

Driving Change from the Middle in High-Tech Organizations: An Approach and Lessons Learned from a Military Science & Technology Development Organization

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Abstract: *The U.S. Army Tank-Automotive Research, Development and Engineering Center (TARDEC) recognized a need for strategic organizational renewal and transformation to become more responsive and relevant to its operational military and funding customers, ongoing war effort support, and anticipated future combat and support system requirements. In an effort to identify and solve significant problems without a major disruption to the organization, a “grass-roots” approach, which balanced middle management sponsorship and leadership with bottoms-up involvement, was taken to identify and implement several strategic “quick wins.” During the process a middle management steering group and champion were identified, and working level action teams formed to identify several significant contemporary problems considered critical to near-and longer-term organizational success. This planned approach was an alternative to the more traditional and protracted strategic organization analysis and renewal process (developing or reviewing mission, vision, goals, objectives, etc.). Identified and reported in this paper are: a research approach and methodology, a case description, some improvement initiative results, and implications for managers of technology. A central research question asked and partially answered was: Is this “grass-roots” engineering and technology management approach effective and efficient for identifying and driving organizational performance improvements. The preliminary answer is: Yes, it was.*

1. Introduction

Science and technology (S&T) planning and development organizations must not only focus and manage their mission, vision, goals, objectives, and customer/stakeholder needs within resource constraints, but occasionally they need to identify and implement performance improvement and change management initiatives. The need for continuous performance improvement is critical to technical organizations in an era of dynamic strategic change, economic constraints, and international competition. As a result, organizations must focus on specific S&T portfolio planning and development to ensure that desired and timely results are achieved, and that customers needs and requirements are satisfied within available resources. The questions this paper addresses are: (a) what

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are the elements of an overall philosophy and process needed to guide strategic and systematic “quick win” S&T organizational transformation and change management? (b) can needed changes be identified from a middle management perspective using a “grass roots” approach? and (c) was this improvement and change management approach effective and efficient for identifying and driving organizational performance improvements.

The focus of this paper is on strategic “quick win” incremental transformation and change management that affects and improves an S&T planning and development organization’s life cycle--from customer/stakeholder needs and requirements identification and funding allocations to enterprise-wide results. Central to the process is the identification of all S&T organizational interfaces and strategic functions (services), roles, responsibilities, products, and deliverables. An object of this paper is to provide a better understanding of strategic transformation and change management from the perspective and example of a focus organization--the U.S. Army Tank-Automotive Research, Development and Engineering Center (TARDEC) of Warren, Michigan. A reflective case study is used to document how TARDEC has initiated the process of refocused and formalized its S&T activities to more relevantly and responsively support: (a) the need for near-term solutions to deployed military system operational capability gaps, (b) the present war on terrorism, and (c) maintenance of a future perspective and technology development competency.

Outlined and described in the remainder of the paper are: (a) the research approach and methodology used, (b) a reflective case description of the target organization, (c) some improvement results achieved, (d) implications for managers of technology including challenges, lessons learned, and success measures and evaluation criteria, and (e) a summary and conclusions. A technology manager should be able to use elements and suggestions made in this paper to review, assess, and revise other S&T organizations through needed transformation and change management initiatives.

2. Research Approach and Methodology

2.1. Research Foundation

To help answer the primary questions of this paper, a review of relevant literature was initially undertaken. Primary areas of management of technology concentration were: organizational transformation, change management, strategic planning, and engineering and project management. From this review, a variety of organizational and technology management challenges, required thrusts, and best practices were identified. The objectives of these reviews were to: (a) develop an overview of performance improvement methods and paradigms, (b) gain insights from the review of past studies on performance improvement, (c) understand the pros/cons of different approaches, and (d) develop a model for “grass roots” performance improvement from the middle of the organization to achieve some “quick win” results as a precursor for longer-term improvements in organizational effectiveness and efficiency. The latter objective was driven by the need to identify and solve identified problems without a major disruption in a military organization with an important technology-driven technology mission.

2.2. Organizational Challenges and Initiatives

From the review of relevant management of technology literature for the concentration areas identified above, it became evident that technology-based organizations continue to face numerous challenges. Of critical importance, is the need to ensure that their S&T efforts produce value to society, the economy, and their organizations [7]. To respond to these value challenges, organizations need to initiate at least two critical initiatives. The first is to ensure that research and development (R&D) activities are fully integrated and that full collaboration exists within the organization and with external stakeholders. In explaining the evolution of the R&D function, Miller and Morris [14] point out that a key element is the inclusion of a full range of stakeholders in the R&D process. These stakeholders include partners, customers, R&D, marketing, and production representatives. Chiesa [5] further

expands the need for fully integrated R&D activities to include competitors, suppliers, customers, and distributors. The participation of stakeholders supports the growth of a shared context (i.e., needs and values) leading to an organization's knowledge about the state-of-technologies, needed technology to be developed, and resultant products and supporting services. For example, technology pull (from users) and push (from developers) satisfy both needs and values, and contribute to a shared context for all stakeholders. This first thrust forces the organization to address another required initiative.

