

GAO Working with Congress to Improve the Information Technology Acquisition Processes

Without properly functioning hardware and software, the US Army's "Future Combat Systems" will be no more than a bunch of dumb boxes that sit and collect dust on the battlefield. Madhav Panwar and Lisa Pracchia of the General Accounting Office explains why Congress now places heavy emphasis - backed up by legislation - on the process for acquiring high quality computer hardware and software for military use.

Recent military operations around the world demonstrate the superiority of US weapon systems developed by the Department of Defense (DOD). Furthermore, an ever increasing percentage of a weapons system's functionality is provided by ever more sophisticated and complex software. While DOD has risen to the challenge, cost overruns and unsatisfactory performance have led the General Accounting Office (GAO) to designate DOD systems development and modernization efforts a high-risk area.

Significant risk factors include the enormous size and complexity of the software used by these systems. Furthermore, most DOD acquisition organizations (i.e., the program offices tasked with defining, developing and fielding weapons systems) lack both disciplined processes for managing software-intensive system acquisitions, and the contractors who develop the IT systems and software embedded in the weapons. As one Congressional source aptly described the acquisition of US weapons systems, "It's not about bending metal any more, it's about routing electrons."

Software enables a myriad of complex capabilities ranging from massive data fusion across geographically disparate large-scale sensor systems; to decision systems that automatically select the most appropriate weapon and platform to attack a given target; and on to autonomous systems that operate without human intervention to destroy incoming missiles. Software will create the network-centric operation, the cornerstone of DOD's transformation.

Other risk factors include the long-standing "cultural" issues highlighted in earlier GAO reports. Two of these remain relevant; the acquisition community's bias towards hardware and their attention to critical software issues too late in the acquisition process. Typically, program managers do not provide adequate oversight of the software phase of an acquisition, relying instead on contractors to manage themselves. While the Software Engineering Institute (SEI)¹ has provided software developers with various process improvement models, it is generally accepted that if the acquisition organization is at a low process maturity, then the entire program is at risk.



Marine Corp's V-22 -
Software Intensive Weapon System

In a 1998 CrossTalk article, Capers Jones of Software Productivity Research, Inc. defined a major DOD system as having 12.5 million C Statements and a development team numbered in the hundreds. A lack of mature development processes and communications were

known to pose problems on such large development efforts. Configuration control and change management were poorly implemented, and documentation and software rework absorbed the bulk of development costs. Partly as a result of these weaknesses, Jones estimated that the probability of a major software-intensive development project being terminated were as high as 65%.



In contrast, today's jointly-developed large weapons systems, some of which form an integrated set of systems (sometimes called "system of systems"), are even larger, with software distributed among many subsidiary systems.

An example is the Army's *Future Combat Systems (FCS)*², a joint Army/Defense Advanced Research Projects Agency³ program. The Army's vision is for FCS to create an integrated "battlespace", where networked information and communications systems provide a

¹ Carnegie Mellon Software Engineering Institute... <http://www.sei.cmu.edu/>

² For more details see... <http://www.darpa.mil/tto/PROGRAMS/fcs.html>

³ DARPA is at... <http://www.darpa.mil>



competitive edge to soldiers in the field and to commanders in the control room. At this early stage in the definition of requirements, one would be hard pressed to estimate the numbers of FCS developers in a program in which the extended team consists of one prime contractor, eight major subcontractors and 55 other companies under contract. According to Congressional sources, "The FCS is estimated at 32 million total Source Lines Of Code". However, the actual number is likely to be far greater, for past experience with software estimation has shown that we both underestimate size, and add functionality as development progresses.

Fielding FCS successfully will require a highly mature acquisition organization, and more mature development and testing approaches than those used in the past on the development of smaller systems. In particular, greater effort will need to be spent on improving processes for managing changes to requirements and for ensuring that information is shared among all stakeholders. Furthermore, program managers will need to exert far greater influence on IT-related issues and obtain more objective "Earned Value" data from contractors. Without properly functioning hardware and software, FCS will be no more than a bunch of "dumb boxes" that sit and collect dust on the battlefield.

Mature processes are essential for ensuring that (a) the requirements are objectively defined, (b) the right management discipline is applied to contract management, and (c) that the software development environment is equally transparent to developer and customer. Other tools, such as Earned Value analysis, will need to be used to ensure that the system functions as intended, and that major problems and errors are caught well in advance of operational testing.

