predicting what outcome will result from specified actions and why. The "why" is important. A theory must explain cause and effect. To do this, a theory contains an explanation of how things work. A theory is proven by showing that its predictions consistently match observations.

To illustrate the importance of theory, consider initial attempts at manned flight. Observing birds, early researchers thought that they could fly if they strapped feathered wings onto their arms and jumped off cliffs. Many animals fly by flapping feathered wings, but this is not the fundamental reason that they can fly. Manned flight only became possible after Daniel Bernoulli developed

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**The Concepts Need to Be Right**

Success may be in the details, but the first step is to get the concepts right. As an example, an organization was using a scoring approach wherein candidate projects were awarded points based on judged performance along various dimensions (financial reward, strategic fit, leverage, probability of success, etc.). The points were added and the result used to rank projects.

Although no one objected to the logic, there was a suspicion that something was wrong. Large projects were nearly always high on the list and small projects near the bottom. One major flaw of the tool is that it fails to account for the resource constraint. The relevant logic is ranking projects by the ratio of benefit-to-cost, not benefit alone.

Another flaw is that adding the points awarded in the various dimensions does not measure project benefit. The aggregation equation must correspond to the way that the various performance dimensions actually influence value (as described by an applicable theory, such as MUA). For example, points indicating probability of success should not be added. Probability of success should be a multiplier—If a project has zero probability of success the project will generate no benefit whatever.
theory explaining how airflow around objects can produce lift.

Many models are like the feathered wings of early would-be aviators. Instead of being derived from theory, they are heuristics—rule-of-thumb relationships based on observations that certain characteristics tend to be associated with certain outcomes. For example, a popular heuristic for constructing project portfolios is balance. Project portfolios of successful companies often contain a balance of low-payoff “sure things” and high-payoff, long-shot gambles. However, balance is not the fundamental characteristic that makes a project portfolio successful. Rather, balance is something that tends to result when the best choices are made based on needs and the nature of available options. Simply choosing a project portfolio that happens to be balanced does not ensure success.

As noted previously, relevant theories for selecting and prioritizing projects include decision analysis [5], multi-attribute utility analysis (MUA) [6], modern portfolio theory [7], portfolio optimization theory [8], and real options [9]. These theories are well-established within the technical and academic communities and have been proven in many real-world applications.

### Modern Portfolio Theory
Modern portfolio theory is a theory of decision making that seeks to construct a portfolio of investments offering maximum expected returns for a given level of risk. The theory quantifies the benefits of diversification as a means of reducing risk.

### Decision Analysis
Decision analysis is theory and collection of methods for making decisions under uncertainty. The approach involves constructing and analyzing a model of the decision problem to identify the choice, or sequence of choices, leading to outcomes most consistent with the preferences of the decision maker.

### Real Options
Real options analysis is a valuation theory that views projects as creating options for dealing with an uncertain future. For example, a new factory created by a project carries options to shut down, abandon, or expand, depending on market conditions. Project value depends on the options created. The theory includes methods for computing project value based on the market prices of related assets.

### Theories Derive from Axioms
As an example, decision analysis is derived from axioms intended to define "rational choice" [10]. One such axiom, known as transitivity, states: "If there are 3 possibilities, labeled A, B, and C, then, if you prefer A to B and you prefer B to C, you will prefer A to C." The theory shows that if you accept the axioms, then there is a way to mathematically measure your preference for alternatives based on the characteristics of those alternatives and your answers to some basic questions about what you like.
that follow from its axioms. If you can demonstrate that the axioms are acceptable and the math is correct), the rest of the theory follows. See the side box for an example.