A second initiative is directed at the essential requirement to develop and execute an integrated management approach for multiple layers of strategies and best practices for R&D and S&T portfolio management. The latter being the balance of projects and activities that best supports the mission, vision, goals, and objectives of the organization and the needs of its stakeholders. Matheson and Matheson [13] define the need and a series of best practices to connect a multitude of corporate, business, portfolio, and project strategies. According to these researchers, technology strategy best practices include: (a) coordinating long-range business and R&D plans, (b) developing a global technology plan that focus on end customer needs, and (c) designing a progression of technology developments. Portfolio management best practices include: (a) evaluating the R&D portfolio, (b) balancing innovations and incremental improvements, (c) managing the pipeline (supply chain), (d) balancing across strategic objectives, and (e) managing and prioritizing different R&D efforts. Project strategy best practices include: (a) the need to fully resource projects, (b) evaluating projects quantitatively, (c) focusing on factors that create value, (d) evaluating and planning all projects, and (e) agreeing on measurable goals. The extent and scope of these best practices point to the need for a systematic approach to organizational transformation and change management.

2.3. Technology Manager Challenges and Thrusts

In the past, managers have used various organizational management tools to improve performance [15]. Today, S&T-focused organizations and technology managers are turning to an expanded and

integrated set of initiatives such as strategic and portfolio management, technology roadmapping, project management, and knowledge management to address the challenges they face. Technology managers are now finding that they must manage and function in an R&D environment pursuing two thrusts: (a) integrating core processes throughout the organization, and (b) implementing multiple strategy layers and best practices. These thrusts create challenges for technology managers that include: (a) strategic planning for technology products, (b) new product project selection, (c) organizational learning about technology, and (d) technology core competencies [16].

Evolving technology organizations and their managers are achieving positive performance outcomes by using an approach of integrating core processes throughout multiple strategic levels in their organizations. These core processes include but are not limited to:

- **Strategic management:** the process by which the organization provides an integrated management system and enables the organization to achieve its vision, mission, goals, and objectives.
- **Program/portfolio management:** the process by which the organization provides an integrated set of technologies and projects to meet the organizations strategic direction.
- **System of systems engineering/systems engineering:** the process by which customer needs are converted into detailed requirements and specifications.
- **Project management:** the process by which projects are planned, organized, directed, and controlled.
- **Technical management:** the process by which the organization produces technology-based products and services.
- **Learning/knowledge management:** the process by which the organization improves its capabilities.

These core processes require the use of various methods and tools to develop and manage a project portfolio. Steps in the portfolio management process include: (a) identifying the R&D budget, (b) defining potential R&D projects, (c) evaluating projects, (d) selecting projects, (e) implementing projects, and (f) measuring and adjusting projects and the portfolio [5].

2.4. Case Study Method and Focus

To better understand how organizations and technology managers can successfully implement the above core processes and manage challenges and initiatives, a reflective case study method described by Kotnour and Landaeta [11], focusing on a target S&T organization was initiated. In essence, this approach consists of: abstracting experience gained; approaches, processes, tools, challenges identified; and lessons learned from a project experience for the benefit of a broader audience of program, technology, and engineering managers. Others contend that a successful or unsuccessful project experience offers a unique perspective to learn from experience [1,6,8]. According to Kanter, Stein and Jick [9], Kleiner and Roth [10] and Kotter [12] the writer's challenge is to document and provide an engineering manager with the knowledge needed to address organizational needs. While the case study method and focus of the research reported in this paper is on a single target organization, it is hoped that others will find the ideas and developed process applicable and useful in understanding the challenges and opportunities other organizations face.

Important information gleaned during a literature review of theory and practices were model parameters, and the identification of transformation and change management applications and lessons learned from the experience of other organizations. In addition to a literature review, interviews were conducted with organizational technologists, directors, and others with vested interests in the organization's S&T future success.

Following these preliminary steps, a steering and focus group was identified and off-site meetings held to further discuss the state of the present organizational systems. Improvement teams were created to delve further into problems and solutions. Insights gained during these meetings resulted in the development of a six problem areas important to Army technology managers and developers. Literature search, interview results, and case study information were then analyzed and integrated to

determine if a developed process change model could be supported or refuted. From these process development activities, the methodology was applied and preliminary results obtained.

The experience gained by the authors in the creation and implementation of a “grass roots” S&T organizational transformation and change management approach offered a unique opportunity to align a technology management organization’s challenge with a performance improvement development and implementation approach, and to share this experience with others. Findings and conclusions presented in this reflective case study are based on a one-year and continuing development and implementation effort by the authors and focus organization management. The ultimate objectives of this endeavor were to: (a) develop, implement, and document a strategic transformation initiative taken by a target organization to satisfy S&T developer and customer/stakeholder S&T goals and objectives, and (b) identify a transformation process, change management methods, and implications for technology managers that can serve as a model for others. A background and some specifics of the target organization are identified in the following section.

3. Case Description

3.1. Focus Organization Overview

The U.S. Army Tank-Automotive Research, Development and Engineering Center (TARDEC) is the nation’s laboratory for advanced military ground combat and support vehicle technologies. Its parent organization is the Army’s Research, Development and Engineering Command (RDECOM). Because TARDEC is headquartered in Warren, MI (a part of metropolitan Detroit and the world’s automotive capital), the organization is uniquely positioned to ensure that it remains committed to developing and delivering near- and longer- term advanced military technologies. The organization accomplishes its mission and vision through: (a) research, development, and engineering, and (b) leveraging and integrating advanced technology into ground systems and tactical (support) equipment throughout a system’s life cycle. The organization is committed to increasing the Army’s agility,

versatility, responsiveness, deployability, lethality, sustainability, and survivability, through the development of advanced ground vehicle and support system technologies for a superior Army [17].

