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Report to Congressional Committees

March 2008

DEFENSE ACQUISITIONS

Assessments of Selected Weapon Programs

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GAO-08-467SP

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Highlights

Highlights of GAO-08-467SP, a report to congressional committees

March 2008

DEFENSE ACQUISITIONS

Assessments of Selected Weapon Programs

Why GAO Did This Study

This report is GAO's sixth annual assessment of selected weapon programs. Since 2000, the Department of Defense (DOD) has roughly doubled its planned investment in new systems from $790 billion to $1.6 trillion in 2007, but acquisition outcomes in terms of cost and schedule have not improved. Total acquisition costs for major defense programs in the fiscal year 2007 portfolio have increased 26 percent from first estimates, compared with 6 percent in 2000. Programs have also often failed to deliver capabilities when promised. DOD's acquisition outcomes appear increasingly suboptimal, a condition that needs to be corrected given the pressures faced by the department from other military and major nondiscretionary government demands.

This report provides congressional and DOD decision makers with an independent, knowledge-based assessment of defense programs, identifying potential risks when a program's projected attainment of knowledge diverges from best practices. The programs assessed—most of which are considered major acquisitions by DOD—were selected using several factors: high dollar value, acquisition stage, and congressional interest. This report also highlights overall trends in DOD acquisition outcomes and issues raised by the cumulative experience of individual programs. GAO updates this report annually under the Comptroller General's authority to conduct evaluations on his own initiative.

To view the full product, including the scope and methodology, click on GAO-08-467SP. For more information, contact Michael Sullivan at (202) 512-4841 or SullivanM@gao.gov.

What GAO Found

Of the 72 programs GAO assessed this year, none of them had proceeded through system development meeting the best practices standards for mature technologies, stable design, or mature production processes by critical junctures of the program, each of which are essential for achieving planned cost, schedule, and performance outcomes. The absence of wide-spread adoption of knowledge-based acquisition processes by DOD continues to be a major contributor to this lack of maturity. Aside from these knowledge-based issues, GAO this year gathered data on four additional factors that have the potential to influence DOD's ability to manage programs and improve outcomes—performance requirements changes, program manager tenure, reliance on nongovernmental personnel to help perform program office roles, and software management. GAO found that 63 percent of the programs had changed requirements once system development began, and also experienced significant program cost increases. Average tenure to date for program managers has been less than half of that called for by DOD policy. About 48 percent of DOD program office staff for programs GAO collected data from is composed of personnel outside of the government. Finally, roughly half the programs that provided GAO data experienced more than a 25 percent increase in the expected lines of software code since starting their respective system development programs.

In response to previous GAO recommendations and congressional direction, DOD has recently taken actions that could help move the department toward more sound, knowledge-based acquisition processes. For example, a new concept decision review initiative, guidance for determining acquisition approaches based on capability need dates, and the establishment of review boards to monitor weapon system configuration changes could enable department officials to make more informed decisions in the early stages of a program and better match program requirements and resources, a key first step. Improvements to individual program acquisition outcomes will likely hinge on the success of initiatives like these, paired with knowledge-based strategies.

Analysis of DOD Major Defense Acquisition Program Portfolios (fiscal year [FY] 2008 dollars)

	FY 2000 Portfolio	FY 2005 Portfolio	FY 2007 Portfolio
Portfolio size			
Number of programs	75	91	95
Total planned commitments	$790 Billion	$1.5 Trillion	$1.6 Trillion
Commitments outstanding	$380 Billion	$887 Billion	$858 Billion
Portfolio performance			
Change to total RDT&E costs from first estimate	27 percent	33 percent	40 percent
Change in total acquisition cost from first estimate	6 percent	18 percent	26 percent
Estimated total acquisition cost growth	$42 Billion	$202 Billion	$295 Billion
Share of programs with 25 percent or more increase in program acquisition unit cost	37 percent	44 percent	44 percent
Average schedule delay in delivering initial capabilities	16 months	17 months	21 months

Source: GAO analysis of DOD data.

Contents

Appendixes

Related GAO Products

Tables

Figures

Abbreviations

AESR	Advanced Electromagnetic Signature Reduction
AIRSS	Alternative Infrared Satellite System
AOA	Analysis of Alternatives
CASPER	Communication and Subsystem Processing Embedded Resource Communication Controller
CAVES WAA	Conformal Acoustic Velocity Sensor Wide Aperture Array
CBA	Capital Budget Account
CCD	Cockpit Control Display
CDR	critical design review
DACS	divert and attitude control system
DCMA	Defense Contract Management Agency
DDR&E	Director for Defense Research and Engineering
DIB	DCGS Integration Backbone
DOD	Department of Defense
DRR	Design Readiness Review
EMALS	electromagnetic aircraft launch system
ER	Extended Range
FAA	Federal Aviation Administration
FPA	focal plane array
FY	fiscal year

GAO	Government Accountability Office
GBI	Ground-based interceptors
GEO	geosynchronous earth orbit
HEO	highly elliptical orbit
HMSD	helmet-mounted sight displays
IAMD	Integrated Air and Missile Defense
ICAP	Improved Capability
IMU	inertial measurement units
ISR	intelligence, surveillance, and reconnaissance
JNN-N	Joint Network Node - Network
JPALS	Joint Precision Approach and Landing System
JTRS	Joint Tactical Radio System
LRIP	low-rate initial production
KDP	Key Decision Point
KP	knowledge points
MDA	Missile Defense Agency
MDAP	Major Defense Acquisition Program
MLP	Mobile Landing Platform
NA	not applicable
NASA	National Aeronautics and Space Administration
NLOS-C	Non-Line-of-Sight Cannon
NOAA	National Oceanic and Atmospheric Administration
NSS AP	National Security Space Acquisition Policy
RDT&E	research, development, test and evaluation
SAR	Selected Acquisition Report
SDACS	Solid Divert and Attitude Control System
SDB	Small Diameter Bomb
SM-3	Standard Missile 3
TBD	to be determined
TIP	Technology Insertion Program
TRTF	Tanker Replacement Transfer Fund
TSRM	Third Stage Rocket Motor
UAS	unmanned aircraft system
UHF	Ultra High Frequency
ULA	United Launch Alliance

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Comptroller General
of the United States

United States Government Accountability Office
Washington, D.C. 20548

March 31, 2008

Congressional Committees

I am pleased to present GAO's sixth annual assessment of selected weapon programs. It comes at a time of large and growing national government fiscal imbalance and budget deficits that continue to strain all of our federal agencies' resources. Our nation faces a range of challenges that will require a more disciplined and balanced approach to discretionary and mandatory spending as we move into the 21st century. In the coming decades, our ability to sustain even the constitutionally enumerated responsibilities of the federal government will come under increasing pressure. Budget experts now agree that growing entitlement costs for mandatory spending programs like Social Security, Medicare, and Medicaid will, absent fundamental reforms, put intense and increasing pressure on discretionary spending programs or tax levels or both.

DOD's investment in weapon systems represents one of the largest discretionary items in the budget. While overall discretionary funding is declining, DOD's budget continues to demand a larger portion of what is available, thereby leaving a smaller percentage for other activities. DOD's investment in weapon acquisition programs is now at its highest level in two decades. The department expects to invest about $900 billion (fiscal year 2008 dollars) over the next 5 years on development and procurement with more than $335 billion, or 37 percent, going specifically for new major weapon systems. Every dollar spent inefficiently in developing and procuring weapon systems is less money available for many other internal and external budget priorities—such as the global war on terror and growing entitlement programs. These inefficiencies also often result in the delivery of less capability than initially planned, either in the form of fewer quantities or delayed delivery to the warfighter.

Unfortunately, our review this year indicates that cost and schedule outcomes for major weapon programs are not improving over the 6 years we have been issuing this report. Although well-conceived acquisition policy changes occurred in 2003 that reflect many best practices we have reported on in the past, these significant policy changes have not yet translated into best practices on individual programs. Flagship acquisitions, as well as many other top priorities in each of the services, continue to cost significantly more, take longer to produce, and deliver less than was promised. This is likely to continue until the overall environment for weapon system acquisitions changes. For example, a balanced, wellprioritized portfolio of weapon system acquisitions that allows for the right mix of weapon systems would alleviate the pressure each program now faces in winning funding from others; a knowledge-based business case at the outset of each program would alleviate overpromising on cost, schedule, and performance and would empower program managers; and more immediate accountability in the execution of each program would alleviate untimely decision making when programs do get into trouble.

The current DOD leadership has recently established initiatives designed to change the strategic environment at the weapon acquisition portfolio level. These initiatives reflect sound business concepts and could lead to better outcomes if implemented fully and correctly. However, policy without practice is not uncommon within the Department and the upcoming change in administration presents challenges in advancing progress through sustained implementation of best practices, as well as addressing new issues that may emerge. Significant changes will only be possible with greater, and continued, department level support, including strong and consistent vision, direction, and advocacy from DOD leadership, as well as sustained oversight by the Congress. Successful implementation will have significant implications for decisions made on individual programs, DOD's larger modernization goals, and the nation at large.

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of the United States

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March 31, 2008

Congressional Committees

This is GAO's sixth annual assessment of selected Department of Defense (DOD) weapon programs. During the past 6 years, GAO has reported on individual programs as well as many crosscutting problems with the acquisition process and has offered numerous recommendations on how DOD could improve acquisition outcomes. DOD's planned investment for new weapon systems now reflects the highest funding levels in two decades, with no significant decline expected in the near term. These levels will be difficult to sustain as the nation begins to address other long-term fiscal imbalances and as DOD encounters considerable pressure to reduce its investment in new weapons. DOD faces pressures within its own budget as new weapon system investments compete with funding needed to procure equipment and support military operations in Iraq and Afghanistan.

This report provides information on 72 individual weapon programs and assesses overall trends in DOD acquisition outcomes for decision makers to use as they determine the best ways to invest limited resources in the face of competing demands. Programs were selected for individual assessment based on several factors, including (1) high dollar value, (2) stage in acquisition, and (3) congressional interest. The majority of the 72 programs covered in the report are considered major defense acquisition programs by DOD.[1] We conducted this performance audit from June 2007 to March 2008 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives. Appendix I contains detailed information on our scope and methodology.

Summary

Since fiscal year 2000, DOD has significantly increased the number of major defense acquisition programs and its overall investment in them.

[1]Major defense acquisition programs (MDAP) are those identified by DOD that require eventual total research, development, test, and evaluation (RDT&E) expenditures of more than $365 million or $2.19 billion for procurement in fiscal year 2000 constant dollars.

Unfortunately, during this same time period, acquisition outcomes did not improve. Based on our analysis, total acquisition costs for the fiscal year 2007 portfolio of major defense acquisition programs increased 26 percent from first estimates, whereas the 2000 portfolio increased by 6 percent. Likewise, development costs for fiscal year 2007 programs increased by 40 percent from first estimates, compared to 27 percent for fiscal year 2000 programs. In most cases, programs also failed to deliver capabilities when promised—often forcing warfighters to spend additional funds on maintaining legacy systems. Our analysis shows that current programs are experiencing an average delay of 21-months in delivering initial capabilities to the warfighter, a 5-month increase over fiscal year 2000 programs.

Of the 72 weapon programs we assessed this year, no program had proceeded through system development meeting the best practices standards for mature technologies, stable design, and mature production processes—all prerequisites for achieving planned cost, schedule, and performance outcomes.[2] Eighty-eight percent of the programs in this assessment began system development without fully maturing critical technologies according to best practices. Ninety-six percent of the programs had not met best practice standards for demonstrating mature technologies and design stability before entering the more costly system demonstration phase. Finally, no programs we assessed had all of their critical manufacturing processes in statistical control when they entered production, and most programs were not even collecting data to do so. Also, programs assessed this year did not improve on the level of knowledge attained at critical junctures from those assessed in 2005. This year, in an effort to further understand the cause of poor DOD outcomes, we gathered data to determine whether two key systems engineering tools—preliminary design reviews and prototypes—had been used by key junctures to ensure appropriate knowledge before moving forward. Our analysis showed that only a small percentage of programs used either key tool to demonstrate the maturity of the product's design by critical junctures.

The results of our analysis indicate that DOD programs continue to be suboptimal and that the lack of knowledge at key junctures of system development continues to be a major cause of these outcomes. The final

[2]Not all programs provided information for every knowledge point or had proceeded through system development. Details of our scope and methodology can be found in appendix I.

result is lost buying power and opportunities to recapitalize the force. About 60 percent of the programs we assessed had to reset their business case at least once because they lacked necessary knowledge to reasonably estimate the cost and time it would take to develop and produce the product. The continuing absence of knowledge-based acquisition processes steeped in disciplined systems engineering practices—aimed at analyzing requirements to determine their reasonableness before a program starts—contributed significantly to this. Our work has shown that systems engineering is a best practice used by commercial firms to ensure that requirements are well understood and achievable within given resources before system development starts. Our analysis of requirements changes occurring after system development began within DOD programs indicates that this practice is not always used. Likewise, increased risks to the government can occur when DOD enters into contracts to develop these complex systems before performing thorough requirements analysis to ensure specific needs can be met. Finally, long development cycle times invite additional instability for programs.

In addition to gathering information on acquisition outcomes and the achievement of critical knowledge at key junctures, this year we also present new data as an indicator of other factors that could potentially influence DOD's ability to manage its programs and improve cost and schedule outcomes. These factors include changes in performance requirements, program manager tenure, composition of the government workforce, and because of its increasing importance to performance, software management. Our analysis of these factors can be summarized as follows:

- Unsettled requirements in acquisition programs can create significant turbulence. Sixty-three percent of the programs we received data from had requirement changes after system development began. These programs encountered cost increases of 72 percent, while costs grew by 11 percent among those programs that did not change requirements.

- Frequent program manager turnover occurs during system development. For programs started since 2001, the average tenure to date for program managers has been 17 months—less than half of what is prescribed by DOD policy—challenging continuity and accountability.

- DOD relies heavily on contractors to perform roles that have in the past been performed by government employees. For programs we assessed, about 48 percent of their staff was made up of individuals outside of the government; performing engineering, business, and supporting program management related roles. These data raise questions about whether DOD has the appropriate mix of staff and capabilities within its workforce to effectively manage programs.

- Programs continue to have difficulty managing software development for weapon systems. Roughly half of the programs that provided us data had more than a 25 percent growth in their expected lines of code since starting system development. Changes to the amount of software needing to be developed for such programs often indicate the potential for cost and schedule problems.

There is reason for optimism. Based in part on GAO recommendations and congressional direction, DOD has recently begun to develop several initiatives that, if adopted and implemented properly, could provide a foundation for establishing sound, knowledge-based business cases for individual acquisition programs and improving program outcomes. For example, a new concept decision review initiative, guidance for determining acquisition approaches based on capability need dates, and the establishment of review boards to monitor weapon system configuration changes are all designed to enable key department leaders to make informed decisions well ahead of a program's start. This should help DOD attain a closer match between each program's requirements and available resources. Improvements to individual acquisition program outcomes hinge on the success of these initiatives paired with rigorous knowledge-based acquisition strategies.

Weapon Acquisition Outcomes Continue to Undermine DOD Investments

DOD is not receiving expected returns on its large investment in weapon systems. Our analysis does not show any improvements in acquisition outcomes as programs continue to experience increased costs and delays in delivering capabilities to the warfighter. In fact, when compared to the performance of the fiscal year 2000 portfolio of major defense acquisition programs, cost and schedule performance for current programs is actually worse. Without improved acquisition outcomes in the future, achieving DOD's transformational objectives in a constrained fiscal environment is highly unlikely.

Trends in DOD's Weapon Acquisitions Investments and Outcomes since 2000

While DOD is committing substantially more investment dollars to develop and procure new weapon systems, our analysis shows that the 2007 portfolio of major defense acquisition programs is experiencing greater cost growth and schedule delays than programs in fiscal years 2000 and 2005.[3] For example, as shown in table 1, total acquisition costs for 2007 programs increased 26 percent from first estimates, whereas programs in fiscal year 2000 increased by 6 percent. Total RDT&E costs for programs in 2007 increased by 40 percent from first estimates, compared to 27 percent for programs in 2000.

