ADAPTATION OF PORTER'S FIVE FORCES MODEL TO RISK MANAGEMENT

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Prominent tools for assessing and managing risk include risk cubes, risk burndown charts, and automated risk management software. They are generally lacking, however, in accommodating ideation and brainstorming to identify potential problems. A suggested approach for improving the process is to apply *strategic management models* currently used as commercial best practices. Many are directly applicable and adaptable to *systems engineering* processes including *risk management*. This article presents traditional risk tools and introduces a complementary management model tailored to the identification, scoring, and tracking of potential program threats. Additional management models are presented for further investigation and adaptation.

Keywords: *Risk Management, Five Forces Model, Systems Engineering, Strategic Management Models, Armed Reconnaissance Helicopter (ARH)*

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Brainstorming
potential problems

In this article, the author presents typical SE models such as the work breakdown structure, functional flow block diagram, and risk cubes, and explains how they are analogous to organizational hierarchies, enterprise flowcharts, and uncertainty matrices, respectively. Particular emphasis is placed on risk management and the associated adaptation of a strategic management model.

The linkage between strategic organizational management and systems engineering has been observed for decades. Management theorists have compared corporate organizations to "systems" (Bertalanffy, 1956, pp. 1–10). Optner (1968) described organizational systems as follows: "A system is here defined as a set of objects together with relationships between the objects and between their attributes related to each other and to their environment so as to form a whole."

Jenkins' (1974) definition of a system is a complex grouping of human beings and machines for which there is an overall objective. Expressed in terms of systems engineering (SE), Hall (1962) viewed this domain as "operating in the space between research and business, assuming the attitudes of both."

Traditional Risk Management

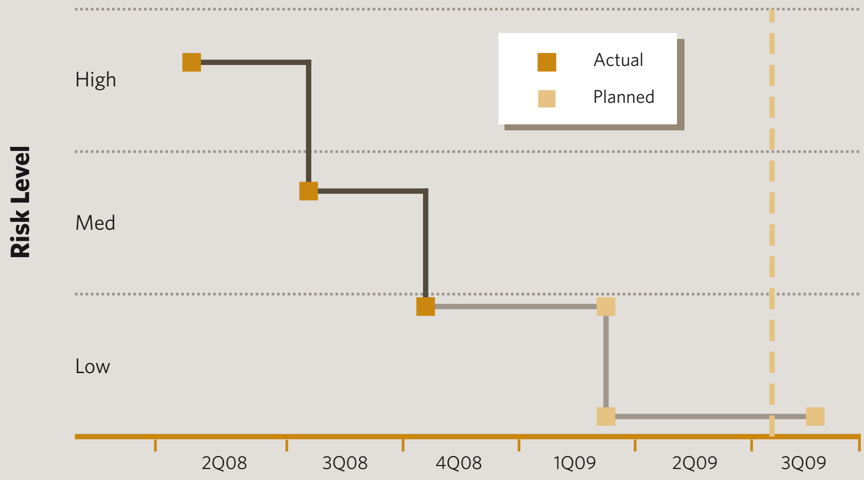
Traditional Risk Management (RM) models have included risk cubes (Figure 1), risk burndown charts (Figure 2), and RM software applications such as Active Risk Manager, Risk Matrix, and Risk+ (DoD, 2009). This article addresses the adaptation of a strategic management tool to model risk as part of a structured SE process (DoD, 2006). By tailoring the management tool for RM, the systems engineer has another "arrow in the quiver" to perform the risk function or to complement existing methods.

FIGURE 1. RISK CUBE

Probability (Likelihood)					
5	G	Y	R	R	R
4	G	Y	Y	R	R
3	G	Y	Y	Y	R
2	G	G	G	Y	Y
1	G	G	G	G	Y
	1	2	3	4	5

Consequence (Impact)

FIGURE 2. RISK BURNDOWN CHART



Five Forces Model

The strategic management model and focal point of this article is known as the *Five Forces Model* (Barney, 1996, p. 6). Its originator, Dr. Michael Porter, University Professor at Harvard Business School, developed the tool for competitive advantage analysis within specific industries. (Other management tools adaptable to RM/SE functions are described in subsequent discussion on "Additional Models.")

As shown in Figure 3, the center block depicts intensity of rivalry among industry competitors. The external forces—new entrants, bargaining power of buyers and suppliers, and substitutes—are shown as the threats acting on the industry.

