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Report to the Chairman and Ranking Member, Subcommittee on Readiness and Management Support, Committee on Armed Services, U.S. Senate

April 2001

BEST PRACTICES

DOD Teaming Practices Not Achieving Potential Results

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April 10, 2001

The Honorable James Inhofe
Chairman
The Honorable Daniel Akaka
Ranking Member
Subcommittee on Readiness and Management Support
Committee on Armed Services
United States Senate

As you requested, this report examines how best practices can help the Department of Defense maximize the benefits of integrated product teams in its development of weapon systems. It examines the factors that are critical to making integrated product teams effective, including the environment in which such teams operate. We make recommendations to the Secretary of Defense on how to better support the use of integrated product teams on weapon system programs.

We are sending copies of this report to the Honorable Donald H. Rumsfeld, Secretary of Defense; the Honorable Joseph W. Westphal, Acting Secretary of the Army; the Honorable Robert B. Pirie, Jr., Acting Secretary of the Navy; the Honorable Lawrence Delaney, Acting Secretary of the Air Force; the Honorable Mitchell E. Daniels, Jr., Director, Office of Management and Budget; and to interested congressional committees. We will also make copies available to others upon request.

If you have any questions regarding this report, please call me at (202) 512-4841. Other key contacts are listed in appendix II.

Katherine V. Schinasi
Director
Acquisition and Sourcing Management

Executive Summary

Purpose

Although the Department of Defense (DOD) has boosted its annual weapon system investment from about $80 billion 4 years ago to about $100 billion for fiscal year 2001, its buying power will be weakened if weapons continue to cost more and take longer to develop than planned. DOD wants to improve program outcomes by reducing weapon system development cost and time, while still producing weapons that meet user needs. It has a long way to go; long-standing practices that impede delivery of new weapons within estimates have proven resistant to reform. GAO issued a series of reports on the success leading commercial firms have had in significantly reducing the time and money it takes to develop new and more sophisticated products—the kinds of results that DOD seeks. Leading commercial firms find that integrated product teams—teams that are responsible for all the activities of development, from design to manufacturing—are key to achievement of such results. The practices of leading commercial firms can help DOD maximize the benefits of integrated product teams in its development of weapon systems.

In response to a request from the Chairman and the Ranking Member, Subcommittee on Readiness and Management Support, Senate Committee on Armed Services, GAO examined (1) whether and how integrated product teams affect decision-making and product outcomes, (2) what factors are key to creating effective integrated product teams, and (3) how the environment in which products are managed affects the prospects for effective integrated product teams.

Background

Integrated product teams bring together the different professions or areas of expertise needed to design and manufacture a new product, such as engineering, manufacturing, purchasing, and finance. The essence of the integrated product team approach is to concentrate this expertise in a single organization together with the authority to design, develop, test, manufacture, and deliver a product. The hallmark of these teams is their ability to efficiently make decisions that cross lines of expertise. In contrast, when the people with the necessary expertise reside in separate organizations, they tend to work on new products sequentially. For example, a product might be handed off from a concept group to a design group, a cost group, a test group, and a manufacturing group before being delivered to the customer. Often, factors such as how to manufacture or repair the product are assessed after it has been designed and tested, forcing redesign and rework from the preceding groups.

Commercial firms came to see this approach as taking too long and being too costly and in the 1980s, began using integrated product teams as a way

to get better results faster. In 1995, DOD adopted integrated product teams in an attempt to improve its weapon system acquisitions. DOD's intention was to use the teams in the same manner as commercial firms—to integrate different functional disciplines into a team responsible for all aspects of a new weapon.

To gain insights on how DOD's implementation of integrated product teams compares with the practices of leading commercial firms, GAO conducted eight case studies: three from leading commercial firms; four from DOD programs experiencing cost, schedule, and performance problems; and one from a DOD program that has been meeting its objectives. Within these case studies, GAO examined 18 teams in detail, including over 100 interviews with team members and leaders.

Results in Brief

Integrated product teams work. Effective integrated product teams can make significant product development decisions quickly and without relying heavily on consultations with organizations outside the team. These teams have developed and delivered superior products within predicted time frames and budgets—often cutting calendar time in half compared with earlier products developed without such teams. Officials from the more successful programs GAO reviewed—three commercial and one from DOD—all cited integrated product teams as a main factor in achieving such results. In the four DOD programs that were not meeting cost and schedule objectives, GAO found that the teams did not operate as effectively. Their decision-making processes were sequential and involved numerous outside consultations for information and approval.

Two elements are essential to determining whether a team is in fact an integrated product team: the knowledge and authority needed to recognize problems and make cross-cutting decisions expeditiously. Knowledge is sufficient when the team has the right mix of expertise to master the different facets of product development. Authority is present when the team is responsible for making both day-to-day decisions and delivering the product. In the programs experiencing problems, the teams either did not have the authority or the right mix of expertise to be considered integrated product teams. If a team lacks expertise, it will miss opportunities to recognize potential problems early; without authority, it can do little about them. Although these teams were called integrated product teams, by and large they were not.

Leading commercial firms took steps to create an environment more conducive to the integrated product team approach. They committed to

making the approach integral to the product development process and backed up that commitment through actions to ensure that implementation was not left to chance. Importantly, the pressures of competing in the commercial market meshed well with the decision-making advantages of integrated product teams. While DOD endorses the integrated product team approach, it has not taken steps to ensure that the approach is implemented at the program execution level. In essence, the approach has been left to germinate in an unchanged environment that is not necessarily conducive to integrated product teams. For example, the pressures to launch and fund new programs create incentives that pose obstacles for integrated product teams. Implementation is thus more dependent on the ingenuity of individuals working on the programs.

GAO makes recommendations on how DOD can better support the implementation of integrated product teams on weapon system programs.

Principal Findings

Integrated Product Teams Help Programs Achieve Better Outcomes

Integrated product teams improved both the speed and quality of the decision-making process. These teams made decisions involving significant trade-offs without relying unduly on other organizations for information or approval. For example, a 3M team developing a new dental material decided, based on its own analyses, to trade off some sophistication in the material to get it to market sooner. Officials from the Advanced Amphibious Assault Vehicle Program report that their teams reduced the time needed to make a system design decision from 6 months to about a week. The teams at the four remaining DOD programs had a less efficient decision-making approach. When these teams faced a significant issue beyond their knowledge and authority, they went through a lengthy, sequential process to obtain information and approval. On one program, for example, a trade-off between reducing performance requirements or increasing weight took a team 6 months and numerous consultations with other teams, the contractor, program managers, and service officials.

GAO observed a consistency between the effectiveness of teams and product outcomes on the eight cases studied: programs that were meeting product development objectives had more effective teams than the programs that were having problems. In addition to meeting objectives, the successful programs were often surpassing the performance of their predecessors in both time to market and performance. For example,

Hewlett-Packard officials stated that an integrated product team cut cycle time and increased productivity six-fold. The four programs with less effective teams were experiencing problems including cost growth, schedule delays, and/or performance difficulties. While not unusual for weapon system programs, these are the kinds of problems DOD hoped integrated product teams could help solve.

Expertise and Authority Are Key to Effective Integrated Product Teams

Integrated product teams in leading commercial firms and the Advanced Amphibious Assault Vehicle program had the right mix of expertise to develop new products. Their teams were responsible for developing and delivering the product and making day-to-day decisions on cost, design, performance, quality, test, and manufacturing issues. The combination of product responsibility and expertise put the teams in a position to have enough information to tackle crucial issues—like trade-offs—without having to rely heavily on outside organizations. The 3M team's decision on the dental material is an excellent example.

Other factors significantly enhanced team effectiveness. Collocating key members facilitated communication, built trust, and contributed to unity of purpose—all key elements of effective decision-making. For example, at the Advanced Amphibious Assault Vehicle Program, because representatives from the contractor and the DOD program office are located in the same building, there is little or no delay in getting answers or sharing information to make decisions. In instances where physical collocation is not possible, leading firms link team members through electronic means—such as by shared databases and software. On the more effective teams, team leaders selected members, rather than having members assigned by another organization. This allowed team members to demonstrate commitment and alignment with the team's goals.

GAO examined 12 teams in detail from the DOD programs experiencing development problems. Seven of these teams did not have responsibility for day-to-day decisions on the range of product development issues, nor did they bear responsibility for delivering the product. Rather, they were limited to a segment of the product development process, such as monitoring system performance requirements, testing the system, or providing logistics during fielding. The remaining five teams that could claim product responsibility were missing representatives from key areas of expertise, such as cost and testing, or from key organizations, like the contractor. Regardless of whether product responsibility or expertise was lacking, the effect on a team was the same—it was not capable of identifying problems and resolving them expeditiously through a

collaborative decision-making process. Moreover, the teams did not enjoy collocation and control over membership.

Differences in DOD and Commercial Teaming Approach Reflect Different Environments

Corporate leaders from DaimlerChrysler, 3M, and Hewlett-Packard demonstrated their commitment to integrated product teams by reorganizing to better align their structure with the teams and making targeted investments in physical assets, training, and other forms of help. These changes helped ensure success at the working level. The firms delegated considerable power to the teams and held the teams accountable for delivering on set goals. They made it possible for the typical program manager to succeed in managing with integrated product teams. DOD did not go much beyond policy statements to create a supportive environment for integrated product teams. On the weapon programs experiencing problems, implementation often meant changing team labels rather than altering lines of authority or team dynamics. Little training was provided and then only at the initiative of the program. Program teams were not often involved in setting key product goals, and program officials observed that unrealistic goals were set before the teams were formed. Regardless of their efforts, the teams could not make up for the unachievable goals.

Differences in how commercial firms and DOD managers measure success and in the pressures they face in starting programs significantly affect the environment for integrated product teams. Commercial products' success is measured in terms of the customer's acceptance of the final product and cycle times short enough to beat the competition. These conditions create incentives for gaining knowledge early, forming realistic goals and estimates, and holding teams accountable for delivering the product—all of which favor an integrated product team approach. In DOD, the pressures to successfully launch new programs and protect their funding, coupled with long cycle times, create incentives to be overly optimistic in setting program goals and to focus on process concerns like obtaining incremental funding. DOD's necessary reliance on defense contractors introduces another complication for integrated product teams because the two organizations are responsible for the product, but they do not necessarily share the same incentives.

The Marine Corps Advanced Amphibious Assault Vehicle program has many of the teaming characteristics of leading commercial firms. This accomplishment was made possible by the unique environment—or culture—that the program's initial manager created to center around the

integrated product team approach. Unlike the other DOD cases, the teams were not made to fit among standing organizations and procedures.

Recommendations for Executive Action

GAO recommends that the Secretary of Defense designate as integrated product teams only those teams that will have the day-to-day responsibility for developing and delivering a product, such as a weapon system, and the cross section of expertise to do so. GAO recommends the Secretary of Defense use the practices and characteristics described in this report to develop and communicate standards for what constitutes an integrated product team. GAO also recommends that the Secretary of Defense put weapon system program offices in a better position to create and sustain effective integrated product teams, such as by giving them responsibility for a deliverable product, authority to make decisions on that product, and representation from the critical areas of expertise. Finally, GAO recommends that the Secretary of Defense help program managers and team leaders become catalysts for implementing the integrated product team approach by (1) devoting professional education to make these individuals capable of creating the culture necessary to foster integrated product teams and (2) drawing lessons from programs like the Advanced Amphibious Assault Vehicle for bridging the barriers between program offices and contractors.

Agency Comments

DOD agreed with the report and most of its recommendations. DOD partially concurred with the recommendation that only those teams with day-to-day responsibility for a product and the necessary cross section of expertise be designated as integrated product teams. It noted that while such teams are unique and require certain conditions and investments, the designation “integrated product team” has spread throughout the workforce and has benefited other teams as well. DOD does not want to lose those benefits by limiting the designation. DOD’s position reflects the practical reality that the designation of integrated product teams is now difficult to restrict. Given the Department’s recognition that program office integrated product teams require certain conditions and investments to succeed that other integrated product teams may not need, GAO believes that if the Department takes the actions contained in GAO’s other recommendations, the objective of the recommendation will be achieved. DOD’s comments appear in full in appendix I.

Chapter 1: Introduction

Reflecting its urgency to acquire new weapon systems to replace those seen as outdated and too costly to operate, the Department of Defense (DOD) has boosted its annual weapon system investment from about $80 billion 4 years ago to about $100 billion for fiscal year 2001. Over the next 5 years, DOD plans to spend over $500 billion developing and acquiring weapon systems. DOD would like to get the most out of this investment and has set goals to develop new weapons in half the traditional time and within budget. Historically, DOD has not received predictable returns on weapon system investments. Although they provide superior capability, they have cost significantly more and taken much longer to complete than originally estimated. When one program needs more money than planned, unplanned trade-offs—such as delaying or canceling other programs—may be necessary. As a result of such recurrent problems, about 5 years ago we began a body of work to examine weapon system acquisition issues from a different, more cross-cutting perspective—one that draws lessons learned from the best commercial product development efforts to see if they can be applied to weapon system development. Leading commercial firms have developed increasingly sophisticated products in significantly less time and at lower costs—the kinds of results that DOD wants.

Our previous work has shown that leading commercial firms expect their program managers to deliver high-quality products on time and within budget.[1] Accordingly, the firms have created an environment and adopted practices that put their program managers in a good position to succeed in meeting these expectations. We have also reported on the importance of having knowledge about a product's technology, design, and producibility at key junctures in the product development process. A key vehicle leading commercial firms employ to attain such knowledge is the integrated product team (IPT). Although organizations may employ various types of teams to develop new products, an IPT is a particular type of team vested with (1) the knowledge from the different areas of expertise needed to design, develop, and manufacture a new product and (2) the authority to use that knowledge in making decisions about the product. According to leading commercial firms, IPTs have proven essential to improving product development outcomes. IPTs have enabled firms like DaimlerChrysler to significantly reduce the time it takes to develop a new product—by as much as 50 percent—while at the same time yielding a product more sophisticated and possessing higher quality

[1] *Best Practices: Better Management of Technology Development Can Improve Weapon System Outcomes* (GAO/NSIAD-99-162, July 30, 1999).

than its predecessors. This report identifies best practices for creating effective IPTs, such as those from leading commercial firms, which can help DOD develop and produce better weapon systems significantly faster and at less cost.