Table 1: Analysis of DOD Major Defense Acquisition Program Portfolios

Fiscal year 2008 dollars

	Fiscal year		
	2000 portfolio	**2005 portfolio**	**2007 portfolio**
Portfolio size			
Number of programs	75	91	95
Total planned commitments	$790 Billion	$1.5 Trillion	$1.6 Trillion
Commitments outstanding	$380 Billion	$887 Billion	$858 Billion
Portfolio performance			
Change to total RDT&E costs from first estimate	27 percent	33 percent	40 percent
Change in total acquisition cost from first estimate	6 percent	18 percent	26 percent
Estimated total acquisition cost growth	$42 Billion	$202 Billion	$295 Billion
Share of programs with 25 percent or more increase in program acquisition unit cost	37 percent	44 percent	44 percent
Average schedule delay in delivering initial capabilities	16 months	17 months	21 months

Source: GAO analysis of DOD data.

Note: Data were obtained from DOD's Selected Acquisition Reports (dated December 1999, 2004, and 2006) or, in a few cases, data were obtained directly from program offices. Number of programs reflects the programs with Selected Acquisition Reports. In our analysis we have broken a few

[3]Our analysis in this area reflects comparisons of performance for programs meeting DOD's criteria for being major defense acquisition programs in fiscal year 2007 and programs meeting the same criteria in fiscal years 2005 and 2000. The analysis does not include all the same systems in all 3 years.

Selected Acquisition Report programs (such as Missile Defense Agency systems) into smaller elements or programs. Not all programs had comparative cost and schedule data, and these programs were excluded from the analysis where appropriate. Also, data do not include full costs of developing Missile Defense Agency systems.

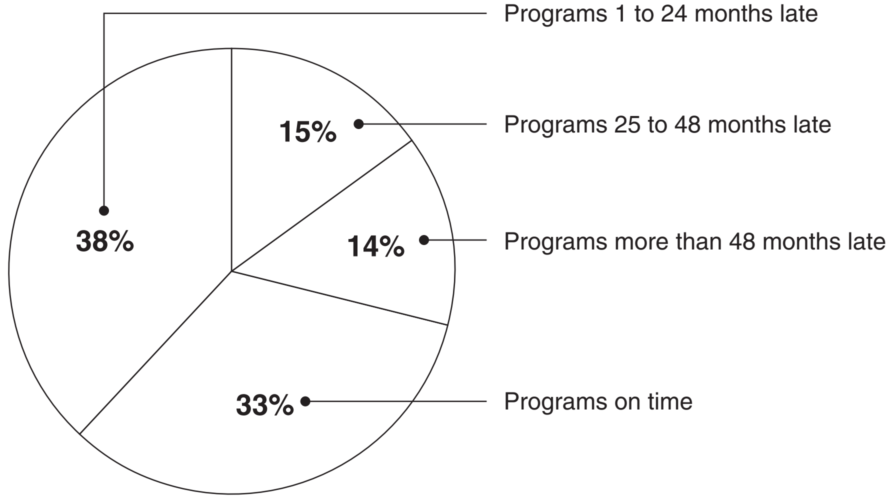
One way to measure program performance is in examining the cost growth as expressed in changes to program acquisition unit cost. This represents the value DOD gets per unit for the acquisition dollars invested in a certain program and shows the net effect of cost growth and quantity changes. According to our analysis of the 2007 portfolio, 44 percent of DOD's major defense acquisition programs are paying at least 25 percent more per unit than originally expected. The proportion of programs experiencing a 25 percent or more increase in program acquisition unit costs in fiscal year 2000 was 37 percent.

The consequence of cost growth is reduced buying power and lost opportunity costs for DOD. Every dollar spent on inefficiencies in acquiring one weapon system is less money available for other opportunities. Total acquisition cost for the current portfolio of major programs under development or in production has grown by nearly $300 billion over initial estimates. As program costs increase, DOD must request more funding to cover the overruns, make trade-offs with existing programs, delay the start of new programs, or take funds from other accounts.

Delivery of Operational Capabilities Continues to Be Late

As important as wasting investment dollars, DOD has already missed fielding dates for many programs and many others are behind schedule. The services' requirement for a new system is often based on replacing aging, legacy systems or filling an expected gap in capability, or both. The warfighter's urgent need for the new weapon system is often cited when the case is first made for developing and producing the system. However, on average, the current portfolio of programs has experienced a 21-month delay in delivering initial operational capability to the warfighter. As shown in figure 1, about two-thirds of the current programs have encountered some form of a delay.

Figure 1: Schedule Delays for Major Weapon Systems



Source: GAO analysis of DOD data.

Note: This reflects planned or actual delivery of initial capabilities for programs with comparable schedule data.

Because of program delays, warfighters often have to operate costly legacy systems longer than expected, find alternatives to fill capability gaps, or go without the capability. Table 2 shows examples where program delays in delivering initial capabilities have affected the military services.

Table 2: Examples of Program Delays and Impacts

Program delays	Impacts
WIN-T	The Army had to take extraordinary efforts to acquire an interim capability to fulfill a gap in communication capabilities for soldiers. The Army's optimistic acquisition approach for the Warfighter Information Network-Tactical (WIN-T) program created the impression that the capability gap was far smaller than it really was, and when the program experienced delays it forced the Army to work outside the normal processes and use supplemental funding to meet an urgent warfighter need. This effort later became the first increment of the WIN-T program.
F-22A and JSF	Because of delayed deliveries and quantity reductions with the F-22A and Joint Strike Fighter (JSF) aircraft, legacy systems (with less capability) will make up a larger proportion of the future fighter fleet for a longer period of time, and the services must now invest billions of dollars to modernize legacy aircraft to keep them available and capable to meet mission requirements. Despite this investment, several legacy F-15 aircraft were recently grounded because of structural safety concerns. Service officials have also raised concerns about whether the number of new aircraft will be sufficient to meet national security requirements with an acceptable level of risk.

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Program delays	Impacts
Aerial Common Sensor	Significant delays in delivering the capabilities expected from the Aerial Common Sensor program are now requiring the Army and Navy to make unanticipated investments in already existing intelligence, surveillance, and reconnaissance systems at the same time that they are developing the new replacement systems.
Global Hawk	Delays in the Global Hawk program have contributed to the need to keep the U- 2 in the inventory longer than anticipated. The Air Force is now developing a plan to fully retire the U-2s a year later in 2013 and at a slower rate, which will increase the funds needed to operate and support these aircraft over this extended period.

Source: GAO.

Current U.S. Fiscal Challenges Will Affect DOD's Acquisition Funding

DOD is in a period of high investment that will be difficult to sustain given the many internal and external budgetary pressures faced by the department in today's fiscal environment. Over the next 5 years, DOD expects to expend approximately $900 billion in research, development, test, and evaluation and procurement funds (fiscal year 2008 dollars). About $335 billion, or 37 percent, is for the acquisition of its current portfolio of 95 major defense acquisition programs. To illustrate the significance of these investments, table 3 lists the top 10 programs that will dominate DOD's budget over that time. If the trend DOD is experiencing today continues into the future years, one can easily see how these programs, now 58 percent of funding for all Major Defense Acquisition Programs, could encompass a much larger share of the funding.

Table 3: Planned RDT&E and Procurement Funding for Major Defense Acquisition Programs, as of December 2006

Fiscal year 2008 dollars in billions

	Fiscal year					
Program	2008	2009	2010	2011	2012	Total
Ballistic Missile Defense System	$8.9	$9.1	$9.1	$8.9	$8.8	**$44.9**
Joint Strike Fighter	6.7	6.9	8.1	8.4	11.3	**$41.4**
Virginia Class Submarine	2.9	3.7	3.9	3.8	4.7	**$19.0**
Future Combat Systems	3.6	3.2	3.2	3.2	3.7	**$17.0**
V-22 Joint Services Advanced Vertical Lift Aircraft	3.0	3.1	3.1	2.8	3.0	**$15.0**
DDG 1000 Destroyer	3.5	2.8	2.9	2.7	2.6	**$14.4**
Future Aircraft Carrier CVN-21	3.1	4.6	1.7	0.6	3.4	**$13.4**
F-22A	4.4	4.3	0.5	0.4	0.5	**$10.1**

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Fiscal year 2008 dollars in billions

	Fiscal year					
Program	**2008**	**2009**	**2010**	**2011**	**2012**	**Total**
P-8A Multi–mission Maritime Aircraft	0.9	1.2	2.9	2.7	2.5	**$10.1**
F/A-18 EF	2.1	1.7	1.9	1.6	1.5	**$8.8**
Funding for Top 10 MDAP programs	39.1	40.6	37.3	35.2	42.0	**$194.2**
Funding for other 85 MDAP programs	33.2	31.5	26.9	25.4	24.1	**$141.1**
Total	**$72.3**	**$72.1**	**$64.2**	**$60.6**	**$66.1**	**$335.3**
Top 10 MDAP programs (percentage of total)	54	56	58	58	64	58

Source: GAO analysis of DOD data.

Note: Numbers may not add due to rounding. The Ballistic Missile Defense System is composed of several programs. We have assessed several of these programs later in this report.

In addition, other military needs can be expected to challenge the funding for these investments. Within DOD's internal budget, investment in new weapon systems competes with those funds necessary to replace equipment and sustain operations in Iraq and Afghanistan. Between September 2001 and May 2007, DOD has been provided $542.9 billion to support the global war on terror. War operations have identified the need for new, alternative systems and have resulted in greater wear on existing weapons that will need refurbishment or replacement sooner than expected. For example, DOD's urgent need for armored vehicles to protect personnel from mine blasts, are not included in the planned acquisition costs for the December 2006 major defense programs discussed above. These vehicles are estimated to cost about $13.5 billion between 2006 and 2008.[4]

Other government spending priorities will place external pressure on DOD's planned investment in major weapon systems. As nondiscretionary programs like Social Security, Medicare, and Medicaid consume a growing percentage of the available budget, discretionary programs—including defense—face competition for increasingly scarce resources. As a result, sustaining real topline budget increases in any discretionary program will

[4]These figures represent cost and quantity estimates based on Presidents' budgets and supplemental requests for fiscal years 2006 through 2008 but do not include recent orders for more vehicles.

be difficult. DOD's investment in weapon systems represents one of the largest discretionary items in the budget. Since 1978, discretionary funding has decreased from 52 percent of the federal budget to an estimated 37 percent in 2007. While the percentage of discretionary funding is declining, DOD's budget continues to demand a larger portion of what is available, thereby leaving a smaller percentage for other activities.

DOD Weapon System Programs Are Still Not Following a Knowledge-Based Approach

We continue to find that a prime contributor to DOD's poor program outcomes is the lack of widespread adoption of a knowledge-based acquisition process within DOD despite polices that support such a process. Our assessment of 72 weapon systems shows that DOD programs continue to proceed through critical junctures with knowledge gaps that expose programs to significant, unnecessary technology, design, and production risks. Because of this, many programs in our assessment have experienced cost growth and schedule delays. Our analysis also shows that there has not been an increase in the share of programs achieving key elements of product knowledge at critical junctures over what we found in our 2005 assessment. As a result, DOD programs are likely to continue to experience a cascade of negative effects that affect both costs and schedules.

A Knowledge-Based Acquisition Approach Can Lead to Better Program Outcomes

In order to have good outcomes, best commercial practices require the use of a knowledge-based approach to product development that demonstrates high levels of knowledge before significant commitments are made. This type of strategy is essential for getting better outcomes for DOD programs. The achievement of the right knowledge at the right time enables leadership to make informed decisions about when and how best to move into various acquisition phases. In essence, knowledge supplants risk over time. This building of knowledge consists of information that should be gathered at three critical points over the course of a program:

- **Knowledge point 1**: Resources and needs match. Achieving a high level of technology maturity by the start of system development is an important indicator of whether this match has been made.[5] This means that the technologies needed to meet essential product requirements have been demonstrated to work in their intended environment. In addition, the producer has completed a preliminary design of the product that shows the design is feasible.

- **Knowledge point 2**: Product design is stable. This point occurs when a program determines that a product's design is stable—that is, it will meet customer requirements, as well as cost, schedule, and reliability targets. A best practice is to achieve design stability at the system-level critical design review, usually held midway through system development. Completion of at least 90 percent of engineering drawings at the system design review provides tangible evidence that the design is stable, and a prototype demonstration shows that the design is capable of meeting performance requirements.

- **Knowledge point 3**: Production processes are mature. This point is achieved when it has been demonstrated that the company can manufacture the product within cost, schedule, and quality targets. A best practice is to ensure that all key manufacturing processes are in statistical control—that is, they are repeatable, sustainable, and capable of consistently producing parts within the product's quality tolerances and standards—at the start of production. Demonstration of a fully integrated product in its intended environment shows that the product works as needed.

Outcomes for the Programs We Assessed Mirror Outcomes for the Overall DOD Major Acquisition Program Portfolio

For this report, we assessed 72 individual programs and found that outcomes for a large portion of those programs are consistent with DOD's

[5]The start of system development as used here indicates the point at which significant financial commitment is made to design, integrate, and demonstrate that the product will meet the user's requirements and can be manufactured on time, with high quality, and at a cost that provides an acceptable return on investment. System development follows concept refinement and technology development which is intended to mature technologies and deliver a preliminary design of the proposed solution.

overall portfolio of major defense acquisition programs—they cost more and are taking longer to field than originally planned (see table 4).[6]

Table 4: Outcomes for Weapon Programs in 2008 Assessment

Performance indicators	Outcomes to date
Increase in RDT&E costs from first estimate	38 percent
Share of programs with more than 25 percent growth in program acquisition unit cost	47 percent
Average schedule delay in delivering initial capabilities	23 months

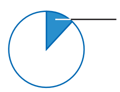
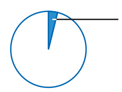
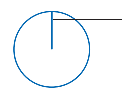
Source: GAO analysis of DOD data.

Note: Not all programs in our assessment have entered system development or had comparable first and latest estimates to measure outcomes. These programs were not included in our analysis. Details of our scope and methodology can be found in appendix I.

In assessing the 72 weapon programs, we found no evidence of widespread adoption of a knowledge-based acquisition strategy. The majority of programs in our assessment this year proceeded with lower levels of knowledge at critical junctures and attained key elements of product knowledge later in development than expected under best practices. The building of knowledge over a product's development is cumulative, as one knowledge point builds on the next, and failure to capture key product knowledge can lead to problems that eventually cascade and become magnified throughout product development and production. Consequently, programs managed without the knowledge-based process are more likely to have surprises in the form of cost and schedule increases. Figure 2 compares the degree of cumulative product knowledge at critical decision points for DOD programs in our assessment versus best practices standards.

[6]While the programs we assessed were not chosen to be representative of the broader defense acquisition portfolio, the outcomes of the programs in our assessment closely mirror those of the 2007 portfolio of major defense acquisition programs discussed earlier in this report.

Figure 2: Knowledge Achievement for Weapon System Programs in 2008 Assessment at Key Junctures

Key junctures	Development start	Design review	Production start
	Knowledge point 1	**Knowledge point 2**	**Knowledge point 3**
Best practices	Mature all critical technologies	Achieve knowledge point 1 on time and complete 90 percent of engineering drawings	Achieve knowledge points 1 and 2 on time, and have all critical processes under statistical control
DOD outcomes[a]	 12 percent of programs	 4 percent of programs	 0 percent of programs[b]

Source: GAO analysis of DOD data.