By the way, the fact that there are multiple theories does not mean that you will get different answers depending on the theory that you choose to apply. The well-established theories for selecting projects typically give the same answers, provided that each theory is able to address all the relevant factors, the theories are properly applied, and the assumptions for the analyses are the same. The situation is analogous to that for theories in other fields, such as physics. For example, the mathematics for Newton’s laws of motion and Einstein’s theory of relativity look very different, but both theories predict the same trajectories for everyday objects under everyday conditions. The predictions only differ in situations (e.g., speeds close to the speed of light or extremely small objects) that invoke considerations that aren’t addressed by Newton’s much simpler laws of motion. Likewise, decision analysis and real-options, for example, look very different, but they give exactly the same answers to any problems that both can fully address provided that each theory is correctly applied [11]. Nevertheless, the choice of the theory is critical. Choosing a solution approach based on ill-suited theory may make it extremely difficult, or impossible, to satisfy the necessary assumptions for the theory (e.g., it may not be possible to provide the required inputs). Thus, the wrong theory can make it impossible to obtain useful and meaningful answers.

Rather than cite the theories on which their tools are based, most providers merely reference the analytic techniques that their tools employ, such as balanced scorecards, strategic alignment, decision trees, linear programming and Monte Carlo simulation. Such techniques, by themselves, provide no explanation for why recommended portfolios should be preferred. Instead, they merely describe or refer to mathematical calculations that are performed. For example, scorecards typically use an equation that weights and adds scores assigned to projects. Projects are ranked based on total weighted score. There is no reason why this should lead to the identification of preferred projects.

Weighted scoring techniques can sometimes be used to effectively apply appropriate theories, but only if the scoring scales and weights are structured to match the requirements of the theory. For example, MUA theory for valuing projects can sometimes be implemented using scorecards and a weight-and-add equation. However, for a weight-and-add equation to work, the metrics that are scored must meet a condition known as additive independence, scaling

Tools Not Based on Sound Theories Are Exposed When Subjected to Technical Review

Congress required the Department of Energy (DOE) to rank potential sites for disposing of radioactive waste from nuclear power plants. To select the best site, the DOE initially used a scorecard approach. Each site was rated against each of the objectives established for a good site, the objectives were weighted, and the rates and weights were combined to rank the sites.

Hanford, a site in Washington State, ranked highest, and the DOE published the results in a draft Environmental Impact Statement. The choice was criticized, especially by officials from Washington State, and the DOE asked a board of the National Academy of Sciences (NAS) to review the ranking methodology.

The board, which included experts in decision theory, responded that DOE’s method was “unsatisfactory, inadequate, undocumented, and biased” [12]. DOE was told to redo its analysis (a site ranking model based on MUA was developed). The new analysis ranked Yucca Mountain, Nevada, highest. DOE was forced to change its decision, causing the agency considerable embarrassment.
functions must be assigned so that the computed performance measures are proportional to value, and the weights must quantify the value of specified improvements against objectives (the weights are often assigned using an assessment technique known as the "swing weight method" [13]). Unless these conditions are met, the aggregated score will not measure value and will not serve as an indicator of decision-maker preference. Thus, the use of a weighted scorecard does not in any way ensure that the requirements of any accepted theory are being met. The defensibility of the recommendations made by any decision model depends on whether the techniques used to value and prioritize projects are consistent with some defensible theory and on how faithfully the model implements the requirements of that theory.

As an example of the dangers of using tools not based on sound theories, see the side box example above describing the Department of Energy’s initial attempt to rank potential sites for a nuclear waste repository. Logical defensibility is particularly important when using a tool to help make controversial decisions. Although most project decisions aren't as controversial as nuclear waste, some (for example, an electric utility's decision to acquire right-of-way to construct a transmission line) can be.

Using a logically sound approach avoids errors associated with unsound methods and reduces the risk of successful challenges to the credibility of decisions. Although logical soundness does not guarantee accuracy (see below), it is far safer and wiser to use a tool based on sound theory than one that merely "seems" reasonable.

**The Tool Must Be Complete**

Being complete means accounting for all significant and relevant considerations. A logically sound tool that is incomplete gives, at best, the right answer to the wrong question. A tool might leave out important considerations because those considerations are difficult to accommodate (e.g., it may be too hard or too costly to obtain the necessary input data) or because they are impossible to include given the nature of the selected decision model (e.g., dynamic considerations within a static model).