The Rise of IPTs in Product Development

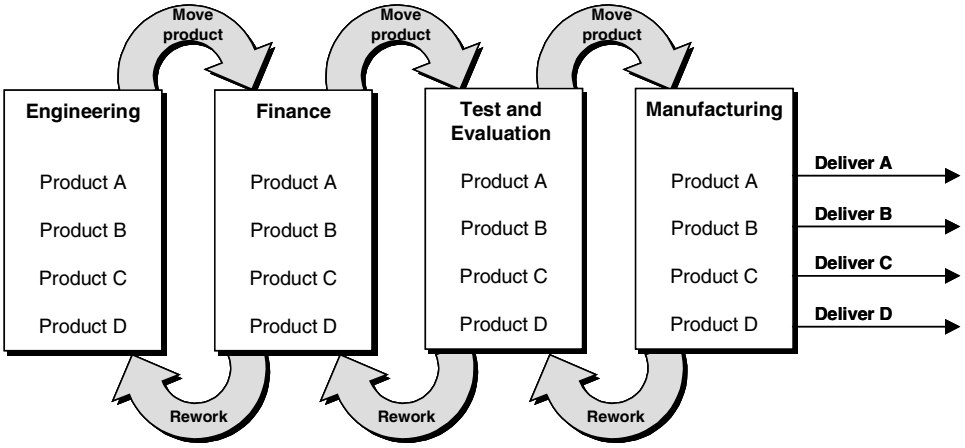
Product development, whether for commercial or defense application, is a complex undertaking. The process begins with a concept or idea for meeting a customer's need, the idea is converted to detailed design drawings, and the design is translated into articles or prototypes that can be tested. During the product's development, the processes for manufacturing the product must be also be identified and tested. The development process is characterized by a tension between competing demands on the product. These demands include the desire for the highest performance and the most features, the lowest cost and shortest time to market, and the ease with which the product can be produced in both quantity and quality. Trade-offs between these demands must be made to provide the customer a desirable product quickly and at a reasonable price. If performance features are allowed to dominate, the product may become too expensive. If costs are cut too much, then the product's quality may suffer. A product design that ignores the limits of manufacturing processes may never make it into the hands of the customer.

Taking a product from idea to delivery requires expertise from a number of different professions or functions, which can vary depending on the type of product. To illustrate, designing a product's features may require the collaboration of people with expertise in areas such as mechanical, electrical, materials, and software engineering. People with a financial management background are needed to accurately estimate the cost of the product and to keep track of the budget. People expert in test and evaluation are needed to objectively assess the performance of product prototypes. Production engineers make sure the design lends itself to proven manufacturing processes, even developing new processes when necessary. Quality assurance experts ensure that defects are kept out of the product design and manufacturing processes. Yet another group of people are responsible for understanding and representing the customer's needs, often part of the marketing function in commercial industry.

In commercial industry, how the knowledge of these experts and the authority for making decisions are brought to bear on the product development process have evolved considerably. Years ago, as companies grew and additional products were developed, many tended to organize

work around departments and divisions that represented areas of expertise, referred to as a functional approach to product development. This approach, with some illustrative functions, is shown in figure 1 below.

Figure 1: Functional Approach to Product Development



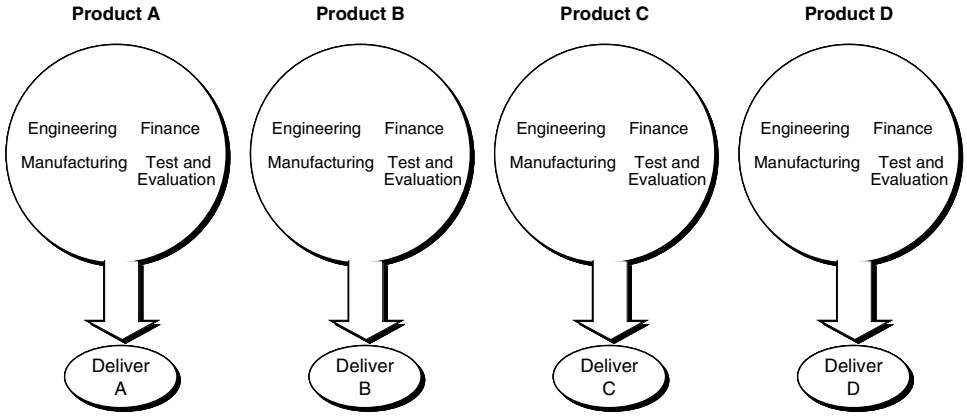
Source: GAO.

In this approach, knowledge was segregated or distributed by function, as was authority. Each organization managed and made decisions on its piece of a number of different products. Development of a product occurred sequentially, with people from each function doing their work on the product and then handing it over to the people from the next function. While each function attained a high level of expertise, the knowledge needed to recognize a potential problem often resided in a function that came later in the product development process. Thus, proposed solutions had to be reworked in the preceding functions. For example, if the manufacturing group for an automobile found that the engine compartment was not large enough to hold the engine, the automobile would be turned back to the design engineers. The engineers would have to redesign the engine compartment, the financial staff would have to reassess the costs and the test and evaluation people might have to reevaluate the vehicle's crash protection performance. After this additional time and effort—rework—the automobile could once again proceed to manufacturing.

In the 1980s, companies began to look for better ways to bring the knowledge of the people in different functions together in the design phase of a new product to reduce rework and shorten cycle times. They organized teams made up of a cross section of the different functional disciplines and gave them responsibility for developing an entire product. These efforts evolved into the IPT approach as it is known today. In the 1990s, Boeing received acclaim for the success of its 777 aircraft, which was developed by using design/build teams, which were IPTs.

The essence of the IPT approach is to concentrate in a single organization the different areas of expertise needed to develop a product, together with the authority and responsibility to design, develop, test, and manufacture the product. Figure 2 illustrates some of the areas of expertise that can be brought into the structure of an IPT organization.

Figure 2: IPT Approach to Product Development



Source: GAO.

Under the IPT approach, each team possesses the knowledge to collaboratively identify problems and propose solutions, minimizing the amount of rework that has to be done. When this knowledge is accompanied by the authority to make key product decisions, IPTs can make trade-offs between competing demands and more quickly make design changes, if necessary. For example, design engineers on a Caterpillar IPT initially proposed that very large differential gears be used to transmit power from the engine to the rear wheels on a large vehicle. While other team members did not see a problem, an experienced production engineer on the team noted that no gear manufacturer made a gear that large and that to create such a production capability would be

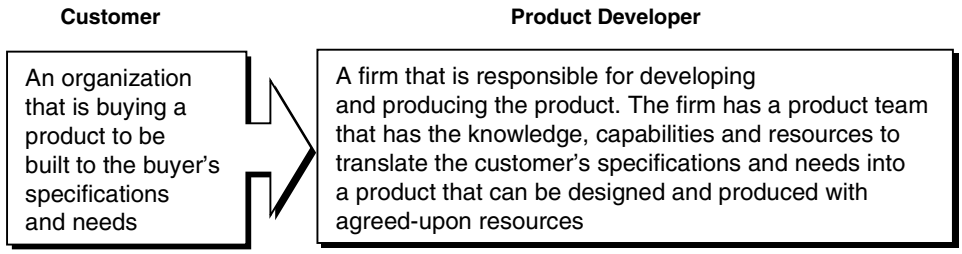
risky. Consequently, the design engineers revised the design to enable existing differential gears to be used, saving significant time in the process. In the functional approach to product development, this design problem might not have been discovered until late in product development, when the manufacturing organization got involved.

Adoption of the IPT Concept in DOD

DOD accepts IPTs as a vehicle for getting better acquisition outcomes. This acceptance was formalized in May 1995, when the Secretary of Defense directed that the concept of IPTs be applied throughout the acquisition process to the maximum extent possible. DOD employs three basic levels of IPTs: (1) the Overarching IPT works above the program level and its primary responsibility is to advise the Defense Acquisition Executive on issues related to all of the programs the executive is responsible for, (2) the Working-Level IPT also works above the program level and links the program manager to the Overarching IPT, and (3) the Program IPT represents the program level and executes the tasks to design, develop, and manufacture a weapon system. The first two types of IPTs perform oversight on a program and other than the program manager, do not typically include people from the program office. Within DOD, IPTs were to become the main element of an overall management approach that calls for considering all aspects of a weapon system, including performance features, manufacturing processes, and logistic support, throughout design and development.

While the basic DOD and commercial product development processes are similar, the number and responsibilities of key players differ. In the commercial world, there are two main players in product development—the product developer and the customer. Figure 3 describes the role of the product developer and the customer in commercial product development.

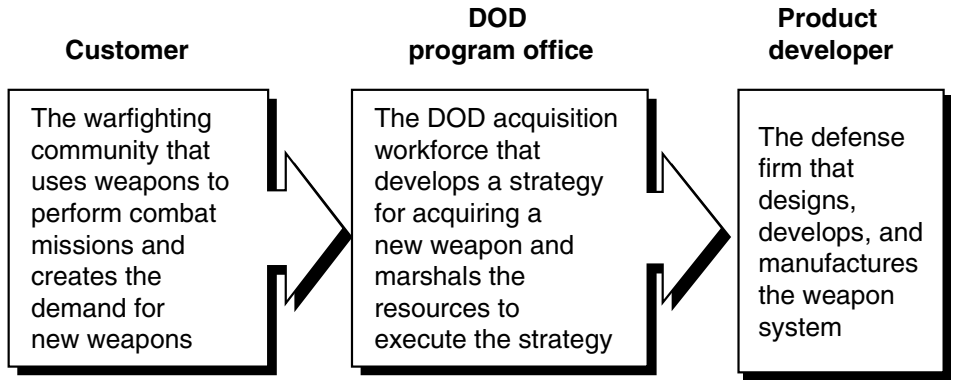
Figure 3: Players in Commercial Product Development



Source: GAO.

The DOD process for product development and acquisition is somewhat more complex because it involves at least three major players—the DOD customer, the DOD program office, and the product developer, as illustrated in figure 4.

Figure 4: Players in DOD's Product Development Programs



Source: GAO.

The additional player complicates the task of taking a product from concept to delivery because the knowledge and authority to accomplish the tasks are distributed between the product developer and the program management office. Thus, to concentrate knowledge and authority in IPTs for weapon systems, organizational and functional barriers must be bridged.

Objectives, Scope, and Methodology

The Chairman and the Ranking Member, Subcommittee on Readiness and Management Support, Senate Committee on Armed Services, requested that we conduct a body of work to examine various aspects of the acquisition process to identify best practices that can improve the outcomes of weapon system programs. To date, we have issued reports on advanced quality concepts, earned value management techniques used to assess progress on major acquisition programs, management of a product's transition from development to production, management of the supplier base, technology maturation, training program offices on the application of best practices, testing and evaluation, and setting product requirements (see related GAO products at the end of this report.)

This report covers the use of IPTs in new product development. Our overall objective was to evaluate best practices for creating effective IPTs which can help management of weapon systems. Specifically, we examined (1) whether and how integrated product teams affect decision-making and product outcomes, (2) what factors are key to creating effective integrated product teams, and (3) how the environment in which products are managed affects the prospects for effective integrated product teams.

We follow a similar overall methodology for conducting best practices reviews of DOD's process for developing new weapon systems. We start by identifying an aspect of weapon system development—in this report, the use of integrated product teams—that has been shown to have a significant impact on the outcomes of new product developments. Our sources for such information include the large body of individual weapon system reviews we have conducted over many years; studies from other sources, such as the Defense Science Board; and discussions with defense experts, including past and current DOD officials, defense industry representatives, and analysts from private organizations that study defense issues. Before beginning a review of a particular topic, we confirm with DOD officials that the topic is one in which the potential for improvement is significant. Once we have identified the topic, we use a case study approach because case studies provide the in-depth knowledge needed to understand individual practices. They show how practices affect program outcomes as well as issues surrounding their adoption and implementation. In selecting case studies, we look for examples of (1) excellent practices from leading commercial firms, (2) typical or prevailing practices within DOD organizations, and (3) where possible, DOD organizations that exhibit excellent practices.

To obtain information about teaming practices and identify the best practices in the use of IPTs in the commercial world, we conducted literature searches and contacted university faculty, industry associations, and consultants in the use of product development teams. We selected several companies known for their exceptional use of integrated teams in product development that resulted in better product performance and reduced development cycle time. We visited each company to discuss (1) the way teams contribute to better product development outcomes, (2) the structure and organization of teams, and (3) the organizational support and commitment needed to enable teams to achieve their potential. In addition, we obtained an understanding of the overall teaming process and the practices that the companies believed were critical for successful teams. We selected at least one team from each company for an in-depth review. After our visits, we prepared individual company summaries from which we developed a model that represents best teaming practices. The firms we visited and a description of the teams we selected follows.

- DaimlerChrysler, an automobile manufacturer located in Auburn Hills, Michigan. DaimlerChrysler's Minivan Platform team is responsible for the design, development, and production of new minivans. Team Epic, part of the minivan platform team, designs and develops electric vehicles.
- 3M, a manufacturer of a variety of industrial and consumer products located in St. Paul, Minnesota. 3M's Pluto team is responsible for the development of a new dental material.
- Hewlett-Packard, a high technology electronic products manufacturer located in Palo Alto, California. Hewlett-Packard's Snakes Program is responsible for developing new computer workstations.

Our report summarizes a number of best commercial practices in the use of IPTs. As such, we do not suggest that all commercial firms use best practices or imply that all commercial practices represent the best. Due to the highly competitive nature of the businesses these firms are involved with, we do not always attribute an individual practice to a specific company.

