Incorporating the Technology Transition Manager in Project Management

Ernest Csoma
United States Air Force
Hanscom Air Force Base, MA 01731

Alfred E. Thal, Jr.
Air Force Institute of Technology
Wright-Patterson Air Force Base, OH 45433

Abstract

Over the last two decades, there has been a fundamental shift in project management related to the development of new products and systems. The traditional approach of a sequential, compartmentalized development process has been replaced by a cross-functional, interdisciplinary approach. This is particularly true in defense-related organizations in which the focus is on the seamless transfer of responsibility for system development and integration from the laboratory environment to production through a process known as technology transfer. However, a frequently cited reason for transitioning immature technologies is a breakdown in communication between key players in the development and transition process. To address this problem, organizations often use a technology transition manager (TTM) to facilitate the transition of proven concepts from the labs to the production centers. Beyond this overarching goal, however, the role of the technology transition manager is somewhat ambiguous. Therefore, the purpose of our research was to define the associated roles and responsibilities by conducting content analysis on data obtained from in-depth interviews with program managers and engineers with experience in technology transfer programs. In doing so, we were able to identify specific expertise, past job experiences, job skills, and individual characteristics desired of technology transition managers.

Keywords
Technology Transition, New Product Development, Technology Transition Manager

1. Introduction

Over the last two decades, there has been a fundamental shift in the way new products are developed. The traditional approach of a sequential, compartmentalized development process has been replaced by a cross-functional, interdisciplinary approach that focuses on the entire development process and emphasizes communication, speed, teamwork, and alliances across multiple teams and organizations to rapidly deliver products to the customer. Companies are exploring new ways to harness innovative ideas across the organization to develop, manufacture, and launch products faster and cheaper than the competition. This push towards innovation in product development is the result of changing customer needs, advances in technology, shorter product life-cycles, and global competition [1]. This new paradigm is characterized by the use of cross-functional teams, participation by all stakeholders, strategic planning, globalization, increased reliance on partnerships with other companies, and added emphasis on manufacturing and affordability early in the design process [2].

An essential component of this new paradigm is the need for continuous and effective communication and coordination of development activities and product responsibility across various teams or business units both within and outside the organization. Companies are relying more on distributed teams, rather than a central research and development (R&D) division to develop new technologies and maximize the value of those technologies across the entire company. Coordination, information sharing, and collaboration in this new environment play a critical role in the design, development, integration, and manufacturing of new products.
1.1 Background
A fundamental aspect of the new product development (NPD) process is the seamless transfer of responsibility for system development and integration from the science and technology (S&T) community to the product centers. Within the Department of Defense (DoD), product centers are responsible for developing, integrating, and fielding the technology for the end-user or customer. The handover from the S&T community to the product centers is known as technology transition, which Dobbins defines as the process by which technology “deemed to be of significant use … is transitioned from the science and technology environment to a military operational field unit for evaluation and then incorporated into an existing acquisition program or identified as the subject matter for a new acquisition program” [3]. This definition highlights several key elements of the DoD’s technology transition process. First, the technology is considered to be of value to the customer or end-user. Second, the transition from the S&T community to the product centers serves two purposes: further technology development and evaluation. Lastly, it suggests a level of system interdependency between the transitioning technology and existing weapon systems that will require system integration to be a large part of the development and transition process.

1.2 Challenges Associated with Technology Transition
One of the main challenges of the NPD process is maintaining coordination among the various development and product teams supporting the project. A constant theme throughout the literature on NPD is the importance of communication, especially during technology transitions. Cooper and Jones’ [4] study of six United Kingdom NPD companies found communication to be a common area of weakness across marketing, R&D, design, and manufacturing. Unclear roles and responsibilities, poor communication and coordination, and lack of understanding of processes were the common themes throughout the study.

