

# Software Doctrine for Fixed-Price Contracting

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**Abstract.** The DoD faces austerity challenges and needs to ensure that defense industry senior executives are committed to meeting these challenges. Consequently, there is a need for a software doctrine for large-scale, software-intensive systems development on fixed-price contracts.

## The Challenge of Fixed Price

The DoD faces austerity challenges. The government understands what it needs. These needs were best stated by the challenges outlined by Dr. Ashton Carter, Undersecretary of Defense for Acquisition, Technology, and Logistics (AT&L) [1]. The message here is to deliver “more without more” and to accomplish this through “better buying power.” These may sound like slogans, but they are backed by well-conceived guideposts designed to rely on normal market forces in focusing the defense industry on competitiveness, innovation, program management, incentives, efficiency, profitability, and productivity.

The DoD needs to ensure that defense industry senior executives are committed to meeting the AT&L challenges and are accountable for demonstrating game changing progress toward solving these challenges.

For example, the most significant game changer a defense industry senior executive can deliver is an “all in” commitment to accept fixed-price contracts on large software-intensive programs along with a convincing capability to deliver that reflecting an understanding of the cultural changes required. Both the DoD and the defense industry need to populate a tool kit of capabilities for successfully engaging in fixed-price contracts and for evaluating the challenges and benefits of doing so.

Reluctance to accept fixed-price contracts within the defense industry community is based on risk and fear of failure in cost, schedule, and quality performance. This reluctance can be offset by DoD incentives based on technical performance measures designed to tilt the risk calculation in favor of fixed price for those capable of delivering.

## Meeting the Challenge on GPS

An example of how a fixed-price contract results in a win/win outcome was turned in by IBM's Federal Systems Division (FSD) [2] performance on the GPS Ground Station, a \$150

million fixed-price program [3, 4, 5, 6]. GPS is a high-assurance, real-time system that provides continuous and accurate positioning information to properly equipped users. So, naturally incentives were tied to achieving accuracy of results and a high availability operation.

A team of IBM FSD and software engineers produced the system of 500,000 source lines of code and experienced first hand the challenges and benefits that come with a fixed-price contract. The challenges and how they were met are highlighted as follows:

1. The first challenge was to convince John Akers, the president of IBM, that we could successfully perform a sizable fixed-price contract. A comprehensive set of technical performance measurement incentives organized around the accuracy of results was instrumental in securing that approval.

2. The second challenge was the commitment to systems engineering and software engineering collaboration needed to obtain the deepest possible user domain awareness. This was done through early operations analysis and simulation in order to integrate the needs of the systems, software, and user in the best possible way. Every eyeball was trained on accuracy and high availability incentives.

3. The third challenge was to structure the software development plan as an incremental development with four-well specified design levels each with fine grained cost accounts, formal software inspections of design level artifacts, careful management and visibility of systems engineering to-be-determined items, and a relentless focus on the innovation needed to meet or exceed the accuracy incentives. Designs were recorded in a program design language and by the end of design level 4 represented a 1:4 ratio of design language to estimated sources lines of code. Design levels 1 and 2 supported the systems engineering preliminary design review with intended functions of components, interface specifications, and software architecture rules of construction; design levels 3 and 4 comprised the basis for the software engineering critical design review with provably correct, stepwise refined elaborations of functionality.

4. The fourth challenge was to apply strict accountability and control of cost accounts and work packages based on a work breakdown structure and work responsibility matrix. Cross charging was prohibited, that is, systems engineers were prohibited from charging software engineering work packages. Work packages were opened only when the entry gates had been either met or waived by explicit decision. Work packages were closed only when and as soon as the work package had achieved 100% earned value so that unexpended funds in completed work packages were not used to offset work packages that were over budget. An Estimate to Complete (ETC) was made for each work package each month. Where actuals to date combined with the ETC for a work package exceeded the budget at completion, a corrective action plan was initiated where possible.

In addition to the challenges of fixed-price contract performance, the benefits that result from an improved culture of performance where no one is outstanding until everyone meets the minimum include the following:

1. The value of the IBM FSD contract for GPS was \$150 million. The actuals at completion were \$165 million. The additional fee paid based on earned incentives was \$25 million. This project was a success.

2. Performing on a fixed-price contract disciplines the mind on things that matter most and provides management the will to align the best organizational capabilities to perform on the essentials. It promotes a sense of priority. It promotes a sense of urgency. It discourages waste of any kind.

3. Of real importance, performing on a fixed-price contract had the effect of elevating the software engineering function to a heightened level of importance because it is traditionally the major source of program risk as the tall pole in the tent. As a practical matter, the software development function held the systems engineering function feet to the fire in insisting on completed requirements and specifications documents delivered on time with few to-be-determined items. This program tension resulted in forging a cooperative peer relationship between systems engineers and software engineers where the only rule was, "The person with superior knowledge dominates."

4. With the onus of cost management shifted to IBM FSD, the Air Force acquisition focus was concentrated on accuracy and high availability along with schedule and quality, not sparring over cost and scope issues. Constructive changes were accommodated through value engineering.

### Software Doctrine

The vision is to achieve affordability through fixed-price contracting with the defense industrial base whereby the onus for cost management and risk is transferred to the defense industry, which is in turn accorded leeway intended to unleash the forces of competitiveness and innovation. The preferred organization software doctrine for large-scale, software-intensive systems development on fixed-price contracts features the following tenets:

1. Requirements and the technical performance incentives for their achievements are fully known at the beginning and managed and controlled throughout the program life cycle.

2. The software engineering organization reports directly to the program manager.

3. Both the systems engineering and software engineering functions are jointly committed to obtain the deepest possible user domain awareness.

4. Project goals for schedule, cost, and quality are explicitly stated and matched by both the readiness to perform and actual performance.

5. Strict accountability and control of cost accounts and work packages are applied based on a work breakdown structure and work responsibility matrix.

6. Software development planning is based on multiple design levels and staged incremental deliveries [7].

7. The frequency of software product releases is planned, managed, and controlled.

8. Joint systems engineering and software engineering team innovation management results in new ideas that are generated, selected, and used in new product releases.

### Conclusion

The market-driven transformation of the defense industry must be fueled by the expectation of the DoD. The government knows what it needs. It now needs to communicate that expectation in practical terms.

Accomplishing this requires a cultural shift away from commoditized software engineering to a more tightly coupled integration of software engineering and systems engineering operating as peer functions reporting directly to the acquisition program management function.

Program risk is directly proportional to the organizational distance among these functions. Being highly competitive by anticipating and leading in the application domain requires understanding the deep needs of the customer and delivering transforming intersectional innovation. This is not achieved by tiers of subcontractors and extended global supply chains. Instead it requires closely-knit, well-integrated management and engineering functions with extended time in market spurred on by the challenge to succeed and not frozen by the fear of failure.

The DoD will know that the defense industry is hearing the message and knows what is expected when prime contractors begin to compete for fixed-price contracts. ♦

### ABOUT THE AUTHOR



**Don O'Neill** served as the President of the Center for National Software Studies from 2005 to 2008. Following 27 years with IBM's Federal Systems Division, he completed a three-year residency at Carnegie Mellon University's SEI under IBM's Technical Academic Career Program and has served as an SEI Visiting Scientist. A seasoned software engineering manager, technologist, and independent consultant, he has a Bachelor of Science degree in mathematics from Dickinson College in Carlisle, Pennsylvania.

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