To obtain insights into the dynamics of IPTs used in new weapon system development efforts, we conducted case studies of five DOD weapon systems. At the program offices, we interviewed key managers for an overall perspective of the program. We focused our work on the teams responsible for executing the development of the weapon system and we interviewed members of those teams. We selected at least three different teams at each program office. The programs were Advanced Amphibious Assault Vehicle, CH-60S Fleet Combat Support Helicopter, Extended

Range Guided Munitions, Global Broadcast Service, and Land Warrior. A description of each program follows.

- The Advanced Amphibious Assault Vehicle is an Acquisition Category I[2] Marine Corps program. It is a high-speed amphibious armored personnel carrier that will replace the current family of amphibious assault vehicles. Its purpose is to transport troops from ships to the shore. The vehicle is estimated to weigh about 37 tons and be able to carry 17 combat-equipped Marines plus a crew of 3. It is to travel in excess of 20 knots in the water and travel over land at 45 mph. Its armament includes a 7.62 mm machine gun and a 30 mm cannon. Total budgeted program cost is about $8.7 billion for 1,013 vehicles. It is expected to begin fielding in fiscal year 2006.

- The CH-60S Fleet Combat Support Helicopter is an Acquisition Category I Navy program. The CH-60S helicopter is the replacement for the current CH-46D. It is a combination of the Army's UH-60 Blackhawk and the Navy's SH-60 Seahawk and is designed to provide the Navy with a capability to replenish forces performing search and rescue missions and airborne mine countermeasures missions at sea. Program costs are estimated at $4.3 billion. The program began in 1998 with initial fielding expected in 2002.

- The Extended Range Guided Munition is an Acquisition Category II Navy program. The weapon is a projectile, 5 inches in diameter, that is fired from guns aboard Navy surface ships. The projectile incorporates a rocket motor, an internal global positioning system, and an inertial navigation system. These systems will give the projectile guidance and control to a fixed target location determined prior to firing. The rocket motor will provide greater range capabilities than current projectiles. The program began in 1996 and is expected to begin fielding in 2004.

[2] DOD makes distinctions among categories of weapon systems, primarily according to the level of investment required. Acquisition Category I programs are defined as major defense acquisition programs estimated to cost over $365 million for research, development, test and evaluation, or have procurement costs of more than $2.190 billion (both in fiscal year 2000 constant dollars). Acquisition Category II programs are defined as acquisition programs estimated to cost over $140 million for research, development, test and evaluation, or have procurement costs of more than $660 million (both in fiscal year 2000 constant dollars).

- The Global Broadcast Service is an Acquisition Category I joint-service program. It will augment and interface with other communications systems and provide continuous, high speed, one-way flow of high-volume data, audio, imagery, and video information to forces around the globe. It consists of a satellites, fixed and transportable transmitters, and fixed and transportable receivers. The program began in 1996 and is expected to begin production in late 2002.

- The Land Warrior is an Acquisition Category II Army program. It is an integrated fighting system for dismounted combat soldiers. It consists of five subsystems: computer/radio, software, protective clothing and individual equipment, integrated helmet assembly, and weapons. The Army currently expects to procure 34,000 units for a total cost of about $2.1 billion. The Land Warrior is designed to enhance lethality, command and control, survivability, mobility, and sustain individual soldiers and infantry units. The program began in 1996, and production is expected to begin in fiscal year 2003.

To select DOD programs, we identified programs from each of the services that had experienced problems in meeting cost, schedule, or performance goals and at least one program that was meeting its development objectives. We selected programs in the engineering, manufacturing, and development phase of the acquisition process so that the teaming practices being reviewed would reflect those of a single prime contractor and enough progress would have been made to determine whether the program was meeting its objectives. We also selected weapon programs that entered this phase after the 1995 policy was implemented to ensure that the programs had a reasonable chance to implement the IPT policy. To address potential variances due to program size, we selected programs from different acquisition category levels. The Land Warrior program provided a range of analytical information. The performance problems described in the report occurred in 1999 and earlier, and revealed limitations in the program's teaming arrangements. The report also covers the current program manager's efforts to overcome these limitations through teaming and other actions.

We selected three teams from each program office to review in detail. We used a structured questionnaire to interview approximately 80 IPT leaders, members, and contractors. Individual team leaders and members also completed a survey we had prepared regarding how respondents viewed their teams and their role on the teams. The information collected from the interviews and the survey was compiled into a database to facilitate a comparative analysis. Through the analysis, we determined a team's

composition, product responsibility, and the environment in which the team operates. In addition, we collected information regarding the process used by the teams to make significant decisions. We flowcharted commercial and DOD program office team decisions to identify the number and level of organizations required to make actual decisions, as well as the length of time it took to make the decision.

To better understand the environment under which IPTs operate, we reviewed current DOD policy directives and guidance on using IPTs in weapon system program offices. We met with officials from the Office of the Secretary of Defense and the services responsible for the implementation of IPTs in DOD. We analyzed studies on IPTs conducted by external organizations such as the Center for Naval Analyses and the Institute for Defense Analyses. We reviewed evaluations conducted on implementation of IPTs by the Army, the Navy, and the National Center for Advanced Technologies.

We also drew on knowledge gained from our prior best practices work. In particular, we have developed a good base of knowledge regarding differences in the commercial and DOD environments as they relate to developing new products. We applied this knowledge in our assessment of the environmental factors that affect the implementation of IPTs in both sectors.

We conducted our review from December 1999 through February 2001 in accordance with generally accepted government auditing standards.

Chapter 2: IPTs Help Programs Achieve Better Outcomes

Of the eight programs we reviewed, four exhibited the characteristics considered the hallmark of IPTs—the ability to efficiently make product development decisions that cut across different lines of expertise. Compared with the other four programs, these IPTs had the knowledge and authority to make decisions in less time, with fewer consultations outside the team, and with fewer reviews and approvals. At the time of our review, their products were developed or were being developed within the time frames and budgets originally estimated. In most cases, the IPTs developed products that outperformed previous products that were developed without IPTs. The IPTs were credited with making these results possible; they were thus not only more efficient; they were also more effective.

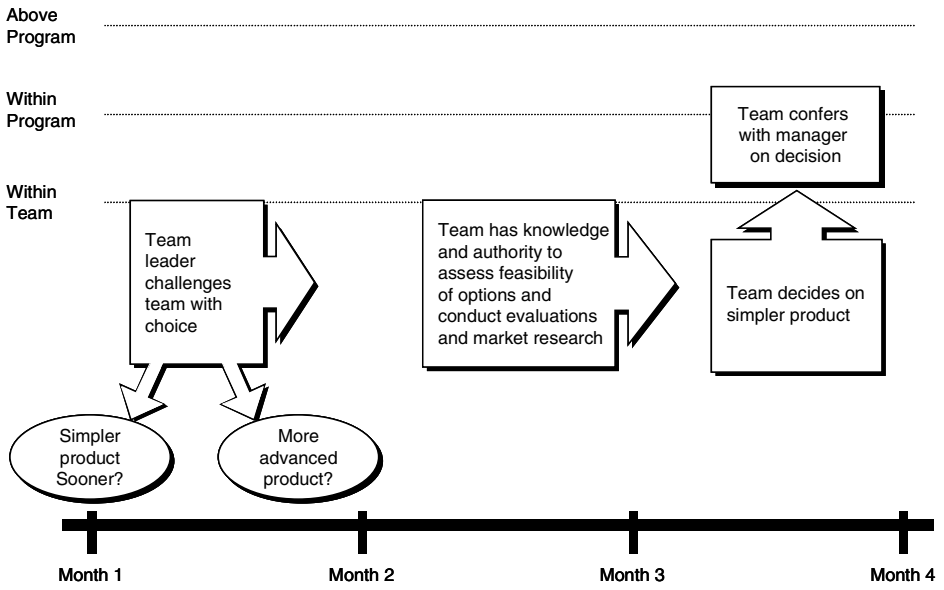
The teams from the remaining four programs relied heavily on consultations with individuals outside of the team to obtain the knowledge and approval to make significant decisions. While no team is expected to operate in isolation, the degree of outside consultations made the decision-making process of these teams much longer and less efficient—much like the process that predated IPTs. The four programs with less effective teams all experienced difficulty in meeting product development objectives—manifested by cost growth, schedule delays, and/or performance problems. While it is difficult to prove a direct cause and effect relationship, in some cases, managers cited the teams' ineffectiveness as directly contributing to the problems; in other cases, the teams were not in a position to solve or prevent problems.

IPTs Can Improve the Decision-Making Process

Officials at the leading commercial firms and DOD's Advanced Amphibious Assault Vehicle program believe that because of the knowledge and authority that resided in their IPTs, the teams required fewer external reviews and approvals. Consequently, the decision-making process was significantly shortened—from months to a week or less. While IPTs do not work in isolation, effective IPTs are self-sufficient, containing the variety of expertise to recognize early when decisions are needed, such as trade-offs between competing demands, and the authority necessary to make these decisions. An example is 3M's Pluto IPT, which was responsible for developing a technology capable of producing a low shrinking dental material. The team needed to make a choice concerning the first product to be marketed based on this new technology. The choice was between producing a simpler material that could be delivered to customers sooner or taking more time to deliver a more technically advanced material. The team assessed the trade-offs and decided in favor of delivering the simpler product sooner and the more technically

advanced material later. Figure 5 depicts the decision-making process used by this IPT.

Figure 5: Decision-Making Process Employed by 3M's Pluto Team



3M's Pluto IPT had the knowledge and authority to make a significant trade-off between product performance and schedule.

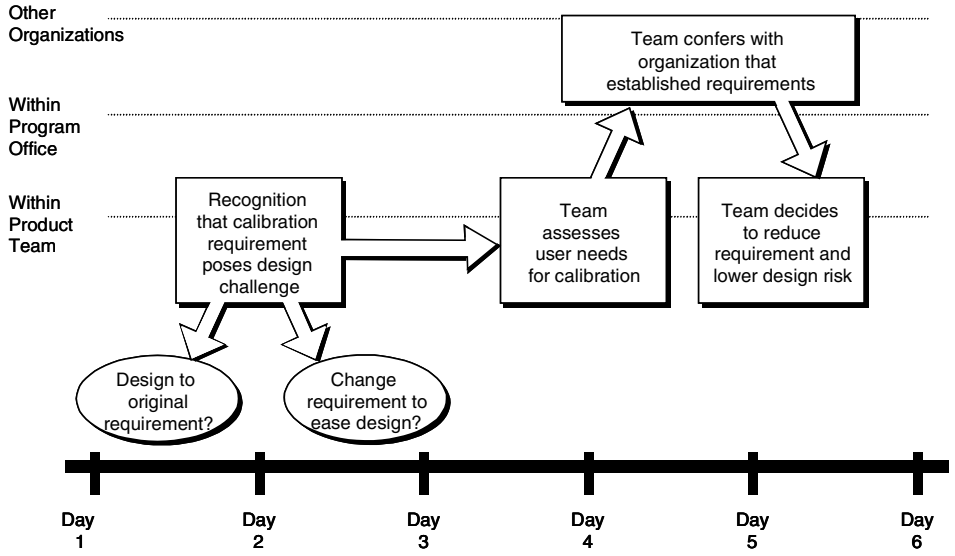
Source: GAO.

Pluto team members represented the key areas of expertise needed for the product and were able to assess the technical feasibility of the two options as well as the cost and schedule trade-offs. The team conducted the necessary evaluations and research to make its decision, which was supported by upper management.

Officials from the Advanced Amphibious Assault Vehicle program cite similar experiences with IPTs. For example, the Firepower IPT developing the 30-mm gun challenged a requirement that the targeting system maintain accurate calibration for several days at a time. The team's design engineers believed the requirement would be costly to achieve. The team's user representative reported that gun operators, as a standard practice, calibrated the targeting system daily before each mission. Therefore, the

requirement for maintaining accuracy could be reduced to 1 day—a trade-off that made for a less sophisticated and less costly design. Such a decision can prevent problems later in the development cycle that additional technical sophistication can cause. Figure 6 depicts the decision-making process used by this IPT.

Figure 6: Decision Process Followed by the Advanced Amphibious Assault Vehicle Firepower IPT



The Firepower IPT made a significant decision to trade performance and reduce cost.

Source: GAO.

The mix of expertise on the Firepower IPT provided the knowledge to identify the problem and reach a decision to make the trade-off between cost and performance. The IPT was able to make the decision in 1 week and only had to consult with one organization outside of the team—the group that set the original performance requirements.

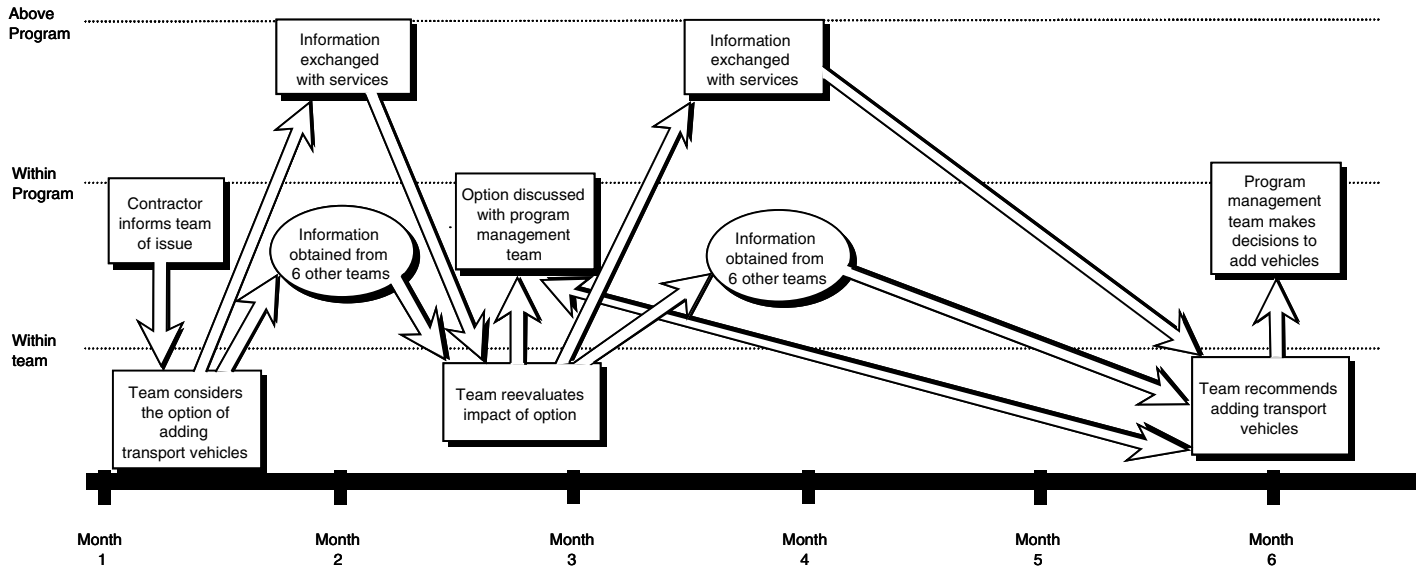
Less Effective Teams Had a More Sequential Decision-Making Process

The teams at the four remaining DOD programs had a less efficient decision-making approach. These teams had to routinely consult with several organizations because the knowledge and authority to make significant decisions did not reside within the team. When these teams were faced with a significant issue that outstripped their knowledge and

authority, decision-making involved a lengthy and inefficient sequential process to obtain information and approval.