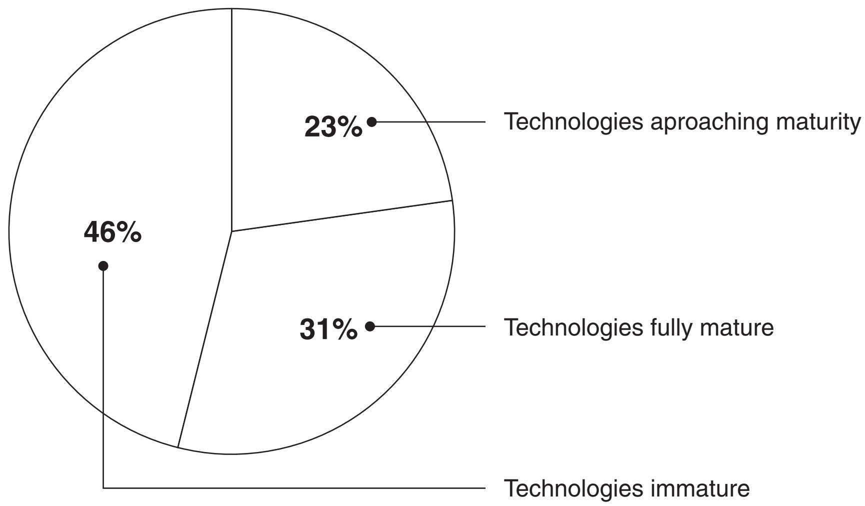
[a]Not all programs provided information for each knowledge point or had passed through all three key junctures.

[b]In our assessment, two programs—the Light Utility Helicopter and the Joint Cargo Aircraft—are depicted as meeting all three knowledge points when they began at production start. We excluded these two programs from our analysis because they were based on commercially available products and we did not assess their knowledge attainment with our best practices metrics.

Programs Enter System Development without Mature Technologies or Sound Preliminary Design

Very few programs start system development with evidence that the proposed solution is based on mature technologies and proven design features. Achieving knowledge point 1 at system development start makes it easier to reach the remaining two knowledge points at the right time. Only 12 percent of the programs in our assessment demonstrated all of their critical technologies as fully mature at the start of system development, meaning that 88 percent fell short of achieving knowledge point 1. Without mature technologies, it is difficult to know whether the product under design will meet customer requirements or if the design allows enough space for technology integration. As shown in figure 3, for the 356 critical technologies at system development start in the programs we assessed, only 31 percent were fully mature and only another 23 percent were approaching full maturity. This means that programs accepted 164 technologies, or 46 percent, into their product's design based on no more than a laboratory demonstration of basic performance, technical feasibility, and functionality, and not on a representative model or prototype demonstration close to form and fit (size, weight, and materials) in a relevant or realistic environment. In some cases, technologies were in very early technology development stages when weapon program managers accepted them as part of their system development programs.

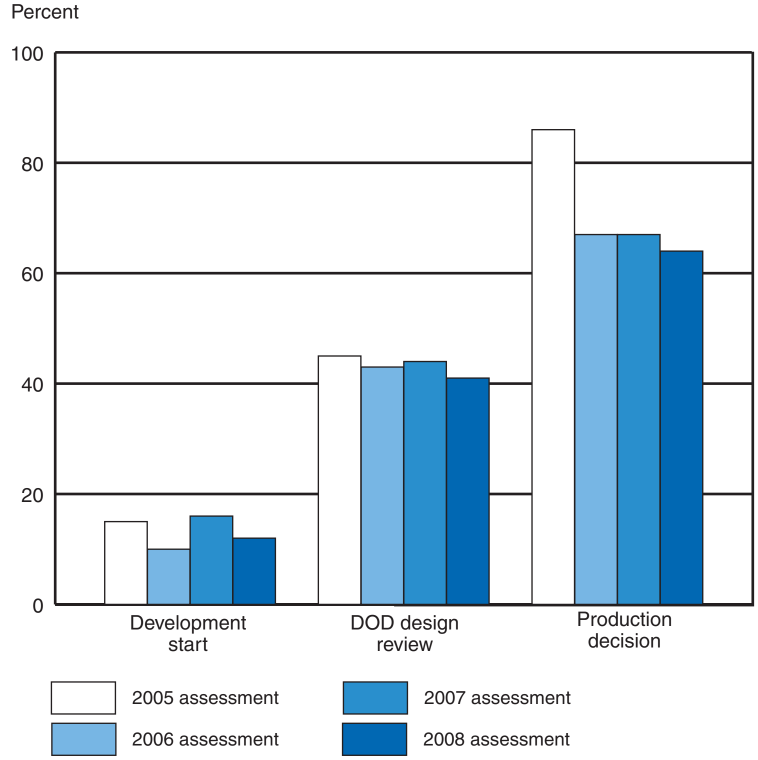
Figure 3: Maturity Levels of Critical Technologies for DOD Programs



Source: GAO analysis of DOD data.

Programs that are still working to mature technologies while they are also maturing the system design and preparing for production have higher cost growth than programs that start system development with mature technologies. For those programs in our assessment with immature technologies at system development start, the total RDT&E costs grew by 44 percent more than for programs that began with mature technologies. More often than not, programs were still maturing technologies late into system development and even into production. This trend is troublesome, as we have found the share of programs with fully mature technologies prior to production has actually decreased from our 2005 assessment (see fig. 4).

Figure 4: Percentage of Programs Achieving Technology Maturity at Key Junctures



Source: GAO analysis of DOD data.

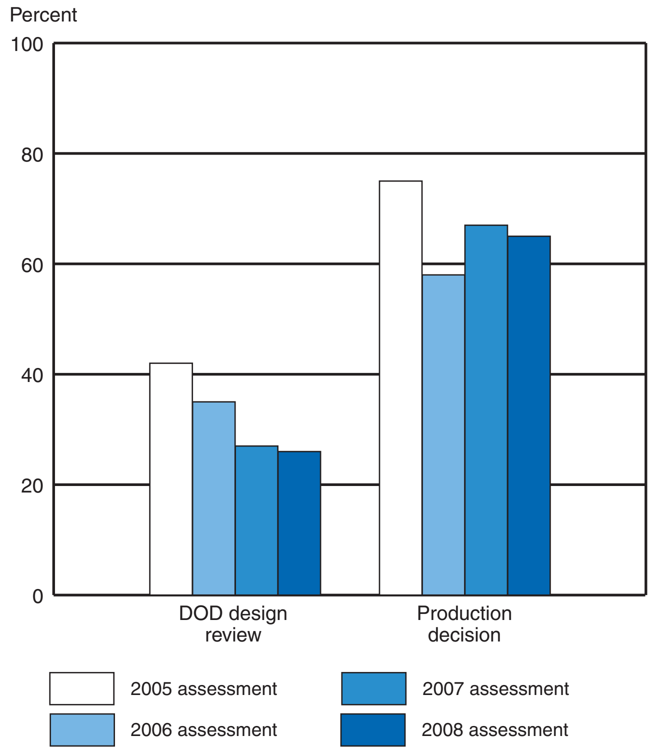
In addition to ensuring that technologies are mature by system development start, best product development practices suggest that the developer should have delivered a preliminary design of the proposed solution based on a robust systems engineering process before committing to system development. This process should allow the developer to analyze the customer's expectations for the product and identify gaps between resources and expectations, which then can be addressed through additional investments, alternate designs, and ultimately trade-offs. Only 10 percent of the programs in our assessment had completed their preliminary design review prior to committing to system development. For programs that had not completed the preliminary design review, it was an average of about 2 1/2 years into system development before the review was completed or was planned to be completed. GAO's work has shown that successfully completing this review and delivering a sound preliminary design based on mature technological solutions leads to better and more predictable program outcomes. DOD programs, like the Aerial Common

Sensor and Joint Strike Fighter, that did not deliver sound preliminary designs at system development start and discovered problems early in their design activities required substantial resources be added to the programs or, in the case of Aerial Common Sensor, termination of the system development contract.

Programs Continue to Move into System Demonstration and Production without Achieving Design Stability

As previously shown in figure 2, only a small portion of the programs in our assessment that have held a design review captured the necessary knowledge to ensure that they had mature technologies at system development start and a stable design before entering the more costly system demonstration phase of development. Over half of the programs in our assessment did not even have mature technologies at the design review (knowledge that actually should have been achieved before system development start). Also less than one-quarter of the programs that provided data on drawings released at the design review reached the best practices standard of 90 percent, which is a smaller share than programs in our 2005 assessment (see fig. 5). Knowing that a product's design is stable before system demonstration reduces the risk of costly design changes occurring during the manufacturing of production representative prototypes—when investments in acquisitions become more significant. Even by the beginning of production, more than a third of the programs that had entered this phase still had not released 90 percent of their engineering drawings.

Figure 5: Percentage of Programs Releasing 90 Percent of Engineering Drawings by Key Junctures



Source: GAO analysis of DOD data.

We have found that programs moving forward into system demonstration with low levels of design stability are more likely than other programs to encounter costly design changes and parts shortages that in turn cause labor inefficiencies, schedule delays, and quality problems. In addition, we found that over 80 percent of the programs providing data did not or did not plan to demonstrate the successful integration of the key subsystems and components needed for the product through an integration laboratory, or better yet through testing an early system prototype by the design review. Demonstrating that the system can be successfully integrated before the critical design review is a best practice that provides additional evidence of design stability before a program makes costly investments in materials, manufacturing equipment, and personnel to begin building production representative prototypes for the system demonstration phase. For example, the Navy's E-2D Advanced Hawkeye moved past the design review and entered systems demonstration without fully proving—through the use of an integration lab or prototype—that the design could be successfully integrated. The program did not have all the components operational in a systems integration lab until almost 2 years after the design review. While the program estimated it had released 90 percent of the drawings needed for the system by the design review, as it was conducting system integration activities, it discovered that it needed substantially more drawings. This increase means that the program really had completed only 53 percent of the drawings prior to the review, making it difficult to ensure the design was stable.

Programs Enter Production without Demonstrating Acceptable Manufacturing and Test Performance

In addition to lacking mature technologies and design stability, most programs have not or do not plan to capture critical manufacturing and testing knowledge before entering production. This knowledge ensures that the product will work as intended and can be manufactured efficiently to meet cost, schedule, and quality targets. Of the 26 programs in our assessment that have had production decisions, none of them provided data showing that they had all their critical processes in statistical control by the time they entered into the production phase.[7] In fact, only three of these programs indicated that they had even identified the key product characteristics or associated critical manufacturing processes—key initial steps to ensuring critical production elements are stable and in control. Failing to capture key manufacturing knowledge before producing the product can lead to inefficiencies and quality problems. For example, the Wideband Global SATCOM program encountered cost and schedule delays because contractor personnel installed fasteners incorrectly. Discovery of the problem resulted in extensive inspection and rework to correct the deficiencies, contributing to a 15-month schedule delay. The Missile Defense Agency's Ground-Based Midcourse Defense system continues to encounter quality issues with delivered interceptors. Officials believe inadequate controls may have allowed less reliable or inappropriate parts to be incorporated into the manufacturing processes of two key subsystems.

[7]We have excluded two programs from this calculation, Light Utility Helicopter and Joint Cargo Aircraft. While we have assessed these programs as having mature manufacturing processes, this is because they are commercial acquisitions, not because processes were demonstrated to be in statistical control. Also, the Multifunctional Information Distribution System (MIDS) program indicates that its two critical processes are in statistical control but it has not formally entered the production phase.

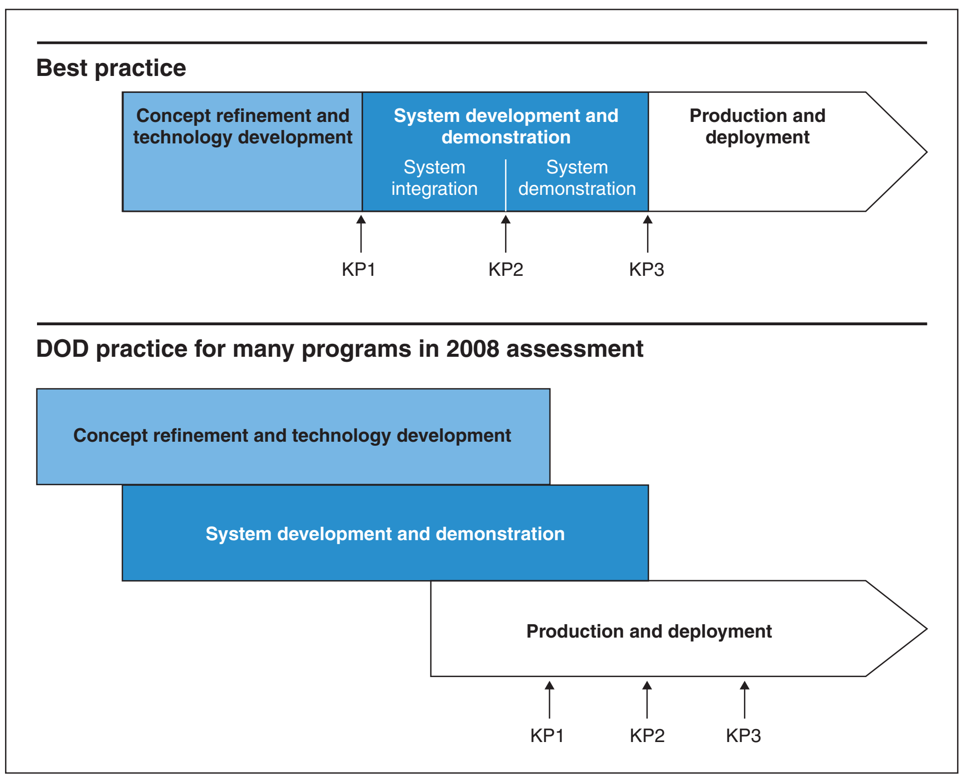
In addition to demonstrating that the product can be built efficiently, GAO's work has shown that production and post-production costs are minimized when a fully integrated, capable prototype is demonstrated to show it will work as intended and in a reliable manner. We found that many programs are very susceptible to discovering costly problems late in development, when the more complex software and advanced capabilities are tested. Of the 33 programs that provided us data about the overlap between system development and production, almost three-quarters still had or planned to have system demonstration activities left to complete after production had begun. For nine programs, the amount of system development work remaining was estimated to be over 4 years. This practice of beginning production before successfully demonstrating that the weapon system will work as intended increases the potential for discovering costly design changes that ripple through production into products already fielded, and usually require substantial modification costs at a later time.

Forty programs we assessed provided us information on when they had or planned to have first tested a fully configured, integrated production representative article (i.e., prototype) in the intended environment. Of these, 38 percent reported that they had already conducted or planned to conduct a development test of a fully configured, integrated prototype before they make a production decision. In other cases, we found instances where it would be several years after production has begun before the fully integrated, capable product was first tested. We also found examples where product reliability is not being demonstrated in a timely fashion. Making design changes to achieve reliability requirements after production begins is inefficient and costly. For example, during flight tests in 2007, the Air Force's Joint Air-to-Surface Standoff Missile encountered four failures during four tests, resulting in an overall missile reliability rate of less than 60 percent despite being more than 5 years past the production decision. The failures halted procurement of new missiles by the Air Force until the problems could be resolved.

DOD's Practices Lead to Concurrent Development, Test, and Production

The absence of a knowledge-based acquisition process results in DOD continuing to develop new weapon systems in a highly concurrent environment, which forces acquisition programs to manage technology, design, and manufacturing risks at the same time and can lead to waste from costly rework. This environment has made it difficult for either DOD or congressional decision makers to make informed decisions because appropriate knowledge has not been available at key decision points. Rather than seeking to reduce risk early in programs, DOD's common practice for managing this environment has been to create aggressive risk mitigation plans in its programs after poor investment decisions have been made. Figure 6 shows a generalization of the overlapping, concurrent approach that DOD uses to develop its weapon systems. As discussed earlier, in a large percentage of cases, DOD programs were still maturing technologies, stabilizing designs, and bringing production processes into control long after the program had entered production. This means that these programs were not achieving all three knowledge points (KP) until after entering production, long after the programs passed through decision points when this knowledge should have been available—a high-risk approach.

Figure 6: Best Practices Compared to DOD Practices for Programs in 2008 Assessment



Source: GAO.

More important, the problems created by this concurrent approach on individual programs can profoundly affect the pressure placed on DOD's budget. It is difficult to prioritize and allocate limited budgets among needed requirements when acquisition programs' costs and schedules are always in question. Programs that are managed without the knowledge-based process are more likely than other programs to have unpredictable cost and schedule implications that are accommodated by either reducing overall program quantities or disrupting the funding of other programs. Because of these disruptions, decision makers are not able to focus on a balanced investment strategy.