Traditionally, TARDEC has focused on program execution and S&T planning and development for the next generation of programs--primarily with a longer-term (3-years and beyond) horizon. The organization's mission is to research, develop, engineer, leverage, and integrate advanced technology into Army ground systems and support equipment throughout the life cycle. TARDEC's 1,100 employees provide and support technology, engineering, and development ground vehicle services for all U.S. Armed Forces, many federal agencies, and more than 60 foreign countries. S&T advances in collaboration with the Army's combat developer and customer soldiers, ensure that robust equipment is developed and fielded that meets aggressive cost, schedule, and performance standards. TARDEC functions to stimulate technology transfer, and to build solid relationships with industry and academia to develop dual-use technologies. To this end, TARDEC's technology transfer arm, the National Automotive Center (NAC) is charged with actively collaborating with private industry to leverage commercial automotive technologies for military use [17].

It is important to understand the scope and diversity of TARDEC's responsibilities and program activities required to produce material solutions for the Army and others. To accomplish its technology development mission, TARDEC is charged with pushing state-of-the-technology programs and a variety of tactical support activities. Main S&T organizational elements and their focus responsibilities include: (a) Mobility (power and energy, engines, transmissions, wheels or tracks, and hybrid components such as motors, switches, inverters, motor controllers and fuel cells), (b) Intelligent Systems (unmanned vehicles, embedded simulation, and crew interfaces), Maneuver Sustainment, (fuels, propellants, lubricants, maintenance, and water purification), Next Generation Software (command and control software development), and Survivability (passive and active armor systems). An example of the later was the development of passive add-on-armor kits for High Mobility

Multipurpose Wheeled Vehicles (HMMWVs) operating in Iraq, to protect occupants from most ballistic and explosive threats. These survivability kits were developed, tested, and deployed by the Army in a period of months instead of a more customary and lengthy period. In addition, and as an indication of the diversity of its activities, TARDEC's tactical support activities include (but are not limited to) development programs for: (a) military bridging, (b) fuel storage and distribution, and (c) equipment for countermines, logistics, and quality surveillance.

To sustain its present and future mission, roles, and responsibilities, TARDEC recently developed and has begun implementation of strategic S&T transformation initiatives to ensure that the organization remains and improves its relevancy and responsiveness to its customers. These improvements were initiated because of the organization's responsibility and need to continually improve its performance during the present war on terrorism, while concurrently supporting its ongoing mandate to provide technology development and supporting services for the Army in the long term. Moving beyond current systems, TARDEC must develop technologies and support future and future combat systems (FCSs). What does the future hold for these next-generation systems? FCS is a highly integrated structure of manned and unmanned, air and ground systems, bound by a distributed network in a joint Department of Defense (DoD) environment. FCS is being designed to possess a full spectrum of combat capabilities and functions "built in," that are readily task organized and modular.

3.2. Interfaces and Responsibilities

To better understand TARDEC's interfaces and responsibilities to conduct day-to-day activities and prepare for the future, Fig. 1 was developed. The figure illustrates TARDEC's loyalty to two masters with regard to providing S&T operational solutions and support services. The first is RDECOM that provides first-level reviews, recommendations, and approval for TARDEC's S&T project initiatives such as Advanced Technology Objectives (ATOs). The second are its primary customers--Program Executive Offices (PEOs) and Project Managers (PMs) who have general

program (e.g., ground combat systems) and specific project (e.g., armored Stryker Brigade vehicles) needs and requirements. This later group represents (from a TARDEC perspective) the ultimate customer--soldiers and other organizations that develop their doctrine and tactics, and provide training and logistics support. As such, TARDEC fits into and supports a Soldier and Ground Systems Life Cycle Enterprise--a life cycle system of Army commands, enterprises and alliances designed to function as a network of linked organizations that are integrated and function as an enterprise system of systems.

