

[H.A.S.C. No. 111-35]

**STATUS OF THE FUTURE COMBAT  
SYSTEMS PROGRAM**

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HEARING

BEFORE THE

AIR AND LAND FORCES SUBCOMMITTEE

OF THE

COMMITTEE ON ARMED SERVICES  
HOUSE OF REPRESENTATIVES

ONE HUNDRED ELEVENTH CONGRESS

FIRST SESSION

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HEARING HELD

MARCH 26, 2009



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###### WITNESS RESPONSES TO QUESTIONS ASKED DURING THE HEARING:

[There were no Questions submitted during the hearing.]

###### QUESTIONS SUBMITTED BY MEMBERS POST HEARING:

[There were no Questions submitted post hearing.]



## STATUS OF THE FUTURE COMBAT SYSTEMS PROGRAM

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HOUSE OF REPRESENTATIVES,  
COMMITTEE ON ARMED SERVICES,  
AIR AND LAND FORCES SUBCOMMITTEE,  
*Washington, DC, Thursday, March 26, 2009.*

The subcommittee met, pursuant to call, at 2:05 p.m., in room 2118, Rayburn House Office Building, Hon. Neil Abercrombie (chairman of the subcommittee) presiding.

### **OPENING STATEMENT OF HON. NEIL ABERCROMBIE, A REPRESENTATIVE FROM HAWAII, CHAIRMAN, AIR AND LAND FORCES SUBCOMMITTEE**

Mr. ABERCROMBIE. Hi everybody. Thank you for coming today.

The Subcommittee on Air and Land Forces is meeting to receive testimony on the Army's Future Combat Systems (FCS) program from the Government Accountability Office, the GAO. The Army was invited to provide witnesses and had agreed to do so; in fact, submitted a statement last week. I was indisposed, and the hearing had to be postponed until today.

As of yesterday, at least, the staff of the committee was notified the Army didn't see fit to inform me as the chairman that no witnesses from the Army would be available to discuss the FCS program and the GAO report today.

I want to make it clear to everybody the hearing is not about FCS in 2010. There are budget considerations under way right now, program considerations under way right now among the President's staff and the Department of Defense (DOD), internal discussions going on there. I had indicated to General Casey that I understood that and, in fact, indicated to him, so that there would be no question in his mind, that these were serious issues to be discussed, that we are not in a contest. We are trying to determine what is the best path forward. Serious decisions had to be made, and I wanted to try and make them together on the basis of what was good for the Nation.

I also indicated that, as far as the hearing was concerned, it was about the GAO report, which I considered a critique as opposed to criticism, i.e., an analysis bent on discussing merits or demerits of the program or adding to or subtracting from positions that were taken about either individual parts of the FCS system, the Future Combat System, and/or the overall philosophy even behind it. That the GAO report as I read it had nothing to do with any of that, rather tried to, and I think successfully did, address what are the premises of the program, what were the procedures and processes in place and implemented to—or not implemented—to try to accomplish the goals and purposes, and critique that with the idea of

then presenting findings and observations as to the success or lack of it in terms of the premises established by the Army itself.

I am speaking a little bit to our witnesses here from the GAO with the idea of establishing what is in my mind; and if you have something different as I am outlining my reading of your report, you, of course, are not only free to do so but I hope you will indicate it.

But I see some heads nodding a little bit, and the body language I am getting is I do believe that I am stating this correctly.

And the idea of the subcommittee taking up the GAO at this time was to provide illumination, I would have hoped, for the—not just the Army but the Pentagon and the Executive to be able to come up with conclusions and recommendations that we could incorporate into the defense bill.

The fact that the Army has chosen not to even appear but to leave standing, I guess, the public relations announcements that were made in the wake of the original publication of the GAO report and its summary as reported in the news media leads me to conclude, I guess, that they don't have any real argument with what you are saying. Otherwise, they would be here today.

So taking the Thomas More approach, silence is assent. So as far as I am concerned the Army has given its assent to the conclusions and observations and the approach, that is to say the methodology, that was used in the GAO report. If they have a different point of view, they, apparently, are reserving it to themselves.

Transparency is the byword and watchword these days. It certainly is that of the Obama Administration. I had no reason before today to believe that would be otherwise with Secretary Gates and/or the Chief of Staff of the Army, but the actions speak for themselves. They are not here. They had the opportunity to be here. As I say, I will take their silence to mean assent.

So no explanation for this change in willingness to provide the Congress and the American people with an update on where the program stands today has been forthcoming.

The goal of this hearing is to lay out for members and the public where the program is today, what has been learned, and where we might go from here. After authorizing and appropriating—forgive me, members of the committee and for you folks from the GAO. Most of this is known to you, but this is in fact a public hearing, and there may be many people out there for whom this information is new.

After authorizing and appropriating more than \$18 billion in taxpayer dollars for the Future Combat Systems program since 2003, it is important that the Congress review what has been accomplished and how much work remains to be done.

The President appears to have some views on defense programs, which those views being relevant I believe to the FCS program when he said as follows, and I quote: "It is time to end the extra costs and long delays that are all too common in our defense contracting. We need to invest in technologies that are proven and cost-effective. If a system isn't ready to be developed, we shouldn't pour resources into it. If a system is plagued by cost overruns, it should be reformed. No more excuses. No more delays. The days of giving defense contractors a blank check are over." Unquote.

Today's hearing hopefully will help Congress and the public—and perhaps even the Army if it is tuning in—I presume that they can get their C-SPAN channels on as well, which will help them understand I hope those qualities that apply to the FCS program.

With regard to the GAO, over the past several years, it has been my experience certainly personally, and I think the experience of the Armed Services Committee in the House, that the GAO has done excellent work in its oversight role, not just in the FCS program but in every other area that we have asked for the observations and recommendations of the GAO. While the Army at times has disagreed with judgments made by the GAO and its analysts, the reports the GAO has produced have helped Congress focus its oversight on critical issues; and it has provided in my judgment independent and dispassionate views not just of this program but of all the other programs that it has made recommendations and observations upon.

I believe that the 2009 report on the FCS continues this tradition. Since its inception, the program has faced serious questions regarding technical feasibility, cost estimates and basic conceptual tenets. From a technical aspect, the fielding dates have moved from 2008 to 2010 to 2015. That speaks for itself.

It is clear now that the Army from a technical standpoint has had little real idea of what exactly development of FCS would entail. As a result, the Army has constantly changed the requirements for individual elements of the FCS program as reality began to intrude on each element's design. I could give several examples which I will produce for the record, but they will probably come out as we explore.

One point I do want to make, though, just last June, while making claims of acceleration of the program, which was made in fact to me face-to-face when I first heard about it in my office that the program was actually going to accelerate—that was the word used—the Army was in fact forced to delay the limited user test for spinout number one equipment by a full year because the equipment was simply not working well enough to proceed with the test as planned. That constituted an acceleration. Just don't do the test. Well, if you don't do the test, you can accelerate the spinout. The assumption being is that there will be absolutely nothing to go wrong and that when it comes forward it will be able to be utilized on the spot.