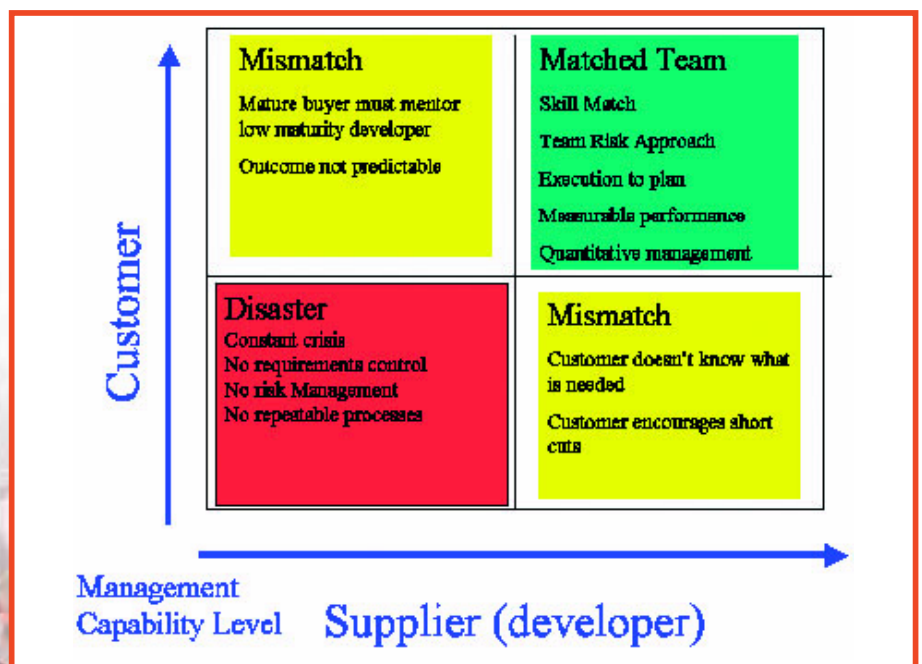
The History

Software Development Process Improvement

In the late 1980s, software developers began to invest in process improvement by adopting best practice models. Many public and private organizations based their improvement programs on the SEI's "Software Capability Maturity Model" (SW-CMM)⁴. Adoption was slow at first, but by the mid-90s, companies with improvement programs were showing results. For example, SEI reported that a major defense contractor who implemented a process improvement program in 1988 had, by

1995, reduced rework costs from about 40 percent to about 10 percent of total project cost, increased staff productivity by 170 percent and reduced defects by about 75 percent. SEI also reported that over an eight year period, a software development contractor had reduced average estimated schedule deviation from 112 percent to 5 percent, and estimated cost deviation from 87 percent to minus 4 percent.

By 2001, software development units within DOD were also showing results from their improvement programs. According to one GAO report, each DOD unit with a software process improvement (SPI) program reported positive results on software/systems quality. For example, the Defense Finance and Accounting Service reported that its SPI program had reduced the overall cost to deliver software by about one-third over comparable organizations; a Navy software activity reported reduced costs and improved product quality, and achieved a 7:1 return on its SPI investment; and an Army activity reported that improvements derived from its SPI program had enabled it to almost double its productivity in writing software for new systems.



⁴ For SW CMM see . . . <http://www.sei.cmu.edu/cmm/>

Software Acquisition Process Improvement

Many defense and civilian contractors who develop software-intensive systems have made performance gains through SPI, but those who acquire the same systems have lagged behind.

Problems occur in situations where low process-maturity acquirers contract for software from high process-maturity developers. Matt Fischer, one of the authors of the SA-CMM, uses this chart to explain why acquirers must also improve their process for managing software contracts.

For example, acquirers may try to circumvent development and management processes because they feel that following them adversely affects their ability to meet their goal. "Process avoidance" by the acquirer can result in rework, additional delays, and unexcusable cost and schedule quotes; had it been followed, this is exactly what the process was designed to avoid.

Other problems can occur at the end of the development process. Where cost and delivery schedules become more important to the acquirer than the developer's obligation to meet their exit criteria for delivering a quality product, the result can be software that contains avoidable defects. GAO reviews of major weapons systems have uncovered consistent problems - such as cost increases, schedule delays and performance shortfalls - for which the underlying causes include pressure on program managers to promise more than they can deliver.

The GAO have recommended⁵ establishing and implementing a DOD-wide SPI program based on accepted best practice improvement models. In response, DOD tasked two working groups within the Office of the Secretary of Defense to develop a plan for implementing DOD-wide SPI and to establish a means of sharing SPI lessons and best practice knowledge throughout DOD. DOD also pointed to a recent revision of their regulation 5000.2-R as

containing the necessary policy guidance. The author believes that subsequent DOD inaction in response to GAO-01-116 played a pivotal role in Congress legislating for software acquisition process improvement.

On 2 December 2002, Section 804 of Defense Authorization Act of Fiscal Year 2003 (or simply "Section 804") was enacted. The report accompanying their version of the Defense Authorization for Fiscal Year 2003 spelled out clearly the Senate's concern about the negative impact of longstanding software problems on major defense acquisition programs. The Senate stated that Section 804 is designed to implement the recommendations set out in GAO 01-116.

Section 804: The Law

Section 804 mandates the improvement of DOD's software acquisition processes. This legislation directly instructs the secretaries of each military department and the heads of relevant defense agencies to establish software acquisition process improvement programs - an apparent message of frustration with the way software improvement has been handled in the past.