DOD Practices Continue to Contribute to Program Risk and Instability

Our work has shown that knowledge-based acquisition processes for individual programs are often lacking because DOD acquisition practices necessary to ensure effective implementation are not always followed, despite policies and guidance to the contrary. We have frequently reported on the importance of having a solid, executable business case before committing resources to new product development. In its simplest form, a sound business case provides evidence that (1) the warfighter's needs are valid and can best be met with the chosen concept and (2) the chosen concept can be developed and produced within existing resources—that is, proven technologies, along with adequate funding, design knowledge, and time to deliver the product when needed. Without the timely use of systems engineering activities, DOD does not effectively translate customer wants into specific product characteristics and functions, and ultimately into a preferred design. As a result, DOD weapon programs suffer from unexecutable business cases, resulting in unsettled requirements and funding instability, which can lead to unnecessary risks and long development cycle times.

Absence of Disciplined Systems Engineering Practices Leads to Unexecutable Business Cases

The absence of a knowledge-based acquisition process steeped in disciplined systems engineering practices contributes greatly to DOD's poor acquisition outcomes. Systems engineering is a process that translates customer wants into specific product features for which requisite technological, software, engineering, and production capabilities can be identified. These activities include requirements analysis, design, and testing to ensure that the product's requirements are achievable and designable given available resources. However, it is not just the use of systems engineering in the development of a new product or weapon system, but also when it is used, that makes it a best practice. Early systems engineering provides knowledge that enables a developer to identify and resolve gaps before product development begins, such as overly optimistic requirements that cannot be expected to be met with current resources. Consequently, establishing a sound acquisition program with an executable business case depends on determining achievable requirements, based on systems engineering, that are agreed to by both the acquirer and the developer before a program's initiation.

DOD programs often do not conduct systems engineering in a timely fashion to support critical investment junctures within programs or, in some cases, omit key systems engineering activities altogether. For example, the C-130 Avionics Modernization Program did not adequately analyze the product's requirements at the program's outset, a key systems engineering activity. As a result, when the program needed to integrate new avionics into the test aircraft, the amount of wiring and the number of harnesses and brackets needed for the installation had been underestimated by 400 percent. In another example, B-2 Radar Modernization Program officials also stated some key aspects of the systems engineering process were not completed. This caused schedule delays when technical problems with the antenna performance were discovered during flight testing. We have recently reported on the impact that poor systems engineering practices have had on several programs such as the Global Hawk Unmanned Aircraft System, F-22A, Expeditionary Fighting Vehicle, Joint Air-to-Surface Standoff Missile, and others.[8]

While these are anecdotal examples, they are indicative of the type of uncertainty that exists when DOD programs begin. Based on information obtained from 43 programs, our analysis shows that 58 percent of the programs had to reset their baseline at least once. Some programs have had a significant number of rebaselines, such as the V-22 program, which has had to reset its baseline 10 times.

Program Uncertainties Lead to Unnecessary Risks

DOD often sets optimistic requirements for weapon programs that require new and unproven technologies. Unfortunately, when early analysis is not performed to ensure that specific DOD needs can be met and that requirements are firmly established and understood prior to starting system development, increased cost risk to the government can occur. During weapon system development, DOD often asks prime contractors to

[8]GAO, *Best Practices: Increased Focus on Requirements and Oversight Needed to Improve DOD's Acquisition Environment and Weapon System Quality,* GAO-08-294 (Washington D.C.: Feb. 1, 2008).

develop cutting-edge systems and awards cost reimbursement type contracts for which the government pays the allowable incurred costs to the extent provided by the contract.[9] In these cases, the government reimburses the contractor for its best efforts in completing the contract requirements. However, because the government often does not perform the proper up-front analysis to determine whether its needs can be met, significant contract cost increases can occur as the scope of the requirements changes or becomes better understood by the government and contractor. As such, the consequences of poorly formed and analyzed requirements are manifested in these changes to contract costs over the course of the period of performance, with the government taking on the burden of the increases. For example, the Joint Strike Fighter and Future Combat Systems (FCS) are expected to be developed on a cost reimbursable basis for 12 years. As of fiscal year 2007, DOD anticipates having to reimburse the prime contractors on these two programs nearly $13 billion more for their work activities than initially expected. Table 5 illustrates eight development programs within the scope of our review that use cost reimbursement type contracts and have experienced or anticipate significant increases to initial contract prices.

Table 5: Significant Changes to Contract Prices for DOD Development Contracts

Then year dollars in millions

Program	Prime contractor	Initial contract target price [a]	DOD's estimated price at completion	Actual or anticipated price change	Percentage change
Joint Strike Fighter	Lockheed Martin	$18,981.9	$25,873.2	$6,891.3	36
Future Combat Systems[b]	Boeing	$14,924.8	$20,882.9	$5,958.1	40
National Polar-orbiting Operational Environmental Satellite System	Northrop Grumman	$2,942.7	$5,106.0	$2,163.3	74
Advanced Extremely High Frequency Satellites	Lockheed Martin	$2,839.0	$4,149.3	$1,310.3	46
Expeditionary Fighting Vehicle	General Dynamics	$712.1	$1,283.9	$571.8	80

[9]In contrast, a firm-fixed price contract provides for a pre-established price, and places more risk and responsibility for costs and resulting profit or loss on the contractor and provides more incentive for efficient and economical performance. With either a cost reimbursement or a firm-fixed price type contract, if the government changes the requirements after performance has begun, which then causes a price or cost increase to the contractor, the government must pay for these changes.

(Continued From Previous Page)

Then year dollars in millions

Program	Prime contractor	Initial contract target price [a]	DOD's estimated price at completion	Actual or anticipated price change	Percentage change
Excalibur Precision Guided Extended Range Artillery Projectile	Raytheon	$51.2	$518.0	$466.8	912
C-130 Avionics Modernization Program	Boeing	$484.6	$2,048.4	$1,563.8	323
Joint Tactical Radio System Ground Mobile Radio	Boeing	$235.5	$966.3	$730.8	310

Source: GAO analysis of data from DOD's Selected Acquisition Reports.

[a]Price means cost plus any fee or profit applicable to the contract type.

[b]Future Combat Systems began under an Other Transaction Authority agreement but was converted to a traditional contract subject to the Federal Acquisition Regulation in 2005. Both the agreement and the contract provided for reimbursement of the vendors costs. The initial contract target price reflects the price under the Other Transaction Authority agreement and DOD's estimated price at completion reflects estimated costs of the contract.

We have found examples of programs extending the use of cost reimbursement contracts into the production phase instead of using fixed priced contracts, reflecting uncertainties as programs enter production. For example, the Joint Strike Fighter plans to use cost reimbursement contracts for as many as 7 years worth of low-rate initial production orders. According to program officials, it hopes to transition to a fixed price contract sometime before full-rate production, but by this time it could have procured over 275 aircraft at a cost of over $40 billion.

Long DOD Development Cycle Times Contribute to Instability

A hallmark of an executable program with a sound business case is short development cycle times. Long cycle times promote instability, especially considering DOD's tendency to have changing requirements and program manager turnover. In fact, DOD itself suggests that system development should be limited to about 5 years. Time-defined constraints such as this are important because they serve to limit the initial product's requirements, allow for more frequent assimilation of new technologies into weapon systems, and speed new capabilities to the warfighter. Most programs we assessed were based on cycle times much longer than those prescribed through best practices. While there are isolated examples of programs with cycle times shorter than 5 years, the majority of programs included in our assessment were established with cycle times much longer than this. For 34 programs that have been started since 2001, only 11 programs (32 percent) even planned their development cycle times to be less than 5 years.

Additional Factors Can Contribute to Poor Weapon Acquisition Outcomes

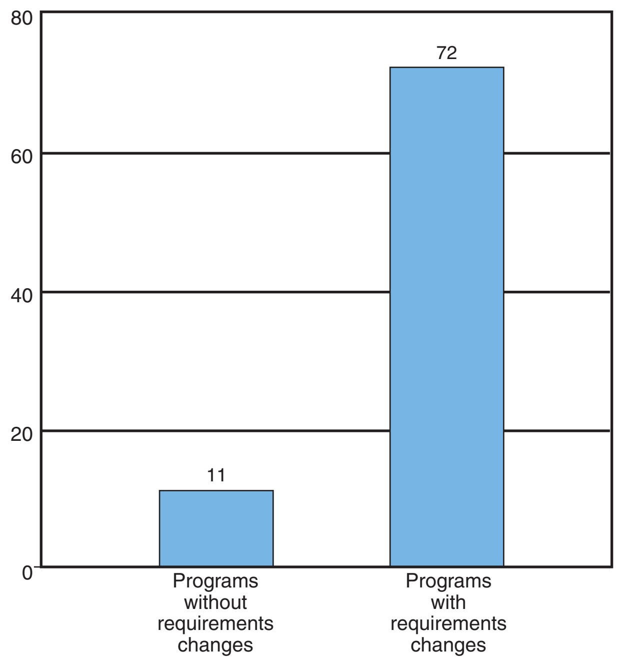
This year we also gathered new data focused on other factors we believe could have a significant influence on DOD's ability to improve cost and schedule outcomes. Foremost, several DOD programs in our assessment incurred requirements changes after the start of system development and also experienced cost increases. At the same time, DOD's practice of frequently changing program managers during a program's development makes it difficult to hold them accountable for the business cases that they are entrusted to manage and deliver. We also found that DOD is relying more on contractors to support the management and oversight of weapon system acquisitions and contracts, which could add risk to programs. Finally, as programs rely more heavily on software to perform critical functions for weapon systems, we found that a large number of programs are encountering difficulties in managing their software development.

Stable Requirements Are Needed for Improved Outcomes

As stated previously, establishing a valid need and translating that into system requirements is essential for obtaining the right program outcome. Without these, DOD increases the risk that it will pay too much for the system or enter too quickly into a business case that exposes the department to unnecessary risks. However, once DOD system development programs are under way, and despite efforts to define needed capabilities, product requirements often do change—the problem or threat the program was seeking to address changes or the user and acquisition communities may simply change their minds about a program. Among the 46 programs we surveyed, 63 percent of them indicated that requirements had changed in some fashion (additions, reductions, or deferments) since system development start. Our analysis of program data shows that this instability can have a profound impact on a program's costs. Figure 7 illustrates how RDT&E costs increased by 11 percent over initial estimates for programs that have not had requirements changes, while they increased 72 percent among those that had requirements changes.[10]

[10]This average does not include the C-130 J program because of its extreme RDT&E cost growth. The average including C-130 J is 210 percent.

Figure 7: Average RDT&E Cost Growth for Programs since Initial Estimates



Source: GAO analysis of DOD data.

Frequent Changes to Program Management Reduce Accountability

DOD frequently changes program managers during a product's development program, making it difficult to hold one program manager accountable for the content of the program's business case when it is established and to ensure that a knowledge-based acquisition process is followed. According to DOD policy, the assignment period for program managers is required to be at least until completion of the major milestone that occurs closest in time to the date on which the manager has served in the position for 4 years. We recently reported that rather than lengthy assignment periods, as suggested by best practices and DOD's own policy, many of the programs we reviewed had multiple program managers within the same milestone.[11] Our analysis indicates that for 39 major acquisition programs started since March 2001, the average time in system development was about 37 months. The average tenure for program

[11]GAO, *Defense Acquisitions: Department of Defense Actions on Program Manager Empowerment and Accountability*, GAO-08-62R (Washington, D.C.: Nov. 9, 2007).

managers on those programs during that time was about 17 months—less than half of what is required by DOD policy. This practice may promote shortsightedness, challenge continuity, and reduce accountability for poor outcomes. It might also discourage managers from raising issues and addressing problems early, keeping them from realistically estimating the resources needed to deliver the program. Consequently, program managers may have little incentive to pursue knowledge-based acquisition approaches, as program funding is not tied to successfully reaching knowledge points before a program can move forward.

As part of a new strategy for program manager empowerment and accountability, DOD plans a variety of actions to enhance development opportunities, provide more incentives, and arrange knowledge-sharing opportunities. For example, DOD intends to increase "just-in-time" training, establish a formal mentoring program, and plans to explore the use of monetary awards. However, the new practices DOD is planning to implement will not be as effective as they could be until DOD ensures that program managers are given acquisition programs that are executable—that is, programs that are the result of an integrated, portfolio-based approach to investments and that have a sound business case. Only then will program managers be placed in a better position to carry out their programs in a manner suited for successful outcomes.

DOD Relying Heavily on Contractors to Support Program Management Responsibilities

The federal government is increasingly reliant on the private sector in general and contractors in particular to deliver a whole range of products and services, provide hard to find skills, augment capacity on an emergency basis, and reduce the size of government.[12] At a time when weapon acquisitions are becoming more complex and larger in size, DOD is likewise relying more on contractors and other non-government personnel to help manage and oversee weapon system programs and their contractors. On the basis of our work looking at various weapon systems, we have observed that DOD has given contractors increased program management responsibilities for activities such as developing requirements, designing products, and estimating costs—key aspects of setting and executing a program's business case. Table 6 shows that the 52 DOD programs that provided information indicated that about 48 percent

[12] *Report of the Acquisition Advisory Panel to the Office of Federal Procurement Policy and the United States Congress* (January 2007).

of the program office staff was composed of individuals outside of the government.

Table 6: Program Office Staffing Composition for 52 DOD Programs

Percentage of staff

	Program management	Administrative support	Business functions	Engineering and technical	Other	Total
Government	**70**	**39**	**64**	**48**	**45**	**52**
Support contractors	22	60	35	34	55	36
Other non-government[a]	8	1	1	18	1	12
Total non-government	**30**	**61**	**36**	**52**	**56**	**48**

Source: GAO analysis of DOD data.

Note: Table may not add due to rounding.

[a]Other includes federally funded research and development centers, universities, and affiliates.

GAO has noted that the DOD workforce faces serious challenges and has expressed concerns about DOD's reliance on contractors to perform roles that have in the past been performed by government employees. Without the right-sized workforce, with the right skills, we believe this could place greater risk on the government for fraud, waste, and abuse.[13] In part, this increased reliance has occurred because DOD is experiencing a critical shortage of certain acquisition professionals with technical skills as it has downsized its workforce over the last decade. For example, in a prior review of space acquisition programs, we found that 8 of 13 cost-estimating organizations and program offices believed the number of cost estimators was inadequate and we found that 10 of those offices had more contractor personnel preparing cost estimates than government personnel. We also found examples during this year's assessment where the program offices expressed concerns about having inadequate personnel to conduct their program office roles.

[13]GAO, *DOD Transformation: Challenges and Opportunities*, GAO-08-323CG (Washington D.C.: Nov. 29, 2007).

Effective Software Management Necessary for Delivering Critical Capability

Modern weapon systems are increasingly more dependent on software than anytime before, and the development of complex software represents a potential leap forward in operational capability for any number of DOD defense acquisitions. Much of a system's functionality is controlled by software. Technological advancements have even made it possible for software to perform functions once handled by hardware. As this demand for complex software grows, the use of disciplined, structured development processes that measure, manage, and control software requirements is essential to delivering software-intensive systems on time and within budget. Our prior work has shown that one key metric used by leading software developers is to measure changes to the amount of software code developed for the program.[14] Size metrics, such as lines of code, are used to compare the amount of software code produced with the amount originally estimated. Changes to the size needed can indicate potential cost and schedule problems.

We have found cases where programs continue to have difficulties in managing software development for weapon systems. Roughly half of the programs that provided us software data had at least a 25 percent growth in their expected lines of code since system development started. For example, software requirements were not well understood on the FCS program when the program began, and as the program moves toward preliminary design activities, the number of lines of software code has nearly tripled. Also, the Expeditionary Fighting Vehicle program experienced software growth during system development, and the Marine Corps testing agency identified software test failures as a factor affecting the system's reliability.