So the cost estimates has faced challenges. The programs cost has grown from \$91 billion in 2003 to \$159 billion today by their own estimates. It does not include the cost of the spinout equipment estimated at \$17 billion to \$21 billion alone for spinout number one. It does not include the cost of the Joint Tactical Radio System (JTRS) program or the Warfighter Information Network Tactical (WIN-T) program, both of which the FCS program requires for fielding.

This has been one of the issues that I have raised over and over again. If you cannot get the radio system and the information system integrated, then what is the efficacy then of pursuing the rest of the program for which the information and exchange system is crucial?

So, finally then, I want to go to the basic conceptual ideas, that the idea was that, through technology and computer network, sufficient knowledge of the enemy's position could be achieved to conduct most engagements at standoff range, thus allowing very light-weight vehicles to survive in the battlefield.

The wars in Iraq and Afghanistan I believe have called some of this into question, but that remains to be seen. A case can still be made. The point is that every single vehicle deployed to Iraq and Afghanistan now weighs more, not less, and has more armor, not less, than the original design entailed. So while it is always a worthy goal to put the enemy at a distance and avoid putting troops at risk, I think the reality of 4,000 years of military history shows that achieving a perfect situational awareness is very difficult if not impossible to achieve and that the troops faced thinking enemies, not static dummies or static situations. So the question of concept, technology, and implementation and cost all are relevant here; and I think the GAO report addresses those elements.

So in today's hearing we also—I would be disingenuous if I didn't indicate that we are looking then not just at one program in isolation but how that fits into the big picture of readiness and capabilities of the Army as a whole.

For the Army, the fundamental choice appears to be keeping the new, larger Army we have today and the larger Army we are pursuing and pursuing at the same time a massive list of Army acquisition programs of which FCS is just one on the books. General Casey himself has indicated with the term, out of balance, quote, unquote, that this is a difficulty.

Whatever foreign phrase one uses, however, the basic facts remain the same: The people in the Army are wearing down from years of deployments. The equipment in the Army's inventory is just barely keeping up with the demands the two wars we now are engaged in require.

So we face a choice, not just with the FCS program but a choice as to where the Army is going. And I will lay that out as I conclude, what I think is at stake in our decisionmaking.

It could choose to end the program entirely, which might save money but would also negate much of the work that has been done to date. It could continue as planned and hope things work out as the program now assumes and that the funding for the Army's other needs will somehow materialize even as the FCS program costs continue to grow. Or it could fundamentally reorganize the FCS program now to take advantage of some of the work done so far but take a much more sober and realistic and disciplined approach to moving forward with the program while investing the savings in less risky modernization plans.

This committee, of course, and the committee as a whole would be delighted to work with all concerned to achieve that. So the purpose of today's hearing then, finally, is to set the stage for that discussion which we expect to have once the Army's fiscal 2010 budget proposal is delivered to the Congress.

I will turn now to my good friend, Mr. Bartlett, for his opening remarks.

**STATEMENT OF HON. ROSCOE G. BARTLETT, A REPRESENTATIVE FROM MARYLAND, RANKING MEMBER, AIR AND LAND FORCES SUBCOMMITTEE**

Mr. BARTLETT. Thank you, Mr. Chairman.

Mr. Chairman, regretting the absence of the Army, I nevertheless want to thank our panel for being here. We are very fortunate to have each of you here. You provide a very valuable service to our country. Thank you for coming today.

As a member of the House Armed Services Committee, I have always been guided by President Ronald Reagan's wisdom that America will ensure peace through strength. Upholding our Constitution and maintaining a strong defense should be our highest priorities as Federal elected officials, because if we don't get these priorities right nothing else will matter.

Today, we are here to talk about the Army's Future Combat Systems program. The Government Accountability Office has recently released its yearly report on the FCS system.

By the way, as you know, Mr. Chairman, the requirement to generate this report came from this subcommittee. In fact, there have been multiple legislative provisions in regard to this program that were all generated from this subcommittee. And, Mr. Chairman, although in recent years we have differed in regards to decrementing the program, every one of the FCS legislative provisions was done in a bipartisan manner; and I applaud your leadership.

There have been recent media reports about a pending major restructure to the FCS program. I would add, Mr. Chairman, that while I understand that we in Congress have many difficult decisions to make in this upcoming budget cycle, that it would be premature for us to condemn the program going forward until we have seen the results of the 2010 budget, full transparency regarding the potential restructured program and, finally, the results of the congressionally mandated go/no-go review. And, again, Mr. Chairman, this review is another provision that originated in this subcommittee.

One last point. While I understand the primary purpose of this hearing is to discuss programmatic issues and concerns, I believe it is difficult to have such a conversation without a thorough understanding of what led the Army down this path. I have heard that some believe that this is a Cold War system. I am not really sure what that means, but it is a good bumper sticker. I believe the Army could benefit from thoroughly explaining what the future threat is and what the capability gaps are that have led the Army down this path. Is the foundation that launched the Army into this program in 2003 still valid today? What lessons have been applied from Iraq and Afghanistan?

At the end of the day, whatever happens, the Army must be allowed to modernize. Parents are reluctant to send their children to school without the latest and greatest cell phones. They certainly aren't going to want them to join the Army so they can defend our Nation in vehicles that were designed in the 1960's and built in the 1970's.

And forcing the Army to choose between personnel and modernization isn't a choice at all. I believe that there should be a bal-

ance between acquisition and procurement needs and research and development for future opportunities.

I am a farmer as well as a scientist and engineer. I would caution if the Army is forced to eat its seed corn, which is its Research and Development (R&D), then we will forego in large measure the potential of future harvest of better technologies.

I look forward to hearing from our witnesses today, and I want to thank you again for your service to our country and for appearing before us this afternoon.

Thank you, Mr. Chairman.

Mr. ABERCROMBIE. Thank you very much.

Before I get to our witnesses, I am going to, on my authority, with the acquiescence of the subcommittee, put into the record a statement by Lieutenant General Ross Thompson, III, which was originally submitted on March 17th—given to us for testimony on March 17th. And it said, “Not for publication until released by the Committee on Armed Services”, and so I am going to put this into the record.

I regret that General Thompson isn’t here to speak to this statement, but I think it is important to be in the record, whether or not the Army is here, so that at least the public has the opportunity to see what the Army thought last week.

[The prepared statement of General Thompson can be found in the Appendix on page 55.]

Mr. ABERCROMBIE. One other administrative point. We will allow members present at the start of the hearing to ask questions in reverse seniority order. I alternate between senior members one hearing and then the least senior members the next hearing being able to start the questions so that everybody has the opportunity.

So, with that in mind, we will go to Mr. Francis, the Director of Acquisition and Sourcing Management from the GAO; Mr. Graveline—is it Graveline?

Mr. GRAVELINE. It is Graveline, sir.

Mr. ABERCROMBIE. Pardon me?

Mr. GRAVELINE. Graveline.

Mr. ABERCROMBIE. Mr. Graveline. Mr. Graveline, Assistant Director for Acquisition and Sourcing Management; and Mr. Ferguson, the Senior Analyst from the GAO. And I read it in that order, but that doesn’t necessarily have to be the order in which you testify. It is up to you gentlemen.

Mr. FRANCIS. I thought I might surprise my colleagues and go in reverse order.

Mr. ABERCROMBIE. Okay.

