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Portfolio Analysis and Management for Naval Research and Development

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Summary

The Office of Naval Research (ONR) has the responsibility for defining and sponsoring research and development (R&D) necessary to support both the current and future requirements of the Navy and Marine Corps. To accomplish this mission ONR must fund a broad spectrum of research, ranging from basic research needed to open up new options for the long-term, to very near-term advanced technology development to support the current fleet. Moreover, ONR must make its R&D funding decisions *in the presence of uncertainty*: uncertainty in required capabilities, uncertainty in performance requirements, and uncertainty in the feasibility of a technology or R&D approach.

This report describes the adaptation of an R&D portfolio management decision framework recently developed by RAND (Silbergliitt and Sherry, 2002), PortMan, to support ONR's R&D decision-making, and the demonstration of its use via a case study evaluation of 20 sample ONR applied research projects.

RAND's PortMan R&D Portfolio Management Decision Framework

RAND's PortMan R&D decision framework computes the *Expected Value*¹ of an R&D project as the *product* of three factors: value to the military of the *capability* sought through R&D, the extent to which the *performance potential* matches the level required to achieve the capability, and the project's *transition probability*. A useful interpretation of this equation is that the performance potential (i.e., the performance level that would be achieved if the project were successful), *scales* the capability value that is based on achieving a required level of performance. That scaled capability is then further reduced by the transition probability in order to obtain the *expected* value of the research, including its subsequent R&D stages and the fielding of the resulting process, component, or system.

¹ The equation for Expected Value used in PortMan is based on an adaptation of Decision Theory (see, e.g., Raiffa, 1997) as described in detail in Silbergliitt and Sherry (2002).

PortMan does not rely on the expected value as a point solution. Rather, it includes an estimate of uncertainty, and evaluates and compares R&D projects based upon all three components of the expected value, including uncertainty, plus their estimated direction of change over time. This requires evaluation based on best current information, and tracking over time as conditions change and the technology matures.

We note that the purpose of PortMan is to evaluate a defined group of actual or proposed projects and to provide a means for creating a portfolio from them that maximizes the value of R&D investments. It does not generate an absolute score for the total portfolio that could be used to compare to portfolios of other projects or to proportionally allocate funds between portfolios of different projects.

An important feature of this approach is that it allows identification of those R&D projects seeking high-value capabilities, but with formidable technical or fielding problems remaining to be solved, and for which management attention may have the greatest leverage.

The case study application of PortMan used RAND's E-DEL+I™ collaborative consensus building method (Wong, 2003) with an expert panel of Naval officers and senior civilian executives. This method retains the independent assessment features of the traditional Delphi method (Dalkey, 1969), and adds a teleconference between the participants to provide verbal feedback, in addition to the traditional written feedback. This case study evaluation was conducted via email and teleconference between participants in California, Rhode Island, Virginia, and Washington, D.C.

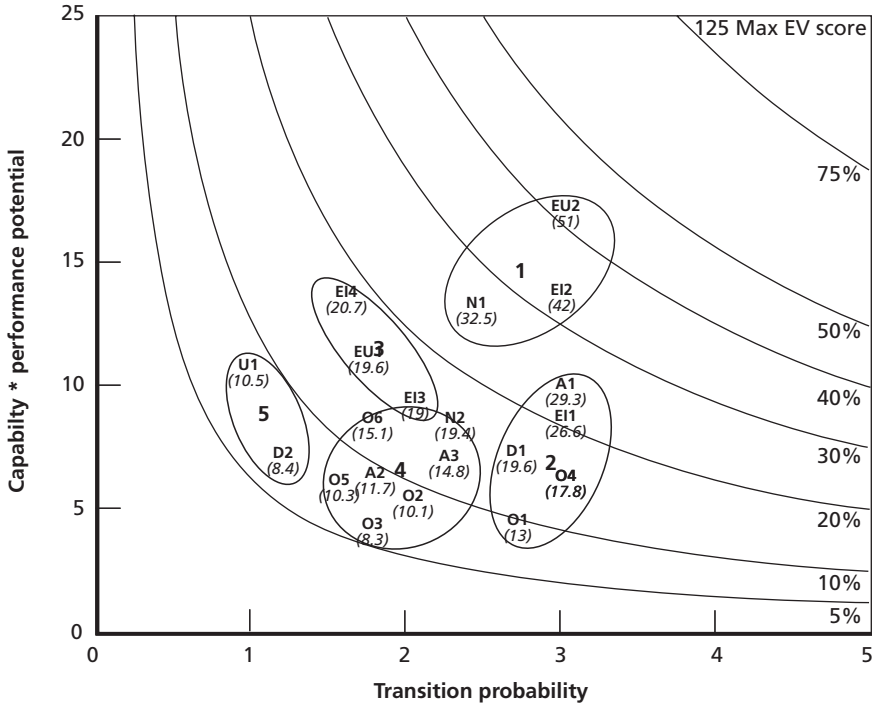
It is important to keep in mind that the evaluation described in this report is only a case study application of the RAND PortMan R&D portfolio management decision framework. As such, it was performed within the time and budget constraints of the project and should not be regarded as a complete or accurate evaluation of the 20 sample R&D projects evaluated. It is, however, valid as a case study demonstration of the use of the framework, because all of the evaluators had exactly the same data on which to base their evaluations, and the RAND E-DEL+I consensus generation method was consistently applied using the decision framework's anchored scales, together with a representative and well-qualified expert panel.