Kono and Lynn’s [5] survey of 161 managers across 15 R&D industries found similar results. According to their study, nearly a fourth of the respondents experienced new product failures because of a “lack of cooperation between R&D, production, and marketing.” Scott’s study identified coordination and management of NPD teams as a top-ten issue involving the development of advanced technologies [2]. A 3-year study conducted between 2001 and 2004 at Intel Corporation on the risks and factors affecting product transitions reinforces Scott’s findings [6]. The study identified “inadequate information sharing and coordination among groups as one of the more important challenges to successful transitions” [6]. The lack of information flow between organizations and teams not only results in unworkable expectations between organizations, but also prevents managers from effectively managing transitions and implementing risk mitigation strategies in the face of unexpected change.

The DoD faces similar challenges. The primary reason for transitioning immature technologies is breakdown in communication between key players in the development and transition process [7]. Effective communication is especially difficult in DoD organizations because they tend to be geographically separated and operate under distinct processes, leadership, reporting hierarchies, and differing expectations between the customer, S&T community, and product centers. The Defense Systems Management College, for example, identifies eight different communities that must work effectively to achieve technology transition: Capability Needs, Science and Technology, Research and Development, Acquisition, Test and Evaluation, Sustainment, Finance, and Security [8]. These factors have led many transitioning technologies to experience what has been termed in the DoD as the “valley of death.” The “valley of death” refers to an encompassing catch-phrase to describe the philosophical, accountability, communication, and at times funding disconnect between the labs and the program offices regarding the line of managerial and program responsibility for maturing the technology past a specific junction in the life of the program.

To address the problem, some organizations across the DoD and industry began designating individuals, referred to as technology transition managers, within the organization who are responsible for facilitating the transition of proven concepts from R&D to fielding. Beyond this overarching goal, however, the role of the technology transition manager is somewhat ambiguous. This often leads to program managers and developers not using technology transition managers effectively, thereby resulting in poor program transition [9].

1.3 Purpose and Research Questions
The purpose of this research was to define the roles and responsibilities of technology transition managers (TTMs) from the perspective of both the developer and integrator/producer. The research defined the roles, responsibilities, and skills required for TTM to facilitate communication, collaboration, and information exchange across teams and organizations. To that affect, we answered five critical questions concerning the role of TTM.
We examined the perceived expectations of TTMs from the multiple viewpoints of the developers in the S&T community and program offices to gain a comprehensive perspective into the role of TTMs. To do this, we conducted in-depth interviews with program managers and engineers from the Air Force Research Laboratory (AFRL) and the program offices with experience in technology transition programs. The data analysis consisted of qualitative analysis measures to condense, categorize, and interpret the interview data.

2. Literature Review

New product development was examined across the DoD, Air Force, Army, and industry to capture NPD best practices, along with existing guidance, policies, and best practices on the roles, responsibilities, and alignment of technology transition managers. The primary sources for information were the Defense Acquisition University’s (DAU) Acquisition Community Connection (ACC) community of practice and the Air Force’s E-Publishing webpage, which had an extensive collection of official, and in the case of DAU, working documents on the topic.

Organizations rely on TTMs to act as deal brokers to foster collaboration, formalize agreements, develop metrics, provide interface, and resolve issues throughout the technology transition process. Table 1 provides a summary of the most commonly identified TTM roles and responsibilities in industry and the DoD. Some of the organizations using the TTM concept collocate R&D personnel from various departments to facilitate communication and build interpersonal ties necessary to resolve issues throughout the transition process. Collocating product line personnel ahead of the transition process “creates an advocate to bring the research results downstream, and builds interpersonal ties for the later assistance” [10]. Conversely, downstream movement of R&D personnel provides the “technical expertise necessary for development to build up its own understanding and capability” [10]. Rather than using a single transition manager, another industry approach is the use of a transition team comprised of “personnel from the project team and the receiving unit, transition-management experts, market-development specialists, and a special oversight board” [11].