In one case, a contractor team working on a weapon system found that a performance requirement could not be met without increasing the weight of the weapon system. The consequence of the increased weight was that more vehicles would be required to transport the system, increasing the logistic burden on the users. The problem was referred to the program office team that was responsible for ensuring that the contractor met performance requirement or the type of vehicles required. The team lacked the authority to change the performance requirement. After 6 months and numerous requests for knowledge and authority, the decision was made to accept the added weight and to increase the number of vehicles. Figure 7 depicts the decision-making process the team used.

Figure 7: Sequential Decision-Making Process for Adding Vehicles to Accommodate More Weapon System Weight



This DOD team, when faced with a significant trade-off issue, required 6 months to reach a decision and had to involve many players from various levels outside of the team.

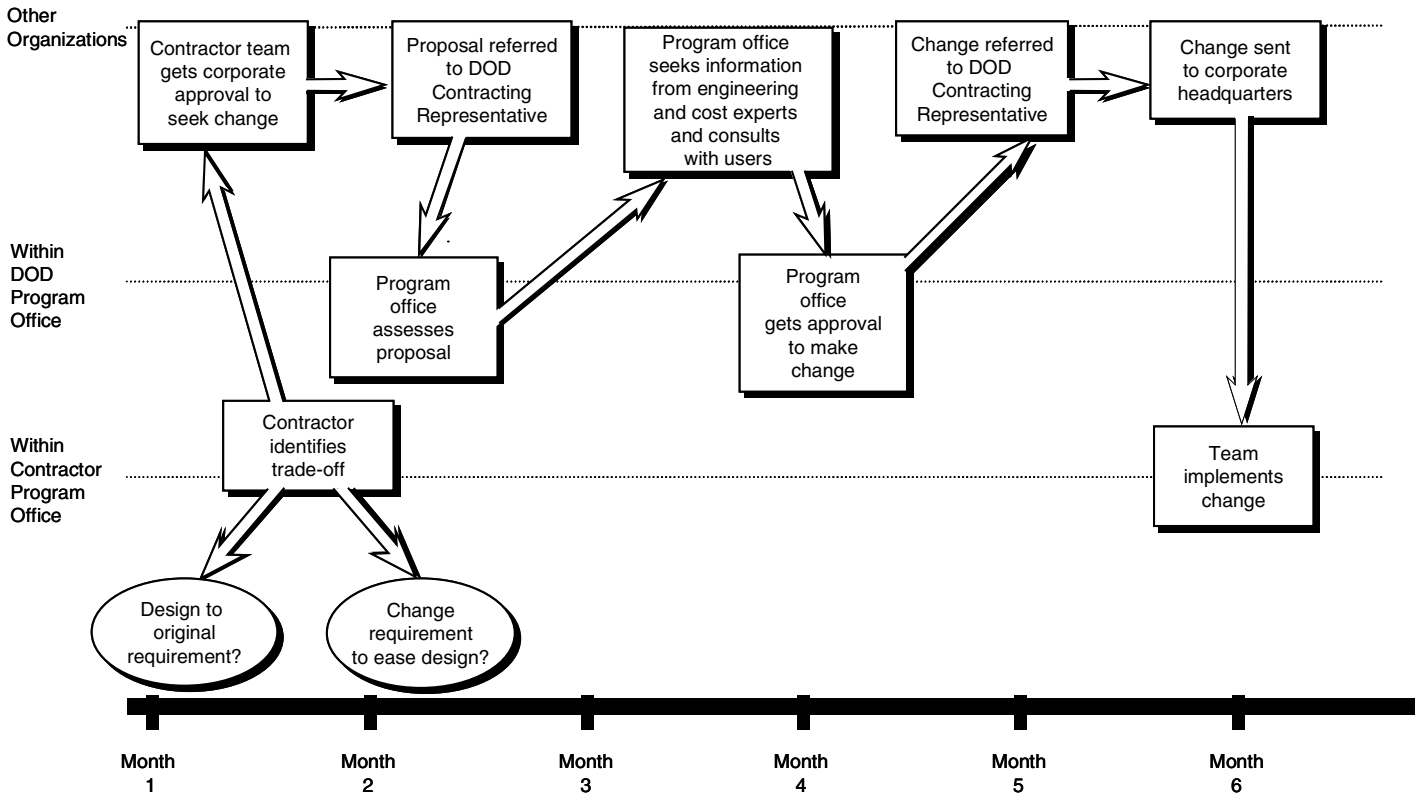
Source: GAO.

The program office team expended a great deal of effort to collect, analyze, and exchange information with six other teams within the program office (such as logistics and testing), the program manager level, the prime contractor, and representatives from all three military services that were to use the weapon system. Moreover, the team had to consult

with these organizations each time new information was obtained—a form of rework. Despite this complicated process, a representative from the prime contractor observed that the decision should have taken less time to make. Furthermore, the representative stated that the contractor was not significantly involved in making the decision and questioned the decision because it increased the complexity of the design and placed additional vehicle and manpower burdens on the system's user.

Officials from the Advanced Amphibious Assault Vehicle program painted a similarly complex picture when they analyzed how the gun calibration decision would have been made without IPTs. They estimated that the decision would have taken 6 months to reach because the required knowledge and authority would have been much more widely dispersed among other teams and organizations. Figure 8 depicts the program office's assessment of how the decision to meet the gun calibration requirement would have been made without an IPT.

Figure 8: How Advanced Amphibious Assault Vehicle Gun Calibration Decision Would Have Been Made Without IPTs



Making the same gun calibration decision on the Advanced Amphibious Assault Vehicle program without an IPT would have required more time to obtain knowledge and authority outside the team, particularly above the program level.

Source: GAO.

This decision would have required sequential consultation with six different functional organizations, the program management office, the user community, and the defense contractor. When facing such a decision path, it is understandable that the team that had the original idea might decide not to propose the change, finding it easier to pursue the technical solution rather than the requirement trade-off. Representatives from the other weapon system programs that experienced problems meeting development objectives described similar processes that required the teams to consult with multiple organizations for information, concurrence, or authorization before a decision could be made.

Improved Product Outcomes Attributed to IPTs

We observed a consistency between the effectiveness of teams and product outcomes on the eight cases we studied: programs that were meeting product development objectives had more effective IPTs than the programs that were having problems. Table 1 depicts the product outcomes for the eight cases.

Table 1: Effective IPTs Also Had Successful Product Development Outcomes

Program	Cost Status	Schedule Status	Performance Status
Effective IPTs			
DaimlerChrysler	Product costs lowered	Decreased development cycle months by 50 percent	Improved vehicle designs
Hewlett-Packard	Decreased cost by over 60 percent	Decreased development schedule by over 60 percent	Improved system integration and product designs
3M	Outperform cost goals	Product delivery estimates shortened by 12 to18 months	In comparison to current products, improved performance by 80 percent
Advanced Amphibious Assault Vehicle	Current product unit cost lower than original product estimate	Ahead of original development schedule	Demonstrated 5 fold increase in speed
Less Effective IPTs			
CH-60S helicopter	[a]	Schedule delayed	Software and structural difficulties
Extended Range Guided Munition	Increases in development costs	Schedule slipped 3 years	Redesigning due to technical difficulties
Global Broadcast Service	Experiencing cost growth	Schedule slipped 1 1/2 years	Software and hardware design shortfalls
Land Warrior[b]	Cost increase of about 50 percent	Schedule delayed 4 years	Overweight equipment, inadequate battery power and design

[a] Program official told us that program costs increased due to a requirement for additional capabilities and an increase in the number of helicopters.

[b] The Land Warrior performance problems cited here primarily reflect the first version of the system, circa 1999. The system has since been redesigned but had not completed testing at the time of our review.

Source: GAO analysis of commercial and DOD data.

In addition to meeting product development objectives, the successful programs were often surpassing the performance of their predecessors in both time to market and performance. These improvements were attributed in large part to the effectiveness of the IPTs. The four programs with less effective teams were experiencing the kinds of problems that, while not unusual for weapon system programs, DOD hoped IPTs could help solve.

Effective IPTs Helped Reduce Product Cost and Cycle Time

Officials at leading commercial firms and the Advanced Amphibious Assault Vehicle program attribute their successful product outcomes directly to their IPTs. Specifically, DaimlerChrysler officials attributed reduced cycle time, improved product performance, and better market success to their switch to IPTs. Hewlett-Packard officials stated that the company's teaming approach resulted in higher product quality, better design results, and improved system integration. A Hewlett-Packard official stated that the Snakes Program team simultaneously developed three computer workstations in 9 months, half the time normally required, with four times the performance of existing workstations. A Hewlett-Packard IPT developing printer equipment increased productivity six-fold, despite using one-quarter fewer employees, and reduced the product defect rate to 2 percent—of which the majority were cosmetic defects. In another example, company officials said that in the past, test equipment was developed at a cost between $25,000 and $70,000 and required up to 4 years to develop—which was well behind the performance of their competitors. Now, their IPT approach enables the company to develop a higher quality product in two-thirds less time and with a price of $10,000 to $25,000.

A 3M official in the dental products division stated that the Pluto IPT created a revolutionary dental material that surpasses similar products on the market. The team leader reported that members developed a material that shrinks 50 percent less than current materials and can withstand 80 percent more stress. In addition, team members filed five patents, of which four have been issued—a valuable benefit to the company. The team leader attributes the IPT's decision-making—including the trade-off between product performance and schedule—with shortening the product development time as much as 18 months. In addition, the team leader believes that the IPT will outperform the competition because 3M's patents make it difficult for other companies to bring a product to market in a similar technology area. Lastly, Advanced Amphibious Assault Vehicle program officials believe their IPT approach was critical to the program's ability to meet or exceed its cost, schedule, and performance objectives since it began in 1995—atypical for large DOD programs.

Programs With Less Effective IPTs Experienced Poor Outcomes

The remaining four DOD cases we reviewed experienced problems, including schedule delays, cost overruns, or a failure to meet performance objectives. For example, the schedule and cost targets were increased for the Extended Range Guided Munition Program because key performance requirements proved too difficult to meet within the original estimates. Also, the Land Warrior program manager restructured the program's

operations, including selecting a new contractor, after the initial version of the equipment proved too heavy and ineffective in testing. Restructuring the program and redesigning, developing, and testing an improved version of the equipment added cost and time to the effort. Finally, the CH-60S and Global Broadcast Service programs also experienced schedule delays when technical problems were revealed as the software or systems were tested; GBS also experienced cost growth.

It is difficult to isolate a cause and effect relationship between less effective teams and program problems. However, in some cases, program officials and team members did link ineffective teams to poor product outcomes. Several team members attributed poor outcomes to one program's IPT structure or the IPT's ineffective decision-making process. Specifically, one team member stated that the inability of the IPT—which was led and primarily staffed by contractor employees—to make a decision on a key technical component resulted in an overall program schedule delay, cost increase, and reduced performance requirements. A team leader from another program observed that the program's structure—which required teams to report to one another—slowed the decision-making process and resulted in difficulties in establishing performance requirements. He added that some of the discrepancies in the requirements could have been avoided. In another case, a team member on a program experiencing cost and schedule increases identified a potential technical issue and proposed a change in the weapon's design. The contractor, who had final authority, refused the change and moved forward with the original design. This design was ultimately deemed unacceptable by the user.

Chapter 3: Authority and Knowledge Are Key to IPT Effectiveness

Effective IPTs possess the knowledge and authority essential to the kind of decision-making that is their hallmark. Knowledge is sufficient when the team has the right mix of expertise to master the different facets of product development. Authority is present when the team is responsible for making both day-to-day decisions and delivering the product. These two elements are essential to determining whether a team is in fact an IPT. Other factors significantly enhance an IPT's effectiveness. For the programs we studied, effective IPTs had key members physically collocated where possible to facilitate the communication, interaction, and overall operations. When physical collocation was not possible, resources were provided to connect members through virtual means, such as shared software. Effective IPTs were also given control over selecting members, and changes in membership were driven by the team's need for different knowledge or skills.

In the programs experiencing product development problems, the teams either did not have responsibility for product development or were missing key areas of expertise. Although called IPTs, in reality, they were not. If a team is missing either the knowledge or the authority to recognize and make difficult decisions, it is ill-equipped to carry out the role expected from an IPT. Some of these programs had separate DOD and defense contractor teams, which further dispersed knowledge and authority. Moreover, DOD did not routinely collocate team members. Less effective teams also did not have control over their composition. Team membership fluctuated often but did not appear to be directly tied to the needs of the project; members left and joined the team due to personnel rotation policies or other reasons.