Recent DOD Actions Provide Opportunities for Improvement

In February 2007, DOD, in response to congressional direction, issued a report on the department's acquisition transformation initiatives and the goals established to achieve change.[15] Within that report, DOD noted that every aspect of how the department does business was being assessed and streamlined to deliver improved capabilities to the warfighter and visibility

[14]GAO, *Defense Acquisitions: Stronger Management Practices are Needed to Improve DOD's Software-intensive Weapon Acquisitions*, GAO-04-393 (Washington, D.C.: Mar. 1, 2004).

[15]Department of Defense, *Secretary of Defense, Defense Acquisition Transformation: Report to Congress* (Washington, D.C.: February 2007).

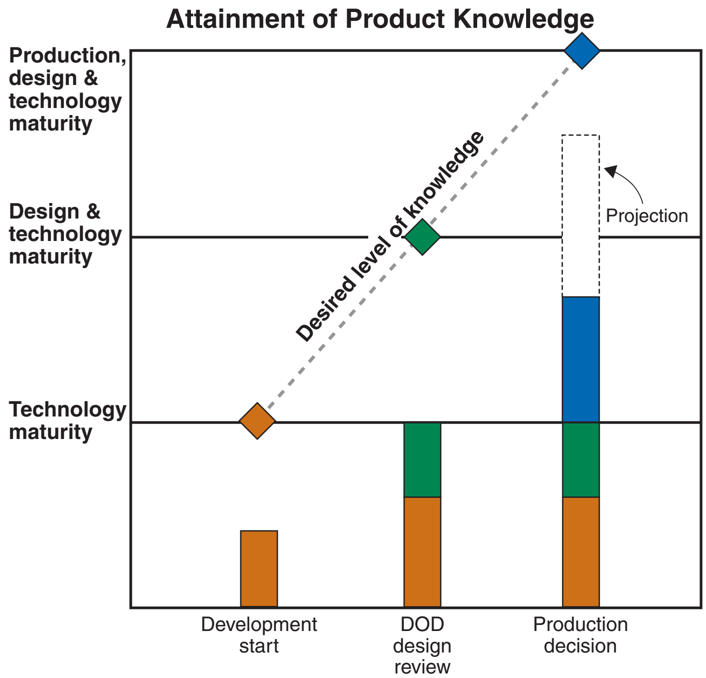
to executive leadership. The report also noted the need for continuous and evolutionary changes across the DOD acquisition system, especially with regard to determining which assets and investments to acquire in order to meet desired capabilities. Future reports on acquisition transformation are expected to build on the outcomes of initiatives described in that report. As such, DOD has set forth its intention to change the strategic environment at the portfolio level. DOD also plans to implement new practices mentioned earlier, similar to past GAO recommendations that are intended to provide program managers more incentives, support, and stability. The department acknowledges that any actions taken to improve accountability must be based on a foundation whereby program managers can launch and manage programs toward greater performance, rather than focusing on maintaining support and funding for individual programs. DOD acquisition leaders have told us that any improvements to program managers' performance hinge on the success of these departmental initiatives.

We have reported that DOD should develop an overarching strategy and decision-making processes that prioritize programs based on a balanced match between customer needs and available department resources. Within its strategy and other reports, DOD has highlighted several initiatives that, if adopted and implemented properly, could provide a foundation for improved outcomes. For example, DOD is experimenting with a new concept decision review practice, selection of different acquisition approaches according to expected fielding times, and panels to review weapon system configuration changes that could adversely affect program cost and schedule. The DOD strategy emphasizes that initiatives designed to improve program manager performance can be successful only if the strategic objectives are accepted and implemented. In addition, in September 2007 the Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics issued a policy memorandum to ensure weapon acquisition programs are able to demonstrate key knowledge elements that could inform future development and budget decisions. This policy directed pending and future programs to include acquisition strategies and funding that provide for two or more competing contractors to develop technically mature prototypes through Milestone B (knowledge point 1), with the hope of reducing technical risk, validating designs and cost estimates, evaluating manufacturing processes, and refining requirements. Each of the initiatives is designed to enable more informed decisions by key department leaders well ahead of a program's start, decisions that provide a closer match between each program's requirements and the department's resources. Our work has shown that if this is to occur, all of the players involved with acquisitions—the requirements community, the comptroller, the Under Secretary of Defense for Acquisition, Technology, and Logistics; and perhaps most importantly, the military services—must be unified in implementing these new policies from top to bottom.

How to Read The Knowledge Graphic for Each Program Assessed

We assess each program in two pages and depict the extent of knowledge in a stacked bar graph and provide a narrative summary at the bottom of the first page. As illustrated in figure 8, the knowledge graph is based on the three knowledge points and the key indicators for the attainment of knowledge: technology maturity (depicted in orange), design stability (depicted in green), and production maturity (depicted in blue). A "best practice" line is drawn based on the ideal attainment of the three types of knowledge at the three knowledge points. The closer a program's attained knowledge is to the best practice line, the more likely the weapon will be delivered within estimated cost and schedule. A knowledge deficit at the start of development—indicated by a gap between the technology knowledge attained and the best practice line—means the program proceeded with immature technologies and faces a greater likelihood of cost and schedule increases as technology risks are discovered and resolved.

Figure 8: Depiction of a Notional Weapon System's Knowledge as Compared with Best Practices



Source: GAO.

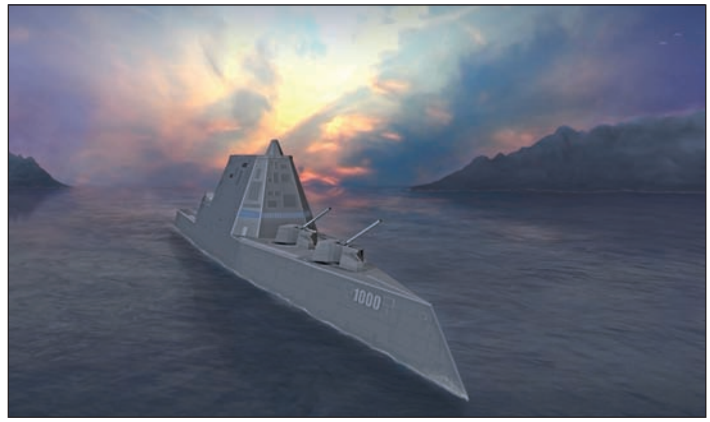
An interpretation of this notional example would be that the system development began with key technologies immature, thereby missing knowledge point 1. Knowledge point 2 was not attained at the design review, as some technologies were still not mature and only a small percentage of engineering drawings had been released. Projections for the production decision show that the program is expected to achieve greater levels of maturity but will still fall short. It is likely that this program would have had significant cost and schedule increases.

Assessments of Individual Programs

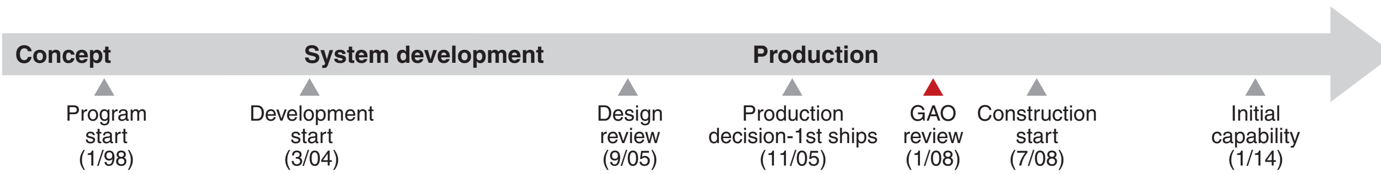
Our assessments of the 72 weapon programs follow.

DDG 1000 Destroyer

The Navy's DDG 1000 destroyer (formerly known as DD(X)) is a multimission surface ship designed to provide advanced land attack capability in support of forces ashore and contribute to U.S. military dominance in littoral operations. The program awarded contracts for detail design in August 2006 and negotiated contract modifications for construction of two lead ships in February 2008. The program will continue to mature its technologies and design as it approaches construction start, currently planned for July 2008.



Source: PEO Ships (PMS 500).



Program Essentials

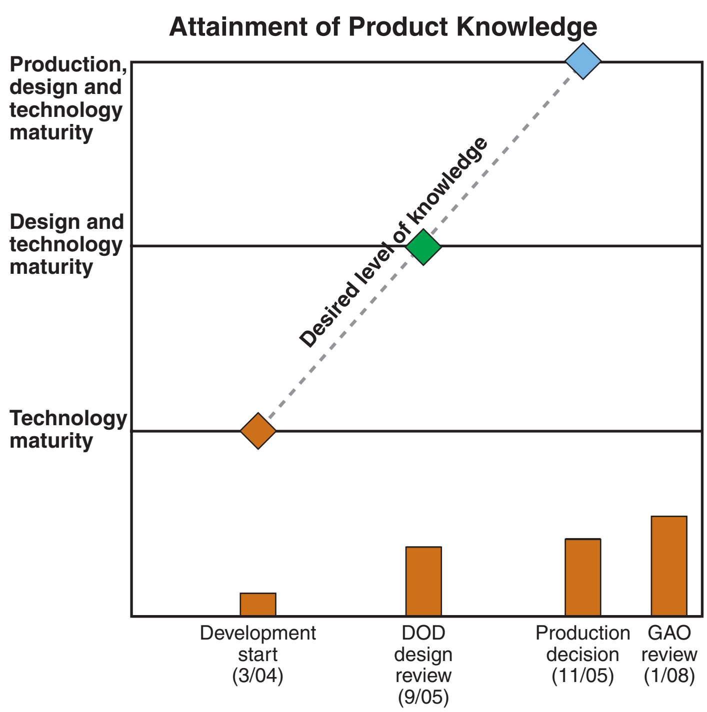
Prime contractor: BAE Systems, Bath Iron Works, Northrop Grumman Shipbuilding, Raytheon
Program office: Washington, D.C.
Funding needed to complete:
R&D: $2,336.4 million
Procurement: $20,291.3 million
Total funding: $22,627.7 million
Procurement quantity: 10

Program Performance (fiscal year 2008 dollars in millions)

	As of 01/1998	Latest 12/2006	Percent change
Research and development cost	$2,163.3	$9,342.4	331.9
Procurement cost	NA	$23,734.9	NA
Total program cost	NA	$33,076.9	NA
Program unit cost	NA	$3,307.694	NA
Total quantities	0	10	NA
Acquisition cycle time (months)	128	192	50

Quantity based on the approved program estimate, the Navy's shipbuilding plan estimates 7 ships.
Costs increased due to changes in quantities, technology development, and program restructuring.

Three of 12 DDG 1000 critical technologies are fully mature, having been demonstrated in a sea environment. While 7 other technologies are approaching full maturity, 5 of them will not demonstrate full maturity until after installation on the ship. Two technologies remain at lower levels of maturity—the volume search radar and total ship computing environment. Land-based testing of a volume search radar prototype is expected to begin in May 2008—a delay of over 12 months since last year's assessment. Software development for the total ship computing environment has been replanned, shifting functionality to later software blocks. The Navy plans on completing 85 percent of the ship's detail design prior to the start of construction.



DDG 1000 Program

Technology Maturity

The volume search and multifunction radars constitute the dual band radar system. While the multifunction radar has been tested at sea, the volume search radar continues to experience delays. Problems in developing the prototype and constructing the test facility have delayed land-based testing of the volume search radar by over a year. In order to support the ship construction schedule, the Navy has begun initial testing at an alternate test site. Because of issues with a critical circuit technology, the volume search radar will not demonstrate full power output until at least 2010—after production of the dual band radar is well under way. Problems or delays discovered during testing will likely affect radar production and installation.

The total ship computing environment includes hardware and six blocks of software code. Current software development is focused on the fourth block. The Navy has reduced its software development efforts in order to accommodate available funding. As a consequence, some functionality has been deferred to blocks five and six. The Navy believes that cost and schedule parameters will still be achieved by leveraging non-development items and existing software code. However, full maturity will not occur until after the start of ship construction.

Of the seven technologies approaching full maturity, the Navy expects to demonstrate full maturity of the integrated deckhouse and peripheral vertical launch system by the start of ship construction in July 2008. Production of a large-scale deckhouse test unit is under way and final validation of the vertical launching system will occur in spring 2008. Practical limitations prevent the Navy from fully demonstrating all critical technologies at sea prior to ship installation. Testing of other technologies continues through ship construction start.

Due to scheduling issues for the lead ships, the Navy did not have time to fully test the integrated power system prior to shipyard delivery and instead requested funds in fiscal year 2008 to procure an additional unit. The Navy will conduct integrated power system testing in 2010 using this unit at a land-based test site. Considerable software development remains and land-based testing will mark the first integrated testing between the power generation and distribution system and the control system. If problems are discovered during testing, construction plans and costs could be at risk because the power systems needed for the first two ships will already have been delivered to the shipyards.

The Navy continues to test prototypes of the ship's hull form to demonstrate stability in extreme sea conditions at higher speeds. According to Navy officials, existing computer simulation tools over-predicted the ship's tendency to capsize. The Navy is now relying on testing of scale models in tanks and on the Chesapeake Bay, and is updating its computer simulation tool. Ongoing testing is aimed at developing guidance for operating the ship safely under different sea conditions.

Design Stability

The Navy estimates that it will complete 85 percent of the detail design prior to the start of lead ship construction. While design progress is being made, the program faced initial technical difficulties in sharing the design tool between shipbuilders. Processing changes between shipyards and contractors resulted in some delays. According to the Navy, the program is on track to reach its design targets. Successfully meeting its target requires that DDG 1000 technologies develop according to plan.

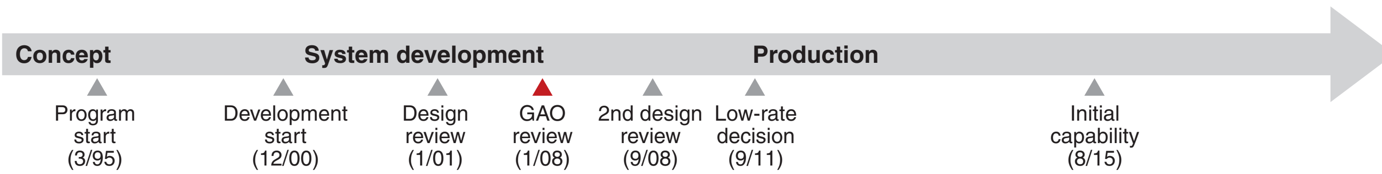
Agency Comments

The Navy stated that DDG 1000 will have the most mature design of any surface combatant at the start of fabrication, resulting in a more affordable construction, with fewer changes. According to the Navy, successful completion of its design review in 2005 certifies that its critical technologies are capable of performing at planned levels and sufficiently mature to remain in the ship baseline, continuing into detail design and construction. Due to the long timeline required to design, develop, and deliver a Navy ship, the Navy stated that some concurrency is unavoidable to prevent the immediate obsolescence of technologies and preclude additional costs associated with stretching the timeline to allow all technologies to reach readiness levels meeting GAO best practice criteria prior to the start of ship construction. The Navy concluded that DDG 1000 strikes the best balance between management risk and delivering required capability within cost and schedule.

Expeditionary Fighting Vehicle (EFV)

The Marine Corps' EFV is designed to transport troops from ships offshore to inland destinations at higher speeds and from longer distances than the system it is designed to replace, the Assault Amphibious Vehicle 7A1 (AAV-7A1). The EFV will have two variants---a troop carrier for 17 combat equipped Marines and 3 crew members and a command vehicle to manage combat operations in the field. We assessed both variants.

Source: EFV Program Office.