**STATEMENT OF PAUL L. FRANCIS, DIRECTOR, ACQUISITION AND SOURCING MANAGEMENT, U.S. GOVERNMENT ACCOUNTABILITY OFFICE; ACCOMPANIED BY WILLIAM R. GRAVELINE, ASSISTANT DIRECTOR, ACQUISITION AND SOURCING MANAGEMENT, U.S. GOVERNMENT ACCOUNTABILITY OFFICE; AND MARCUS FERGUSON, SENIOR ANALYST, U.S. GOVERNMENT ACCOUNTABILITY OFFICE**

Mr. FRANCIS. Thank you, Mr. Chairman, Mr. Bartlett, and members of the subcommittee. We are pleased to be here to discuss Fu-

ture Combat Systems today. I would ask that our statement be submitted for the record.

Mr. ABERCROMBIE. Without objection.

Mr. FRANCIS. What we have been asked to do is to walk through our March 12th report. So how I would propose to do that is each of us will just basically take a section of the report and walk through it, if that is all right with you.

I was surprised when we read the press accounts from the Army and the reaction to our report. We do have, I think, a pretty robust process for vetting the draft report, meeting with the Army, soliciting comments. We got full concurrence from the Department of Defense on all the recommendations. So indeed I was rather surprised by the Army's reaction.

So I think our analysis is clear, as you will see. We don't have a position on whether the program is a good or bad program or whether it should or shouldn't be pursued but simply can it be executed for the resources that are estimated. And I think that is our job and that is the counsel we would provide to you.

I will just start off by talking a little bit about FCS. I think many of you know these things, but in the interest of it being a public hearing I thought I should cover them, in any event.

FCS is a revolutionary program for a variety of reasons. The weapons that it embodies, the fighting concept that comes with it, and the organizational communication systems that come with FCS are all revolutionary. It is a system of 14 systems whose combat capability largely comes from an unprecedented information network.

The FCS does present a smaller, lighter force than what is currently fielded but does offer or advertise that that smaller lighter force will be as lethal and survivable as the current M1 and Bradley force. It is a system that will rely a lot on robots—unmanned air vehicles (UAVs), unmanned ground vehicles (UGVs), unattended sensors, unattended munitions.

But the heart of FCS is the communications network or the information network, and in a very basic sense the network is going to enable the Army to substitute information for mass.

So the vehicles in FCS, as I mentioned, are going to be lighter; and they are going to be designed not so much to withstand the hit but rather to avoid taking the hit. I think that is sort of the design philosophy for FCS.

The network that we are talking about is not like any network that we are familiar with. If you think of a cell phone network or the Internet, those are basically fixed infrastructures. So your cell phone, while it is mobile, as soon as you make a call—like if I was going to call Mr. Abercrombie, my cell phone doesn't connect to his cell phone; rather, it connects to a cell tower and into a fixed infrastructure which then eventually gets to Mr. Abercrombie's phone.

Mr. ABERCROMBIE. I better turn it off.

Mr. FRANCIS. I thought you were a Luddite, Mr. Abercrombie. I am surprised you have one.

Even the Internet, if you have a wireless laptop, you are one connection away from a fixed server; and, right away, you are into a fixed infrastructure driven by fiber-optic cable. The network does not move.

But the FCS network is quite different. It is a mobile, self-forming network whose linchpin is what Mr. Abercrombie mentioned in his opening statement, the joint tactical radio. All of the vehicles, both manned and unmanned, all of the sensors, even the unattended munitions, have some form of this radio in them. And the radio is software programmable. It is a computer that functions both as a radio and it is your cell tower, if you will. So all the communications, all the relays go through these radios.

So, again, if I am going to make a call, say, to Mr. Ferguson on the end here, if I call him or I want to send him information, the FCS network will decide how to route that communication, and it may route through all the members of the panel before it gets to Mr. Ferguson. And then if he is going to respond to me, we are all in vehicles or on foot, we have all moved before he responds, so that when he does respond that message could take a different route coming back. And so the network will decide what radios it is going to use as relays to send that information.

So the real challenge is what happens if you have 5,000 radios operating and you are really dependent on getting that information right away. So it is quite a different network. There isn't anything like it today.

Having said that, a lot of things about FCS that we do like and we do appreciate, the idea of having an architecture where you conceive how you are going to fight before you design individual systems, I think is a very good approach and something the Army has not done in the past. I think it would have been easier for the Army to have designed and built a new Bradley or a new M1, but they didn't do that. They wanted to look ahead and see what they really needed, and they broke with tradition. So they didn't do what was easy. They did what was hard. And I admire that, and I think the Army leaders deserve our respect for that.

Where GAO comes in is our analysis is on can they do it. It is not enough for it to be a good idea. It is not enough to want it. It is not enough even to need it. You have to be able to do it. And we have a number of concerns on that regard. So I thought I would talk a little bit about our methodology, how we look at this program. Because that is part of the contention between us and how the Army looks at the program.

So I have the first chart there, and I believe you each have a handout if you can't read the chart. But I just direct your attention to the top bar there.

When we look at programs we basically look for three knowledge points. Does everyone have a chart?

[The chart referred to can be found in the Appendix on page 67.]

Mr. FRANCIS. So if you look on that top bar, there is a black triangle there called (Knowledge Point) KP 1 and (Preliminary Design Review) PDR. That is knowledge point one and—

Mr. ABERCROMBIE. Hang on one second on the charts.

Mr. FRANCIS. It may be at the end of your statement.

Mr. ABERCROMBIE. We will pass them out. I thought it was in the back of the statement, but it may not be in here inadvertently.

It is in the back of the GAO testimony, but we will pass it out anyway.

Go ahead.

Mr. FRANCIS. So on that, on chart one, there is—on that top bar there is a black triangle called—it is knowledge point one and preliminary design review. What we look for early in a program, that is the milestone B decision when you start a system development, we look for mature technologies and stable requirements. And the way you get a dot check on whether you have that is through a preliminary design review where you are actually matching requirements with technologies.

This is also codified in DOD's acquisition policy. So it is not just our methodology, it is DOD policy. So we look for that when a program starts.

About halfway through, just move to the right, the next triangle, knowledge point two, that is critical design review. About halfway through system development we are looking for the design of the system to be stable. And stability is achieved by having integrated all the different subsystems, the technologies are done, and you are actually ready to build high-fidelity production-representative prototypes.

Mr. ABERCROMBIE. Excuse me. Mr. Francis, that can be replicated, right?

Mr. FRANCIS. Yes.

Mr. ABERCROMBIE. That when you do something one time you can do it 2, 5, 10, 20, 100 times.

Mr. FRANCIS. Yes. And then when you build those prototypes after that point you are actually establishing your ability to be able to repeat.

The third thing we look for, knowledge point three, the third black triangle there, coincides with the milestone C or the initial low rate production decision. What we are looking for there, and again in DOD policy, is a mature design that has been proven through testing. It proves that it meets requirements and that it is reliable and that it can be produced. So that is the lens we use.

FCS is in the sixth year of a 10-year program, and it is nowhere near the level of knowledge it should have using this as a guide. That is why we believe, and our report says, we think it is unlikely that the remainder of the program can be executed as planned, because there aren't many resources left.