Table 1: Summary of Roles and Responsibilities for TTMs in DoD and Industry

<table>
<thead>
<tr>
<th>DARPA (Operational Liaisons)</th>
<th>AFMC (IPT)</th>
<th>JCTD (Transition Mgr.)</th>
<th>US Army (Technology Officer/Coordinator)</th>
<th>Leifer et al. (Transition Team)</th>
<th>GAO-06-883 (Relationship Manager)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agreements</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Customer Representative</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Reporting</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Provide Strategic Inputs</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Resolve Issues</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Develop Strategy</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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</table>

3. Research Design and Methodology

During our research, we used a qualitative approach to study the subject in detail because it offered the flexibility to discover new concepts, ideas, and phenomena in the course of the research. Step one followed a top-down approach advocated by Booth, Colomb, and Williams [12] to take a broad topic of interest in new product development, narrow it to a manageable research question, and translate the research question into a workable problem statement. We subsequently used elements of the job analysis technique to develop six research constructs to define the technology transition manager: expertise, past job experiences, organizational alignment, roles, characteristics, and
The research relied on in-depth interviews as the data collection method. Step three consisted of designing the interview process and developing the interview questions. The interview questions were built to facilitate the interview with program managers who had experience with, or have detailed understanding of, technology development and the transition process. Developing each question consisted of determining the question purpose, scope, and content; determining the response format to the question; and wording the question to get at the issue of interest. The questions were divided into content mapping and content mining questions. The interview questions were reviewed by a subject matter expert in technology transition at AFRL, with the reviewer’s comments and recommendations being incorporated into the finished product.

The research targeted approximately 30 employees (engineers and project managers) across Air Force Material Command (AFMC) with experience in technology transition. All participants had previous experience in managing or being part of product development and were considered experts within their respective organizations. None of the participants were technology transition managers, although some of them acted in that capacity as part of their program responsibilities. Potential interviewees were identified through contacts at AFRL and the Aeronautical Systems Center (ASC). The research focused on AFRL and ASC because of the geographic proximity of both organizations and to allow the analysis of both the laboratory (development) and product center (integrating and fielding) perspectives regarding technology transition. Each interview lasted between 45-60 minutes. With the permission of the participants, interviews were digitally recorded to aid in data retention and transcription.

Because of its iterative nature and conduciveness to categorizing, interpreting, and analyzing large volumes of data, the research employed Miles and Huberman’s [13] interactive data analysis model to perform the data analysis (step 4). Within this framework, the researcher used the ATLAS.ti 5.2 qualitative software to perform the data analysis. The overall data analysis consisted of four distinct steps.

- **Step 1** – Transcribe all interviews to text
- **Step 2** – Assign data files to qualitative research software database
- **Step 3** – Read interview transcripts and manually assign key words and phrases (codes) to text. Organize documents, codes, etc. into hierarchies or “families.”
- **Step 4** – Within the framework of grounded theory [14], use the networking feature in ATLAS.ti to weave codes into theoretical concepts to define the organizational alignment, experience, expertise, roles, skills and personal traits of technology transition managers.

To ensure validity and reliability in qualitative studies, we applied the guidelines set forth by Miles and Huberman [15]. To ensure the objectivity, conformability, and reliability of the study, a systematic approach was used to develop and document the research design. The steps, interview questions, and protocol established for the research were followed to the maximum extent possible. Any deviations were clearly stated and documented. The researcher had prior government acquisitions experience, but no prior experience with technology transition. Any potential biases that might have been introduced into the interview instrument were minimized by a thorough review of the intended interview questions by the research team. To address internal validity, credibility, and authenticity issues, a comprehensive analysis of all the data was performed to identify any patterns of convergence or links between common themes or constructs discovered throughout the course of the research. Outliers and areas of uncertainty in the data were also identified and documented, and plausible explanations were provided based on the researcher’s experience or expertise and discussions with subject matter experts. To address issues with external validity and transferability, the study interviewed program managers with various levels of experience and expertise from different organizations across AFRL and the product centers. The results of the research were compared to previous theories and studies on similar topics. Additionally, implications for transferability were framed within the limits of the study. Lastly, to address the pragmatic validity of the study, great care was taken to ensure recommendations were specific enough to help decision-makers take steps towards implementing the results of the research, while allowing generalizations across the DoD and industry.