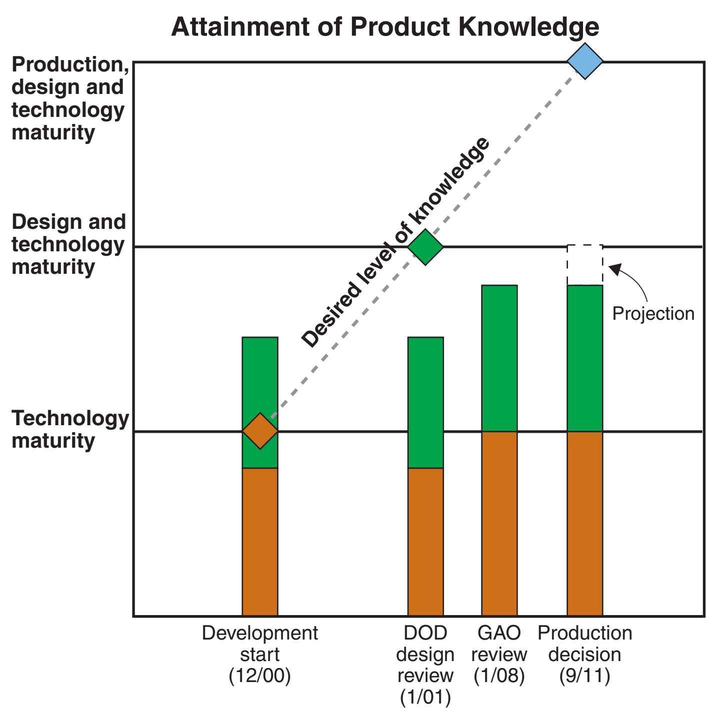
Program Essentials

Prime contractor: General Dynamics
Program office: Woodbridge, Va.
Funding needed to complete:
R&D: $1,279.5 million
Procurement: $9,632.3 million
Total funding: $10,978.7 million
Procurement quantity: 573

Program Performance (fiscal year 2008 dollars in millions)

	As of 12/2000	Latest 08/2007	Percent change
Research and development cost	$1,569.1	$3,565.0	127.2
Procurement cost	$7,037.3	$9,846.9	39.9
Total program cost	$8,696.7	$13,504.4	55.3
Program unit cost	$8.485	$22.773	168.4
Total quantities	1025	593	-42.1
Acquisition cycle time (months)	138	245	77.5

The EFV's technologies are mature. However, the system design proved unstable following the original design review. After reliability shortfalls were discovered, the program was restructured to extend development, initiate a design-for-reliability process, and to enhance program oversight and monitoring. The EFV is scheduled to have a second design review in September 2008, and projected initial capability has been delayed by almost 5 years, to 2015. Program officials said that the redesign of key systems should enable the program to meet reliability metrics. The program has currently identified 12 critical manufacturing processes, but does not require the contractor to use statistical process controls. The Navy reported a Nunn-McCurdy unit cost increase over the critical cost threshold in part because of reliability issues and quantity reductions.



EFV Program

Technology Maturity

All four of the EFV system's critical technologies are mature and have been demonstrated in a full-up system prototype. According to program officials, the current redesign effort will not affect the maturity of any of the existing critical technologies.

Design Stability

The EFV design was thought to be approaching stability at the time of the original design review. However, reliability shortfalls were discovered during an operational assessment in 2006 when the EFV achieved only a fraction of the required operational goal of 43.5 hours of operations before maintenance was required. Given the discovery of problems with reliability, the program was restructured to extend development efforts and build a second set of prototypes. The program is redesigning various systems, such as the drivetrain, and plans to monitor their predicted and demonstrated reliability. The program reports that 70 percent of its design drawings have been released to manufacturing and expects to release all drawings by the newly established design review in September 2008. This schedule may be ambitious given the design instability related to ongoing redesign and testing efforts to resolve reliability issues.

The EFV design currently has a flat hull, which enables the vehicle to move very quickly over the water. Program officials said they recently completed a review of using a "v-shaped" hull, and found that such a hull would reduce the vehicle's vulnerability to ground-based explosive devices, but would make it impossible to meet its key performance parameters. In order to provide additional blast protection, officials said additional hull belly armor could be added to the vehicle for land operations.

Production Maturity

The program office currently does not require the contractor to use statistical process controls to ensure critical processes will produce products within cost, schedule, performance, and quality targets. Instead, the program is using production representative processes for the manufacture of prototype vehicles during development. Twelve critical processes have been identified so far and will be used to manufacture the next seven prototype vehicles. The program expects to continue to evolve these processes.

Other Program Issues

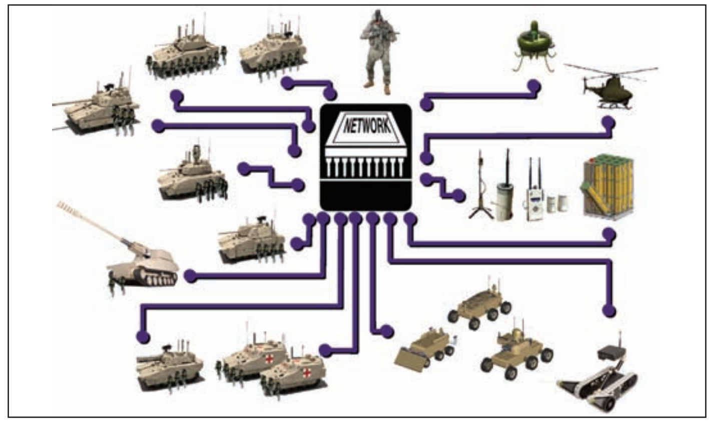
In February 2007, the Navy reported a Nunn-McCurdy unit cost increase over the critical cost growth threshold. Various factors contributed to cost increases, including reliability challenges, optimistic estimating assumptions, and reduced procurement quantities because of changes in the Marine Corps ground mobility strategy. After a comprehensive review, the program was restructured in June 2007 to extend system development. This will delay initial production to 2011 to allow for development of a second set of prototypes to resolve reliability issues. Furthermore, the Under Secretary of Defense for Acquisition, Technology and Logistics has established a set of oversight, monitoring, and reporting mechanisms to ensure successful management of the program.

Agency Comments

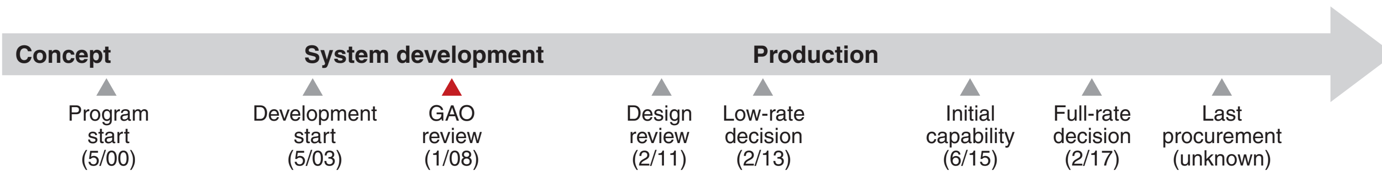
The program office provided technical comments to a draft of this assessment, which were incorporated as appropriate.

Future Combat Systems (FCS)

The FCS program consists of an integrated family of advanced, networked combat and sustainment systems; unmanned ground and air vehicles; and unattended sensors and munitions intended to equip the Army's new transformational modular combat brigades. Within a system-of-systems architecture, FCS features 14 major systems and other enabling systems along with an overarching network for information superiority and survivability. This assessment focuses on the full FCS program.



Source: U.S. Army.



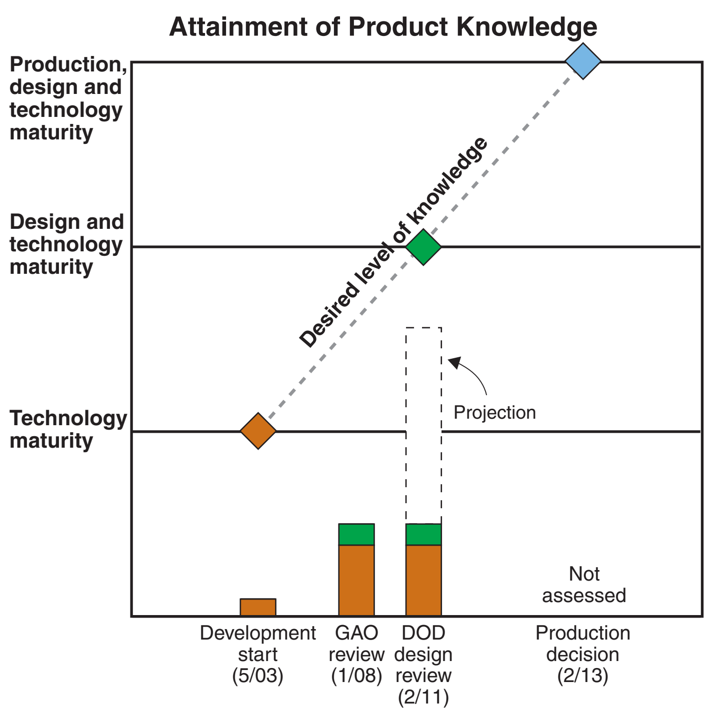
Program Essentials

Prime contractor: Boeing
Program office: Hazelwood, Mo.
Funding needed to complete:
R&D: $16,651.9 million
Procurement: $99,275.0 million
Total funding: $116,657.9 million
Procurement quantity: 15

Program Performance (fiscal year 2008 dollars in millions)

	As of 05/2003	Latest 12/2006	Percent change
Research and development cost	$20,537.8	$28,478.2	38.9
Procurement cost	$67,060.0	$99,275.0	48.0
Total program cost	$88,278.7	$128,483.8	45.5
Program unit cost	$5,885.245	$8,565.589	45.5
Total quantities	15	15	0
Acquisition cycle time (months)	91	145	59.3

Since last year's assessment, the Army has made progress maturing six technologies, but three other critical technologies are now assessed as less mature. The Army continues to define the requirements for core FCS systems, and contractors continue to refine their initial designs. Testing of the initial FCS items to be delivered to current Army forces is expected to begin in fiscal year 2008. The Army also plans to begin initial production of both the Non-Line-of-Sight Cannon and a few other related systems in fiscal year 2009. The Army has eliminated four of the core FCS systems due to budget considerations. The Army's development cost estimate for FCS is much lower than two independent estimates and is based on less demonstrated knowledge than would normally be expected near the midpoint of development.



FCS Program

Technology Maturity

Only 2 of the program's 44 technologies are fully mature and 30 are nearing full maturity. Based on the Army's assessment, 6 technologies have demonstrated higher maturity since last year, but 3 are now assessed as less mature. All critical technologies may not be fully mature until the Army's production decision in February 2013. The next independent verification of FCS critical technologies should be available in early 2009 for the preliminary design review.

The Army is using a phased approach to "spin out" mature FCS equipment to current forces, provided the equipment demonstrates military utility during testing. Testing of the initial spinout items should begin in fiscal year 2008. Because technical issues have delayed development of new radios, the Army will be testing spinout hardware using surrogate radios. As currently scheduled, production-representative radios will not be available for testing until at least 2009, which is after the production decision for spinout items.

Design Stability

The Army plans to conduct a preliminary design review in February 2009 and a critical design review in February 2011. At the critical design review, the Army expects to have completed 90 percent of FCS design drawings. FCS contractors have released some design drawings for a small number of systems that are candidates for near-term spinout fielding including unattended sensors, the Non-Line-of-Sight Launch System, and various communications equipment. Contractors have also released some design drawings for an early production version of the Non-Line-of-Sight Cannon. The vehicles are being built to satisfy a congressional mandate for the early fielding of cannon vehicles.

Production Maturity

Since the low-rate production decision for the core FCS systems is not scheduled until February 2013, we did not assess production maturity. However, the Army plans to spend more than $5 billion to begin initial production of both the Non-Line-of-Sight Cannon and a few spinout systems in 2009—4 years before the program's system-of-systems production decision and before any of the other manned ground vehicles are subject to any developmental, live fire, or operational testing. The Army intends to use a sole source contract with the current lead system integrator for all FCS low-rate production.

Other Program Issues

Since last year's assessment, the Army deleted four systems and made several other adjustments to the FCS development program based largely on budgetary constraints. The Army also reduced the annual FCS production rate and stretched out the production phase by about 5 years, also due to budgetary limitations. As a result, total cost estimates for the program were slightly reduced.

The Army's FCS development cost estimate depends on a number of assumptions. Historically, programs using such assumptions tend to underestimate costs. Program officials stated they will not spend more in development than the current value of the FCS development contract. Any projected cost overruns would be eliminated by deleting requirements, forcing the user to forego certain capabilities.

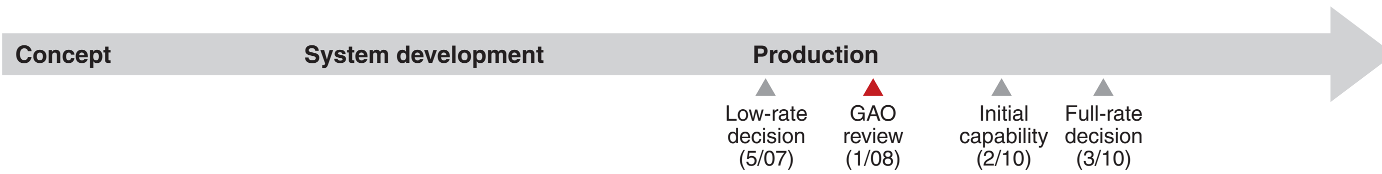
Agency Comments

In commenting on a draft of this assessment, the Army provided technical comments, which were incorporated as appropriate.

Joint Cargo Aircraft

Joint Cargo Aircraft (JCA) is a joint acquisition by the Army and the Air Force for a medium lift, fixed-wing aircraft which will move mission-critical and time-sensitive cargo to tactical units in remote and austere locations. The six JCA missions are (1) critical resupply, (2) casualty evacuation, (3) air drop (personnel/supplies), (4) aerial sustainment, (5) troop transport, and (6) homeland security. This is a fully-developed commercial-off-the-shelf aircraft that is currently being delivered to multiple military customers worldwide.

Source: C-27J Spartan www.c-27j.com, ©2006 C-27J Team.



Program Essentials

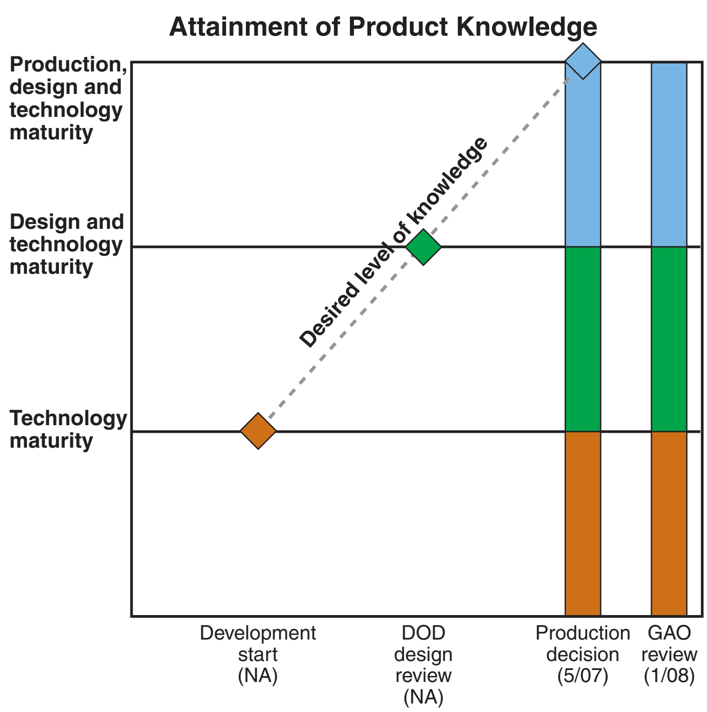
Prime contractor: L-3 Communications
Program office: Huntsville, Ala.
Funding needed to complete:
R&D: $98.7 million
Procurement: $3,590.7 million
Total funding: $3,689.4 million
Procurement quantity: 76

Program Performance (fiscal year 2008 dollars in millions)

	As of NA	Latest 08/2007	Percent change
Research and development cost	NA	$113.9	NA
Procurement cost	NA	$3,669.5	NA
Total program cost	NA	$3,783.1	NA
Program unit cost	NA	$48.502	NA
Total quantities	NA	78	NA
Acquisition cycle time (months)	NA	32	NA

Costs reflect Army's and Air Force's dollars through fiscal year 2013. Total program cost beyond fiscal year 2013 is to be determined.