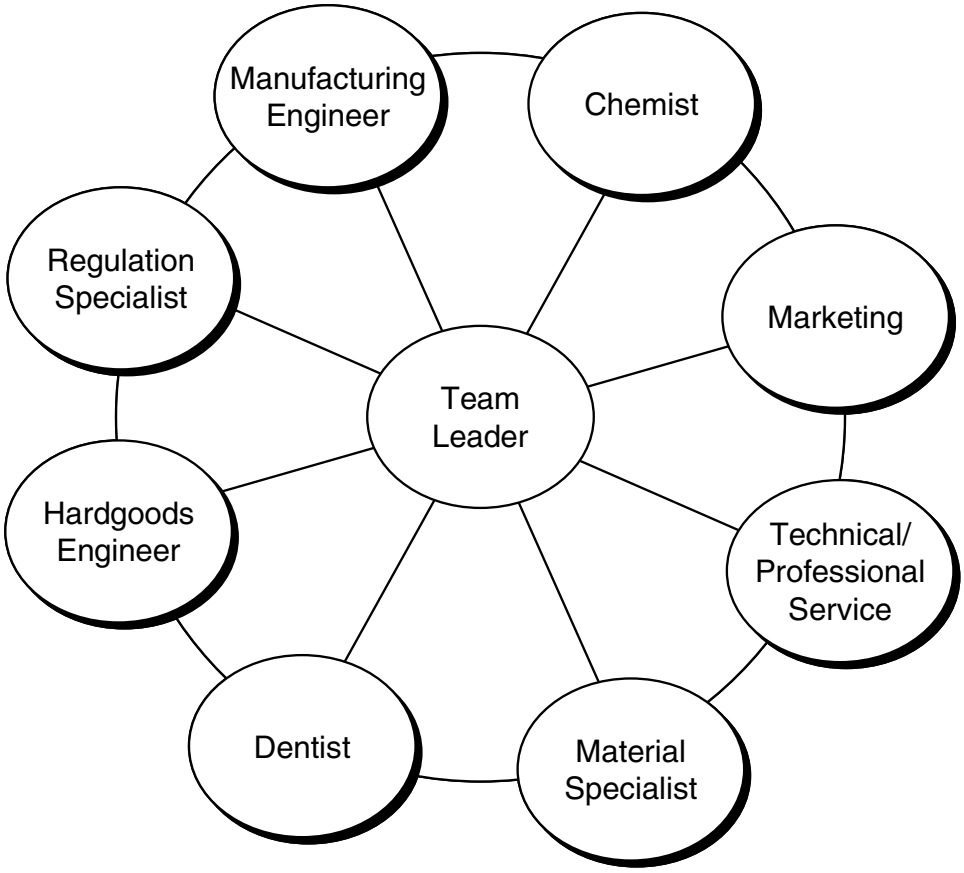
The Best IPTs Had the Knowledge, Authority, and Other Elements to Be Effective

Research shows that product development responsibility and cross-functional membership are fundamental IPT elements. If a team lacks expertise, it will miss opportunities to recognize potential problems early; without authority, it can do little about them. IPTs in leading commercial firms and the Advanced Amphibious Assault Vehicle program had the right cross section of functional disciplines to develop new products. Their IPTs were responsible for developing and delivering the product and making day-to-day decisions on cost, design, performance, quality, test, and manufacturing issues. The combination of product responsibility and expertise equipped the IPTs with the information needed to tackle crucial issues—like trade-offs—without having to rely heavily on organizations outside the IPT. Once so-equipped, the collocation of team members and control over the selection of members made the IPTs even better.

Product Responsibility and Cross-functional Membership Are Essential IPT Elements

Along with being responsible for developing a complex new dental material, 3M's Pluto IPT had the authority to conduct research, select material attributes based on customer needs, determine the delivery schedule, estimate the cost of the material, and perform and evaluate the scientific experiments to create the material. To meet these expectations, the team possessed all key areas of expertise. Figure 9 illustrates the variety and types of expertise found on the IPT.

Figure 9: Organization of 3M's Pluto IPT



3M's Pluto IPT has representation from all of the functional disciplines needed to design, develop, and produce the new dental material.

Source: GAO analysis based on discussions with 3M.

Hewlett-Packard's Snakes IPT consisted of representatives from research and development, marketing, quality, leadership, finance, and

manufacturing. Collectively, the IPT is responsible for designing, developing, and building new computer workstations. Company officials noted that the breadth of knowledge on the IPT not only speeds the pace of development but the amount of innovation as well. They also stated that IPTs may also include customers and suppliers.

Similarly, Daimler Chrysler's Minivan platform team comprise design engineers and representatives from planning, finance, marketing, procurement, and manufacturing. They are vested with full authority to design, develop, and produce new vehicle lines. Given the complexity of developing a vehicle, smaller IPTs concentrate on developing component parts, such as the door. Even the door IPT includes specialists for sheet metal, glass, hardware, wiring, electrical switches, customer liaison, and manufacturing. This IPT addresses day-to-day issues on designing door features, determining performance characteristics, and constructing the door. Equally important, the IPT is responsible for ensuring the entire door is ready when production of the vehicle starts. If it is not, the IPT could delay the entire delivery schedule.

Similarly, the Firepower IPT on the Advanced Amphibious Assault Vehicle program has responsibility for designing, developing, prototyping, and testing the gun system, including the barrel, ammunition feeder, and the gunner's station. The IPT has members from engineering, testing, logistics, cost estimating, manufacturing, and modeling and simulation. Importantly, these members are drawn from the Marine Corps acquisition workforce, weapon system operators, and the defense contractor and subcontractors responsible for building the system.

Collocated Members Provide Benefits to IPTs

All of the IPTs that were producing good outcomes had their core team members physically working in the same location. Based on actual results, officials from the three commercial firms and the Advanced Amphibious Assault Vehicle office shared the view that collocation provided many benefits and cited it as a key factor to positioning an IPT for success. For example, collocated IPT members can raise issues earlier, perform tasks faster, and reach decisions quicker than core members who are geographically dispersed.

Figure 10: Hewlett-Packard Printer

Hewlett-Packard uses special software, the internet, and communication devices to virtually collocate remote IPT members that develop new products such as the printer shown here.

Source: Hewlett-Packard.

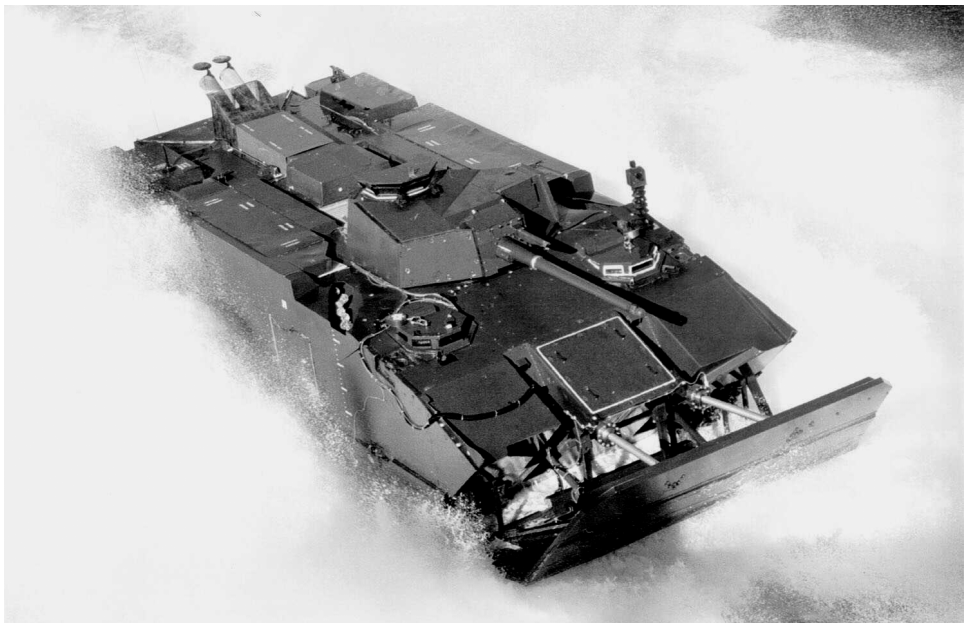
When collocated, team members can have frequent ad hoc meetings to share information and identify issues that could require tradeoffs. Face-to-face informal communication greatly adds to information flow, better

cohesion, and a full understanding of other members' roles—all of which help foster team unity and performance. Company representatives told us that the regular informal interaction reduces the need for formal team meetings—such meetings account for a small percent of an IPT member's time. Lastly, company officials told us that collocated teams are able to build trust, which can improve their functioning.

Company leaders observed negative team dynamics when members were geographically dispersed. Without constant face-to-face interaction, team members were inclined to have separate discussions and make decisions regarding product development without involving one another. On occasion, this resulted in a disconnect and took the members in opposing directions. Representatives from one company observed that when members are at remote locations, it is difficult to have team cohesion, and the individuals must work harder to achieve the same level of efficiency as the collocated representatives. Several officials stated that remote IPT members can be excluded from spontaneous informal communications or interactions. As a case in point, the leader of one IPT is very concerned that a contemplated move of some members 1 mile from the core team could damage the team's effectiveness.

The three commercial firms and the Advanced Amphibious Assault Vehicle program went to great lengths to collocate IPT members. When Daimler Chrysler relocated its operations, the firm constructed a facility to house all platform team members in one location, including 800 to 900 permanent engineers, 300 to 500 contract engineers; representatives from planning, finance, procurement, manufacturing; and some key suppliers. Officials at 3M report that they also constructed a facility to collocate their IPT members.

Figure 11: The Marine Corps Advanced Amphibious Assault Vehicle



Collocation has facilitated communications between DOD and contractor personnel during the development of the Advanced Amphibious Assault Vehicle shown here.

Source: DOD.

The Advanced Amphibious Assault Vehicle program office and the defense contractor for the vehicle are collocated—which is atypical for most DOD programs. The original program manager believed that IPTs are the right way to manage the program and that collocation was essential to effective IPTs. As a result, he required the contractor to lease a facility—at DOD's cost—to house the its research and development operation on one floor and the DOD program office staff on another floor. A Marine Corps IPT member explained that a contractor, when not collocated, may work in isolation and periodically brief DOD. Much of the work done to that point might need to be redone if issues arose. He added that working side by side with the contractor has eliminated the need for formal meetings or briefings because DOD and contractor members are equally informed regarding the program's status and progress.

Given that the commercial firms we reviewed have worldwide facilities, physical collocation of every team member, particularly key suppliers, is not always feasible. When team members can not be physically collocated,

leading firms connect remote members through virtual means. The best of these are shared software and databases that enable team members in one location to see the results of work done in another location. For example, if the product designs are stored in a computer database, when one team member makes a change, the other members can see it in near real-time. Other companies use advanced equipment to improve their video conferencing capabilities or enable online team meetings through the Internet. Still, officials at 3M and Daimler Chrysler believe that virtual collocation does not replicate the benefits of face-to-face interactions. As a result, companies temporarily collocate remote members during key phases of product development to enable them to work side by side with their team.

Control Over Membership Can Enhance IPTs

IPTs at leading commercial firms are given control over selecting members. The firms believe that it is very important a team have the right expertise on the team. As a result, team leaders are hand-selected by upper management based on reputation, knowledge, and/or expertise. In turn, team leaders select team members they believe have the expertise and the interpersonal skills that would match the team's needs.

At 3M, when a new team is formed, an announcement is sent to employees notifying them of team's purpose, time frame, and skills needed. Employees are allowed to volunteer for teams. Team leaders select team members from the pool of volunteers. According to company officials, the self-nomination process allows staff to demonstrate commitment and alignment with the team goals and ensures that the team members share a common purpose.

Membership on commercial IPTs can change for different reasons, such as attrition or promotion. However, we found that the predominant reason to change members was to meet the changing needs of the team. At one company, as the product moved through the development phases, the mix of expertise was sometimes changed as the team's need for knowledge and skills changed. For example, conceptual staffs, such as design engineers, are needed in the initial stages but may be replaced with test engineers as the product proceeds.

Most DOD Teams Did Not Possess the Key Ingredients of IPTs

The four DOD programs that were experiencing problems had teams that lacked the key elements— product responsibility and cross-functional representation—found in the successful cases. In our view, these teams were IPTs in name only. Most of these teams did not have responsibility for decisions on product development issues or delivering the product. Teams that could claim product responsibility did not have sufficient cross-functional representation. Regardless of whether product responsibility or expertise was lacking teams were incapable of identifying problems and resolving them expeditiously through a collaborative decision-making process. Moreover, the teams did not exhibit other characteristics—collocation and control over membership—that contribute to effectiveness. Neither characteristic appears to be required or encouraged by DOD policy and team leaders and members perceived difficulties in adopting these characteristics within DOD.

DOD Teams Lacked the Knowledge and Authority Necessary for IPTs

Seven of the 12 teams we studied were not responsible for the delivery of a weapon system or a component, nor were they responsible for day-to-day decisions on product development issues. Instead, the teams were responsible for monitoring or managing a part of the development process. For example, several teams exclusively managed the test process—under DOD guidance—including reviewing the contractor's test procedures, scheduling the system for developmental and operational tests, and ensuring that the test certification requirements were met. Other teams were responsible for monitoring the contractor to ensure performance requirements were met, addressing logistics issues when the system was fielded, tracking system costs, or handling contract management issues. Still other teams primarily focused on planning, coordinating, or developing acquisition strategies and program schedules—and bore no direct responsibility for delivering the weapon system or one of its components.

The remaining five teams that believed they had product responsibility for the most part excluded representatives from critical product development functions such as design or manufacturing. Instead of being integrated into the team, members from the missing functions were consulted by the team as issues arose, which made decisions take longer. For example, one team co-leader stated that his team's responsibility was limited to technical issues; people from other key disciplines, such as cost, were not team members. When a cost issue occurs, the leader needs to contact cost experts for their input. Another team leader from the same program stated that his team is primarily comprised of mechanical engineers with responsibility for many issues, including design, requirements,

manufacturing, schedule, and production. However, representatives from cost, test, quality, or logistics were not team members. Those represented are invited to participate in team activities when an issue arises. We were told that a team for one program had all of the key functional disciplines, including members from the cost and testing functions. However, after meeting with those individuals, it was clear that they were not real members; they were either unaware of the team's existence or had not attended a meeting for a long period of time.