Portfolio Analysis and Investment Strategy

Figure S.1 summarizes the results of the case study evaluation of 20 sample ONR applied research projects. It plots the product of the mean values, as determined by the expert panel, of capability and performance potential versus the mean values of transition probability. The expected value for each project is shown in parentheses next to its data point. Contours of equal expected value are shown as a percentage of the maximum expected value.

This method of combining the components of expected value provides a convenient way to identify R&D projects with similar characteristics from an investment

Figure S.1
Portfolio View of Case Study Evaluation Results



RAND MG271-S.1

strategy perspective. For example, consider the groupings shown in Figure S.1. Group 1, the highest on both axes, are the projects that are most likely to provide high-value capabilities that can be transitioned to use by the Navy. Group 2 are projects that are likely to be transitioned, but, because of their relatively low values on the y-axis, are also likely to provide only incremental improvements in current capabilities. Group 3 are projects with the potential to provide high-value capabilities, but which are not likely to transition without some changes to current approaches and plans. Group 4 are projects that appear to be aimed at incremental capabilities and do not have strong transition plans. Group 5 are projects that have not yet formed their transition strategies; one of these is aimed at a highly-valued capability, while the other is not.

As shown in Chapter 5 (see Figures 5.8 through 5.12), these project groupings are consistent with the uncertainty indicated by the spread of judgments obtained from the expert panel, in that the mean values for each group, plus the range of uncertainty, occupies a separate area of the plot.

The project groupings in Figure S.1 identify projects for which the R&D manager may have the greatest leverage. Consider, for example, the projects in Group 3, which are currently ranked relatively high in value and in the intermediate- to low-range in transition probability. In order to be successful, these projects will have to develop and implement a transition plan. We posit that, absent attention by the Program Manager,

the Principal Investigators may fail to do this within the time needed for a successful transition. Or, if they are not constrained sufficiently by floors on performance objectives, their tendency may be to seek out and pursue the easiest possible transition opportunities. This will increase their transition probability, but will likely happen at the expense of lowered performance objectives, which will move them toward (the incremental) Group 2 Management's job in this case is to provide the resources (e.g., staff, funds, facilities, information, coordination, planning) to overcome either of these tendencies and push the projects toward Group 1, as opposed to Group 2, maintaining or even improving the capability and performance potential objectives, while improving the transition prospects. Chapter 5 suggests the following set of steps to develop an investment strategy that can accomplish this task.

1. Review the data, consider the reasons for large uncertainties and outliers, and note any effects on project positions;
2. Give a high priority to providing sufficient resources for each Group 1 project to achieve its objectives;
3. Review the transition plans of the projects in Group 2 and allocate funds based on the relative importance of their capabilities, based on user inputs;
4. Review the technical approach and objectives of the projects in Group 3, then provide the resources to develop and implement transition plans that will allow the achievement and fielding of their identified capabilities;
5. Look for additional opportunities for projects in Groups 4 and 5 that have highly valued capabilities and for which the same approach as above in 4 can be pursued.
6. Fund remaining Group 4 and Group 5 projects based on the value of their capabilities, if and only if a sound case can be made for their moving into Group 2 on a specific time frame consistent with program objectives.