**4. Data Analysis and Results**

Responses to each interview question were analyzed individually and within the context of the six constructs identified in Section 3 to uncover overarching themes, patterns, similarities, differences, etc., that helped answer the overall investigative questions for the research. Table 2 captures a top-level summary of the technology transition manager; the subsequent sections discuss each area in more detail.
Table 2: Summary of Expertise, Alignment, Skills, Traits, Roles, and Responsibilities for TTMs

<table>
<thead>
<tr>
<th>Expertise</th>
<th>Organizational Alignment</th>
<th>Job Skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>-- Operational</td>
<td>-- Position on authority</td>
<td>-- Communication skills</td>
</tr>
<tr>
<td>-- Organizational processes</td>
<td>-- Independence</td>
<td>-- People skills</td>
</tr>
<tr>
<td>-- Management</td>
<td></td>
<td>-- Management skills</td>
</tr>
<tr>
<td>-- Technical</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Personality Traits | Roles | Responsibilities |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>-- Credible</td>
<td>-- Communicator</td>
<td>-- Inform stakeholders</td>
</tr>
<tr>
<td>-- Organized</td>
<td>-- Advocate</td>
<td>-- Articulate benefits</td>
</tr>
<tr>
<td>-- Flexible</td>
<td>-- Marketer</td>
<td>-- Priority and visibility</td>
</tr>
<tr>
<td>-- Fast learner</td>
<td>-- Market analysis</td>
<td>-- Understand need</td>
</tr>
<tr>
<td>-- Endure adversity</td>
<td>-- Customer commitment</td>
<td></td>
</tr>
<tr>
<td>-- Overcome challenges</td>
<td>-- Relationship builder</td>
<td>-- Connect people</td>
</tr>
<tr>
<td>-- Outgoing, personable, cordial</td>
<td>-- Technical</td>
<td>-- Advisor</td>
</tr>
<tr>
<td>-- Visionary</td>
<td>-- Manager</td>
<td>-- Assess/evaluate technology</td>
</tr>
</tbody>
</table>

4.1 What type of experience and expertise is most desirable in technology transition managers?
There seemed to have been an overarching consensus that in order to be effective, technology transition managers require four areas of expertise. First, the TTM must have a good understanding of the operational environment, to include how different systems work together, as well as understand the attributes and operational roles of the weapons systems. Second, TTMs require a good understanding of organizational processes, specifically the processes of other organizations. Third, TTMs must have a strong management expertise. Lastly, TTMs require a strong technical understanding, which was the most cited requisite for TTMs. The individual would not have to be the expert but must have a basic knowledge (generalist) of the technologies the S&T community is developing.

4.2 How should technology transition managers be aligned in the acquisition community?
The common theme that surfaced throughout the interviews was that in order to be effective, the technology transition manager should be placed in a position of authority and independence. Authority was important because it enabled the TTM to affect the course of technology transition through intervention at critical points in the program. Independence was crucial because of the perceived notion that in order to be effective and credible, TTMs require a degree of organizational autonomy to be able to perform their jobs with objectivity and impartiality. While some participants were hesitant to put a number behind the level of experience required from these individuals, responses to the question ranged from a mid-level position working in an integrated product team with 10 years of experience to a senior person with 20+ years of experience working at headquarters looking across multiple platforms and capabilities.

4.3 What job skills and individual characteristics and traits are most desirable in TTMs?
In the area of job skills, three overarching themes emerged from the interview data. First and foremost, technology transition managers require strong communications skills in concert with strong people skills. Additionally, management skills are another important skill set. Strong program management skills and the ability to plan, schedule, problem solve, and organize and run effective teams from multiple organizations with diverse backgrounds were specifically mentioned as critical attributes of effective TTMs.

In terms of individual character and personality traits, several themes emerged from the interview data. First, the technology transition manager must be credible. Credibility is an indispensable quality when the TTM assumes a marketing role and attempts to convince stakeholders of the benefits of a new technology. Credibility is also an important role when TTMs are asked to assess the technology and provide recommendations to decision-makers. At any given time, TTMs will be involved in multiple projects supporting several programs and working with
numerous outside organizations. Therefore, TTM s have to be organized, flexible, and fast learners. To be effective, TTM s also have to be able to make difficult decisions. Therefore, they require a high degree of confidence to be able to provide difficult answers to senior leadership amidst competing technologies and organizational pressure. Part of making tough decisions is the ability to face and endure adversity. The ability to remain calm and withstand adversity is thus an important quality. Additionally, TTM s cannot be introverts. The job requires them to go out and find connections, establish relationships, and remain engaged with stakeholders. In addition to being personable and cordial, they must have the diplomacy skills necessary to get past inter-organizational politics and barriers that typically inhibit effective communication, teaming, and information flow across organizations. Lastly, technology transition managers must be visionary – they ought to be strategic thinkers who can see past the “now” and anticipate, influence, and shape the future 5, 10, and 20 years out. An indispensable quality in this area is the ability to maintain a “big picture” outlook. TTM s must have the full picture and view technology from a system-level perspective, from cradle to grave.