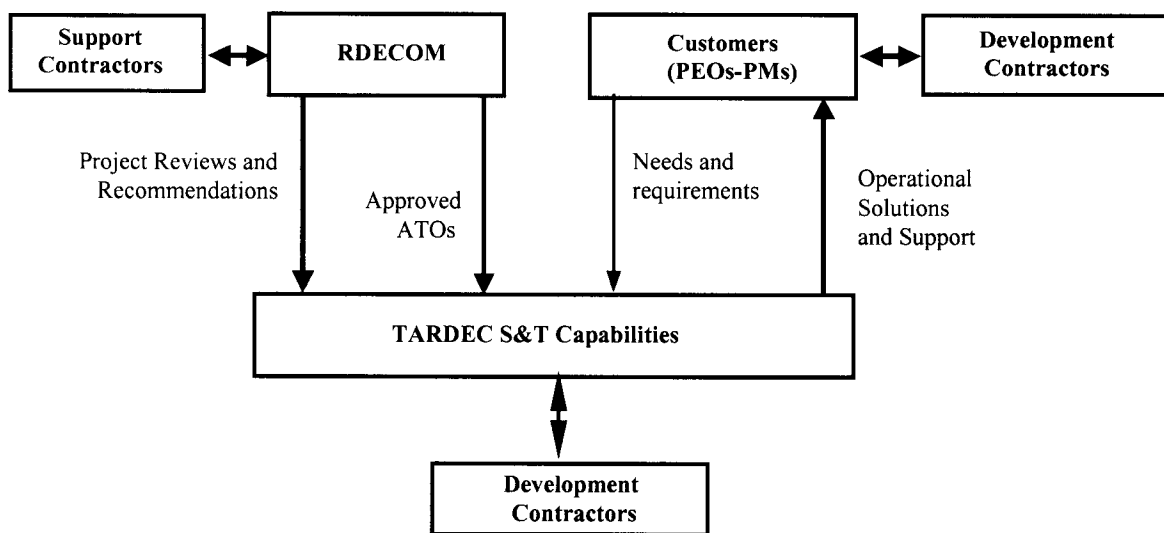


Figure 1. TARDEC S&T Interface Process Model

While Fig. 1 is a summary chart, numerous other Army and DoD elements (including support and development contractors) are involved in the complete S&T interface process model. For example, funding is authorized and provided by the U.S. Congress, through the Assistant Secretary of the Army for Acquisition, Logistics and Technology [ASA(ALT)], for TARDEC S&T activities based on review recommendations at the RDECOM level. As is indicated in Fig. 1, support contractor services are provided to RDECOM, and development (and frequently the same) contractors such as General Dynamics and United Defense, L.P. support multiple elements, as is the case for TARDEC S&T and its PEO-PM customers. While not complete, all essential elements are represented in Fig. 1 for the purpose of this paper.

Table 1 provides answers to the following TARDEC-S&T related process model questions: (a) what customer/stakeholder services are performed? and (b) what products and deliverables does the organization produce? While Table 1 is not all-inclusive for TARDEC, because some engineering, development, and operations business unit services are not included, it does portray primary TARDEC research and technology development responsibilities. From the table it becomes evident that S&T elements are also involved in numerous and diverse supporting service activities. Central is its role in providing near- and longer-term S&T capability developments through technology creation, or adoption/adoption of commercial-off-the-shelf (COTS) systems. It is also important to recognize that TARDEC does not have production capabilities. Instead they provide S&T development and advisory services for other Army and DoD agencies that eventually initiate, through major contractors and vendors, large-scale acquisition and production of operational combat and support systems.

Customer/Stakeholder Services	Products and Deliverables
1. Platform concept developments	<ul style="list-style-type: none"> • Concept identifications
2. Platform concept system of systems analyses	<ul style="list-style-type: none"> • Computer/virtual platform concept modeling and simulation
	<ul style="list-style-type: none"> • War gaming inputs and results
	<ul style="list-style-type: none"> • Concept simulation and tradeoff results
3. Research activities	<ul style="list-style-type: none"> • Research results and reports
4. Model developments	<ul style="list-style-type: none"> • Computer models and reports
	<ul style="list-style-type: none"> • Physical models and reports
5. Technology developments	<ul style="list-style-type: none"> • Created, adapted, and/or adopted technologies
6. System/subsystem/component testing and analyses	<ul style="list-style-type: none"> • Developed S&T testing and analysis reports
	<ul style="list-style-type: none"> • COTS S&T testing and analysis reports
7. Platform demonstrator/prototype developments	<ul style="list-style-type: none"> • Virtual models
	<ul style="list-style-type: none"> • Physical models
8. Platform demonstrator testing and analysis	<ul style="list-style-type: none"> • Virtual models results
	<ul style="list-style-type: none"> • Physical models results
9. Dual-use application identification	<ul style="list-style-type: none"> • Reports
	<ul style="list-style-type: none"> • Technology transfers
10. S&T planning	<ul style="list-style-type: none"> • S&T plans and roadmaps
11. Specification shaping	<ul style="list-style-type: none"> • Information to Program Managers (PMs)
12. Funding identification	<ul style="list-style-type: none"> • Funding requirements

Table 1. TARDEC Customer/Stakeholders S&T Services, Products, and Deliverables

3.3. The Need for Change

In spite of established and understood S&T interfaces and accepted TARDEC relationships (ref. Fig. 1) and identified customer/stakeholder services, products, and deliverable responsibilities (ref. Table 1), several organizational problems and a need for change became evident. As a result, TARDEC recognized a need for strategic organizational renewal and transformation to become more responsive and relevant to its operational military and funding customers, ongoing war effort support, and anticipated future combat and support system requirements--constraints to a revolutionary disruption in ongoing strategic activities. But TARDEC was not alone in driving change. The U.S. Army and DoD have identified the need for transformation. An example of the scope and rationale to move the Army into the future lies in a Transformation Executive Summary [2], which states:

“... Army Transformation combines advanced technologies, organizations, people, and processes with concepts to create new sources of military power that are more responsive, deployable, agile, versatile, lethal, survivable and sustainable. We are also transforming our institutions and business processes to produce these capabilities...”