Since R&D decisions are made under uncertainty, it is critical to periodically reconsider the analysis and decisions based on the latest and best updated available data. In this sense, the S&T metric of RAND's PortMan decision framework is the position of each project on the chart of Figure S.1, together with its uncertainty, monitored over time. As the framework is repeatedly used, and the steps above repeatedly performed, this metric, and estimates of its direction of motion, will constitute a dynamic means for maximizing the leverage of program funds to develop and transition highly valued capabilities. We note that when using this metric, it is crucial to either continue with substantially the same expert panel, or to use a control group or perform a detailed analysis of variation to ensure that changes in the evaluations result principally from changes in the projects or the requirements and not from changes in the panel.

Conclusions and Recommendations

As described in detail in Chapters 1–5, RAND successfully adapted PortMan from civilian to military use. The case study evaluation demonstrated the use of the framework to develop and analyze the data needed to perform an R&D portfolio analysis and develop an R&D investment strategy, including uncertainty.

This framework can be used with an expert group determining the values of capability, performance potential, and transition probability, including uncertainty. In the case study evaluation, this was accomplished with RAND's E-DEL+I consensus building method.

The framework is capable of comparing and contrasting individual and groups of research projects as a function of key management variables such as their potential value and status and quality of transition planning. It also provides a straightforward and logical set of repeatable steps, (as described in Chapter 5) based on auditable data (e.g., developed for the case study as described in Chapter 4), to determine the expected value of research projects, together with a measure of uncertainty.

The framework provides a set of parameters for each research project (capability, performance potential, transition probability) that, together with measures of their uncertainties, form a metric that can be monitored over time as the framework is applied iteratively.

Based on the success of the case study evaluation, and the illustrations of its use for portfolio analysis and investment strategy development presented in Chapter 5, we recommend that ONR take the next step of demonstrating the framework on a specific project portfolio.

One possibility might be to incorporate the framework into an existing project review process, such as that currently used by ONR Code 31, as described in Chapter 2. In this case, capability value scales would be based on a group of scenarios or mission capability packages identified in collaboration with ONR Code 31, the value determinations would be made by the existing Code 31 expert panel, and the data for the evaluation would be presentations and background material prepared by the Program Managers and Principal Investigators. The panel evaluation could follow its current open meeting consensus-building approach, or use a Delphi-type consensus-building method such as RAND's E-DEL+I that was used in this project. RAND would then compile the data and develop and analyze the portfolio charts.

Another possible implementation of this decision framework might be to evaluate specific ONR project portfolios on a periodic basis by a standing expert panel, (e.g., appointed to staggered three-year terms with one-third of the panel new each year). The RAND E-DEL+I consensus building method might be used to structure the panel's deliberations together with the RAND PortMan decision framework used to perform a portfolio analysis and develop an investment strategy, in a fashion similar to that described in Chapters 4 and 5.

This application of the decision framework could be accomplished with a first round by email, and the additional rounds during a one-day or two-day meeting at which the data on capability, performance potential, and transition probability would be developed and plotted on the portfolio chart. The panel could then debate both the position of the projects on the portfolio chart and the likely direction of motion. Feedback could be provided to the ONR Program Managers and Principal Investigators concerning where they were placed on the chart and why.

This standing panel meeting could be used as a tool to redirect funding towards the most promising projects, with the data and analysis updated at each meeting. A note of caution: successful R&D projects take time, so one would not expect to see wholesale changes in funding. Perhaps projects might be reviewed on a yearly basis, and funding changes made only after multiple unsatisfactory reviews. Such yearly reviews could enable ONR management to emphasize higher payoff R&D, and to track progress towards achieving needed performance, as well as responding to changing requirements in a timely fashion, consistent with sound R&D management practices. Whether it is applied to a subprogram, program, or entire class of projects (e.g., 6.2, applied research, or 6.3, advanced technology development), RAND's PortMan decision framework can be tailored both to the scope of the evaluation and to the available resources. Projects can be evaluated in groups to achieve the desired number of individual units for the evaluation. The amount of data used in the review would then be the maximum consistent with the resources available for the evaluation.