Software acquisition process improvement program requirements include:

- A documented process for software acquisition planning; requirements development and management; project management and oversight; and risk management.
- Efforts to develop appropriate metrics for performance measurement and continual process improvement.
- A process to ensure that key program personnel have an appropriate level of experience or training in software acquisition.
- A process to ensure that each military department and defense agency implements and adheres to

established software acquisition processes and requirements.

Section 804 also requires the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence (in consultation with the Under Secretary of Defense for Acquisition, Technology, and Logistics) to:

- Provide applicable improvement program administration and compliance guidance, and to ensure that secretaries of the departments and agencies comply with that guidance.
- Assist departments and agencies with their respective improvement programs by ensuring that they use applicable source selection criteria and also have access to a clearinghouse for best practice information on software development and acquisition in both the public and private sectors.

Congressional Intent

"Anyone looking at the past Congressional actions and listening to the frustration expressed in Congressional Hearings will find the fundamental improvements mandated in Section 804 come as no surprise. The only surprise is that Congress has been as patient as they have been. Now, Congressional patience seems to be turning to impatience; an impatience to see significant improvement in fixing our perennial problems with cost, schedule, and performance - and in addressing the underlying drivers that are causing these problems."⁶

Congressional sources affirm that "DOD is going to have to pay attention from the ground up, in other words, at the program manager level, or programs will continue to get tanked. Congress will remain interested and we're not going to let this go until DOD significantly improves how it acquires software-intensive systems. The only way it's going to get fixed is by people on the inside - it simply makes no sense on any level to continue ignoring it."

⁵ See report GAO-01-116 (DOD Information Technology: Software and Systems Process Improvement Programs Vary in Use of Best Practices), published in March 2001.

⁶ Norm Brown, Founder and Former Director of the Software Program Managers Network, and Navy Department Member of the 2000 Defense Science Board Task Force on Defense Software.

DOD Response and Implementation Guideline

On 21 March 2003, DOD issued a memorandum to provide the uniform implementation guidance that Section 804 requires. This memorandum identifies applicability, delineated organizational roles and responsibilities for overseeing implementation, and clarifies initial expectations for DOD Component process improvement programs. It also instructed military departments and those defense agencies that manage major defense acquisition programs to establish software acquisition process improvement programs. Requirements for these programs included defining and applying measures; following applicable methods based on some structured approach that includes an appraisal method; and determining and reporting the status of process adherence and performance effectiveness.

The DOD memorandum also gives the Office of the Secretary of Defense Software Intensive Systems Steering Group the role of leading a DOD-wide effort to improve software acquisition processes. This role entails providing program guidance; identifying best practices; establishing a clearinghouse of information regarding best practices and lessons learned in software development and acquisition; and providing guidance for documenting, performing, and continuously improving a minimum of eight specific software acquisition processes.

Conclusions

Section 804's mandate for DOD software acquisition process improvement programs is here to stay. It is not one-time legislation with little or no follow-up, but the result of a consistent, well documented and growing need. Congressional sources are already considering actively identifying certain key programs for greater scrutiny to see if they have adequately implemented the legislation's requirements. According to GAO sources, *"the outcome is what's important, and not which best practice*

Highlights of Recent GAO Reports Relating to Acquisition Process Improvement

GAO report GAO-01-116 (<http://www.gao.gov/new.items/d01116.pdf>):

- Compared and contrasted DOD software and systems engineering practices with leading best practices.
- Recommended issuing a DOD-wide policy implementing SPI for software-intensive systems based on SEI best practice improvement models; developing a program to gauge compliance to that policy; and developing a means of sharing SPI lessons learned throughout the DOD.

GAO report GAO-02-9 (<http://www.gao.gov/new.items/d029.pdf>):

- Reviewed the quality of the Defense Logistics Agency's processes, its application of best practices and opportunities to improve.
- Recommended issuing a DLA-wide policy requiring software-intensive acquisition projects - both the acquirers and contract developers - to achieve a specific level of process maturity based on a combination of SEI improvement models; and to establish/sustain a software process improvement program.

GAO report GAO-02-701 (<http://www.gao.gov/new.items/d02701.pdf>):

- Assessed the impact of design and manufacturing knowledge on DOD program outcomes, compared best practices to those used by DOD, and analyzed current weapons system acquisition guidance for application of best practices to obtain better program outcomes.
- Recommended taking steps to close the gaps between the current DOD acquisition environment and best practices; ensuring that its acquisition processes capture specific design and manufacturing knowledge at key junctures; and providing incentives to use knowledge-based processes.

GAO report GAO-03-476 (<http://www.gao.gov/new.items/d03476.pdf>):

- Provided an independent, knowledge-based assessment of 26 major defense acquisition programs to gauge projected attainment of program goals relative to best practices.
- Observed that when programs proceed with less knowledge than suggested by best practices, cost, schedule and performance problems often result; to varying degrees all programs assessed proceeded with inadequate knowledge at key junctures and suffered negative consequences.

improvement model is used as a road map to achieve the mandated requirements." Given that the GAO and Congress both feel that the acquisition of systems with major software components needs to be

improved, it is imperative that DOD program managers understand that their efforts will be measured against Section 804 requirements.

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