COMMERCIAL INDUSTRY RESEARCH AND DEVELOPMENT BEST PRACTICES

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The Problem

Global competition has led major U.S. companies to fundamentally rethink their research and development practices. The Department of Defense (DoD) is also challenged by the globalization of technological knowledge. Are there best practices from commercial industry that can help DoD meet this challenge?

IDA identified current commercial industry practices for organizing and managing research and development (R&D) by focusing on the question: "How does industry place its R&D bets and manage R&D outcomes to meet corporate goals?"

Along with a detailed review of the R&D management literature, IDA researchers interviewed R&D leaders at seven large U.S.-based companies with significant R&D programs: Applied Materials (AMAT), The Boeing Company, Exxon Mobil Corporation, General Electric (GE), International Business Machines (IBM), Intel, and Procter & Gamble (P&G).

R&D Strategy and Overall Management

Changing competitive market environments have caused some U.S. companies to fundamentally refocus, reorganize, and rethink their business practices, including the R&D they conduct to keep pace with rapid technological advances and to improve their business results.

We found four common themes among leading research-oriented companies:

1. Setting and maintaining the direction of technology development is a top-level corporate responsibility.
2. R&D, even for exploratory projects, is managed for business results.
3. Companies are increasingly accessing external R&D and integrating it with internal R&D, rather than depending primarily on internal discoveries.
4. Technology thrusts are explicitly derived from the company's strategic perspective on how its R&D should be aligned with business goals.

Changing competitive market environments have caused many large U.S. companies to fundamentally refocus, reorganize, and rethink their business practices, including the R&D they conduct to keep pace with rapid technological advances and to improve their business results.

A key focus of the research was how industry leaders measure and assess the results and value of R&D, and how they use this information to manage the R&D process. Consistently, this involved the following:

- Developing a clear, coherent strategic direction and plan
- Managing to get results out of the R&D process
- Broadening the sources of new ideas and integrating them into company R&D
- Measuring and assessing the results and value of R&D.

An important step taken by most firms reviewed is a structured process for corporate and business unit management to design a clear, coherent plan and roadmap for implementing the innovation strategy. This plan elaborates on which units are in charge of what activities and when they should be completed, and connects individual project roadmaps to the overall organizational vision. It also establishes requirements for long-term success—in other words, evaluation metrics beyond the next quarter's earnings.

To achieve a more strategic, results-oriented R&D management system, companies have restructured their R&D. One major shift has been the reduced role of central R&D laboratories. Companies have sought R&D from outside the company through venture investment. They have also endeavored to make R&D more productive by creating internal corporate entrepreneurship groups and through various open innovation approaches. Open innovation—which is becoming increasingly commonplace—entails creating R&D and new product development partnerships with end-users, suppliers, competing firms, and research institutions. Many technology-focused firms have determined that partnering with other firms that have different knowledge and capabilities achieves better results in developing and implementing new concepts and products. Open innovation entails establishing relationships, not just acquisition.

In linking R&D outcomes to long-term financial performance, most of the firms IDA interviewed made it clear that the chief executive officer (CEO) and the chief technology officer (CTO) fight hard to maintain R&D funding as a strategic investment that is not affected by business fluctuations—especially overall revenue.

R&D Portfolio Planning and Assessment

Leading firms that invest substantially in R&D have well-defined and assiduously monitored assessment processes. These companies often start with an explicit definition of the value of R&D in their corporate strategy, which is usually expressed in terms of how and in what way R&D contributes to the firm's ability to effectively and competitively introduce and produce new products. In commercial business, R&D is defined by results and, thus, measured more in terms of impacts, rather than inputs and activity.

Leading technology companies focus a great deal on developing an

R&D portfolio mix and managing the portfolio relative to explicitly defined (deliberated and negotiated) strategic goals. R&D portfolio development and assessment make up a strategic enterprise usually under the CTO but with high-level business unit involvement. Portfolios may be defined in many ways, including distribution of projects across businesses; allocation to single businesses versus enabling or cross-cutting platform technologies; internal versus external capabilities; and allocation for potentially new businesses versus current businesses.

R&D Project Management

Project portfolio management refers to the management of a group of related projects within the company. The focus is on maximizing the value of the portfolio through managing resources. In another related approach, innovation portfolio management, executives develop a strategy to select and develop new concepts, connecting them eventually to project portfolios.

A key takeaway from both the literature and interviews is that R&D needs to be organized and managed in different ways at different stages. The relevant managerial question for early-stage opportunity creation is how to generate more and better targets: Which people, which structures, which strategies can be employed for more effective idea generation for these objectives? Later, as a technology is ready to be transitioned and scaled into commercialization, the focus is on deployment success with tight control.

Gate Process for Managing R&D Projects

The R&D management literature and IDA's interviews show that most technology-based firms use a gate process in their R&D management (that is, a structured process for managing R&D projects by dividing the project into phases or stages, which are assessed for progress and risk to decide whether to continue to the next phase, stop the project, or hold it at the current stage until exit criteria are met). Thus, success is not just getting through the gate; it is determining whether a potential technology should get through based on agreed upon tests and criteria. Many firms have also embraced the Technology Readiness Level (TRL) concept and use TRL assessments in the technology gate decisions.