As noted earlier, project decisions tend to produce broad, enterprise-level impacts. This makes creating a complete model challenging. As illustrated by the example in the side box, if the decision problem is extremely complex, a complete model may need to be large, requiring many inputs and sophisticated mathematical algorithms.

One way to assess the completeness of a model is through sensitivity analysis. Try varying the description of a complicated project in subtle ways that should logically affect the attractiveness of that project. Do the inputs permitted by the model allow you to reflect such considerations? Do the priorities established by the model behave as they should? No model can capture

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**Completeness Requires Addressing "Hard" and "Soft" Considerations**

A water utility desired a system for prioritizing capital improvements. To fully value such investments, it was necessary to include "soft" project benefits, such as enhanced public health and safety, reduced flood risk, increased community recreational opportunities, and expanded capability and knowledge.

Providing inputs for quantifying project value required information from databases associated with many different applications, including asset utilization systems, customer information systems, GIS, work management systems, and investment modeling applications. Furthermore, it was clear that field personnel had local knowledge of needs and the effectiveness of proposed projects that was not captured by historical data.

Thus, the resulting priority system included both an extensive scoring logic (to capture judgments) plus analytic techniques for logically combining empirical and judgmental data.
The Tool Must Be Practical

Accuracy, logical soundness, and completeness are the reasons that prioritization tools must often include sophisticated decision models. But, a tool must also be practical. Building a quality tool that is still practical is a significant challenge facing expert tool designers.

To be practical, users must have sufficient expertise to understand and apply the tool. The required inputs must be available. Computational resources must be adequate, and applications must be completed within available time. All this must be accomplished without unacceptably degrading the accuracy, logical soundness, or completeness of the model.

Experience Creates Capability and Demand for More Sophisticated Tools

In the early 1990's, a client operating an oil and gas pipeline sought help in designing a system for prioritizing investments to reduce risk. The new system was much more detailed and formal than existing practices. It required training, implementing new processes, constructing additional databases, and creating computationally sophisticated solution algorithms. The system manual was over 200 pages long!

Many outside the development team argued that the system was "far too complicated." However, backing of senior management was secured when it was demonstrated that the system uncovered ways to significantly reduce risks without increasing total costs. The client has continued to use the system independently for many years, and each year the system has been expanded. Experience, better documentation and internal training led to increased confidence and expertise, promoting the desire for more capability and accuracy.

How can such challenges be addressed? Obviously, skill is required and experts should guide the development of the decision model used by the tool. At the same time, the organization can take steps to make it practical for it to use more sophisticated tools. These steps can include investing in internal training, reassigning responsibilities, developing new sources of data, and adjusting budgeting schedules.

Although the above recommendations may seem daunting, it is worth noting that it is common for an organization to initially view a quality tool as "too complex," and then later, after gaining experience and comfort with its use, to want to expand the tool and make it even more sophisticated (see the side box above for an example). Thus, organizations should avoid simplistic tools and tools whose decision model cannot be improved as experience and understanding grows.

The Tool Must Be Effective

A PPM tool cannot be effective unless it fits the way that the organization actually makes decisions. The considerations to which the tool may need to be sensitive include:

- **Timing.** When are decisions made? Annually, quarterly, monthly, or “just in time”? Once a decision is made, is the commitment over multiple years, or can it be revisited at any time?


- **Project management.** How are needs identified, project solutions conceptualized, and a preferred solution identified? How are projects planned, scheduled, and staffed? If a
project stage gate process is used, how are decisions made about whether projects proceed through each gate?

- Performance monitoring. What information is available to help the organization track its performance? What types of performance data are collected?

Such considerations must be understood and the tool and its application process must be designed to ensure that there is a good fit to the organization. See the side box for an example.