Mr. ABERCROMBIE. For purposes—the committee can see this. I am not sure that those who are viewing it can see the chart. I am not sure how the camera—they can't see it, is that right?

Could you explain then the second line where the technology development start, the PDR in the ideal setting is—

Mr. FRANCIS. That is what I just went through.

Mr. ABERCROMBIE. Now, where is it in the second line?

Mr. FRANCIS. I am going to turn that over to Mr. Ferguson, and he is going to walk you through that. So we have a game plan.

Mr. ABERCROMBIE. Okay, very good.

Mr. FRANCIS. This is not to be a criticism of FCS in the sense that we think FCS should have gone better, shouldn't have had any problems. It is just where it is.

Mr. ABERCROMBIE. That is not an issue. Let's put this to rest right now. We are not here throwing rocks. We are here to try to analyze where we are and what the situation is. We are dealing in real time with real numbers in a real situation in which we have

a defense bill that we have to put forward shortly. That is what this is all about. That is all it is about.

Mr. FRANCIS. Yes, sir.

Mr. ABERCROMBIE. We are not here to throw rocks in the green. I am not interested in that, never have been.

Mr. FRANCIS. So I will just wrap up here by saying 2009 is going to be a very big year. There is a go/no-go decision that is scheduled for late summer which this subcommittee championed. We look at that as a grassroots look at the program to see if it should continue or not.

Congress has—or in what form. Congress has laid out criteria that DOD is to respond to in doing that review; and my colleague, Marcus Ferguson, is going to go through—he'll go through the bottom half of this chart and basically stack up what we think the Army will know against those criteria of that milestone decision.

Mr. FERGUSON. Good afternoon. It is a pleasure being here today.

I will be discussing the Army's activities leading up to the congressionally required milestone review happening later this year. Congress outlined numerous criteria for that review. These criteria relate to four key areas: technology, designs, demonstrations, and cost. We found that the FCS program has knowledge gaps in these areas; and, as a result, we believe the Army will be challenged to convincingly demonstrate the knowledge necessary to warrant an unqualified commitment to the FCS program of record at the 2009 milestone review.

The first of these key areas is technology maturity. Technology readiness levels, or TRLs, are measures pioneered by the National Aeronautics and Space Administration (NASA) and adopted by DOD to gauge technology maturity. The maturity assessment is based on two factors: fidelity of the test article and fidelity of the test environment. For instance, a TRL four would be a low fidelity breadboard in a laboratory, while a TRL six would be a prototype that is very close to form, fit, and function demonstrated in a relevant environment.

It is TRL six that is the minimum acceptable maturity level required by DOD to begin development. Applying the standard means that FCS should have achieved TRL six in 2003. The Army now expects to demonstrate TRL six for all technologies by May of this year.

I would like to use an example that illustrates why it is so important to mature FCS technologies. As Mr. Francis pointed out, these vehicles break from traditional survivability methods which simply used a lot of armor. They rely on a layered approach to survivability that begins with the information network technologies to enhance situational awareness and avoid detection. If that first layer fails and an FCS vehicle is detected and fired upon, then hit avoidance technologies like the active protection system would need to counter the incoming threat. If that layer fails, then the FCS vehicle must be able to withstand the impact using the lightweight armor technologies that are currently in development. Each of these survivability layers depends on the maturation of those associated technologies.

Technology maturity has been a key predictor of program success. Historically, acquisition programs that proceed with imma-

ture technologies have much more cost growth than those with mature technologies. Extending technology development this late into the acquisition process puts FCS at risk for experiencing problems that may require large amounts of time and money to fix.

Mr. FRANCIS. Marcus, could you, on the chart there, show the members where we are with technology, because that is the second bar there.

Mr. FERGUSON. Certainly. Right.

So if you look at the timeline at 2003, the top portion that Mr. Francis just discussed has knowledge point one and PDR. If you come down to the second area where the FCS approach is, they started that second shaded bar, that system development and demonstration, in 2003, but not all their technologies had been matured to a TRL six. So now we have progressed six years and spent \$18 billion, and now we are at the preliminary design review, and technologies are now getting to the point where they should have been to start the development process.

Mr. ABERCROMBIE. Six years?

Mr. FERGUSON. Yes, sir.

Mr. ABERCROMBIE. And what point are they now?

Mr. FERGUSON. They are approaching preliminary design review where they have—they plan to demonstrate all technologies to a TRL six by the summer.

Mr. ABERCROMBIE. Demonstrate that?

Mr. FERGUSON. Yes, sir.

Mr. ABERCROMBIE. Would that mean that the—I want to make sure I understand this, because Mr. Francis just said with regard to the radio network—I will just refer to it as the radio network.

Mr. FERGUSON. Okay.

Mr. ABERCROMBIE. There isn't anything like it today, I believe is the exact quote. There isn't anything like it today. Does that mean that the radio network is now at a stage—the last time I saw it, it was being simulated.

Mr. FERGUSON. Right.

Mr. ABERCROMBIE. Is that at a stage now where it is ready to be integrated at a six level?

Mr. FERGUSON. The TRL six would be for the individual radios and not the integrated comprehensive network. So that would progress in phases. You would have the TRL six demonstration for just the individual radio capability, and then you would start netting together all of those individual radios to demonstrate that you can actually produce a mobile ad hoc network.

Mr. ABERCROMBIE. But wouldn't that be the level six? Am I misunderstanding you? That would be the level six. An individual radio, what is that? That is just a start. Am I misunderstanding?

Mr. FRANCIS. No. The level six is just the individual technologies. The integration of the technologies and whether they can actually form a network is to be determined. So the TRL six is your first triangle. It is your starting point.

Mr. ABERCROMBIE. I understand that, but I am still not sure that I understand how just simply putting a radio in isolation, that that doesn't have anything to do with the integrative requirement.

Mr. FRANCIS. Correct. It is the first step to getting there.

Mr. ABERCROMBIE. If it is the first step, then how come it would be labeled at a six level? Wouldn't that be at the beginning level?

Mr. FRANCIS. Well, that is the beginning level, but that is just an individual technology to see if you have the building blocks to put a network together.

Mr. ABERCROMBIE. Okay.

Mr. FERGUSON. The next key criteria area relates to requirements and designs. The first real check to determine whether a system's design is able to meet requirements occurs at that preliminary design review we just discussed, and so if you will turn back to our graphic you will see that the PDR ideally would have happened in 2003 for the FCS. This is happening six years later, this summer.

Nevertheless, the Army has worked very hard defining the FCS concept, detailed requirements, preliminary designs for the family of FCS systems and the information network. The Army plans to complete its review of the requirements and designs for individual FCS systems and the information network and conduct a comprehensive system of systems preliminary design review before the go/no-go review this summer. However, the schedule to close out all those reviews may take more time than anticipated. The Army has identified key gaps between the requirements and designs for several elements of the information network. Also, the projected weight of the FCS manned ground vehicles has grown significantly beyond earlier estimates, which could have a number of impacts on their cost and performance. In the coming months, the Army will have to address these and other issues as it charts its course through the next phase of development.