The first TARDEC identified challenge was the need to improve the way the organization interfaced and collaborated with those external to the organization--namely its PM customers, stakeholders, the active military (soldiers and their needs being the primary focus), and funding groups. Second, it was felt that these interface relationships should and could be improved by formalizing the organization's internal method and processes for S&T planning and development. The overall rationale for supporting these felt needs was to maintain and improve TARDEC's continued viability as a relevant, responsive, and ready organization through the effectively and efficiently management of its external and internal relationships and activities. The need for change was also made even more acute by the current war on terrorism. To be relevant and responsive to PMs who are responsible for current and operational military force combat and support systems, TARDEC needed to focus more on near-term S&T (less than 2 year) developments, balanced with their traditional longer-term activities. With improvement needs and drivers identified, it was decided that a concerted action

be initiated to address and resolve TARDEC identified problems, and capitalize on the Army transformation-driven opportunity [2] for organizational improvement.

3.4. Approach Details

In an effort to identify and solve existing organizational problems, a “grass-roots” approach, which balances middle management sponsorship and leadership with bottoms-up involvement, was undertaken to identify and implement several strategic “quick wins.” This approach was an alternative to the more traditional and lengthy strategic organization planning and renewal process flow. This latter method of organization renewal is to start at the top strategically (i.e. mission, vision, goal, objectives, etc.) and involve senior management. To initiate the “grass roots” renewal process, a middle management steering group and champion were identified, and a series of off-site working sessions held at a nearby conference center beginning in mid-May 2004 and continuing through December. These group sessions, and the open dialog that occurred under the leadership of an “outside” facilitator resulted in the identification of a number of organizational problems that participants felt existed.

The overall and agreed upon approach was to identify a support infrastructure for S&T strategic transformation with an identified hierarchy of roles and responsibilities. Members of this TARDEC infrastructure consisted of selected TARDEC Executive Directors, Associate Directors, team leaders, and cross-functional teams. This arrangement is shown in Table 2. The heart and sole of the TARDEC’s middle management improvements initiative approach taken was the identification and use of a working-level steering and focus group. With outside facilitator help, the responsibilities of this mid-level TARDEC team at off-site meetings were to: (a) identify and understand organizational problems, (b) group identified sub-problems into major problem categories, (c) form solution teams, (d) focus on quick wins, (e) present action plans to upper management, and (f) ensure that change implementation occurred.

Groups	Roles and Responsibilities	Members
Executive Steering Committee and Champion	<ul style="list-style-type: none"> • Provide overall leadership and alignment • Provide overall analysis and transformation framework, bring ideas, work initiative, program manage, and think of how 	<ul style="list-style-type: none"> • Executive Committee
Steering and Focus Group	<ul style="list-style-type: none"> • Provide organizational-wide view and implementation • Provide day-to-day leadership • Make the transformation work 	<ul style="list-style-type: none"> • Associate Directors • Team Leaders
Improvement Teams	<ul style="list-style-type: none"> • Implement improvement initiatives 	<ul style="list-style-type: none"> • Associate Directors • Cross-functional teams

Table 2. Support Infrastructure for S&T Strategic Transformation

Since the mission and vision of the organization were to remain unchanged (by design since this was intended to be a “grass roots” effort), two primary objectives were identified for the improvement initiative development team. The first was to achieve tangible results that would be important enough to justify the effort expended for their identification and solution. It was also felt that any initiative undertaken should consist of a “quick win” that could be identified, understood, and accepted as being significant and representative of a solution possibility in a reasonable period (i.e. several months and not years). A second objective was to obtain change management support and eventual ownership of the problem and its full implementation over time.

Concurrent with initiative objective identification, a transformation process flow was developed that identified the strategic S&T transformation and change management process. The resultant transformation roadmap is illustrated in Fig. 2. Important considerations for future actions to be taken were: (a) first, recognize and accept the fact that change was needed, (b) second, create momentum to initiate corrective actions, and (c) third, implement systemic, long-term change evolution for full implementation of “quick win” initiatives and future actions. It was also recognized that at critical stages of the process, appropriate decisions (indicated as decision gates in Fig, 2) would be required before proceeding to the next step.

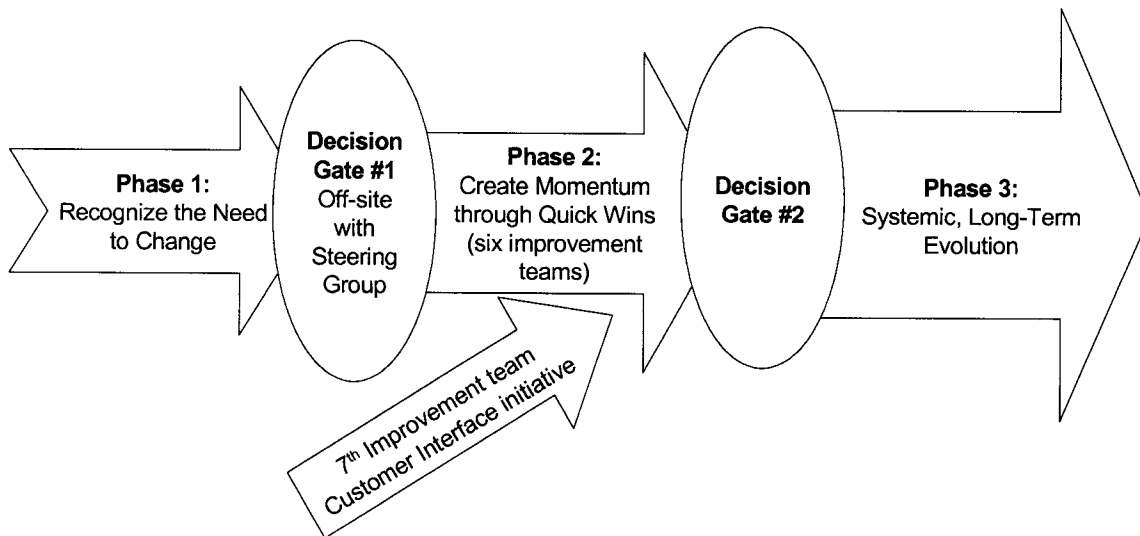


Figure 2. TARDEC Transformation Roadmap

For more information and details on TARDEC driving change from the middle in high-tech organizations, and TARDEC strategic S&T planning and development see [3,4].