Being effective also means achieving the specific goals that motivate using a tool. For example, a tool intended for backroom use would be designed differently than one whose purpose is to demonstrate to regulators and local citizens that the organization's project decisions are in the best interests of the community. Not only would the latter have different user characteristics and features, the definitions of project benefits would be quite different.

A Centralized Project Ranking Tool May Not Fit a Decentralized Decision-Making Environment

An electric utility desired a system for allocating its $250 million annual O&M budget. The organization had a decentralized decision-making structure. The managers of business units (e.g., line clearance, meter reading, the call center) had historically been given authority to decide how best to spend within their respective areas. A single, centralized, project ranking system was unacceptable. It would dictate to each manager how the projects within his or her area should be prioritized. On the other hand, allowing each business unit to have its own, separate priority system would not provide a consistent approach for the enterprise as a whole.

The selected system [14] involved a tiered approach to PPM. It allowed each department to apply a tool to determine the value generated under different funding levels, based on the projects that would be conducted under those funding levels. This design allowed area managers to retain authority to prioritize and select projects within their respective areas while rewarding managers who propose projects that create value consistent with corporate objectives. Before building or purchasing a tool, think carefully about what the tool needs to do in order to be effective. See the second side box for another example of an application requiring a specialized approach. Although a tool may appear to offer lots of flexibility, it can only be adjusted within the limitations dictated by its underlying decision model. Few tools allow users to change the mathematical logic by which projects are valued or optimal portfolios are identified.

Being Effective May Require a New Approach

A recent effort was conducted for an electric utility to provide a system for prioritizing bids for long-term (greater than 10-year) energy contracts. Standard contract valuation methods were overly sensitive to discount rate assumptions. Therefore, an alternative model not dependent on discount rates was developed based on real options theory. Real options [9] adopts the view that projects and assets create options (e.g., a contract creates the option to buy energy according to a predetermined price rule). The

The Tool Must Be Acceptable to Stakeholders

A tool that is practical and effective is not always acceptable to decision makers and other stakeholders. An acceptable tool must be compatible with existing organizational processes and culture. It must be understandable and understood. A tool that impacts funding decisions will be perceived as a threat to some interests. All key stakeholders must have confidence that the tool will help them, as well as the organization, to succeed.
Developing the Tool as a Collaborative Effort Promotes Buy-In

A client was investing heavily in information technology. A system was desired that would prioritize proposals submitted by different departments. Department managers were naturally concerned about how the new system would affect their ability to obtain funding.

One department head, responsible for core systems, was particularly pessimistic about the ability of a tool to fairly evaluate his projects. "How can you quantify the value of adding capacity? Our projects don't increase revenue or reduce costs, and they are invisible to our customers. The only time we ever get more funding is when things stop working."

The manager only agreed to participate after attempts to get his projects exempted from the system failed. To address the concerns, the selected design included a feature not common to priority systems—If an infrastructure project enabled or facilitated another project, the enabling project obtained a share of the benefit derived from the enabled project. The approach worked, and the core systems department obtained approval for several projects that had previously been denied funding.

Notes


Part 7: The Best Approach

Tools are good. Tools for project portfolio management can help organizations improve the selection and management of their project portfolios. This can and will allow organizations to increase value even while cutting costs. Tools promote a more deliberate, careful, and consistent evaluation of project alternatives. They force the generation of more and generally better project data. Many of the available tools provide excellent data management and reporting capabilities, making it much easier for managers and executives throughout the organization to understand the work that is being conducted.

All tools, however, are not equally good.

Which Approach is Best?

If you’ve read the rest of this paper, you already know my answer. The best tool is one that actually helps your organization make better project choices. Outputs that support the management of individual projects are nice, but the greatest opportunity is being able to use the power of analysis to enable the organization to make the best project choices. For a tool to do this, it must make the right recommendations, and this requires that it be based on a decision model that is accurate, logically sound, and complete. Furthermore, the tool must be practical, effective, and acceptable, otherwise it won’t be used or its use won’t actually influence decisions. Although some tools are clearly better than others, no one approach is best (or even adequate) for all circumstances. The choice of a PPM tool needs to be made differently for different organizations and applications.