Knowledge and authority were further dispersed on the 12 DOD teams because their programs operated with two sets of teams—one belonging to DOD and the other belonging to the contractor. The DOD teams interacted with the defense contractor staff to solve problems or to provide periodic updates but did not routinely include representation from the contractors. When DOD program officials did participate on contractor IPTs, they typically served as the customer representative, not fully participating team members. Program office and contractor teams met separately and addressed issues independently, and involvement was limited to sequential reviews.

When limited by lack of product responsibility or lack of requisite expertise, a team must go to other teams and organizations to get the knowledge and authority needed to make decisions. The result is a sequential decision-making process, with numerous rework loops. Program managers and team leaders put in extra effort to overcome these limitations. One program manager created temporary teams on an ad hoc basis to address specific product issues, such as difficulties in meeting a weight requirement. Team leaders in other programs informed us that they frequently invite individuals from other disciplines to participate in their team meetings on an as-needed basis to obtain a broader perspective. The Land Warrior program manager went so far as to create a "shadow" IPT organization to manage the program on a day-to-day basis, while leaving the formal, functionally organized teams in place. He noted that the formal structure had been set up and members assigned before he became the program manager. Finding this structure difficult to manage effectively, he created the shadow organization and staffed it with team members of his choice.

DOD Teams Typically Did Not Collocate

Most of the DOD teams on the less successful programs were not fully collocated, and none of the teams were collocated with their contractor counterparts. Many of the team members found that this made it difficult to communicate on a real time basis and they had to work harder to

operate well. One leader stated that he is not always aware of what other teams are doing that may affect his team. A contractor official observed that the DOD team that she interfaced with could have taken less time if they were collocated and able to work the issue side by side.

DOD guidance does not address collocation, despite its advantages, as a means to enhance IPT effectiveness. DOD officials cite the cost and logistical difficulties with relocating geographically dispersed programs and defense contractors as the primary reason for not collocating core team members. For example, one program manager noted that his program involves a variety of DOD agencies, commands, and all three services located throughout the United States and several foreign countries, including Italy and Korea. The program manager thought it impractical to collocate all of the organizations. Appropriately, DOD still supports developing the capabilities for shared databases and other technical means to replicate collocation. Marine Corps and contractor officials from the amphibious vehicle program had the same initial misgivings about collocation. Today, they told us they cannot imagine running a program any other way. Officials from leading commercial firms stated that they also confronted cost and logistical issues but believed that the investment to collocate was warranted relative to the investment made in a new product development.

DOD Teams Do Not Control Membership

Most team leaders had little say in the composition of their teams. Team members also had little input into the teams they were assigned to as the functional organizations made the assignments. If defense contractor representatives are included on the team, they are typically chosen by their organizations without DOD's involvement.

Although some team leaders stated that they would like the opportunity to select the members, DOD does not routinely empower teams to do so. In fact, the DOD Integrated Product and Process Development Handbook states that the "selection of team members for IPTs often lies outside the direct control of the IPT leader." According to DOD guidance, IPT members should be drawn from a functional discipline—organizations such as engineering and financial management that operate independently of weapon system programs. Generally, the functional leaders assign team members to IPTs, and while some negotiation can occur, program and IPT leaders have little say over choosing members.

DOD teams also did not have control over the membership changes. In general, we found that membership fluctuated frequently, and the majority

of the team members were not original members. For example, at one program office, 71 percent of the team members were not original members. One team member told us that his team has had four different team leaders since he became a member 2 years ago. Another team member had four different program managers within 4 years. Unlike commercial firms, where changes in membership were driven by changes in the team's needs, the reasons for turnover in DOD teams were seldom driven by the needs of the team. For example, some military personnel stated that they join and leave teams frequently because military policy is to rotate people every 3 years, but they can rotate as often as 18 months. Unsurprisingly, the majority of military personnel stated that it was not likely that they would be involved on the IPT through the program's life cycle—which can last 15 years.

Regardless of the reason, team members and leaders observed that frequent turnover results in a loss of corporate knowledge and sets the team back. For example, one member stated that when new members join the team, there is an inclination to revisit issues and past decisions, which can slow the team's progress. Another team member noted that when the IPT is initially launched, goals and mission statements are established. When original members rotate, the IPT can lose sight of the objectives and lose some of the advances gained in the early stages.

Chapter 4: Differences in DOD and Commercial Teaming Approach Reflect Different Environments

Differences in the environment in which teams operate can have a significant effect on successfully implementing the IPT approach. We found that leading commercial firms provided a more supportive foundation for IPTs. Company leaders committed to the IPT approach and backed up that commitment through actions designed to ensure that implementation was not left to chance. In short, they created a different, more conducive environment for IPTs. While DOD endorses the IPT approach and has issued policies and other guidance, it has not taken steps to ensure that IPTs are implemented at the program execution level. In essence, the IPT approach has been left to germinate in an unchanged environment that is not necessarily conducive to IPTs. Successful implementation is thus more dependent on the ingenuity of individuals working on programs.

Differences in how commercial firms and DOD managers measure success and in the pressures they face in starting programs significantly affects the environment for integrated product teams. Commercial products' success is measured in terms of the customer's acceptance of the final product and cycle times short enough to beat the competition. These conditions create incentives for gaining knowledge early, forming realistic goals and estimates, and holding teams accountable for delivering the product—all of which favor an IPT approach. In DOD, the pressures to successfully launch new programs and protect their funding, coupled with long cycle times, create incentives to be overly optimistic in setting program goals and to focus on process—versus product—concerns. DOD's necessary reliance on defense contractors introduces another complication for IPTs because two major organizations (DOD and defense contractors) are responsible for the product, and they do not necessarily share the same incentives. Notably, the amphibious vehicle program has overcome these obstacles and made IPTs work in the DOD environment.

Commercial Firms Provided a Different, Supportive Environment for IPTs

DaimlerChrysler, 3M, and Hewlett-Packard all provided an environment that supported the IPT approach to product development. Corporate leaders not only embraced the IPT approach, but demonstrated their commitment by reorganizing to better align their structure with IPTs and making targeted investments in physical assets, training, and other forms of help. The firms delegated considerable power to IPTs, such as in setting product development goals, but held the teams accountable for delivering on those goals. In addition, the pressures of successfully competing in the marketplace—that foster realism, short cycle times, and satisfying the customer—play well to the strengths of the IPT approach.

Leading Commercial Firms Demonstrate Commitment Through Action

Although DaimlerChrysler and 3M did not plan to restructure their organizations when they decided to implement IPTs, they found that their former organizations were at odds with the IPT approach. For example, in the 1980s, DaimlerChrysler (then Chrysler) had separate organizations for key functions, such as engineering, finance, and manufacturing. Moreover, engineers were organized around the types of components—such as climate control—rather than product types. This organization made it difficult even for all of the engineers working on a particular vehicle to talk with one another, let alone interact with functions other than engineering, such as finance. DaimlerChrysler realized that IPTs could not simply be patched across such organizations. This realization was followed by a corporate reorganization along platform lines—classes of vehicles—to reinforce the emphasis on products, rather than functions or components.

Figure 12: DaimlerChrysler's Town and Country Minivan

DaimlerChrysler reorganized around platform teams to better support its IPT approach.

Source: DaimlerChrysler.

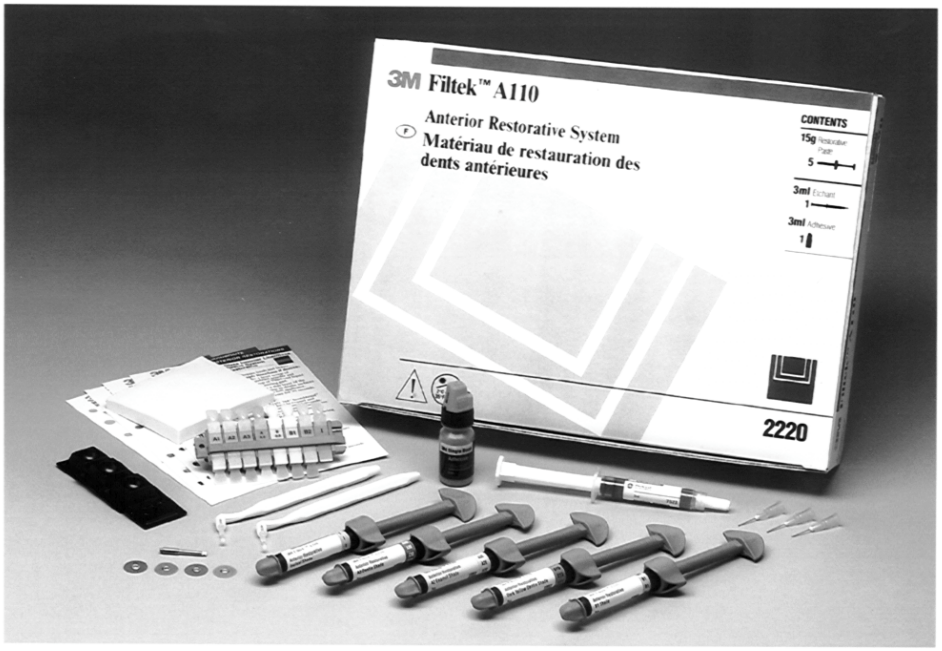
The companies took other steps to reinforce their commitment to IPTs. For example, DaimlerChrysler officials noted that some employees were resistant to the IPT approach. To encourage employee acceptance and ensure organizational and product goals were achieved, a two-pronged

performance appraisal process was instituted that solicited input from both an IPT member's immediate supervisor and other members and organizations the member interfaced with. We found that at 3M and Hewlett-Packard, the IPT leader either prepared the members' performance evaluations or provided significant input to it. Officials noted that capturing an individual's performance on an IPT was a driving factor in garnering acceptance of the IPT approach.

In addition to the physical infrastructure investments made to collocate and integrate the workplace, the companies invested other resources to ensure that IPTs were successfully implemented at the product development level. In an earlier report on best training practices, we noted that leading firms focus on a few, key initiatives at any one time[1] and deliver targeted, hands-on training to ensure that implementation is successful at the product development level. DaimlerChrysler, 3M, and Hewlett-Packard took the same approach. These companies offered extensive front-end planning assistance. For example, Hewlett-Packard helps new teams plan and define their priorities and track their progress. A company official believed this help could reduce a project's time by 10 to 20 percent. At 3M, the company provided team sponsors, who were top managers that established the IPT and assisted the team with leadership and high-level decision-making. In some cases, the companies provided facilitators that assisted IPTs with hands-on guidance to enhance their daily performance.

[1] *Best Practices: DOD Training Can Do More to Help Weapon System Programs Implement Best Practices* (GAO/NSIAD-99-206; Aug. 16, 1999).

Figure 13: 3M Dental Products



3M top managers served as team sponsors

Source: 3M

Companies Give IPTs Control Over the Product but Hold Them Accountable

According to officials from the leading commercial firms, achievable, clear, and shared goals are vital to an IPT's success. The goals include the timing of bringing a product to market, its features, and a cost that will appeal to customers yet yield an acceptable profit. The three companies routinely involve their IPTs early in the product development process, giving them the opportunity and authority to affect a product's goals. While subject to some constraints, IPT leaders and members were given the flexibility to make trade-offs between competing objectives. The role 3M's Pluto team played in trading off product sophistication for an earlier delivery date is a prime example of a team being given both the opportunity to be involved in goal-setting and the authority to affect the goals.

There is a consequence for IPTs having such influence over product goals—the product's success is readily measurable, and the teams are held accountable for its success. If the product is delivered late, does not perform as expected, or costs more than it could sell for profitably, the

IPT is responsible. If a product fails because it does not meet one or more of its goals, the team is held accountable for that failure. This consequence helps the team to be aggressive but realistic in setting goals and motivates the team toward achievement of goals as it develops the product.

Incentives in Commercial Environment Are Conducive to IPTs

Based on our current and previous work on best practices,[2] the demands leading commercial firms make of new product developments create a set of incentives that mesh well with the IPT approach. These firms insist on a solid business case for starting a new product, which centers on designing and manufacturing a product that will sell well enough to make an acceptable profit. Barring an unforeseen change in the market, if the firm delivers the right product on time and for the right price, the customer will buy and the product succeeds. To ensure success, leading commercial firms insist on having high levels of knowledge about the technological, design, and production content of the product. In particular, before a new product development is launched, leading firms ensure that technology development is complete and that immature technology is not allowed onto a product. To meet market demands and stay competitive, the firms consciously limit cycle time—the length of time it takes to develop a new product. The leading commercial firms we have visited had cycle times that ranged from 18 months to just over 4 years.

With product success clearly defined in terms of customer acceptance and cycle times kept short, accountability is readily established in terms of delivering a quality product on time. This reality helps keep an IPT focused on the product itself, can minimize membership changes, and fosters trade-offs. Candor in recognizing risks early and realism in making estimates are fostered because doing otherwise, such as overselling product performance or delivery dates, can set the team up for disappointing the customer and failing. Similarly, the leading firms' insistence on demonstrated knowledge about technology maturity and other aspects of the product reinforces realism because knowledge is more directly linked to product success than promises or projections. The IPT, with its full cross section of expertise, is ideally suited to having the key aspects of product knowledge on hand to provide realism, minimize surprises, and quickly respond to potential problems.

[2] See related GAO products.

DOD Environment Not As Conducive to IPTs

In the programs we reviewed, DOD's environment was not conducive to IPTs. DOD has not backed up its commitment to the IPT approach with investments and other actions to ensure success at the program execution level. Teams typically were not involved in the goal-setting process and could not really be held accountable for goals that were unrealistic. Moreover, the pressures on launching and funding new programs created incentives that posed obstacles for IPTs. Shared responsibility between program offices and contractors further complicated the environment for IPTs.