4.4 What are the expected roles and responsibilities for transition managers?

First, a technology transition manager must be a communicator. In this role, the TTM keeps stakeholders informed, educates stakeholders regarding all aspects of the technology, and works to create a shared understanding across all organizations. Closely related to the communicator role is another function critical for TTM s: being an advocate. Transition managers must ensure technologies slated for transition remain a top priority and get the required visibility to maintain momentum. Another aspect of this role is advocating for new technologies, which involves articulating the benefits of new technologies and convincing the customer that the technology is worth pursuing.

Closely related to the advocacy function is the idea of a marketer. Technology transition managers should be at the forefront of the acquisition process and be aware of potential problems, capability shortfalls, etc., and bring that information back to the S&T community. This idea of linking technology and need was by far the most frequently coded task for TTM s. The TTM must have a good understanding of the user’s requirements, needs, and capability shortfalls, and be able to identify and match technologies or potential technologies that will solve the customer’s needs. Once a technology is identified for transition, the technology transition manager should work with the user to also identify other areas of applicability of the technology. Lastly, another aspect of advocacy is establishing program office commitment. TTM s ought to play a key role in establishing commitment from the program office to transition and integrate the technology.

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The catalyst that ties all of these functions together is the ability to build relationships across organizations. To be effective, technology transition managers must know the right people and know where to go for the right information. As one participant put it, TTM s must have a “big phonebook.” The ability to connect people and bring key players together was the second most coded aspect of TTM s. The ability to make connections and establish relationships across organizations is fundamental to successful transitions.

Technology transition managers also play a technical role in the technology development and transition process. Because of their ability to see across multiple platforms and technologies, transition managers could provide technical expertise, assessment, and counsel to decision-makers on the merits of the technology. Part of this task includes assessing the applicability or potential of new technologies, its potential impacts on the system, and highlighting any manufacturability and supportability needs or requirements that must be addressed prior to transition.

Finally, technology transition managers must also assume the role of manager. This area covers a wide range of tasks and responsibilities that can be grouped into five categories: documentation, schedule, process, funding, and post-transition. Transition managers in this capacity assume the roles and responsibilities of a process manager to ensure technology programs have the needed documentation, funding, and schedule in place to effectively transition to the receiving organization for integration into the larger system. Additionally, TTM s could play a key role in advising stakeholders on technology transition policy, keeping critical decision milestones in the forefront for project managers and decision-makers, and ensuring the transition effort does not stall. Lastly, TTM s have an important role to play in post-transition activities as well. Once the technology is fielded, the TTM should also perform a post-transition evaluation of the transition process and document lessons learned for future efforts. An important component of this activity is follow-up with the customer to evaluate whether the technology is delivering the capability the acquisition community promised.
4.5 Do expectations for transition managers differ between the labs and the receiving organizations?

The responses were remarkably consistent across organizations. However, there were some differences across the labs and program offices that are worth noting. Most of those differences were related to the roles and responsibilities TTM should assume in the technology development and transition process. The idea of a marketer and technology advocate were predominantly echoed within the lab community. This is not surprising considering that the labs consistently work on technologies for which specific applications have yet to be identified. Advocacy, salesmanship, and developing organizational commitment (funding, schedule, and resources) play a critical role in those areas. The role of evaluator produced another area of differing perspectives. While both organizations agreed on the importance of this role for TTM, the specific tasks and responsibilities associated with this function were remarkably different. From the labs’ perspective, this function primarily dealt with evaluating the military applicability of emerging technologies. The program office, on the other hand, was much more concerned with evaluating the merits of the technology and the impact of incorporating those technologies into existing programs and systems. Lastly, funding stability was much more of a concern for the labs than the program offices. The labs viewed funding as a major component of the technology transition process. Funding availability can become a major barrier to technology transitioning into a weapon system. Funding stability, therefore, figured much more prominently into the responsibilities of TTM from their perspective.