FIGURE 3. PORTER'S FIVE FORCES MODEL

The purpose of developing a model of environmental threats is to aid managers in evaluating these threats so they can become more successful in creating strategies to neutralize them. Porter and Millar (1985) contend the five characteristics of corporate structure can threaten the ability of an organization to either preserve or produce above-normal returns.

Adaptation to Risk Management

Adapting the Five Forces Model to RM involves replacing intra-industry rivalries and competitive threats with the following risk forces (a.k.a. *the five I's*):

- Internal organization
- Industry
- Information
- Infrastructure
- Influences

For discussion purposes, these forces are stated in the current tense. Actual risks would be stated in the future tense with root causes, and probabilities and consequences.

Internal organization risks include enterprise functions such as task sharing, personnel loads, cross training, assignment duration, and related parameters. Industry risks are associated with contractor and subcontractor organizations, technology maturity, product support, and contractual matters.

Information risks include software availability and functionality, information system backup, and network security. Infrastructure refers to physical security, communications networks, event recovery, and safety. Influences include external demands (e.g., meetings, travel), senior leadership support, and policy mandates.

It should be noted that the tailoring of Porter's model to a program-level effort involves more than a change in nomenclature. It requires a change of perspective from an industry view to an enterprise view. Additionally, the forces are no longer competitive in nature, but risk-related.

The RM version of the Five Forces Model, hereafter called *RM5*, has numerous benefits, including the ability to:

- Perform back-of-the-envelope cursory analyses
- Promote and capture brainstorming among groups
- Document the identification of potential risks from the brainstorming session
- Categorize the risks into one of the five I's

- Measure the impact of each risk using a consensus scoring approach
- Track risk trends through comparison of RM5 iterations.

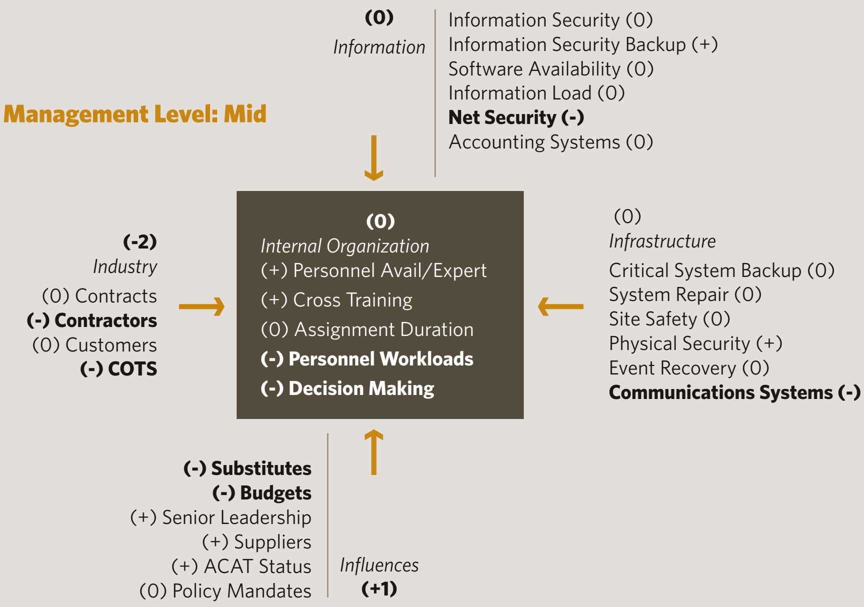
As a consequence, it can be shown all categories have some degree of risk, and those items could be targeted for mitigation. The risks for either approach could be weighted to underscore their importance.

Practical Application

The author initially utilized RM5 in 2004 to assess risk in the U.S. Army's *Armed Reconnaissance Helicopter (ARH)* Product Office—specifically, while serving on the proposal evaluation team. As shown in Figure 4, each of the five I's was examined for candidate risks such as contractor (Industry), communications (Information), budget (Influences), personnel (Internal), and system risks (Infrastructure).

The identification of risks was generated from subject matter experts, experienced systems engineers, and brainstorming sessions. Initially, some of the submitted risks were of low significance or relevance. Through iterative reviews, the candidates were promoted or demoted to validate their importance.

FIGURE 4. RM5 MODEL



Note. COTS = Commercial Off-the-Shelf; ACAT = Acquisition Category

Scoring and weighting of risks are also features of RM5. Scoring is performed in a manner similar to Porter's model where +, 0, and – are used to indicate a positive, neutral, or negative condition. In risk terminology, this is stated as a positive trend, unlikely/unknown risk, or negative trend.