4. Improvement Initiative Results

Early off-site steering and focus group organizational problem discussions resulted in the identification and focus on six “quick win” problems (challenges). They were the need to: (a) “build the bench” by enhancing the workforce, (b) improve the strategic budgeting/funding process, (c) improve collaboration strategies, (d) change perceptions and tell a better story for the organization, (e) regain a lead vehicle integration role, and (f) improve S&T planning. After approval by the Executive Steering Committee and Champion, the next phase of activities was the identification of focus team leaders and cross-functional team member responsible for problem resolution and solution implementation.

All of these identified problem areas were considered to be: (a) “quick wins” and “doable”, (b) significant enough to warrant focus and attention, (c) sufficiently defined to provided insights into the challenges and opportunities that lay ahead, and (d) representative examples for future improvement initiatives relevant to the topic and approach of this paper. Table 3 lists developed improvement

initiatives and their objectives. The seventh initiative listed in Table 3 and shown in Fig. 2 evolved during the later stages of discussion and is in its early implementation stages--yet to be completed and or documented in a final report or a management of technology paper. This latter initiative is an effort to reach out and extend many of the other initiative results to an external customer environment.

Improvement Initiatives	Objectives
1. Build the Bench	Focus on the development of a TARDEC environment that attracts, nurtures, retains, and contributes effective leaders; facilitates essential experiences for growth and success; and improves the environment for essential competencies.
2. Strategic Organizational Fund Process	Create a flexible budgeting process that allows TARDEC to strategically finance solutions to current problems, and innovation technology approaches as seeds for future efforts.
3. Collaboration Strategy	Develop improved collaboration with DoD, other Army groups, industry, and academia within TARDEC at various levels.
4. Change Perceptions/Tell the Story	Establish improved external and internal communications to better describe the mission, vision, goals, objectives, and accomplishments of TARDEC S&T elements.
5. Regain Lead Vehicle Integration Role	Reestablish a system of systems and systems engineering-based focus for TARDEC integrated systems technology development.
6. S&T Planning Process	Develop and formalize a systematic S&T planning process to facilitate TARDEC technology development and communications.
7. TARDEC/Customer Interface Improvement Initiative (Under Development)	Develop a mutually beneficial, two-way cooperative interface between PEO/PM customers and TARDEC S&T service providers important for mission accomplishment.

Table 3. Improvement Initiatives and Objectives

The next step in this “grass roots” process was to identify six performance improvement project leaders and team members. The responsibilities of these leaders and teams was to: (a) identify the scope and nature of the problem, (b) establish success criteria and objectives, (c) develop solution concepts and recommended solutions, and (d) develop implementation and resource plans. As part of these team efforts, primary upper-level TARDEC Executive Committee sponsors were identified and

support solicited. Concurrently, benchmark identification and analysis of other organizations were conducted, to aid in the development of an overall philosophy and S&T program management and solution suite of performance drivers. For several months, team meetings were held with weekly status reported. An important byproduct of this initiative, shown in Fig. 3, was the development and mapping of the seven improvement initiatives with developed performance drivers (i.e. customer outcomes and organizational process, capability, and outcomes).