DOD-Level Support for IPTs Does Not Extend Much Beyond Policy

After DOD formally adopted the IPT approach in 1995, it mandated the use of the IPTs on all weapon programs to the extent possible and made a significant amount of IPT information, instructions, directives, and manuals available. However, some of the information is too vague and is not practical for implementation at the program execution level. Moreover, the policy is not coupled with top-level action—instead, implementation falls on the shoulders of the program offices. For example, the 1995 policy memorandum directing program offices to implement IPTs does not include the factors essential for an effective IPT. Other IPT policies designate as IPTs teams that have a legitimate purpose but cannot practically operate as effective IPTs. For example, the Overarching and Working-Level IPTs are oversight in nature and cannot be expected to execute the day-to-day responsibilities of an IPT. Also, the policies specify that some IPTs be comprised of a single functional discipline or profession, such as test and evaluation and cost, that by definition do not possess the mix of expertise to make the cross-functional decisions expected of an IPT. It is not that these teams should not exist, but that assigning the designation of "IPT" to teams for which it should not apply dilutes the designation. It contributes to the view that IPTs are nothing new. On that point, over half of the team members we interviewed stated that DOD's adoption of IPTs resulted in little change at the program execution level; most saw IPTs as simply a new name for an old approach.

No DOD organization ensures or monitors implementation of IPTs, leaving implementation dependent on the circumstances of the individual program and the capability of the government and contractor managers. According to a representative from the DOD organization that writes IPT guidance, the organization's role is not to ensure or monitor the program offices' implementation of the guidance. An IPT point of contact for one of the services informed us that his office makes IPT information available but that implementation is left up to the programs. While a reasonable amount of latitude for IPTs is good, DOD has not provided top-level attention, as

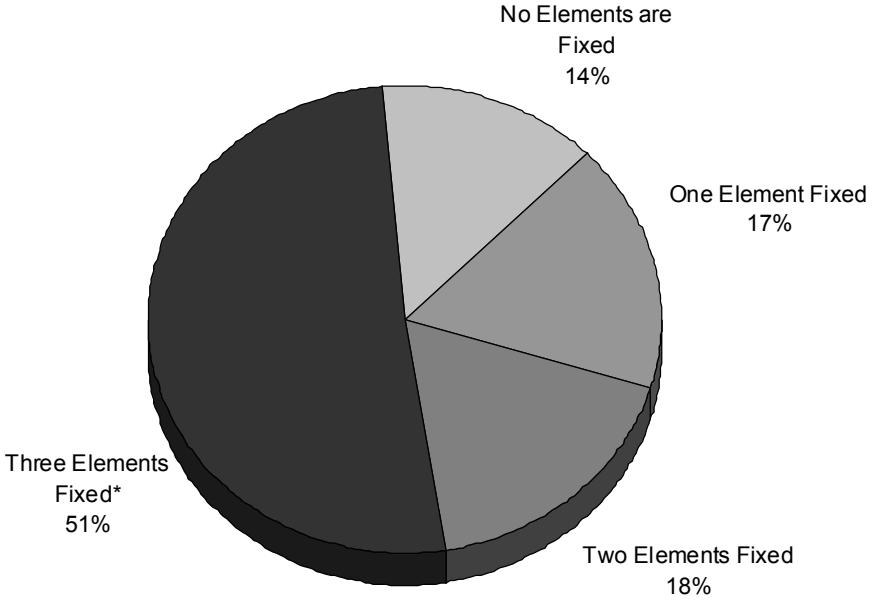
leading commercial firms have, to ensure that the guidance is followed at the program execution level. At the program or program execution level, resources provided to IPTs varied and were not part of a systematic approach to ensure IPT effectiveness. For example, 71 percent of the team members we interviewed said that if program offices provided support, it was usually in response to a team request.

While commercial firms went through an organizational transformation to support IPTs, in many respects DOD maintained the status quo after it adopted the IPT policy. Organizations set up years ago around functional disciplines, such as engineering and financial management, continue to write guidelines for their functions, and to hire, train, and manage the career progression of the acquisition workforce. Thus, they still wield considerable control over members of program teams. When a program office is set up to develop and produce a new weapon system, the staff is drawn from these organizations but maintains their professional ties to them. Program offices and their IPTs are in essence superimposed over the standing functional organizations. Performance appraisals for staff working on the weapons we reviewed are still largely controlled by the functional organizations, not the program teams. Nearly 80 percent of the team members we interviewed said that they continue to be evaluated by superiors in their parent functional organization, not the IPT leader. Furthermore, most team members were not aware whether their performance appraisers received input from the IPT supervisors.

Teams Did Not Have Control Over Goals

In the programs experiencing developmental problems, DOD did not systematically involve IPTs in setting product development goals. Often, these goals were not realistic and resulted from overselling a new program in its early stages. This made it unlikely for any team, regardless of capability, to meet the goals and difficult to hold team members accountable for results. According to most IPT members we interviewed, key product goals, such as system cost, delivery schedule, and performance requirements were often fixed and outside of the team's control. Their responses are captured in figure 14.

Figure 14: Percentage of DOD IPT Members That Perceived Key Product Elements As Outside the Team's Control



Over half of the team members believe the key product elements—cost, schedule, requirements are outside of the team's control.

Source: GAO analysis.

In some cases, the key product goals were established during the initial concept stage—years before IPTs were set up. We have previously reported that such goals are often set optimistically, reducing the probability that they can be achieved despite best efforts. One program manager told us that overselling at the concept stage locked the program and its IPTs into unachievable goals. Of the IPT members interviewed, 45 percent stated that the fixed elements hampered their decision-making ability. For example, an IPT leader told us that during the concept stage, a requirement was set that the program would use commercial off-the-shelf technology. When a key piece of commercial software unexpectedly became unavailable and there were uncertainties regarding the reliability of other commercial products, the IPT could not change the requirement.

It was the team leader's opinion that the requirement led to problems that contributed to significant delays in the delivery schedule.

DOD teams were not routinely held accountable for product outcomes. Two program managers informed us that instead their teams were held accountable for how well they managed aspects of the acquisition process, such as test and evaluation. A program manager with cost and schedule overruns was hesitant to hold the teams accountable because the original goals were never achievable. Similarly, a team leader unable to maintain the program schedule stated that his team was not a failure because the schedule goal was unrealistic and out of the team's control. Another team member noted that IPTs can influence key program elements but that the teams are not penalized when their actions lead to cost and schedule overruns.

Incentives in DOD Environment Create Obstacles for IPTs

DOD's incentives for managing weapon systems do not put IPTs in as good a position to succeed as their commercial counterparts. Programs are started with a legitimate desire for an improved combat capability. However, the intense competition for funds needed to launch a new weapon system program encourages the conceptualization of a new weapon that offers significantly greater—even unique—performance relative to its predecessor. As a result, new programs are often started with immature technologies, that deny managers and teams the high levels of product knowledge that are important to realism. Moreover, new programs must fit into forecasts of available funding; as a result, incentives are strong to make optimistic estimates of cost and cycle time. Because actual cycle times can be very long, lasting 10 to 15 years, the more tangible goals for teams become securing the next increment of funding and getting approval for moving into the next stage of development—process, versus product, goals. Weapon system programs are developed in a more critical environment in which evidence of problems, such as an unreachable performance goal, can invite criticism and a potential loss of funding and other support. Thus, the candor needed to identify and resolve trade-offs, for which IPTs are ideally suited, is implicitly discouraged.

Accountability for meeting weapon system goals is difficult to establish. Unlike the commercial environment, in DOD the customer is very involved throughout the development cycle and becomes increasingly vested in a particular weapon. The DOD customer is thus not likely to walk away from a weapon even if it took longer, cost more, and performed less than anticipated. Long cycle times, coupled with DOD's policy for rotating

military personnel, also impair accountability. Military personnel, including most program managers, stay with a program for a limited amount of time and then are rotated to new assignments. A DOD analysis shows that a program with an 11-year development cycle will have, on the average, four program managers. Most of the military personnel we interviewed did not expect to participate on a team throughout the program's development. Other team members believed that, as a result, military personnel may have less accountability or commitment to the team.

DOD's employment of defense contractors to design and build its weapon systems is an additional complication for IPTs that commercial firms do not face. With the exception of two programs, the DOD and contractor personnel worked on separate teams, usually in different geographic areas. Team leaders and members informed us that a lack of trust between the DOD program office and the contractor might inhibit effective teaming. Team members also perceive that the DOD program office teams and the contractor might have conflicting incentives or competing interests. For example, a team leader noted that contractors are paid to participate in IPT activities. As a result, the leader believed the contractor had an incentive to generate meaningless IPT documents to receive credit for the activities. According to a member of another team, the contractor was not interested in a proposal made by the DOD team that could reduce the program schedule because it would have reduced the contractor's payment. On the other hand, a contractor representative cited the contractor's inability to convince DOD team members that increasing the test schedule would unnecessarily extend the program schedule.

In other cases, DOD team members believed the contractors resisted trade-offs and other changes that could have prevented problems because the contractor would be paid more money to correct rather than to prevent problems. Consistent with the competitive pressures at the start of a program, one team co-leader stated that the contract proposal process may encourage contractors to underestimate cost and schedule estimates and overestimate performance expectations to win the contract. Those estimates then contribute to unrealistic program baselines. The point is not so much that the team members' statements are accurate, but that their perceptions pose obstacles to effective IPTs and further blur accountability for successfully delivering the product.

Amphibious Vehicle Program Found Ways to Provide a More Supportive IPT Environment

The Advanced Amphibious Assault Vehicle program has many of the teaming characteristics of leading commercial firms. This accomplishment was made possible by the unique environment—or culture—that the program's initial manager created to center around the IPT approach. The IPTs were responsible for delivering components of the vehicle and had the knowledge and authority to make trade-offs, such as reducing the calibration requirement for the 30-mm gun[3]. Unlike the other DOD cases, Advanced Amphibious Assault Vehicle IPTs were not made to fit among standing organizations and procedures. Clearly, the program manager's vision and entrepreneurship were the driving forces behind the program's success with IPTs—traits that one cannot reasonably expect to find across the board. However, his recognition of the need to create a culture for such teams, the steps he took to create that culture, and the other conditions that helped make IPTs successful on this program are both observable and replicable.

The original program manager saw IPTs as the key to the new vehicle's success and collocation as the only way to break down the barriers between DOD program offices and contractors. By making collocation a requirement in the request for contract proposals, he forced the contractor and DOD program office staff to work in the same facility—the first DOD weapon system program office to do so. Moreover, he created one set of teams—comprised of both Marine Corps and contractor staff. Officials and team members from both the Marine Corps and the contractor were adamant that the IPT structure, bolstered by collocation, created a positive working relationship by helping to break down barriers to trust, improving communication, and creating common goals between the Marine Corps and the program office for developing the vehicle.

The program manager actively sought to create a shared understanding of the customer's needs among Marine Corps and contractor staff. He provided opportunities for the contractor's engineers to learn first hand the user's conditions and needs. For example, he had the contractor's staff spend a night aboard an amphibious ship and stay in the troop compartment. Contractor staff drove the existing amphibious assault

[3] Another example of trade-offs made by amphibious vehicle IPTs includes that between the baseline transmission and the six-speed transmission. Although the six-speed transmission required a greater investment during the development phase of the program, it is expected to result in a 21 to 1 rate of return during the life-cycle of the vehicle. Additional benefits of the six-speed transmission are a 5 percent decrease in fuel consumption and a 40 percent increase in the interval before maintenance is required.

vehicle to understand the environment that Marines were operating in and the limitations of the current vehicle. Contractors also took Marine Corps leadership training classes, where they heard the experiences of a Marine Corps corporal who almost drowned in the current vehicle. Moreover, because the prototypes for the new vehicle are being built in the facility where the IPTs work, the teams can see and experience first hand the results of their design efforts. This provides immediate feedback to the team members and fosters a sense of ownership.

Other features of the program were conducive to effective IPTs. Because the program was the most important acquisition for the Marine Corps, it had full and stable funding, and the program manager had the full backing of the Marine Corps hierarchy. This enabled the program to provide financial incentives, including bonuses to the contractor personnel, when key performance requirements were exceeded and to make significant investments in training and information systems. We have previously reported that the program emulated the best practices of leading commercial firms in targeting hands-on training to staff on key initiatives, including IPTs.[4] The program also developed a paperless communication system; a virtual product model of the amphibious vehicle; and an on-line, real-time shared data source that enabled teams to operate from the same set of records. Moreover, the program is one of the few we have found that matured key technologies, most notably the propulsion system, before the program was started.[5] Finally, the program has had very low turnover in key personnel; the original program manager stayed with the program for 10 years. Both he and the deputy program manager worked on the enabling technologies in a science and technology effort before the program began.

[4] *Best Practices: DOD Training Can Do More to Help Weapon System Programs Implement Best Practices* (GAO/NSIAD-99-206, Aug. 16, 1999).

[5] *Best Practices: Better Management of Technology Development Can Improve Weapon System Outcomes* (GAO/NSIAD-99-162, July 30, 1999).

Previous GAO Recommendations and DOD Actions Are Aimed at Making the Weapon System Environment More Conducive to Best Practices

The effect the environment has on the success of IPTs is consistent with what we have observed on other best practices. In previous reports on how best practices can improve the weapon acquisition process, we have consistently pointed out that practices are adopted because they help a program—commercial or defense—succeed in its environment (see Related GAO Products). Thus, to identify specific best practices from commercial firms and simply recommend that DOD adopt them will not produce the desired improvement. Rather, one must first address how to change the factors that reinforce the prevailing—and suboptimal—practices. In our reports, we have identified a number of actions DOD needs to take to make the weapon system acquisition environment more conducive to adopting best practices. DOD has agreed with these reports and with the need to make changes in its environment. Perhaps the most significant action DOD has taken to date has been to revamp its policies that guide weapon acquisitions to emulate some of the conditions that encourage best practices. DOD's success in implementing these policies on individual weapon system programs will affect several conditions important to creating effective IPTs.