The JCA is a commercial off-the-shelf procurement. No developmental efforts are planned, and the system's technology and design are mature. Production maturity is high since this aircraft is currently in use commercially. On June 13, 2007, the Army awarded a $2.04 billion contract with L-3 Communications for an initial quantity of 78 aircraft by 2013, along with training and support. The delivery date for the first aircraft is September 2008. The system is scheduled to undergo initial operational test and evaluation from September to November 2009 and its initial operational capability is planned for February 2010.



JCA Program

Technology Maturity

The JCA is an off-the-shelf procurement of a fully developed commercial aircraft that is currently produced and delivered to multiple military customers worldwide. As such, the JCA program office states that the system's technologies are mature. The Army submitted a technology readiness assessment for JCA in support of program entry at Milestone C. This assessment concluded that nondevelopmental capabilities presently embodied in both military and commercially available aircraft are sufficient to meet the JCA mission requirements without further technology development. The assessment also determined that there are no technology elements associated with the JCA's performance, manufacturing process, material, or tooling/manufacturing infrastructure that are new or novel or are being used in a new or novel way. The Office of the Director of Defense Research and Engineering concurred with this conclusion in a memorandum on May 30, 2007, and noted that the aircraft has been demonstrated in a relevant environment. It was also noted that if any future technology insertions are included in the JCA program, a technology certification should be revisited for those technologies.

Design Stability

We did not assess the JCA's design stability because program officials said that the design of the JCA is stable, since the aircraft is already a fully developed commercial aircraft.

Production Maturity

Program officials state that the production maturity is at a high level because the aircraft is commercially available, and production lines are already established. The delivery date for the first aircraft to the JCA program is September 2008. The system will undergo initial operational tests from September to November 2009 and be fielded shortly thereafter, in February 2010.

Other Program Issues

The Army awarded a low-rate initial production contract for 13 aircraft on June 13, 2007, with full-rate production decision scheduled for March 2010. A bid protest that was filed shortly after the contract award was resolved, but program officials stated that this had a 3 month impact on the JCA's schedule.

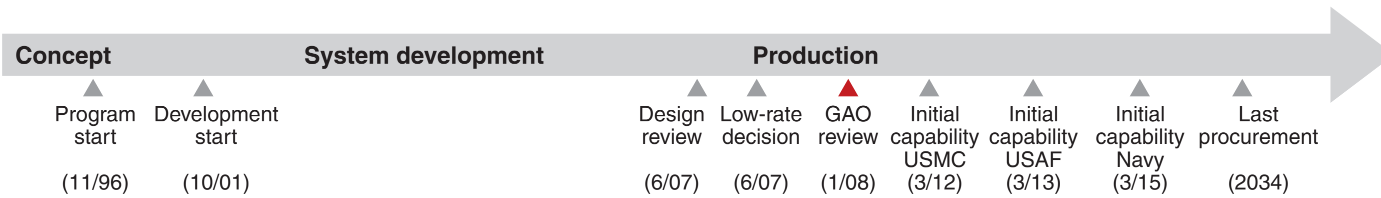
Agency Comments

In commenting on a draft of this assessment, the Army provided technical comments, which were incorporated as appropriate.

Joint Strike Fighter (JSF)

The JSF program goals are to develop and field a family of stealthy strike fighter aircraft for the Navy, Air Force, Marine Corps, and U.S. allies, with maximum commonality to minimize costs. The carrier-suitable variant will complement the Navy's F/A-18 E/F. The conventional takeoff and landing variant will primarily be an air-to-ground replacement for the Air Force's F-16 and the A-10 aircraft, and will complement the F-22A. The short takeoff and vertical landing variant will replace the Marine Corps' F/A-18 and AV-8B aircraft.

Source: JSF Program Office.



Program Essentials

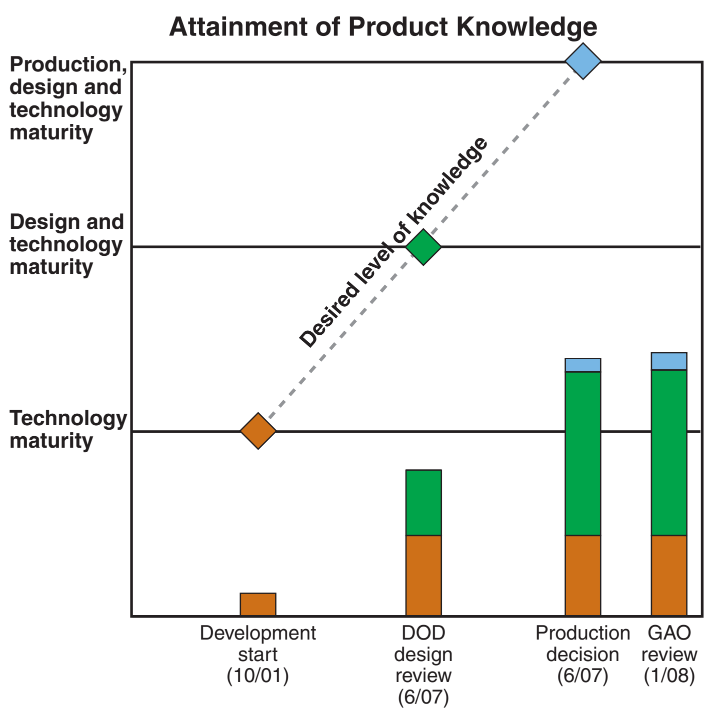
Prime contractor: Lockheed Martin
Program office: Arlington, Va.
Funding needed to complete:
- R&D: $13,976.3 million
- Procurement: $192,764.7 million
- Total funding: $207,178.9 million
- Procurement quantity: 2,441

Program Performance (fiscal year 2008 dollars in millions)

	As of 10/2001	Latest 12/2006	Percent change
Research and development cost	$37,015.8	$45,826.0	23.8
Procurement cost	$164,221.9	$193,652.1	17.9
Total program cost	$202,956.7	$239,974.3	18.2
Program unit cost	$70.815	$97.630	37.9
Total quantities	2,866	2,458	-14.2
Acquisition cycle time (months)	175	196	12.0

Cycle time calculations are based on the Air Force's inital capability because they represent over 70 percent of the procurement quantities.

Two of the eight JSF critical technologies are mature, three are nearing maturity, and three (mission systems integration, prognostics and health management, and manufacturing technologies) are still immature 6 years past the start of development. None of the variants demonstrated design stability at their design review, though two have now met the standard. The program collects data to manage manufacturing maturity, but currently unproven processes and a lack of flight testing could mean costly future changes to design and manufacturing processes. Program costs have continued to increase and the schedule has slipped since the 2004 rebaseline. Very little flight testing has occurred to date and the first fully integrated aircraft will not begin flight testing for at least 4 years. In 2007 DOD cut the number of test aircraft and flight test hours to maintain cost and schedule plans.



JSF Program

Technology Maturity

Two of the JSF's eight critical technologies are fully mature and three are approaching maturity, but three (mission systems integration, prognostics and health management, and manufacturing technologies) are immature despite being past the design review. Maturing critical technologies during development has led to cost growth, with the electric-hydraulic actuation and power thermal management systems costs increasing by 195 and 93 percent respectively since 2003.

Design Stability

As of August 2007, the contractor said it had released 99 percent of planned engineering drawings for the short takeoff and vertical landing variant, 91 percent for the conventional takeoff and landing variant, and 46 percent for the carrier variant. All three variants fell significantly short of meeting the best practices standard of 90 percent of drawings released by the critical design reviews—46 percent for the short takeoff and landing variant, 43 percent for the carrier variant, and 3 percent for the conventional takeoff and landing variant. The late release of drawings led to late parts deliveries, delaying the program schedule and forcing inefficient manufacturing processes. The program began production before delivering an aircraft representing the expected design.

Production Maturity

The program is collecting information on production maturity and reports that about 10 percent of its critical manufacturing processes are in statistical control. While we credit the program for collecting this information, efforts to mature production are constrained because the designs are not fully proven and tested, and manufacturing processes are not demonstrated. The first test aircraft completed needed 35 percent more labor hours than planned, and follow-on aircraft are not meeting a revised schedule put in place in 2007. Because of parts shortages and schedule delays, the test aircraft are being built differently from the process expected for the production aircraft. Flight testing, began in late 2006, is still in its infancy, with only 19 of some 5,500 planned flights completed as of November 2007. A fully integrated, capable aircraft is not expected to enter flight testing until 2012, increasing risks that problems found may require design and production changes, as well as retrofit expenses for aircraft already built.

Other Program Issues

Since the program rebaseline in fiscal year 2004, estimated acquisition costs have increased by about $55 billion (then-year dollars). Estimated procurement costs rose due to greater material costs, labor costs, and labor hours, a 7-year extension of the procurement schedule from fiscal year 2027 to 2034, and a reduction in annual production rates. Development costs since the rebaseline have been stable largely because the program removed about $2.8 billion for risk reduction and an alternate engine program. The program recently restructured development efforts to meet schedule and budget requirements. DOD cut the number of flight test aircraft and flight test sorties, putting greater reliance on the remaining flight test aircraft as well as ground tests to free up funds to replace dwindling management reserves.

Agency Comments

In commenting on a draft of this assessment, program officials challenged its balance, use of best practices, and depiction of program status. They noted the first aircraft is in flight test, includes all major subsystems, and along with other aircraft in work is showing unprecedented assembly fit and quality improvements with each aircraft. They stated the flying test bed is flying mission systems software and reducing risk prior to their first flight on a JSF in early 2009, and all mission systems are maturing as planned. The final software block enters testing in 2011, and later blocks mainly incorporate sensor and weapons updates after lab testing. Officials asserted that data on design maturity and drawing release at critical design reviews are not accurately presented, saying drawing changes are very low compared to legacy systems. They said their plan for spiral blocks of capability balances cost, schedule and risk, while GAO's approach would increase costs by billions and delay delivery of capability to warfighters.

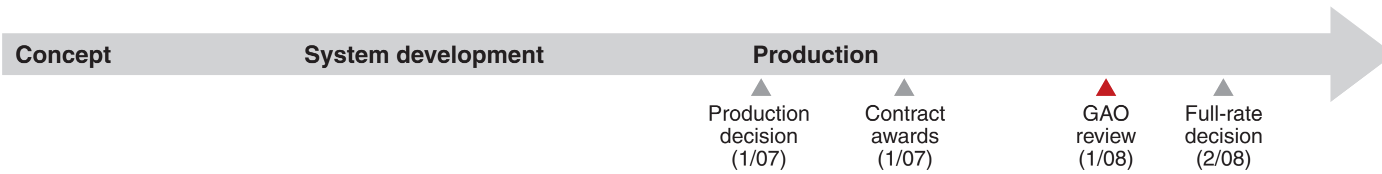
GAO Response

JSF cost increases and schedule delays are indicative of a program that consistently proceeds through critical junctures with knowledge gaps that expose the program to significant risks. The new plan to cut test assets and test activities is another example of adding risk.

Mine Resistant Ambush Protected (MRAP) Vehicle

The MRAP is a joint program led by the Navy and Marine Corps to procure a family of armored vehicles to protect personnel from mine blasts, and fragmentary and direct-fire weapons. DOD will acquire three categories of vehicles: Category I for urban combat missions; Category II for convoy escort, troop transport, explosive ordinance disposal, and ambulance missions; and Category III for clearing mines and improvised explosive devices. The Marine Corps, Army, Air Force, Navy, and Special Operations Command are acquiring vehicles.

Source: Joint MRAP Family of Vehicles Program Office.



Program Essentials

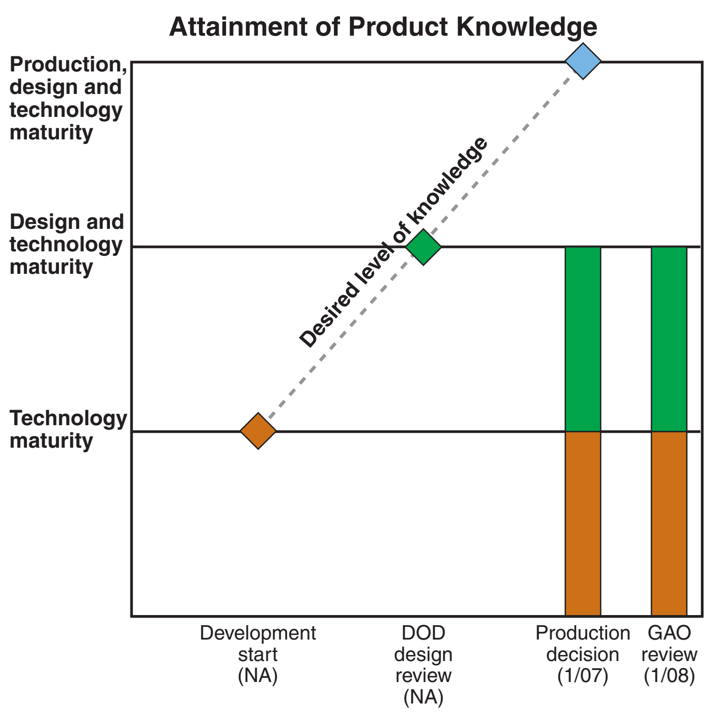
Prime contractor: Various
Program office: Quantico, Va.
Funding needed to complete:
R&D: TBD
Procurement: TBD
Total funding: TBD
Procurement quantity: TBD

Program Performance (fiscal year 2008 dollars in millions)

	As of NA	Latest 10/2007	Percent change
Research and development cost	NA	$177.3	NA
Procurement cost	NA	$12,552.6	NA
Total program cost	NA	$13,501.4	NA
Program unit cost	NA	$1.430	NA
Total quantities	NA	9439	NA
Acquisition cycle time (months)	NA	NA	NA

Latest cost and quantity estimate is based on the President's budgets and supplemental requests for fiscal years 2006 through 2008 but does not include recent orders for more vehicles.

The MRAP program is DOD's highest-priority acquisition program. To meet an urgent, joint-service operational need, DOD is buying MRAP as nondevelopmental items. The greatest challenge for vendors will be obtaining sufficient quantities of ballistic-grade steel. Another significant challenge will be producing enough tires to equip the fleet and provide for replacements. Finally, integration of government-furnished equipment is taking three times longer than desired. DOD is pursuing a very aggressive schedule while at the same time grappling with a significant number of unknowns that could delay fielding or increase costs. The program is trying to concurrently produce the baseline MRAP, develop and produce various upgrades, and develop an MRAP II vehicle.



MRAP Program

Production Maturity

DOD is buying MRAP vehicles as nondevelopmental items, so we did not assess whether production processes were mature. We did assess the ability of vendors to manufacture the required number of vehicles in the time frames needed to achieve accelerated production and fielding requirements.

The greatest challenge for vendors is obtaining sufficient quantities of ballistic-grade steel. A DOD assessment found there is sufficient steel available to produce the 11,891 contracted vehicles. However, as the total number of vehicles procured increases and the amount of armor per vehicle grows to meet the threat, there may not be enough steel. A second challenge is producing enough tires to equip the fleet and provide replacements. Tire production was expected to reach 9,500 per month by February 2008, but 20,000 per month could be needed to support production and replacement in the field. Replacement rates are not yet known.

DOD has taken steps to ensure availability of key materials. For example, DOD has given MRAP contracts a higher priority (DX rating) that requires these contracts to be accepted and performed before all other nonpriority government and commercial contracts. DOD has also allocated funds to procure an advance reserve of steel and to increase tire production capacity. In addition, some of the vendors and suppliers have made corporate investments to maximize capacity.

All vehicles come from the vendor without mission equipment, which must be integrated onto vehicles before fielding. This equipment is 20 percent of the total program cost and includes items such as a tracking system that identifies friendly forces and a system to jam improvised explosive devices. A large challenge is integrating the entire suite of mission equipment onto the vehicles in a timely manner. It currently takes an average of 21 days to install the equipment on a vehicle, but the goal is to reduce that to 7 days. The plan is to process 50 vehicles per day for a total of 1,000 vehicles per month.

Other Program Issues

Due to urgent fielding requirements, the MRAP program is pursuing a very aggressive schedule while at the same time grappling with a significant number of unknowns, such as the total quantity required and the long-term sustainment strategy. DOD has taken steps to reduce these risks, including implementing a contracting strategy that only commited the government to purchase initial test assets. Additional purchases are based on demonstrated performance and production capability. Further, the focus of the effort is on crew protection, with reliability given less priority.