The third key criteria area pertains to demonstration of the FCS information network software and the overall FCS concept. As Mr. Francis pointed out, the network is crucial to the FCS concept as it is designed to ensure that Army forces know more about what is going on in the battle space than does the enemy. The Army has been able to demonstrate its capabilities on a limited scale. However, DOD officials tell us that this type of network the Army is developing becomes more complex as more radios are added, an issue called scalability. As a result, it is hard to have a great deal of confidence in the network until demonstrations become more robust and incorporate more real production representative hardware components.

The Army will be challenged to meet the congressional direction to demonstrate, rather than just simulate, that the network concept will work by the milestone review. To date, the Army has conducted many simulations but only limited demonstrations of select capabilities, including the manned ground vehicles and software. It has not yet attempted a broad field demonstration of the FCS concept as a whole. That type of event will not happen until 2012 as part of what is called the limited user test three. That is about one year before the Army plans to begin low rate initial production for core FCS systems. If that demonstration is unsuccessful, it may require major changes to the FCS family of systems at a time when change is usually the most costly.

The final key criteria area for the go/no-go review relates to cost and affordability. The Army's original estimate for developing and

procuring FCS was \$92 billion dollars. The Army's current estimate is \$159 billion. These figures do not include the cost for complementary programs or spinouts, as you pointed out, Mr. Abercrombie.

In the coming months, the Army is expected to update its cost estimate for FCS program. Last year, the Army indicated that FCS costs may increase substantially, but it has not yet indicated whether it would tradeoff FCS capabilities to accommodate those higher costs as it has done in the past.

The Army did signal that it may reduce funding for upgrades to current force systems such as Abrams and Bradley to provide additional funding for FCS. While the updated program cost estimate should be a better representation of actual cost than previous estimates, the program still has many risks and unprecedented challenges to meet, and thus the estimate will likely change as more knowledge is required over time.

I will now turn to Mr. Graveline, who will discuss several other key aspects of the program. Thank you.

Mr. BARTLETT. Mr. Chairman.

Mr. ABERCROMBIE. Yes.

Mr. BARTLETT. I want to make sure I understand this flow chart. Am I to understand that we have critical design review before technology development is complete? And, if so, how do you do that?

Mr. FRANCIS. Mr. Bartlett, where are you looking on the chart?

Mr. BARTLETT. I am on the bottom thing there. You have technology development continuing until about 2013, and yet you have critical design review—we are doing it in about 2011. And I want to know how you do critical design review before you have technology development completed.

Mr. GRAVELINE. I would just say that it is a matter of having the review versus accomplishing the goals of that review. They are attempting the preliminary design review here shortly.

Mr. ABERCROMBIE. Mr. Graveline, for the benefit of the record, could you pull the mic a little closer and repeat what you just said?

Mr. GRAVELINE. Okay. I would address that question by saying it is one thing to have the review, and it is another one to complete the objectives of the review. To certainly get a good, solid preliminary design review or a critical design review technology should not be a question any longer. They should be mature. So at this stage that is still to be determined with FCS as to whether—how successful those reviews are going to be, and technology will be one of those questions that needs to be answered.

Mr. BARTLETT. They are just presuming the results of the technology development in their critical design review.

Mr. FRANCIS. Well, Mr. Bartlett, there is actually two things going on here. We have plotted on the top chart—the Department of Defense and the Army use the metric of TRL six as technology maturity. What we have plotted on the bottom, our work shows that TRL seven is the better measure. So that bar down below we say that is when they will get a TRL seven, which will be after critical design review, but the Army believes they only need TRL six to hold that review.

Mr. BARTLETT. Your best practices charted on the top shows technical development completed before you do the preliminary design review.

Mr. FRANCIS. Yes.

Mr. BARTLETT. And here you have technology development still continuing after you have done critical design review. I am just confused.

Mr. FRANCIS. No, that is correct. That is the strategy for Future Combat Systems. They will not be done—fully done with technology development until the production decision.

Mr. ABERCROMBIE. Mr. Bartlett, your question is a good one.

Do you understand what is being asked here, Mr. Francis? I think you do. But the audience and everybody may not be clear as to what we are talking about.

Mr. Bartlett, as you know, is a physicist and a scientist, so his level of incredulity when the proposition is put forward, as it just has been, is understandable. What he is saying, quite simply, is, you mean you are going to go ahead with something before you know whether it is going to work.

Mr. FRANCIS. Yes, that is correct.

Mr. ABERCROMBIE. Is that a colloquial way of putting it?

Mr. FRANCIS. Yes.

Mr. ABERCROMBIE. That has been—and that is the difficulty here—has been the difficulty for the subcommittee all along, is you are trying—what the FCS approach seems to be is that if the laws of physics don't apply the way we want it to apply, we will bend the laws of physics verbally so that we can say, well, before we have reached technology maturity or what the DOD definition is of that, we will simply presume that that is going to occur and move on to the next stage.

Mr. FRANCIS. Yes.

Mr. ABERCROMBIE. Is that an unfair, not necessarily summary, but an unfair analysis of the approach that they are using?

Mr. FRANCIS. No, I think that is a fair characterization. It is a concurrent approach to do technology and design at the same time and, as we will talk later, actually start to commit to production before you have the design done.

Mr. ABERCROMBIE. I have characterized this myself in the past as sympathetic magic. And I am not being sarcastic about it. It is an anthropological term. And it is a well-known—magic is not always evil, not always sticking pins in people to—or in dolls to make them hurt. Magic also takes place when you engage in incantations and so on in order to try to have a good outcome. And what is being said here is if we talk about the critical design review and the technical readiness level being synonymous or advancing verbally, then maybe it will actually happen. The problem comes, does it not, in relation to Mr. Bartlett's question, if that doesn't occur.

Mr. FRANCIS. That is correct. If it doesn't occur and you have created all of your estimates around that assumption, then you cannot get the program done for those estimates.

Mr. ABERCROMBIE. And that causes us then to run into a real brick wall with a lot of bleeding from the eyes, does it not?

Mr. FRANCIS. It does.

Mr. ABERCROMBIE. Okay.

Mr. GRAVELINE. Good afternoon. It is my pleasure to be here today to discuss our most recent work on FCS. Beyond the cost and technical issues that Mark has just covered, I would like to discuss the road ahead for the FCS program.

The Army faces a number of challenges as it moves forward to complete FCS development. We believe that under its current acquisition strategy the FCS program may not be executable within current cost and schedule projections. The schedule for spinouts is aggressive, and production commitments may happen before adequate supporting knowledge is available. The remainder of the current FCS program of record is very ambitious, and events are driven more by the calendar than by the achievements of specific acquisition knowledge.

To illustrate, I would like to turn your attention back to our chart number one here.

As we have already discussed, the Army has, among other things, been developing technologies and defining requirements since 2003. In 2009, the Army is approaching the preliminary design review point and potential achievement of knowledge point 1. Ideally, the critical design review would be held halfway through program. The desired outcome of this event, as Mr. Francis indicated earlier, is that the design is shown to be stable.

In FCS's case, the critical design review will be held 8 years into the 10-year program. Moreover, the Army has scheduled only two years between the preliminary design review and the critical design review and another two years between critical design review and production. This ambitious schedule leaves little room to gain knowledge and make needed adjustments between the key events in the system engineering process. It also results in prototypes being built from the less mature preliminary designs, as opposed to the more mature critical designs.