5. Discussion

The answers to the above questions indicate that the technology transition manager would play a critical part in the DoD’s technology development and transition process. The idea of a single point of contact for transition activities in the form of the TTM is attractive for several reasons. First, a TTM would add flexibility, responsiveness, and cohesion to the bureaucratic process already in place for transition. Second, the TTM would play a direct role in ensuring that the success factors (commitment, communication, and clear need) that drive technology transition in the DoD are continuously addressed throughout the technology development and transition process. Lastly, many activities within the DoD’s technology transition process cut across multiple organizations and stakeholders. Ownership for these activities are often ambiguous or outside the direct control of any single organization. As a result, best practices, key milestones, and activities within the transition process may get overlooked or not addressed in a timely manner. The TTM would take a holistic view of the transition process and assume ownership of those crucial activities within the development and transition process.

The findings are in many ways consistent with the literature presented in Section 2. The need to connect organizations, people, and processes, and establish agreements, advocacy, and management of the transition process were in line with the roles and responsibilities of technology transition managers in the literature. There is one key difference between the current literature and the findings of this research. The role of marketer for TTM is a new theme that emerged in the course of this research. The explanation for this is twofold. First, while marketing management is an important function within the NPD process, it is typically done by a separate management function in industry. However, the DoD does not have a marketing management function. While it may seem like a novel concept in the DoD, the concept of a marketer to establish communication across organizations, manage customer interface, foresee technology opportunities, oversee requirements, etc., is remarkably consistent with the factors that drive successful technology development and transition in the DoD.

5.1 Theoretical Implications of the Research

This research provided additional insight into overcoming organizational boundaries in NPD. The data revealed that successful technology transition within the DoD is driven by a clear need that depends on commitment from all stakeholders and made possible by effective communication across multiple organizations. Within this context, the experience, expertise, organizational alignment, skills, individual characteristics, roles, and responsibilities of technology transition managers are summarized in the following theoretical propositions.

Proposition 1. The DoD’s technology transition process involves multiple organizations and stakeholders, which necessitates the establishment of a transition manager to provide a holistic process view and an all-inclusive approach to managing technology transition.

Proposition 2. The job description of transition managers in the DoD ought to be tied to their ability to promote communication, link customer needs with technologies, and secure organizational and stakeholder commitment for transition.

Proposition 3. The position of the TTM in the DoD is situational dependent. The relative importance of areas of expertise, skills, roles, and responsibilities defined in this study depends on the stage of technology development and transition.
This theoretical framework presents program managers and decision-makers a tool for defining the technology transition manager to fit the unique circumstances of the technology development process, organization, program, etc. Since the job description of the TTM is situational dependent, managers and decision-makers need to ensure the technology transition manager’s focus remains on the factors that drive technology transition in the DoD.

5.2 Recommendations for Future Research
The conclusions drawn in this study provide areas for further inquiry. Since the research was an individual-level study to define the technology transition manager, the next area requiring further study involves the establishment an Air Force or DoD-wide office for TTM. What resources are required for establishing a technology transition office? What would the career progression path, training, certification, etc., be comprised of for TTM? Moreover, due to the exploratory nature of the study, an all-encompassing approach was used in this research to define the TTM. Therefore, there is a strong possibility that one individual would not have all the required expertise, job skills, etc., to be able to perform all the responsibilities desired of TTM. Further research is thus required to help narrow the scope of the TTM. Another approach may be to adopt the industry model and narrow the scope of the TTM to mirror that of the relationship manager in industry and establish a marketer function or position within the DoD. The last area requiring further research is the notion of a marketer function for DoD acquisitions. According to the data, marketing is an important component of new product development. Further research is required to define the boundaries, objectives, roles, and responsibilities of a marketing function in DoD.

References