More specifically, for a tool to be the best approach it must compute project priorities based on the value that alternative project portfolios would add to the enterprise. An acceptable tool must be based on sound project valuation theory, one that captures best understanding of how projects actually create value for the enterprise. As described in the previous parts to this paper, most tools aren’t based on sound project valuation theory and, therefore, fail to provide accurate estimates of project portfolio value. As a result, they do not offer much help for making tough project choices. The quality of the model used to quantify project and portfolio value, in my opinion, is the critical discriminator for choosing a PPM tool.
Recommendations

More than 100 tools are currently being marketed for project portfolio management (see the list in Part 1).

1. Do NOT assume that available products are similar. As described in this paper, they differ in ways likely to be of critical importance to buyers.

2. Be skeptical of marketing claims. Clearly understand your business, functional, and technical needs before reviewing or choosing tools.

3. Understand the underlying architecture of candidate tools. This includes not just software, hardware, and integration issues, but also knowing how the tool does what it does and how much flexibility really exists.

4. Consider obtaining help for tool selection from knowledgeable and independent advisors. They can help you to avoid costly mistakes by suggesting evaluation questions and providing objective reviews of candidate tools.

5. Learn a little about theories for valuing projects (especially multi-attribute utility theory and real options). Understand how these theories apply to your organization. Use them to develop a model for how your projects create value. Determine whether candidate tools offer sufficient flexibility to enable them to represent your organization’s decision model, now, and in the future as your understanding and needs grow.

6. Reject tools that fail to include sound algorithms for valuing projects and optimizing project portfolios. Ask to see an independent peer review, or arrange for your own technical review through a local university. Buying a tool that can’t optimize the project portfolio is like buying a hand-held calculator that can’t add. The tool should enable you to make better decisions than you could make on your own, not just provide you with pretty bubble charts.

7. Don’t use tools that select projects based on balance, strategic alignment, any approach based on assigning “points”, or any other logic not directly tied to value maximization. Use tools aimed at maximizing the total (risk-adjusted) value of the project portfolio. CEO’s and CFO’s want to know how much value will be created by their project portfolio. They want to be assured that projects are chosen so as to maximize this value. Metrics based on portfolio balance, strategic alignment, and or “points” are not surrogates for value, and won’t (or shouldn’t be) of primary interest.

8. Avoid tools that define project value solely in terms of the tradition financial metrics, such as net present value (NPV), return on investment (ROI), or payback period. Financial metrics are important, but they fail to capture the non-financial benefits of projects. Typically, such tools grossly undervalue certain types of projects as well as the project portfolio.

9. Make sure the tool can capture all considerations critical to your decisions. Commonly ignored considerations include various “soft” project benefits, investment urgency (as opposed to investment value), project sequencing and other types of project interdependencies, and risk (especially market risks and other “correlated risks” that similarly impact multiple projects).

10. When comparing tool costs, take a total cost of ownership (TCO) approach and cumulate costs over at least 3 years, including costs for software support and maintenance, software customization, tool implementation and training.

11. Assess tool risks, including tool adoption and tool productivity risks.

12. If you purchase a tool from a vendor, make sure that you use all available flexibility to tailor it to suit your needs. If the tool ranks projects, it is particularly important that criteria and weights be defined such that the underlying model prioritizes projects based on the value added per unit of cost. If the vendor can’t provide the expertise, get help from an expert.

13. If you engage consultants to help you build a tool, be sure that they are experts, not just in software development, but experts in the theory and algorithms for valuing projects and optimizing project portfolios. The field is highly specialized, so check references carefully.
14. Plan on the need for education and training. Having a thorough understanding of concepts is as important as knowing how to use the tool.