Weighting can be applied by assigning multiple notations (e.g., + +) based on consensus or expertise, or through numerical methods such as regression analysis. Using historical run data, a trend analysis can be performed and plotted as curves, Gantt charts, or similar illustrations.

Results from ARH

When initially applied to ARH as a brainstorming effort, several risks were identified beyond the cost and schedule constraints formally tracked by the Product Office. Certainly a Product Office's risk management resources are limited, and not all risks can or should be tracked. However, the time and effort to apply RM5 and identify other significant risks proved valuable.

The results of this initial run yielded the following example risks not tracked by the Product Office:

- Market research was indicating **COTS/MOTS** (commercial off-the-shelf/modified COTS) technical maturity might be lower than originally assessed. This raised the likelihood of future, unplanned subsystem development with the consequence of depleted resources.
- **Substitute** technologies and platforms were lacking. The likelihood of a gap in fielded capabilities was evident, with the consequence of compromised operational missions.
- **Enterprise Communications Systems** for the proposal evaluation team were limited compared to typical office systems with e-mail and instant messaging. This raised the likelihood that critical information during proposal assessment could remain isolated, with the consequence of unreported risks or opportunities.

During subsequent runs, these risks remained notable, and additional RM5 risks proved to be consequential:

- **Physical security**, originally assessed as positive, was compromised during the proposal evaluation period. An individual in the team's facility lacked credentials and authorization, and was immediately escorted from the facility.

- **Assignment duration** was more than twice as long as planned, with detrimental effects on matrixed personnel. Engineers reported inability to complete their functional office tasks resulting in "other program" delays.

RM5 Validity

The ARH contract was awarded in 2006 to Bell Helicopter. The contract later experienced a Nunn-McCurdy breach for significant cost overages. It was acknowledged by the Government Accountability Office (GAO, 2008, p. 43) that the inclusion of immature COTS technologies resulted in significant, unplanned development funding and schedule delays. It was also noted that this program's shortcomings have left a void in the Army's ability to perform armed reconnaissance. Excessive delays and growth in program costs forced the ARH program's cancellation on October 16, 2008, when the Department of Defense failed to certify the program to Congress.

Negative consequences from the physical security breach, communication system inadequacies, and other noted RM5 risks could have been avoided had RM5 been formalized. However, the method was novel and nonstandard, impeding its adoption in the Product Office. ARH subsequently experienced a Nunn-McCurdy breach as a result of technical challenges and cost overruns associated with many of the RM5 risks. The author contends a more formal treatment of RM5 would have uncovered and highlighted several "show-stopping" risks.

Other Model Uses

Other uses for the model include applying it specifically to identification of existing, rather than projected, program issues. This could provide managers a snapshot of information that would otherwise escape attention and provide them with the insight to head off problems. Likewise, RM5 could be used to identify strengths or opportunities that were previously unrecognized and could support or provide visibility to a program.

In all of the above cases, the potential for cost savings or revenue generation is apparent since reducing risks or capturing opportunities are means to improving the bottom line.

Furthermore, having a model to complement existing SE tools provides an additional decision aid to validate current assumptions or to promote ideation for new process/product development.

Additional Models

Other management tools adaptable to RM or SE functions include, but are not limited to:

- Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis for requirements development
- Gap analysis for trade studies (Robbins & Coulter, 1996, pp. 264–265)
- Value Chain analysis for determining value added from technical processes (Crawford, 1997, pp. 480–481).

SWOT ANALYSIS

SWOT analysis (Figure 5) can be performed by compiling a list of organizational attributes applied to each of these categories. This allows management to determine where resources need to be allocated to either shore up or scale back attributes to optimize program performance.

FIGURE 5. SWOT ANALYSIS

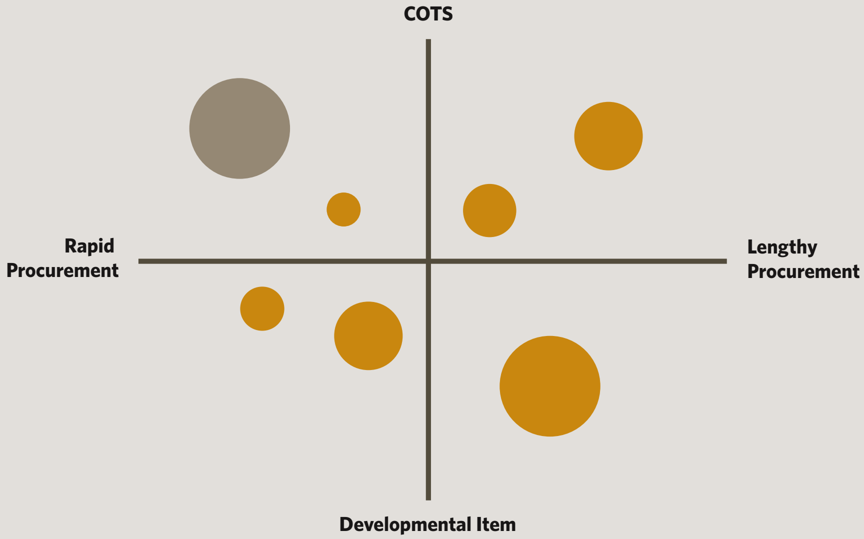
Strengths	Weaknesses	Opportunities	Threats
Subject matter experts	Insufficient funding	Contract Personnel	Budget cuts
Certified processes	Process software outdated	Develop software internally	International standards
Market demand	Production limitations	Outsource production	Loss in quality

