Technology, Innovation, and R&D Alignments for Enhanced Research Transition

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Given the accelerating pace of breakthrough technologies and paradigm-shifting innovation (T&I), the research and development (R&D) process must similarly be accelerated to leverage this T&I, and further developed to enable enhanced research transition into effective solutions for the military enterprise. This paper examines three forms of alignment necessary to achieve this enhancement, namely technical alignment, organizational alignment, and financial alignment. A fourth alignment, Legal/Contractual, is also necessary, but is the subject of a future paper. This paper also highlights the immense amount of R&D being conducted by Other Government Agencies (OGAs) external to an organization, but supporting its goals and needs, that is not being effectively leveraged due to the inability of the R&D community to make the case for the value of R&D.

Whether called technology transfer, research transition, dual-use, commercialization, spin-off formation, or a number of other terms, the federal government is interested in demonstrating the value of research investments for the public good. With efforts in this area dating back to the late 1950s, DARPA probably has the longest history of technology transfer, in response to the 1957 Sputnik launch and other associated events, with a mission of making investments in "breakthrough technologies for national security."[1] Since 1964, NASA too has a long and successful history of technology transfer and spinoff formation, in response to a congressional mandate to facilitate the process.[2] NASA's technology transfer program is "focused on creating benefits for society through transferring the Agency's inventions and innovative knowledge to outside organizations."[3] This focus was motivated by the "Presidential Memorandum -- Accelerating Technology Transfer and Commercialization of Federal Research in Support of High-Growth Businesses."[4] The NASA focus is in contrast to DoD's, which is focused on developing technologies to support the warfighter or field dual-use technologies.

To facilitate a quantitatively uniform discussion of R&D and technology transition, reference is made to the DHS Technology Readiness Level (TRLs).[5] Originally developed in 1974 by NASA researcher Stan Sadin[6], the TRL definitions have evolved over the years, reflecting increased understanding, greater sophistication and advanced applications of the TRLs by R&D transition practitioners from the various agencies, such as DARPA, NASA, and others. Given the diversity of these efforts across government agencies, it is no surprise that the pathway from research to transition also varies widely. A summary of transition programs and planning tools is provided in Manager's Guide to Technology Transition in an Evolutionary Acquisition Environment.[7] Importantly,

> DOD has long noted the existence of a chasm between its science and technology community and its acquisition community that impedes technology transition from consistently occurring. This chasm, often referred to by department insiders as "the valley of death," exists because the acquisition community often requires a higher level of technology maturity than the science and technology community is willing to fund and develop. In 2007, DOD reported that this gap can only be bridged through cooperative efforts and investments from both

communities, such as early and frequent collaboration among the developer, acquirer, and user.[7]

This paper supplements previous studies of research transition by examining the additional factors of R&D alignment necessary to achieve enhanced research transition success. Specifically in this effort, enhanced research transition success means increased use of R&D outputs, whether software, hardware, technology and/or knowledge products, by the intended warfighter, regardless of whether an R&D project's output is otherwise commercially viable, licensed by an industrial partner for dual use, or spun-off completely for other non-military uses.

This study has identified three forms of alignments and coordination to guide the "early and frequent collaboration among the developer, acquirer, and user"[6] that are necessary for maximizing R&D transition success, and developed challenges and options for R&D project selection process implementation consideration as described below. The three forms of alignments and coordination studied in this effort are:

- **Technical Alignment** of all applicable R&D projects, including both a) projects internal to the organization, and b) externally funded R&D programs, both sources being presented with the same clear organizational strategies, requirements, needs and gap (RNGs) targets, developed using quantifiable metrics.
- **Organizational Alignment,** both a) within and across the extended organization's divisions and components, as well as b) with the external organizations' management structures conducting the relevant external R&D.
- **Financial Alignment** to a) merge and synchronize with government funding cycles and processes, and b) cost data gathering and allocation across the organizational missions, assets and activities to enable return-on-investment (ROI) and benefit-cost ratio (BCR) calculations and assignments to specific programs, projects and results.

It is also worth repeating that the fourth alignment of the **legal/contractual** issues associated with R&D projects should also be addressed in their early stages.

To overcome technical alignment challenges, an organization would benefit from

- Improved development processes for and better-defined RNGs, as these serve as the targets for the R&D projects to address;
- Increased analytical, modeling and simulation (M&S) support for project impact and ROI/BCR evaluations and ranking processes;
- Increased use of metrics, Key Performance Indicators (KPIs), both performance-based and BCR-type, with appropriate decision-making visualization dashboards;
- Integrated/increased use of data science methods in evaluations, M&S analyses, rankings and decision-making.

To overcome organization alignment challenges, an organization would benefit from

- Quantitatively developing the case for the value of R&D to improved operations and decision-making;
- Demonstrating the value in organizational communication of needs and "buy-in" for the supporting effort and resource investment needed to conduct and improve review and evaluation of ideas;
- Demonstrating the value obtained from leveraging external R&D;
- Demonstrated examples of how R&D has been / is being applied and used;
- Quantifying the value to the organization of transition success.

To achieve financial alignment, an organization would benefit from

- understanding the time scales for the phases of project solicitation, review and ranking, selection and budgeting across the candidate participating OGAs with relevant external R&D programs;
- organizing its own cost data collection efforts to support their subsequent use in ROI/BCR calculations of effectiveness;
- increased and more refined use of ***Metrics, M&S and Data Analytics*** to make the "Case for the (Financial) Value of R&D".

It is important to note that financial alignment data is essential to supporting the above-listed technical and organizational alignments.

The Federal Government's investment in R&D is large and distributed among numerous agencies. The total R&D funding greatly exceeds that focused strictly on the warfighter's needs. Thus, there is generally a very large upside potential for leveraging external R&D. However, the effort to leverage R&D is very labor-intensive, requiring intensive literature review and searching, researcher and leadership contacts and outreach, cultivation of relationships, matching to organizational RNGs and their corresponding organizational alignment personnel, etc. The relative magnitude of R&D investments internally versus externally should motivate allocation of internal resources specifically directed to this external outreach and leveraging effort, which could then yield extraordinarily high returns.

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[1] http://www.darpa.mil/about-us/about-darpa , accessed February 2017.
[2] http://spinoff.nasa.gov/about.html , accessed February 2017.
[3] http://www.nasa.gov/pdf/709314main_NASA_PLAN_FINAL.pdf , accessed February 2017.
[4] The White House, "Accelerating Technology Transfer and Commercialization of Federal Research in Support of High Growth Businesses," Presidential Memorandum, October 28, 2011.
[5] https://www.dhs.gov/sites/default/files/publications/Product%20Realization%20Guide.pdf (2013), accessed February 2017.
[6] https://www.nasa.gov/topics/aeronautics/features/trl_demystified.html , accessed February 2017.
[7] DoD, "Manager's Guide to Technology Transition in an Evolutionary Acquisition Environment," Defense Acquisition University Press, Fort Belvoir, VA, 2005.