In order to rapidly field the vehicles, DOD substantially reduced the normal scope of test and evaluation. For example, there is no minimum requirement for vehicle reliability, and durability testing covered only 300 hard surface miles and 200 off-road miles in the first test phase. By the time the first phase of developmental testing had been completed, over 3,700 vehicles were already on order—a commitment of nearly $2 billion. The current plan places 11,891 vehicles on contract before operational effectiveness and operational suitability are determined. As a result, test results could lead to costly retrofits or replacements.

The program is concurrently pursuing the original baseline MRAP, varioius upgrades, and an MRAP II variant. In order to avoid a break in production, orders for additional vehicles may be necessary before test results are available for the upgrade efforts or the MRAP II.

DOD acknowledges that a long-term sustainability strategy and full life cycle support cost estimate has yet to be established. This is an area of risk that could have a large impact on DOD.

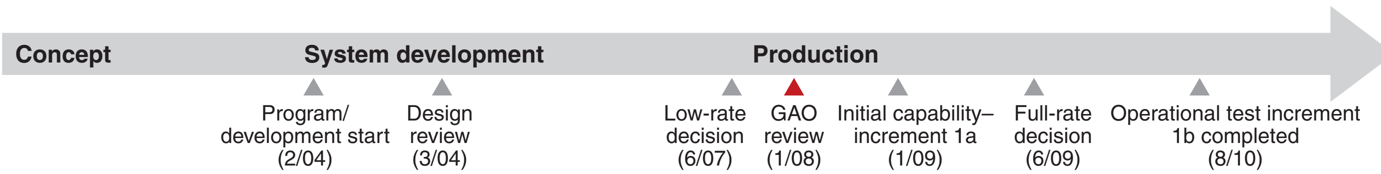
Agency Comments

Joint Program Office officals provided technical comments, which were incorporated. In commenting, officials characterized the test program as phased to support key decisions in order to field the most survivable vehicles as quickly as possible while addressing upgrades or modifications in future testing. As developmental and operational tests continue, vehicles will undergo additional reliability and durability testing. Changes resulting from these tests will be incorporated as appropriate.

Warfighter Information Network-Tactical (WIN-T), Increment 1

WIN-T is the Army's high-speed and high-capacity backbone communications network. WIN-T connects Army units with higher levels of command and provides the Army's tactical portion of the Global Information Grid. WIN-T is being restructured following a Nunn-McCurdy unit cost breach, and will be fielded in four increments. The first increment absorbs the former Joint Network Node-Network (JNN-N) program and provides the Army an initial battlefield networking capability down to the Army's battalion level. We assessed the first increment.

Source: PM, WIN-T.



Program Essentials

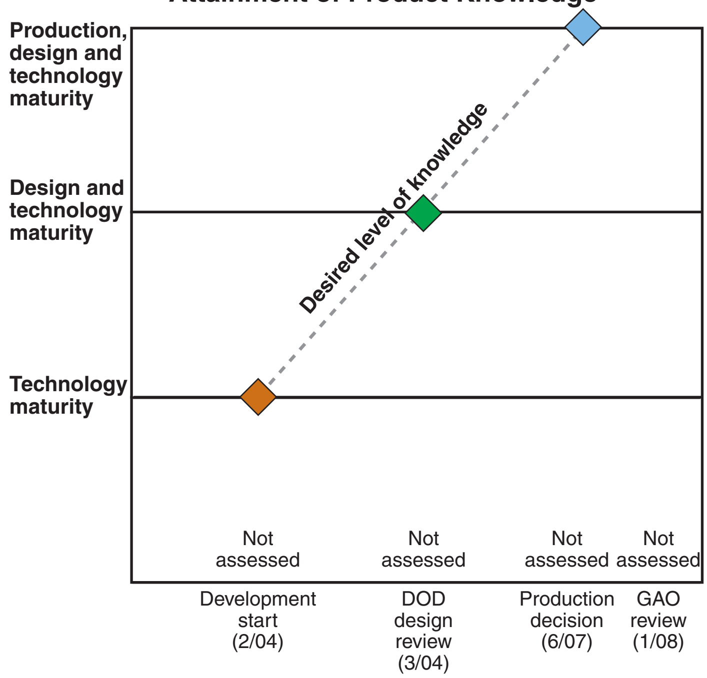
Prime contractor: General Dynamics C4 Systems
Program office: Fort Monmouth, N.J.
Funding needed to complete:
- R&D: $16.2 million
- Procurement: $1,789.3 million
- Total funding: $1,805.4 million
- Procurement quantity: 607

Program Performance (fiscal year 2008 dollars in millions)

	As of NA	Latest 10/2007	Percent change
Research and development cost	NA	$23.9	NA
Procurement cost	NA	$3,865.5	NA
Total program cost	NA	$3,889.0	NA
Program unit cost	NA	$2.319	NA
Total quantities	NA	1,677	NA
Acquisition cycle time (months)	NA	19	NA

Because its precursor, the JNN-N program, was based on mature commercial networking and satellite communications technologies, the Army had not initially identified any critical technologies for WIN-T Increment 1. Therefore we did not assess its technology maturity. The Army completed a technology readiness assessment for WIN-T Increment 1 in early 2008. While design stability is evaluated during design reviews, it cannot be assessed using our methodology because the program office does not produce releasable drawings for the design, which is based upon mature commercial hardware and software products. In October 2007, DOD approved an acquisition program baseline for Increment 1. The WIN-T overarching acquisition strategy was approved in early January; the Increment 1 annex to this strategy is in final processing.

Attainment of Product Knowledge



WIN-T Incr. I Program

Technology Maturity

Technology maturity for WIN-T Increment 1 could not be assessed because the Army had not identified any critical technologies for JNN-N, the precursor to WIN-T Increment 1. However, the June 2007 acquisition decision memorandum that approved the restructuring of the WIN-T program requires the Army to conduct a technology readiness assessment of the winning proposal for WIN-T Increment 1 within 120 days of contract award, and to submit this assessment to the department's Director for Defense Research and Engineering (DDR&E) for approval. As contract award took place in late September 2007, this technology readiness assessment was due to DDR&E by late January 2008. In February 2008, a DDR&E representative confirmed that her office had received the Army's assessment and was reviewing it. If the Army decides to insert technologies from future WIN-T increments into Increment 1, DDR&E must agree that those technologies are mature prior to insertion.

Design Stability

Design stability for WIN-T Increment 1 could not be assessed using our methodology because, according to a program office representative, the development program integrates mature hardware and software products and does not produce drawings for these commercial products. Rather, according to this representative, design stability is assessed during design reviews and subsequent testing of those designs. The program office also noted that it does not redesign the system from one production lot to another; rather, newer, more capable commercial components replace outdated components as they become available.

Other Program Issues

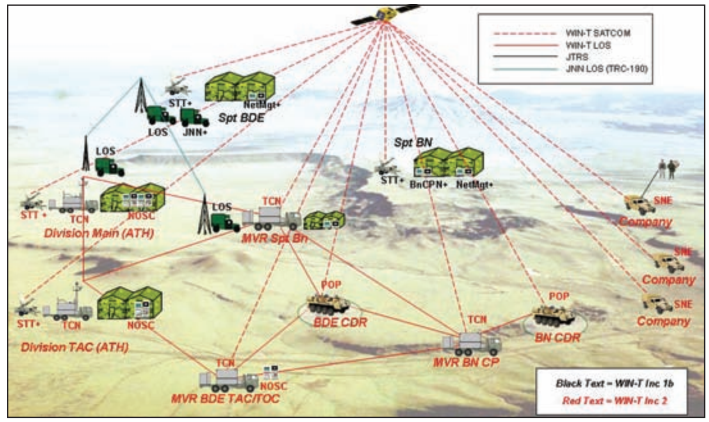
Previously, the Army fielded JNN-N as a separate beyond-line-of-sight communications network to units deployed in Iraq. JNN-N began the transitioning of the Army's communications systems to Internet protocol-based systems, and provided an interface to DOD communications services, such as the Defense Information Systems Network, with multiple levels of security. However, JNN-N was only established as a formal program when it was designated as the first increment of the restructured WIN-T program in June 2007. Prior to WIN-T restructuring, the Army had already procured 759 JNN-N nodes and proposed moving forward with the acquisition of low-rate initial production (LRIP) quantities of JNN-N equipment needed to conduct initial operational testing, and to equip deploying units. As of March 2007, shortly before the WIN-T restructuring, the Army had planned to acquire additional quantities of JNN-N to field to the rest of the Army once initial operational testing had been completed, a beyond-LRIP report had been submitted to Congress, and a full-rate production decision had been made. As a result of the WIN-T restructuring, the Under Secretary of Defense for Acquisition Technology and Logistics approved the Army moving forward with the acquisition of the full complement of needed JNN-N capabilities as the first increment of WIN-T. Initial operational tests will still be conducted in the first quarter of fiscal year 2009. Army representatives stated that recent statutory changes made by Section 231 of the National Defense Authorization Act for Fiscal Year 2007 grant the Director, Operational Test and Evaluation, the flexibility to deliver the beyond-LRIP report "as soon as practicable," and allow the Army to acquire Increment 1 assets in lots sized to meet its operational needs. The Army interprets this new statutory language to permit it to contract for quantities of WIN-T Increment 1 nodes in fiscal year 2008 to support operational needs, even if prior to the completion of initial operational testing required for a beyond-LRIP report. In September 2007, the Army contracted for 336 more Increment 1 nodes, 25 more than the 311 nodes identified as the LRIP quantities in the September 2007 WIN-T Increment 1 Selected Acquisition Report, which was submitted to Congress on November 14, 2007. This will be clarified in future SAR submissions.

Agency Comments

In commenting on a draft of this assessment, the Army provided technical comments, which were incorporated as appropriate.

Warfighter Information Network-Tactical (WIN-T), Increment 2

WIN-T is the Army's high-speed and high-capacity backbone communications network. WIN-T connects Army units with higher levels of command and provides the Army's tactical portion of the Global Information Grid. WIN-T is being restructured following a Nunn-McCurdy unit cost breach, and will be fielded in four increments. The second increment will provide the Army with an initial networking on-the-move capability, while the third will provide a full networking on-the-move capability and fully support the Army's Future Combat Systems.



Source: PM, WIN-T.

Concept | **System development** | **Production**

- Program/ development start (6/07)
- GAO review (1/08)
- Design review (2/08)
- Low-rate decision (4/09)
- Full-rate decision (11/10)
- Initial capability (8/11)

Program Essentials

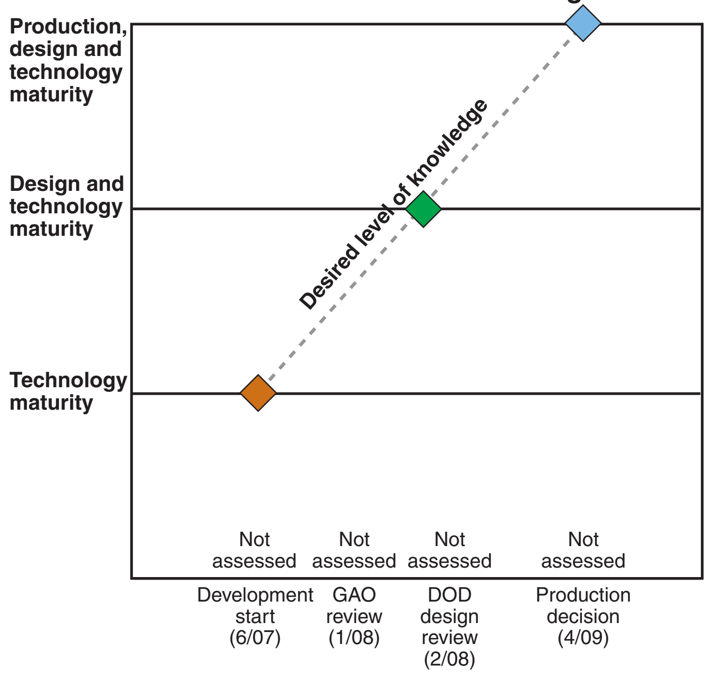
Prime contractor: General Dynamics C4 Systems
Program office: Fort Monmouth, N.J.
Funding needed to complete:
- R&D: $218.8 million
- Procurement: $3,301.4 million
- Total funding: $3,520.2 million
- Procurement quantity: 1,837

Program Performance (fiscal year 2008 dollars in millions)

	As of NA	Latest 10/2007	Percent change
Research and development cost	NA	$227.0	NA
Procurement cost	NA	$3,301.4	NA
Total program cost	NA	$3,528.4	NA
Program unit cost	NA	$1.864	NA
Total quantities	NA	1,893	NA
Acquisition cycle time (months)	NA	50	NA

The original WIN-T program entered system development in August 2003 with 3 of its 12 critical technologies nearing maturity. Insufficient technical readiness was cited as one of the key factors leading to the Nunn-McCurdy unit cost breach. Subsequently, DOD decided to field WIN-T incrementally using only mature technologies. However, on the basis of what was determined to be an insufficient body of evidence for assessing technology readiness, the Office of the Secretary of Defense and the Army have agreed that additional information will be provided in order to prove the critical technologies. While design stability will be evaluated during WIN-T design reviews, it cannot be assessed using our methodology because the program office does not track the number of releasable drawings.

Attainment of Product Knowledge



WIN-T Incr. 2 Program

Technology Maturity

Technology maturity for WIN-T Increment 2 could not be assessed because it was only recently separated from the original WIN-T system development effort, and the required technology readiness assessment for this increment has not yet been approved by the Office of the Secretary of Defense's Director of Defense Research and Engineering. In June 2007, the WIN-T program was restructured to field in four increments using technologies for each increment that DDR&E assesses as approaching maturity prior to establishment of the increment's baseline and fully mature prior to the start of production for the increment. Increment 2 will provide the Army with initial networking on-the-move capabilities, while future increments will provide full networking on-the-move capabilities, will fully support FCS, and will provide the Army protected satellite communication on-the-move.

The original WIN-T program entered system development with only 3 of its original 12 critical technologies approaching full maturity. Insufficient technical readiness was cited as one of the key factors leading to the March 2007 Nunn-McCurdy unit cost breach of the original WIN-T program. Moreover, while the Army had prepared a revised technology readiness assessment for the original WIN-T program in 2006, DDR&E did not concur with the Army's assessment for two of the five critical technology areas identified in this revised assessment—network operations and high-mobility networking. The Army was required to submit a new technology readiness assessment for WIN-T Increment 2 to DDR&E by early November 2007. DDR&E must agree that each critical technology assessed is approaching maturity—a prototype tested in a relevant environment—to be considered part of the system development baseline for this increment. While the Army and DDR&E were unable to reach consensus in 2006 on the maturity of the WIN-T's critical technologies, an agreement in principle has now been reached regarding how to measure such maturity. As agreed, the Army submitted an initial Increment 2 technology readiness assessment in November 2007; this assessment was updated with results from tests of Increment 2 capabilities that were held in October and November 2007. In February 2008, a DDR&E representative confirmed that her office had received the Army's updated assessment and is reviewing it.

Other Program Issues

In March 2007, the WIN-T program reported a Nunn-McCurdy unit cost breach to the congressional defense committees. In June 2007, the Under Secretary of Defense for Acquisition, Technology and Logistics provided formal certification of the restructured WIN-T program to Congress. The restructured program now consists of four increments, each governed by an overarching acquisition strategy for providing networking and communications capability to operational and tactical ground forces. Acquisition program baselines for Increments 1 and 2 were approved in October 2007. Establishment of an acquisition program baseline for WIN-T Increment 3, intended to field full networking on-the-move capabilities and to fully support the needs of the Army's Future Combat System, will take place once FCS requirements for WIN-T have been firmly established. A formal agreement between the WIN-T and FCS program managers was expected to be completed later this year, in time for the Increment 3 preliminary design review currently scheduled for August 2008.

Agency Comments

In commenting on a draft of this assessment, the Army provided technical comments, which were incorporated as appropriate.