GAP ANALYSIS

A gap map (Figure 6) employs a two-axis, four-quadrant graphic depicting variables of interest to the systems engineer. Variables could be metrics relating to cost, schedule, and performance, for example; however, the axes are not restricted to specific categories. The systems engineer determines what is of value or interest.

The space is populated to show occurrences of the variables or lack thereof. Should a particular quadrant, for example, be void of data points, this could be an indication of an opportunity or perhaps a deficiency in the enterprise. To demonstrate the scale of an occurrence, symbols (e.g., circle) are sized accordingly. For instance, if many COTS systems were identified in a quadrant, the size of the symbol would be indicative. Conversely, few occurrences would be represented as a small symbol.

FIGURE 6. GAP MAP

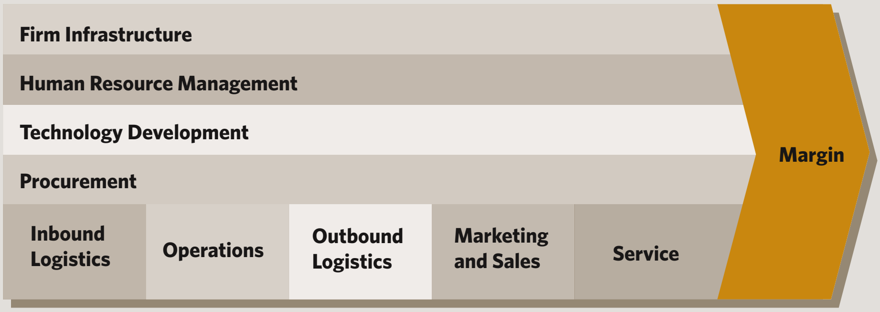


Finally, an opportunity or deficiency could be shown as a dashed, unfilled symbol—scaled to show the magnitude of the gap.

VALUE CHAIN ANALYSIS

The value chain (Figure 7) is comprised of the functions performed to create a product or service. A margin is depicted to highlight the value added for the customer. This would be a useful model for trade studies to represent alternative approaches and determine which produces the greatest margin or best value.

FIGURE 7. VALUE CHAIN



The elements of the value chain are defined as follows:

Firm infrastructure—Support of entire value chain, such as general management, planning, finance, accounting, legal services, government affairs, and quality management

Human resource management—Recruiting, hiring, training, and development

Technology development—Improving product and manufacturing process

Procurement—Function or purchasing input

Inbound logistics—Materials receiving, storing, and distribution to manufacturing premises

Operations—Transforming inputs into finished products

Outbound logistics—Storing and distributing products

Marketing and sales—Promotion and sales force

Service—Service to maintain or enhance product value (Crawford, 1997)

Conclusions

The multidisciplinary aspects of strategic management tools lend themselves to other uses. This article focused on one tool to present this approach as it pertains to RM. However, it is apparent from the other models presented that the overlap between strategic management and SE yields opportunities for similar analyses (della Cava, 2009). Opportunities exist to extend this approach to broad SE disciplines or focus the model on specialty domains. Examples include technology readiness, information assurance, and environmental considerations.

Author Biography

Professor John Rice is currently a professor of systems engineering at the Defense Acquisition University (DAU) South Region, in Huntsville, Alabama. He developed the RM5 approach as a principal systems engineer with Wyle Laboratories, Inc., in Huntsville. Professor Rice holds a BS in Mechanical Engineering from Auburn University and an MBA from The University of Alabama in Huntsville. His related work has been published in *IEEE Software* and *Information Display* magazines and within DAU's Communities of Practice (https://acc.dau.mil/CommunityBrowser.aspx).

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