I would like to now turn to chart number two, and that is also in your handout called "Remaining FCS Research and Development Funding and Key Events." The Army's cost estimate for all of FCS development is around \$30 billion. Through fiscal year 2009, the Army has received about \$18 billion or about 60 percent of the total estimated. Of the roughly ten years projected from program start to the projected beginning of initial production, FCS is approaching the sixth year, or 60 percent mark.

Within the next four years, the Army will have to further mature and integrate many of the individual critical technologies which we already talked about: mature the system designs, complete the development, integration, and testing of a huge volume of software, fabricate numerous prototypes, conduct extensive development testing, and the fix test, fixed kind of approach at the end, and prepare the design, processes, and facilities for production.

If the current FCS program receives approval to proceed at the next milestone review, the Army will have to complete development with only 40 percent of its financial and schedule resources remaining of what is typically the most challenging expensive work ahead, such as building and testing of prototypes. We don't believe this to be an executable strategy.

[The chart referred to can be found in the Appendix on page 68.]

Mr. ABERCROMBIE. Mr. Graveline, before you go further with that, is that because you are assuming that the \$30 billion funding for research and development will remain static?

Mr. GRAVELINE. Yes. We assume the current program of record until the Army decides to increase their program estimate, they could, and actually they indicated to that extent last year that they may be headed that direction. But yes.

Mr. ABERCROMBIE. Did you have a figure for that, or am I anticipating the rest of your testimony?

Mr. GRAVELINE. In our reports and in the statement for the record I believe we talk about the Army's projected cost increases for the program, and they were talking about \$2 billion in development and upwards of \$17 billion in procurement. So there was a \$19 billion cost difference.

Mr. ABERCROMBIE. Added to the \$30 billion.

Mr. GRAVELINE. No, that would be to the \$159 billion, the whole program.

Mr. ABERCROMBIE. What about the \$30 billion?

Mr. GRAVELINE. The \$30 billion would be about \$32 billion. But that is probably just the first down payment on additional costs there.

To carry on, though, for the next—for the last few years, the Army has not only pursued the goal of eventually fielding 15 FCS brigade combat teams (BCTs)—that is what is called the core FCS program—but also field selected FCS capabilities to current Army forces. The Army plans to spin out some early FCS capabilities to infantry brigade combat teams in 2011 and other FCS capabilities later.

The initial production decision for these items is now expected this December. However, testing to date has been limited, and it has involved surrogates or nonproduction representative systems or forms of the spinout systems.

The three tests scheduled for later—

Mr. ABERCROMBIE. What examples do you have? Give us an example.

Mr. GRAVELINE. Well, for one, some of the radios that are intended for the systems that we have talked about are not ready. They will be using surrogates for those. And some of the other systems are still in design, and they are using an engineering development model type of thing.

The three tests scheduled for later this year will also follow the same practice. That is a concern for us, and we have recommended that DOD base its initial production decision on testing of the actual systems to be fielded.

In conjunction with its spin-out efforts, the Army Evaluation Task Force at Fort Bliss has been, in our view, a wise investment by the Army, in that FCS and other capabilities will be given early evaluations by Active-Duty soldiers. The lessons learned from this process should be very beneficial.

Finally, let me spend a moment to discuss Army's plans to pursue an incremental approach for FCS. Last year Army officials said they were considering an incremental of block acquisition approach for FCS for several reasons. One was immature requirements in several key areas, challenges in meeting performance expectations

within program costs and schedule, funding limitations, and continuing challenges and aligning schedules and expectations for FCS and its complementary programs. At this point it is not clear if this incremental approach will feature—

Mr. ABERCROMBIE. Mr Graveline, excuse me one second. Mr. Marshall.

Mr. MARSHALL. I am on page seven of your written testimony. There are four items listed as part of this incremental approach. And the second item is limited availability of performance trade space to maintain program cost and schedule, given current program risks. Could you explain what “performance trade space” means? I am just not familiar with that concept.

Mr. GRAVELINE. Well, it is where you have a couple of competing requirements, and to accomplish it you are finding it difficult to accomplish them both, where, for example, the Army’s manned ground vehicles are turning out to be quite heavier than they anticipated, the designs with the new armor they are using and other things. So that has an impact on the speed and endurance and range, how far you can go on a tank of gas, for example. There is a tension there because the manned ground vehicles, the engine and propulsion system will only give you so much thrust. So the heavier you are, the slower you will go and the less range you will have. So that is one of the tension things where they can’t work out both right now.

Mr. MARSHALL. This may be a term of art in your business, I don’t know; so when you say limited availability of performance trade space, what you are saying is that a given component of the system has a number of different requirements and you might be able to give a little bit with one requirement, but at some point if you are giving a little bit here and giving a little bit there, the total capability just isn’t going to be what was expected. Is that what is meant by this limited availability of performance—

Mr. GRAVELINE. Right. At this point you can’t accomplish everything. Frankly, that is what they are finding in the preliminary design reviews. They are doing a whole series of early ones on the pieces. They are finding out gaps like that, that you can’t get everything. And so there is a laundry list of items that they will have to work through after the reviews are done and make some tradeoffs and give a little bit here and do additional things in other areas.

Mr. MARSHALL. Trade space is what you are referring to?

Mr. GRAVELINE. Tradeoff.

Mr. MARSHALL. Swap this for that; you might get a little less here but get more here.

Mr. GRAVELINE. Right. They may decide on the weight issue that they are actually probably too heavy, so they will have to do some design work and other maybe technology work to reduce the weight. It will just be another thing added to the workload to work that out in different ways.

Mr. MARSHALL. Thank you.

Mr. GRAVELINE. And at this point it is not clear if this incremental approach will feature reduced requirements for some FCS systems or reduced sets of FCS systems to be produced or fielded, or a combination of these options.

Restructuring the FCS program around an incremental approach has the potential to alleviate some of the risks in the strategy. We look forward to hearing more about the Army's incremental plans for FCS when they are finalized. In any case, an incremental approach should be carefully scrutinized.

I will now turn back to Mr. Francis for some concluding remarks.

Mr. FRANCIS. Mr. Chairman, just something very quickly. And we are putting up a third chart; it should look like this in your handouts. The one thing I want to draw your attention to here, it is a busy chart, but while the development of the FCS program is finishing late, the commitments to production are coming early.

And I just wanted to point out on the congressional calendar what is going to be expected of you in the coming years. So at this time next year, February 2010, that is when the first request for FCS production money will come for core systems. It is for facilities. But that will just be a few months after your go/no-go decision. You will be asked to put up the first production money.

A year from that, February 2011, will be the second year of production money and, again, you are still before the critical design review.

The third request for production money will come in February 2012. That will be for fiscal year 2013. And at that time you will have the critical design review; but that limited user test three, which is the first systems, a systems test will not have been held yet. So conceivably the Congress could be asked to invest \$50 billion in FCS, 12 of that being production, before we have a test where we think the FCS can do what it is supposed to do. So those commitments come pretty quickly.

Mr. Chairman, it was a long opening statement, but we are ready for any more questions you might have.

[The chart referred to can be found in the Appendix on page 69.]