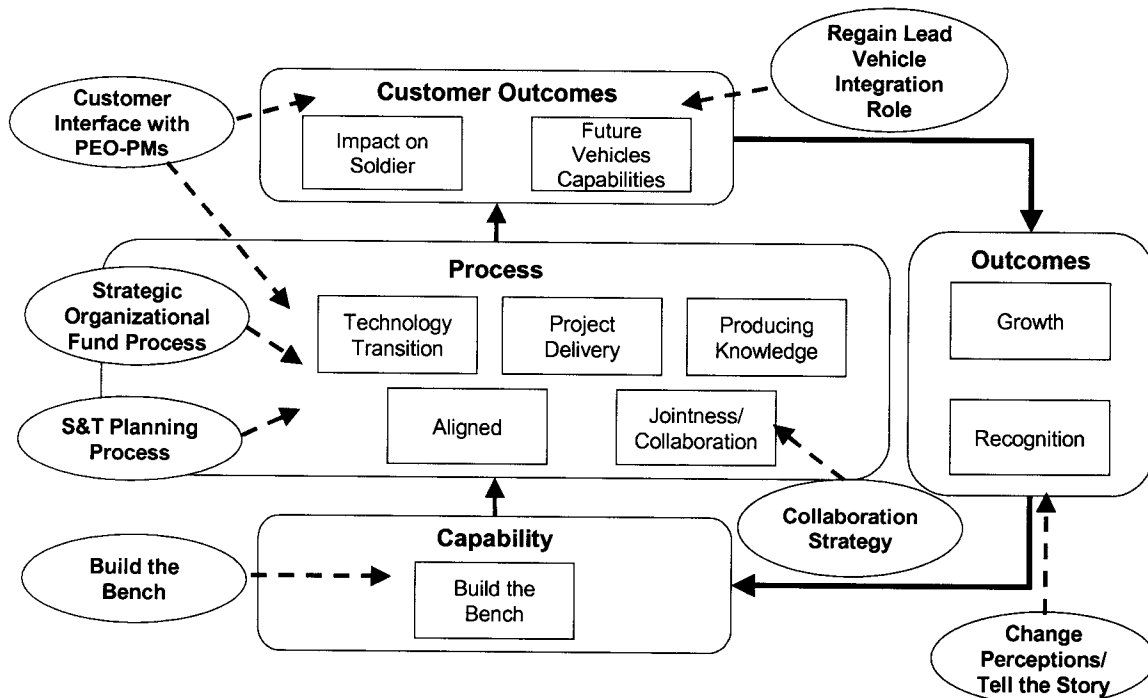


Figure 3. S&T Linked Performance Drivers and Improvement Initiatives

4.1. Preliminary Implementation Evaluation

Prior to the identification and implementation of TARDEC's S&T organizational transformation improvements and change management initiatives, there was some external and internal criticism that the organization was not as effective and efficient as it should and could be. At issue were organizational relevancy and responsiveness. As a result of shortcomings, key technology managers in TARDEC realized changes were needed to various processes and methods, and that the S&T planning and development process needed improvement and formalization.

Post-implementation assessment of TARDEC's "grass root" developed improvements is yet to be fully evaluated--as full implementation has not been fully achieved and remains "a work in progress." More complete results will be reported at a later date when full implementations are achieved. However, it has been already been determined that organizational learning has occurred, and top TARDEC organizational management are now knowledgeable about the initiatives and their significance. It is also important to note that all of the organization's Directors have recognized the importance of the suggested changes, supported their adoption, and have even made them "their" initiatives. To a great extent, this highest-level acceptance is verification and validation that the "grass-roots" approach used to make organization changes served its purpose. That is, make needed changes without disrupting the entire organization. While results are reaching full implementation and a full evaluation is yet to be completed, several implications for technology managers have been identified and include: (a) implications for managers of technology, (b) lessons learned, and (c) success measures and evaluation criteria. These initial results are included in the following section.

5. Implications for Managers of Technology

5.1. Challenges

Key organizational questions to be asked and answered by any S&T organization and its technology managers are: why, when, and how should improvements and change management initiatives be implemented? To answer these questions, the following sub-questions and resultant challenges must be asked and answered:

- Does a "quick wins" grass-roots approach support approval, acceptance, and ownership over time?
- Why is a change to an existing system or method needed?
- Is there an acceptance that a change or a new method is needed?
- What is the best way to build consensus on a development approach or revision?
- Will the improvements justify the time and energy that will be required for development and implementation?

- Does needed management support exist to make these improvements a reality?
- What will be required to build the required infrastructure--people/skills/values and tools?
- Do the skills exist to build the processes and defining roles/responsibilities for improvements?
- How will performance of the new systems be measured?
- What are the hidden costs and risks for implementation?
- Will organization members support the suggested changes?
- Will higher-level leaders and organizational representatives, customers, stakeholders, partners, contractors, etc. accept the desired and resultant organizational changes?
- Will the timeframe for implementation support customer/stakeholder and organizational needs?
- Will real cost savings/avoidance be realized?
- Will this change make the organization more proactive, relevant, and responsive?

Of course, the corollary to the above key primary and sub-questions is: can an S&T organization that provides critical services, products, and deliverables to customers and stakeholders afford *not* to continually improve its system and processes through change management in a world of constrained resources, expanding competition, and dynamic changes? The obvious answer should be *no, it can not*-assuming that there are organizational shortcomings in systems, methods, process, and procedures that *do not* support the mission, vision, goals, and objectives of involved and affected organizations.

5.2. Lessons Learned

The following is a preliminary collection of lessons learned from the TARDEC transformation and change management actions. They are offered to help guide others who find value in this strategic middle management developed “grass roots” S&T planning and development approach and process.

Captured lessons learned to date are as follows:

- Be proactive as an organization to add significant value to S&T planning and development.
- Make customers/stakeholders part of strategic S&T program management activities.
- Function as a team to improve relevancy and responsiveness to customer/stakeholder needs and requirements and funding agency accountability.

- Initially think top level downward from needs/requirements to system of systems to supporting systems, and upward for solution accomplishment and status reporting.
- Work to build win-win, collaborative partnerships (internal and external) and contractor relationships.
- View all activities as projects with performance, schedule, and cost measures.
- Function more in a system of systems and systems engineering mode.
- Take advantage of the synergy of Integrated Product/Project Teams (IPTs) both internally and externally for all major needs, requirements, and funded activities.
- Identify points of contact and responsibilities at all levels of S&T activities.
- Provide status (feedback) at each stage of S&T activities.
- Identify an individual and/or organization element early to orchestrate the total process to ensure that all phases of the model are integrated, continuous, and complete.