Leading firms use rigorous, but specifically designed, gate processes to manage the cost of failure. The objective is not to prevent failure per se, because that implies a lack of innovation and exploration of new ideas. Rather the focus is on encouraging risk-taking in exploring new ideas early, while employing disciplined processes, such that:

- The rejection rate of projects is highest in the early stages of ideation when the costs of the project are lower.
- The stages represent milestones at which a new level of investment is needed to move forward.
- The objective is to manage the business risk while testing key assumptions.

Transition and Scaling

Any new product offering has a set of risks beyond the technical performance and capabilities of the product, including the unknowns of the future market, the availability of financing for scaling into production, and the firm's own internal capabilities to absorb and effectively manage the new product's entry into production and marketing. Therefore, determining how much risk to take on when introducing a new product (and attendant production processes) is a crucial decision that the firm must make—essentially it is an informed bet based on judgment and experience, as well as customer-focused competitive assessments. From the review of the literature and the interviews conducted, the most prominent lesson from this IDA research regarding transitioning technology is that frontrunner companies assiduously avoid introducing immature products and processes.

Implications for DoD

The organizational context of DoD R&D must be carefully differentiated from that of private industry. Commercial industry inherently has much clearer and specific metrics of results. Generally, commercial firms define results in terms of financial results, particularly profits and revenue growth. Many firms recognize that in technology-driven businesses, R&D can provide important means to identify, develop, and implement new products and related production processes that provide the basis for growth. Measuring the value of DoD R&D is more difficult because the desired end-goal is the broader and multidimensional goal of maintaining U.S. national security while sustaining U.S. commitments to allies and partner nations.

In addition, DoD conducts R&D within its own governmental institutions, such as the defense labs, but also funds R&D through contracts to a wide range of performers—defense contractors, universities, and private firms. DoD is the developer and acquirer of systems for its own use that it pays others as contractors to provide. Thus, DoD is a customer that specifies its needs and formulates these into requirements that become embedded into the R&D and acquisition systems for others to execute. These differentiating factors make the direct implementation of commercial industry R&D management best practices in DoD challenging and, in some cases, inappropriate.

Practices for Consideration

That said, some commercial industry best practices for R&D management merit assessment in the DoD context:

- Top corporate leadership is actively involved in setting direction for R&D and then making course corrections. The active involvement of very senior management is deemed necessary by most of these firms as essential to commercializing technologies.
- Corporate, business unit, and innovation strategies are explicitly linked.
- A coordinated and coherent corporate effort to execute open innovation guides development activities. This involves scouting for

technologies outside the company, as well as industry collaborations.

- Gate processes are successfully applied early in the flow from idea to product: at the equivalent of transitions between DoD's Applied Research to Advanced Technology Development (BA 2 to BA 3) while the DoD 5000 process picks up at milestones for Materiel Development Decision (MDD) A and B.
- Gate processes generally involve substantial early involvement of marketing and manufacturing organizations and are empowered to modify or terminate R&D efforts. An important objective is to stop low-potential projects early.
- Generally companies assign a champion, often self-selected, to a promising project. This person provides strong business guidance to the project team.
- Identifying potential customer needs involves substantive research to ascertain market potential.
- Commercial portfolio management is employed from research through development.
- Transition planning is an important issue addressed early in development by commercial companies. Leading firms do not attempt to transition immature technology to manufacturing.
- There is generally a long-term commitment of people to projects.

Observations, Questions, and Future Direction

Cost, schedule, and performance are the essential trade-offs, but existing incentives lead DoD too often to sacrifice meeting cost and schedule to meet specified performance goals. Many commercial, high-technology firms emphasize well-articulated spiral development processes. To what extent could this type of process be applicable to defense systems, which are of a much different scale, often stay in the field for decades, and for which interoperability is a key factor?

The concept of portfolio management is deeply embedded in the R&D management of commercial firms. Could such portfolio thinking be applied more routinely across DoD programs? A 2011 IDA analysis on improving the "front-end" of the DoD acquisition process affirmed that effective analytic approaches to defining, assessing, and managing such portfolios have not been implemented systematically within DoD.

A leading commercial industry R&D trend is open innovation, partnering with others in developing new capabilities. Under what circumstances could DoD adopt commercial best practices for open innovation to find and track relevant commercial and government investments? Industry executives emphasized that DoD's role in partnerships with their firms has been a crucial factor in their ability to take on risky projects.

While commercial management approaches to R&D management will be difficult to employ across the board, DoD should consider:

- Expanding efforts to attract more outside collaborations with R&D partners

- Developing and employing tools for evaluating technology development through partnering with external R&D performers linked to its own labs
- Exploring ways to improve how it finds, evaluates, and engages new R&D partners
- Undertaking a benchmarking assessment on best practices for collaborating with university R&D performers as well as others
- Assessing how gate assessment could be employed early and throughout DoD R&D so that programs that do not demonstrate appropriate value are restructured or terminated
- Analyzing how private industry processes for measuring returns on R&D investment might provide guidance for ways to measure the results of defense R&D investment
- Implementing and assessing a pilot portfolio management based on strategic objectives across DoD over distinct time horizons
- Developing platform technologies and approaches to transition platform technologies across multiple weapons systems, especially across multiple defense labs, acquisition program offices, and military services
- Developing its own incubator programs (including technical assistance and early stage commercialization-transition funds) to help it better engage small- and medium-sized enterprises and non-traditional suppliers (both large and small).

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