Mr. ABERCROMBIE. It is difficult not to observe that it is understandable why the Army isn't here. Although I just want to repeat for the record, we are not here to beat anybody up; that is not the issue here. These are life-and-death issues and the people, as you have observed yourself, and, I would emphasize, that are doing this, the motives are good and the intentions are clear, but that doesn't necessarily make something happen. These are deadly serious issues, not just figuratively. They are certainly really, really serious with respect to where the money, the resources are.

Have you concluded, then, Mr. Francis?

Mr. FRANCIS. Yes.

Mr. ABERCROMBIE. We will go to Mr. Massa first.

Mr. MASSA. Thank you, Mr. Chairman. And, gentlemen, thank you for the work that you do as oversight watchdogs of the American taxpayers' money.

Mr. Francis, you said at heart of this entire concept is a radio network. Did I understand that correctly?

Mr. FRANCIS. Yes, sir.

Mr. MASSA. We will be asked in the very near future to fund approximately \$1 billion in procurement for what is generally known as the radio system called SINGARS. Are you familiar with that?

Mr. FRANCIS. Yes, I am.

Mr. MASSA. Would you characterize that as a radio frequency-hopping single channel Very High Frequency (VHF) mobile radio system?

Mr. FRANCIS. I will take your word for it.

Mr. MASSA. Do you have an understanding of whether or not this \$1 billion in procurement for a 1982 legacy system developed under an Operational Requirements Document (ORD) in 1976 in the United States Army has any compatibility at all, either theoretically or operationally, with the FCS network of radios that are at the heart of this system?

Mr. FRANCIS. It will be compatible, but it cannot function as that relay that I had talked about. So it can talk to FCS, but you are not going to be able to route any message traffic through the SINCGARS radio.

Mr. MASSA. And is it not true that the ability to route message traffic through the radio system at the heart of this is, in fact, what creates the revolution in information warfare that characterizes FCS?

Mr. FRANCIS. Yes.

Mr. MASSA. So while it can function, it cannot do what FCS has at the heart of its technological revolution; is that correct?

Mr. FRANCIS. That is correct.

Mr. MASSA. So we are going to spend a billion dollars on radio equipment that has nothing to do with FCS as it moves forward.

Mr. FRANCIS. That is correct.

Mr. MASSA. I am trying very hard—because I am burdened with the reality that I was in the room when this concept was created—I am trying hard not to be punitive. But to date, besides one class four UAV, which in fact had nothing to do with FCS but in fact was a Navy system that was procured off the shelf, besides that it is my nonexpert opinion—and I am just an upstate New York country farm boy—

Mr. ABERCROMBIE. Watch out.

Mr. MASSA. I really would like to express for the record that the most important weapons system yet created by FCS is approximately 700 tons of PowerPoint slides. And unless we plan on dropping them on the enemy, I don't understand how this will ever become reality.

And it is a matter of common sense. Army acquisition, on one hand, is asking us to spend a billion with a B, and I know we toss that number around here like it is normal—back where I come from in farm country, a billion dollars is still a lot of money—a billion dollars on a handheld radio system developed with technology in 1976 that has virtually nothing to do with what the Army is telling us is the backbone of the future of the network of radio systems that the Army wants to move forward on.

Can you kindly tell me why I should vote to spend a billion dollars on something that has nothing to do with what you and the Army is saying is the future of the Army?

Mr. ABERCROMBIE. I beg your pardon, Mr. Massa, but Mr. Francis cannot kindly tell you that one way or the other, not in this hearing anyway.

Mr. MASSA. I apologize for being emotive about this. I understand at the core of professionalism is objectivity. But we as legis-

lators are asked only to command money; that is all that we are asked to do. And yet we talk about a \$40 billion cost overrun as if it is normal, because we have allowed it to become normal. A billion here and a billion there, and pretty soon you are talking real money.

I value your input because I know you are dispassionate, you bring to the table something that I don't. I bring a lot of passion to this, because I, again, was there when this started.

And the thing that Chairman Abercrombie brings to this table, that all the generals who have been before us have not, is longevity. We have heard it all, we have seen the parade of experts over time, and we have a corporate memory that this has been going on and on and on. And we—ask at least I do as a new guy—when will it end?

And so I appreciate your testimony and your frankness. But I illustrate for the record that we are being asked to make decisions that are in direct contradiction to common sense. They are in direct contradiction to procurement policy. And, frankly, I don't know if I can support it.

Can you please give me some measure of hope that we can get to the bottom of this in an intelligent manner and, in fact, look to the future?

Mr. FRANCIS. I can try.

Mr. MASSA. Thank you.

Mr. FRANCIS. I think what we are seeing here is the larger problems with acquisition as we know them. That is, when a new program is proposed and it is proposed with an optimistic schedule, and everyone counts on that and then it doesn't come. Well, what happens in the meantime is the current forces have to be sustained and they need equipment. And I think that is the case with SINCGARS versus JTRS. The JTRS was supposed to be fielded years ago and was supposed to replace SINCGARS and Enhanced Position Location and Reporting System (EPLARS).

Mr. MASSA. And yet many of us who were on the staff of this committee and supported the members who had the main decisions said, very clearly, what was being proposed would never happen, over and over and over again. We are throwing acronyms around like cereal floating in an alphabet soup. The Non-Line-of-Sight cannon is an artillery piece. The manned ground vehicle, I love—I saw a tank-like vehicle—it is a tank. And yet we believe that somehow by giving them a new revolutionary name, that we are going to be led to believe that something revolutionary is going to happen. And when it doesn't, those of us who said, "I told you so" have nowhere to go but to then go back to the American taxpayer and pull money out of their wallets, especially at a time when they don't have it. That is the frustration that freshman Members of Congress like me who are embedded in dairy farm common sense bring to this table.

Mr. FRANCIS. Well, I think that enriches the discussion because those viewpoints—I think those of us who have been in the business, I think you are right, after a while you get used to, well, ten percent cost increases isn't much. But it is.

But to come back to SINCGARS, what ends up happening is you get a request, because we have to replace things for the forces that are in the field today. And the reason we are having to do it is the

things that we promised never came, and we have been in that cycle for quite some time now.

Mr. MASSA. Well, thank you for your frankness. I apologize for my passion about this, but I think it is important that we bring some reality back to these PowerPoint presentations and, frankly, understand that what we are ultimately talking about is fielding weapons systems for soldiers, so they can break things and do the work of the Nation when we ask them. There are radios out there that are far beyond SINCGARS, that were developed just in the past five years, that are more cost-effective and cheaper.

And, Mr. Chairman, thank you for your patience with me. I yield back my time.

Mr. ABERCROMBIE. Not a bit. Mr. Kissell and then Mr. Bartlett.

Mr. KISSELL. You have another freshman up here, and while I am not from upstate New York and don't have the dairy farm common sense, I maybe can refer to down south, North Carolina, living in rural areas, working in textile mills.

We don't go in these hearings in a vacuum of other information or what we have learned in other hearings. One of the hearings that we have had recently is on procurement. And the statements that were made is we just keep making the same mistakes.

And it does become very hard to accept that cost overruns are a part of life. And we at some point in time have got to have the consequences and systems to take care of that.