5.3. Success Measures and Evaluation Criteria

Subsequent to and during implementation of TARDEC's S&T-related strategic improvements, several implications and issues evolved in the form of questions that can serve as success measures and evaluation criteria. Likewise, they function as a set of implications for other application technology management change agents to think about and evaluate as they proceed down the organizational improvement and change management path for their own target organizational applications. These measures and criteria include:

- In the end will this process result in the satisfaction of customer/stakeholder needs and requirements?
- Do process results improve or make the organization relevant and responsiveness to customers/stakeholders?
- Does the process significantly improve the organizations planning, internal communications, and team building activities?
- Does the process directly support customer/stakeholder and S&T developer organizational missions, visions, goals, and objectives?
- Will the process encourage, build, support, and sustain collaborative synergistic partnerships (internally and externally) and encourage future relationships?

- Does the process support both “market pull” customer needs and “technology push” (i.e. support for new technologies and applications identified by lower-level technologists, respectively)?

6. Summary and Conclusions

6.1. Summary

This paper identified the ongoing need for an S&T planning and development organization to focus and manage its mission, vision, goals, objectives, and customer/stakeholder needs within the constraints of human and physical resources, budgets, and schedules to produce value to society, the economy, and their own organizations. An overall improvement and change management philosophy and process were identified and addressed, and the elements of the S&T transformation methodology were identified and described. Also recognized was the need for continuous performance improvement that is critical to technical organizations in an era of dynamic changes, economic constraints, and international competition.

A literature search identified the need for technology-driven organizations to respond to value challenges by focusing on internal and external R&D collaboration and integration, and to develop a formalized approach to manage multiple layers of strategies and best practices. This planned approach was a far less disruptive alternative to the more traditional and prolonged strategic organization planning and renewal process flow (i.e. analyzing or developing mission, vision, goals, objectives, etc.). Also identified was the need for S&T organizations and technology managers to improve performance by using an expanded and integrated set of initiatives such as strategic management, portfolio management, technology roadmapping, project management and engineering, and knowledge management to address the challenges they face. Technology managers must now manage and operate in an R&D environment pursuing two thrusts: (a) integrating core processes throughout the organization, and (b) implementing multiple strategy layers and best practices. A set of core processes important to achieve positive performance outcomes were identified that ranged from strategic

management to learning/knowledge management. Identified best practices for technology strategy, portfolio management, and project strategy point to the need for a systematic approach to technology management.

The target organization for reflective case study and implementation was the U.S. Army's primary organization responsible for tank and automotive research, development, and engineering with a focus placed S&T-related planning and development activities. This organization was selected because the paper's authors were intimately involved in the development and implementation improvement areas of needed improvement and change management. The objective of this effort was to take several steps forward to enhance TARDEC and its collaborative partner's ability to: (a) respond proactively as an organization to add significant value through advanced ground vehicle and support system technologies, (b) function as a team to improve its relevancy and responsiveness, (c) take advantage of internal and external synergism opportunities, and (d), develop and maintain win-win collaborative partnerships.

For the identification and resolution of strategic S&T needed improvements, a middle management steering group and action teams were formed (under change management sponsorship of a champion) to formulate and implement an improved process model considered essential to near- and longer-term organizational success and the ever-present goal of providing "Superior Technology for a Superior Army."

Finally, a series of implications for managers of technology were identified that included challenges, lessons learned, and some success measures and evaluation criteria. These implications were derived from the process of developing suggested and needed TARDEC process and methodology improvements, and their initial implementations.

6.2. Conclusions

Discussion elements of this paper and the methodology developed and used provides a partial answer to the initial research questions asked. They were: (a) what are the elements of an overall philosophy and process needed to guide strategic and systematic “quick win” S&T organizational transformation and change management? (b) can needed changes be identified from a middle management perspective using a “grass roots” approach? and (c) was this improvement and change management approach effective and efficient for identifying and driving organizational performance improvements. The preliminary answer to these questions is: *Yes, it was in all cases.*

The literature search provided philosophy and process insights into the responsibility of R&D organizations to add value through integrated and collaborative activities, and the importance of integrating multiple layers of strategies and best practices. These integration thrusts were accomplished during the early stages of the improvement and change management process, but are not yet fully implemented. The middle management and “grass roots” approach to organizational improvement and change management was validated and verified in the fact that top TARDEC organizational management has recognized the importance of the suggested changes, and has made them their initiatives. Finally, with regard to effectiveness and efficiency, the resultant problem identifications and steps to take corrective action were effective in accomplishing an initial goal of making needed changes without disrupting the entire organization while moving forward to identify and solve organizational felt needs. Efficiency (i.e. the ratio of process and results outputs vs. inputs) is yet to be determined, but appears initially to be very much worth the efforts expended by those involved in the TARDEC improvement initiatives.

While the focus of the research, methodology, and preliminary results reported in this paper related to a single military S&T organization with a somewhat unique mission, numerous S&T organizations that also have the responsibility to develop and transfer technology and provide technical services to

customers and stakeholders can benefit from the results of this paper. Other researchers and technology managers should be able to use elements of this paper and its described approach and methodology, derived strategic S&T planning and development model, and identified implications (challenges, lessons learned, and success measures and evaluation criteria) to more effectively and efficiently review, assess, and revise as needed the S&T initiatives of other organizations.

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