15. Unless your organization is very small, use a phased approach to implementation. Start with one department, conduct a post-implementation lessons-learned review, and make changes before you move to the next level.

16. Make sure that all stakeholders have necessary buy-in and confidence in the tool. Otherwise, insufficient effort will be devoted to generating inputs and/or model recommendations won’t change decisions.

17. If the answer seems wrong, then either your intuition is wrong or there is a flaw in the model. Check the model logic. A good model will have a compelling logic. If you still don’t agree, don’t trust the model (replace it). Remember, a tool is an aid to, not a substitute for, sound decision making.

Custom-Designed vs. Configurable Tools

A significant difference among tool providers is one of philosophy. As noted previously, the approach favored by most software vendors and many consultants involves creating a tool based on a “configurable” decision model—a model that is hard-coded within the software, but that includes parameters and options that can be set to help fit the tool to a range of different applications or situations. Invariably, marketing materials describe such tools as being “fully customizable,” but the truth is they can be adjusted only within a narrow range allowed by the software.

The alternative approach, favored by some consultants, is one that provides flexibility for creating custom decision models. These tools are created on modeling platforms — high-level programming languages designed to facilitate general purpose modeling and analysis. These platforms include Analytica, Excel, Visual Basic, Crystal Ball®, and DPL Portfolio, as well as web-based project portfolio management tools that allow one of these or a similar modeling platform to be accessed via a web portal.

Each approach has its own advantages and disadvantages. Tools with configurable models are convenient. They can be implemented quickly. They do not require effort on your part to design a custom model—that work has already been done. The key question is whether the configurable model is adequate for your application. Potentially relevant questions include: Does the tool provide capability to handle all types of projects and project portfolios that might eventually need to be analyzed? Does it account for all types of project benefits, including dynamic, time-varying project impacts? Does it allow for rigorous multi-attribute utility valuation of projects? Does it allow for true portfolio optimization (not just ranking)? Does it allow for risk valuation as well as risk characterization?

Configurable models are typically programmed in software languages that are not friendly to changes. If the configurable model doesn’t provide some capability (either a capability currently desired or one that might be desired in the future), beware that it may be difficult or impossible to obtain this capability. The code may be so complicated that only the original programmers are capable of making changes. Changes that affect structure often produce ripple effects that require extensive rewriting of source code. For example, if a tool expects cost savings resulting from a project to be entered as an annual average value, changing the model to allow entering year-by-year estimates can be difficult.
Custom tools built on modeling platforms are much more flexible than tools based on pre-set, but configurable models. (Compare the ease of changing an Excel spreadsheet with the difficulty of getting a software vendor to make a model change to its tool.) Custom tools implemented on flexible modeling platforms can more easily “grow” as the user organization gains experience and understanding. However, developing customized, quality tools for project portfolio management using Excel or another general-purpose modeling platform is labor intensive. It requires the client organization to participate in the design process and requires a consultant skilled in modeling and portfolio analysis to implement the custom model on the modeling platform. The process is faster if the consultant has compiled a library of sub-models for use as building blocks, and if the tool automates some of the labor-intensive programming steps (such as creating user templates that provide inputs to the custom model). However, tools with flexible modeling platforms are more costly to develop and may be more expensive to acquire than configurable tools.

If a configurable tool fits the need and contains a defensible logic for valuing projects and optimizing project portfolios, then such a tool can probably be implemented more quickly and with less cost than a custom tool. However, these are big “if’s.” My experience to date has been that customers who want a tool that correctly identifies value-maximizing project portfolios (in situations where project value is more than discounted project cash flow) must either use a custom tool built on a general modeling platform or must link a vendor tool (i.e., tool providing the desired data management and reporting capability) to external models that correctly compute the components of project value. However, tool capabilities are advancing rapidly, and new options will become available that reduce the costs and difficulty of obtaining a tool that meets all of the needs of the organization.