Actions we have previously recommended or suggested DOD take that we believe can help IPTs operate successfully are summarized in the points that follow:

- Mature key technologies and match available resources with weapon system requirements before launching a development program.
- Develop an initial version of a weapon system that provides a worthwhile capability and introduce more advanced capabilities in later versions as the enabling technologies mature.
- Make the acquisition process knowledge-based by focusing on attaining key aspects of product knowledge—technology maturity, design maturity, and production process maturity—at the right times.
- Keep weapon system development cycle times to 5 years or less and tie a program manager's tenure to the full cycle.
- Target training on key improvements to acquisition management to program offices and ensure that it is delivered to the program office work site.
- Involve key suppliers—that is, those firms that make key components and subsystems for prime contractors—early in the design and development process.
- Send the right signals on individual weapon system decisions—that is, decisions that reinforce the above principles rather than make exceptions to them.

These actions, collectively, can (1) lower the pressures to oversell weapon system performance and underestimate costs and schedules at program launch, (2) infuse more knowledge of a new weapon system earlier and throughout the development process, (3) make people more capable of delivering the weapon system as promised, and (4) hold people more accountable for delivering the weapon system.

DOD has made important changes to its policies that guide how weapon systems are acquired and managed, commonly referred to as the "5000 series." Among these changes are (1) changing the launch point for new weapon system programs and calling for technologies to be mature before including them on a program and (2) adopting an evolutionary approach to developing new weapons, allowing for better versions with more advanced technologies to be fielded when they are ready. In other statements and memoranda, DOD has called for limiting cycle time to 5 to 7 years, agreed to take steps to better match technology and other resources with requirements before launching new programs, and revamped its professional education for the acquisition workforce to be more responsive to managers' needs and more capable of providing needed help to the workplace.

These are positive steps toward creating a better environment for best practices. Clearly, more steps remain to be taken. Perhaps the most important of these is implementation at the service and individual program level. Thus far, the positive changes we have seen on specific programs, including IPTs, have been the result of extraordinary effort on the part of individual executives and managers. The systemic pressures and incentives that reinforce the practices of the past have been slow to change.

Chapter 5: Conclusions and Recommendations

Conclusions

When properly armed with knowledge and authority, IPTs improve decision-making and help better products to be developed more quickly. They do this by reducing rework in product planning, design, and manufacturing; reducing cycle time and costs; and improving first-time product quality. At issue is not so much whether to employ IPTs but rather how to employ them effectively. Leading commercial firms have been successful with IPTs because (1) they have given their teams the key elements of IPTs, (2) they have taken action and made investments at the corporate level to ensure implementation occurs at the program execution level, and (3) their competitive environment creates incentives that align well with IPTs. In addition, their IPTs have worked in conjunction with other good management practices, such as maturing technologies before they are turned over to a team responsible for delivering the final product.

DOD has rightly endorsed IPTs as a vehicle to improve management of the development of weapon systems. On the programs that were experiencing problems in meeting their objectives, IPTs were not effective because they did not have the knowledge or authority to recognize problems early and resolve them. The teams were at a disadvantage because they did not possess the key elements of IPTs and in fact were IPTs in name only; DOD did not back policies up with actions to ensure IPTs were implemented at the program execution level; and the DOD environment for managing weapon systems created obstacles, not incentives, for IPTs.

In leading commercial companies, the corporate environment has become conducive to IPTs, so that the typical program manager can employ IPTs effectively. In DOD, it takes a rare program manager to make IPTs work. Much of the success of IPTs on the amphibious vehicle program, for example, can be attributed to extraordinary individual efforts and unique circumstances, rather than to a systematic DOD approach. The challenge for DOD is to create the conditions under which the resources and tools typically provided to most weapon system program managers will enable the effective use of IPTs. We have previously reported on how DOD can create conditions more conducive to adopting best practices and DOD has taken initial actions to do so. These changes could make the DOD environment more conducive to IPTs. If DOD is successful in implementing changes at the individual program execution level, it will be more likely that the typical program manager will be able to create effective IPTs. Still, DOD must take specific steps to put program offices in a better position to create the elements of effective IPTs.

Recommendations for Executive Action

We recommend that the Secretary of Defense designate as IPTs only those teams that will have the day-to-day responsibility for developing and delivering a product, such as a weapon system, and the cross-section of expertise to do so. For those teams so designated, we recommend the Secretary of Defense use the IPT practices and characteristics in this report to develop and communicate to program offices standards for defining what constitutes an effective IPT. Such standards could then be used to (1) determine the extent that IPTs have been effectively implemented in weapon system programs and (2) track progress in implementing IPTs.

We also recommend that the Secretary of Defense put program offices in a better position to create and sustain effective IPTs by

- refining the IPT designation to be used exclusively for new product development teams encompassing core components;
- ensuring IPTs have the sufficient knowledge and authority by (1) giving them responsibility for a deliverable product, along with the authority to make decisions on that product and (2) providing representation from each functional area of expertise critical to product design, development, and manufacture;
- enabling IPT leaders to participate in program goal setting and holding the teams accountable for achieving those goals;
- encouraging and supporting program managers' efforts to collocate team members, including contractor personnel;
- providing program managers and team leaders with greater authority and control over selection of IPT members, rating authority, and rotation of members; and
- establishing indicators to enable program and team management to evaluate the performance of IPTs, such as the efficiency of the decision-making process employed by a team.

Finally, we recommend that the Secretary of Defense help program managers and team leaders become catalysts for IPT implementation by

- devoting professional education to make existing and prospective program managers and IPT leaders aware of and capable of creating the culture necessary to foster IPTs in weapon system programs;

- drawing lessons from programs like the Advanced Amphibious Assault Vehicle to (1) bridge barriers between program offices and contractors and (2) use collocation to break down barriers and create trust; and
- supporting IPT s with the resources—such as information technology, training, and expert help—needed to maximize their effectiveness.

Agency Comments and Our Evaluation

DOD concurred with a draft of this report and most of its recommendations and agreed to emphasize the practices and characteristics discussed in the report concerning the operation of program offices' integrated product teams. (See app. I.)

DOD partially concurred with the recommendation that only those teams with day-to–day responsibility for a product and the necessary cross section of expertise be designated as integrated product teams. It noted that while such teams are unique and require certain conditions and investments, the designation "integrated product team" has spread throughout the workforce and has benefited other teams as well. DOD did not want to lose those benefits by limiting the designation. DOD's position reflects the practical reality that the designation of integrated product teams is now difficult to restrict. Given the Department's recognition that program office integrated product teams require certain conditions and investments to succeed that other integrated product teams may not need, we believe that if the Department takes the actions contained in our other recommendations, the objective of the recommendation will be achieved.

Appendix I: Comments From the Department of Defense

PRINCIPAL DEPUTY UNDER SECRETARY OF DEFENSE
3015 DEFENSE PENTAGON
WASHINGTON, DC 20301-3015

ACQUISITION AND TECHNOLOGY

APR 9 2001

Ms. Katherine V. Schinasi
Director, Acquisition and Sourcing Management Team
U.S. General Accounting Office
Washington, DC 20548

Dear Ms. Schinasi:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) draft report, " BEST PRACTICES: DoD Teaming Practices Not Achieving Potential Results," dated March 12, 2001, (GAO Code 707465).

The Department concurs with the GAO draft report and agrees to emphasize the practices and characteristics discussed in the report concerning the operation of program office integrated product teams. The DoD's agreement with the recommendation that "the Secretary of Defense designate as IPTs only those teams that will have the day-to-day responsibility for developing and delivering a product, such as a weapon system, and the cross-section of expertise to do so" is qualified. The Department agrees it is important that teams designated as IPTs within program offices have the day-to-day responsibility and the cross-section of expertise needed to deliver a product and that these IPTs should be the focus of the actions taken on the report's other recommendations. However, other teams without a hardware focus, such as those focused on oversight and on test and evaluation, have benefited from being designated as IPTs and the Department does not want to lose those benefits. The salient point is that the DoD recognizes that those program office IPTs responsible for delivering products are unique and require certain conditions and investments to succeed that other IPTs may not need.

We would also note that the review of the Army Land Warrior program is based on data from 1999 and earlier. Many changes, consistent with those suggested in the report, have been implemented since then.

Thank you for the opportunity to review and comment on the report. The professionalism and the level of cooperation between my staff and yours are appreciated and we look forward to working with your staff again in the future.

Sincerely,

Dave Oliver

Now on pp. 7 and 54.

Now on pp. 7 and 54.

DEPARTMENT OF DEFENSE COMMENTS

"Best Practices: DoD Teaming Practices Not Achieving Potential Results," dated March 12, 2001 (Code 707465 / Case 3056)

RECOMMENDATIONS

RECOMMENDATON 1: GAO recommends that the Secretary of Defense designate integrated product teams (IPTs) as only those teams that will have day-to-day responsibility for developing and delivering a product, such as a weapons system, and the need for a cross-section of expertise to do so. (p. 45/ GAO Draft Report)

DoD RESPONSE: Partially concur. The DoD's agreement with the recommendation that "the Secretary of Defense designate as IPTs only those teams that will have the day-to-day responsibility for developing and delivering a product, such as a weapon system, and the cross-section of expertise to do so" is qualified. The Department agrees it is important that teams designated as IPTs within program offices have the day-to-day responsibility and the cross-section of expertise needed to deliver a product and that these IPTs should be the focus of the actions taken on the report's other recommendations. However, other teams without a hardware focus, such as those focused on oversight and on test and evaluation, have benefited from being designated as IPTs and the Department does not want to lose those benefits. The salient point is that the DoD recognizes that those program office IPTs responsible for delivering products are unique and require certain conditions and investments to succeed that other IPTs may not need. Further, "reserving" the designation as an IPT may not be possible, as the training and practice have infiltrated the workforce and the positive results at all levels should not be jeopardized.

RECOMMENDATION 2: For those teams designated as IPTs, GAO recommends the Secretary of Defense use the IPT practices and characteristics in this report to develop and communicate to program offices standards for defining what constitutes an effective IPT. Such standards could then be used to (1) determine the extent that IPTs have been effectively implemented in weapons systems programs and (2) track progress in implementing IPTs. (pp. 45-46 / GAO Report)

DoD Response: Concur. The DoD has developed policy, and published guidelines and training material to facilitate the implementation and institutionalization of the IPT approach. For example, DoD has just released a web-based IPT training course and updated the IPT "Rules of the Road". We will consider the GAO observations and the applicability to the DoD environment as we refine our policies.

RECOMMENDATION 3: GAO recommends that the Secretary of Defense put program offices in a better position to create and sustain effective IPTs by:

- Refining the IPT designation to be used exclusively for new product development teams encompassing core components;
- Ensuring IPTs have sufficient knowledge and authority by (1) giving them responsibility for a deliverable product, along with the authority to make decisions on that product and (2) providing representation from each functional area of expertise critical to product design, development, and manufacture;
- Enabling IPT leaders to participate in program goal setting and holding the teams accountable to achieving those goals;
- Encouraging and supporting program managers' efforts to collocate team members, including contractor personnel;
- Providing program managers and team leaders with greater authority and control over selection of IPT members, rating authority, and rotation of members; and
- Establishing indicators to enable program and team management to evaluate the performance of IPTs, such as the efficiency of the decision-making process employed by the team. (p. 46/GAO Draft Report)

Now on pp. 7 and 54.

DoD Response: Partially Concur. As stated in the response to recommendation #1, the Department agrees it is important that teams designated as IPTs within program offices have the day-to-day responsibility and the cross-section of expertise needed to deliver a product, other teams without a hardware focus, such as those focused on oversight and on test and evaluation, have benefited from being designated as IPTs and the Department does not want to lose those benefits. Other GAO observations will be considered in the DoD context, which includes variables such as assignment policies and co-location limitations that are inconsistent with the ideal IPT model.

RECOMMENDATION 4: GAO recommends that the Secretary of Defense help program managers and team leaders become catalysts for IPT implementation by:

- Devoting professional education to make existing and prospective program managers and IPT leaders aware of and capable of creating the culture necessary to foster IPTs in weapons systems programs;
- Drawing lessons from programs like the Advanced Amphibious Assault Vehicle to (1) bridge the program office and contractor barrier and (2) use collocation to break down barriers and create trust; and
- Supporting IPTs with the resources—such as information technology, training, and expert help—needed to maximize their effectiveness. (p. 46/GAO Draft Report)

Now on pp. 7, 54, and 55.

DoD Response: Concur. DoD agrees that education, training, and resource allocation have been and will continue to be key to successful implementation of the IPT approach. All have been emphasized in policy, and in the training we provide to our acquisition personnel. Training will be enhanced by including lessons learned from successful programs such as the Advanced Amphibious Assault Vehicle.

Appendix II: GAO Contacts and Staff Acknowledgments

GAO Contacts

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Acknowledgments

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Related GAO Products

Best Practices: Better Matching of Needs and Resources Will Lead to Better Weapon System Outcomes (GAO-01-288 March 8, 2001).

Best Practices: A More Constructive Test Approach Is Key to Better Weapon System Outcomes (GAO/NSIAD-00-199 July 31, 2000).

Defense Acquisition: Employing Best Practices Can Shape Better Weapon System Decisions (GAO/T-NSIAD-00-137, Apr. 26, 2000).

Best Practices: DOD Training Can Do More to Help Weapon System Programs Implement Best Practices (GAO/NSIAD-99-206, Aug. 16, 1999).

Best Practices: Better Management of Technology Development Can Improve Weapon System Outcomes (GAO/NSIAD-99-162, July 30, 1999).

Defense Acquisitions: Best Commercial Practices Can Improve Program Outcomes (GAO/T-NSIAD-99-116, Mar. 17, 1999).

Defense Acquisition: Improved Program Outcomes Are Possible (GAO/T-NSIAD-98-123, Mar. 17, 1998).

Best Practices: DOD Can Help Suppliers Contribute More to Weapon System Programs (GAO/NSIAD-98-87, Mar. 17, 1998).

Best Practices: Successful Application to Weapon Acquisition Requires Changes in DOD's Environment (GAO/NSIAD-98-56, Feb. 24, 1998).

Major Acquisitions: Significant Changes Underway in DOD's Earned Value Management Process (GAO/NSIAD-97-108, May 5, 1997).

Best Practices: Commercial Quality Assurance Practices Offer Improvements for DOD (GAO/NSIAD-96-162, Aug. 26, 1996).

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