With that said, in opening remarks, Mr. Francis, you said you were surprised at the Army's reaction. Can you characterize that a little further, please? What was that reaction?

Mr. FRANCIS. The Army had said they didn't understand how we came up with some of our calculations and didn't agree with our methodology. And my surprise is that I think the press has characterized our report as scathing, and used other adjectives. But we have been very consistent over these past five or six years, and we hold the program to DOD's own policy. I don't know of any other way to look at the program.

Mr. KISSELL. Have you had a chance to get with the Army since then, to help explain it should not have been surprising?

Mr. FRANCIS. Yes, we have.

Mr. KISSELL. I am an economist by college background, and one of the words that economists use a lot, and we have heard a lot recently, is "let's assume." And we have been seemingly using that concept in this procurement process; let's assume it is going to work.

And somewhere in my past I came across levels of knowledge, things you know that you know, things that you know that you don't know. One of those areas of knowledge is things that we don't know that we don't know. In this kind of process, we have an assumption in the charts that are going rapidly toward out of money before the procurement process is tested and implemented.

Based upon things like this we have done before, what is out there that we don't know? What is the chance there are going to be some glitches that we just can't anticipate, that is going to throw this off even more?

Mr. FRANCIS. I think there is a lot of discovery out there, as the conversation we had with Mr. Abercrombie about TRL six tech-

nology for radios; that is that first point. So you have—I think the term of art is unknown unknowns. And you go through those when you develop that radio and you solve them and make tradeoffs. But now we are about the business of integrating that into a network that has to function with other systems. There will be other discoveries there and I think what you find when you go through a system development like this is that, as the design is better understood, complexity increases because you make those discoveries.

Mr. KISSELL. And the no-go or go point, how is that decision going to be made and who is going to make it?

Mr. FRANCIS. Do you want to take that, Bill?

Mr. GRAVELINE. Sure. There the Congress set out a number of expectations of certain analyses and assessments that should be done in preparation for that. The Army is going to be coming forth with a series of presentations, data, studies and the like. Others in the Pentagon are going to be bringing these things forth. There will be a cost estimate, and even an independent cost estimate. So things are all in play already to bring this information together that will be assembled and evaluated really first by DOD staff people in the Pentagon to put all these things together and sort it out.

And then at the end, it will be, the Defense Acquisition Board and the Under Secretary for Acquisition, Technology, and Logistics (AT&L) is the chairman of that. And they will get together for at least a series of meetings and discussions to evaluate what do we have here. Because that is the whole essence of this go/no-go, where the program—most agree that didn't get a good start, or the starting point was just let the Army go ahead on this, even though technologies weren't in place, it wasn't a good cost estimate, the requirements were nebulous, at best.

So the committee legislatively thought that it would be a good point, around preliminary design review, to come back together once you have done some work, you have got your technologies in order, the requirement process is completed, then get together and say where are we, and is this product that is emerging, does it continue to make sense, how achievable is it? You will have better information available to look at those and make solid projections, rather than just a wish that we can have it done at a certain time to do a real go/no-go; does it really make sense? That was the essence of the logic of putting this requirement together.

And so, again, things are in play already to get the information, the studies, the various viewpoints coming together this summer. The Defense Acquisition Board will get together, I believe they have already scheduled that at the end of July. And then there will be a report, or maybe a series of reports, that will be issued and reported to the committee. I believe the legislation says 120 days after preliminary design review.

So it is going to be a busy time in the Pentagon and Army circles, going through that. And we intend to keep on top of that and review all the materials as they come in.

Mr. FRANCIS. It is the Office of Secretary of Defense who will make that decision, not the Army.

Mr. KISSELL. Thank you.

Mr. ABERCROMBIE. Mr. Bartlett.

Mr. BARTLETT. Thank you very much.

Can you help me understand the Army's urgent field need that embarked us on this never-before-used development and procurement protocol, obviously fraught with uncertainties?

Mr. FRANCIS. We were involved just before the program got started and heard the Army's rationale. I think they were looking ahead to next generation and to future forces. And they were looking at Future Combat Systems as a replacement for the heavy force. It was going to replace M1s and Bradleys, but it was going to do so in such a way that a smaller force could have the combat power of a larger force. It would be easier to get the equipment into theater and easier to support it when it was there.

So I think it was, in terms of art again, as long as we are talking, it was a "capabilities-based decision" that the Army thought it needed this capability for the future versus reacting to a particular threat.

I think there was also the thought at the time that there was a limit to how much armor you could put on a vehicle, and some anti-armor weapons were outstripping the ability of armor to protect. And you would have to take another step now to provide that protection, which now would be in the form of the information network.

Mr. BARTLETT. But that relates only to specific vehicles, not to this very complex integrated system.

Let me ask a couple of kind of practical questions here. Another provision that was initiated to full committee level was the elimination of lead systems integrator and I suspect Future Combat Systems had something to do with that.

Obviously the lead systems integrator has an intimate relationship with the subs, and communicates with them on a continuous basis to know what they are doing and are they really getting there.

The usual contracting mechanism that we have, the Pentagon has with the industry, is that we interface only with the prime; and we see the subs only through this really dark prism of the prime. Do you think we ought to look at reconsidering that if, in fact, we are going to be the lead systems integrator?

Mr. FRANCIS. I think so.

Mr. ABERCROMBIE. Mr. Francis, when you answer that question, would you elucidate a little bit on what we mean by lead systems integrator? We know what we are talking about, but we are being viewed by people for whom that may not be a familiar phrase.

Mr. FRANCIS. Certainly. A traditional contracting arrangement would be, say, between the government and a prime contractor. And this has been changing over time, but generally you look at that as an arms-length relationship where the government will write a set of requirements, and the prime contractor is responsible for designing and building a system to meet those requirements. And the prime contractor brings with them all of their suppliers. So the government only has visibility really into that prime contractor.

Now, DOD has been trying to get away from that over time. They have been going with integrated product teams and arrangements like that so it is a closer working relationship. The lead system integrator is perhaps the closest working relationship that we

have come across, and that is a situation where the government actually partners with a contractor and the contractor helps the government make decisions about requirements. And what the government gets out of that, then, is in the case of FCS the government can participate in the selection of the contractor supplier. So they get a lot more visibility there.

So you give up the arms-length relationship, but what you gain is joint decision making and the government gets more insight into the supplier base. I think that enables—

Mr. ABERCROMBIE. That works two ways, doesn't it?

Mr. FRANCIS. It works two ways, yes. It does make the government more agile, but then it becomes in our view a little more difficult for oversight, because it is hard to separate the contractor's contribution from the government's contribution.

But I do think insight into the suppliers is a benefit of that relationship. I think the government can get better insight without necessarily having to go through a lead system integrator relationship with another contractor. So I take your point. I think there are lessons to be learned for the government. If the government is to be the integrator, it should find ways, I think, to get more visibility into the suppliers.

Mr. BARTLETT. Thank you. One more kind of a commonsense question. Obviously, we can increase the cost of these systems if we go too slow. And we increase the cost of the system if we try to go too fast, which is what we have done here. How do you know from the get-go whether you are going too fast or too slow? What is the right balance between these?

Mr. FRANCIS. Mr. Bartlett, I think it is knowing where to go fast and where to go slow. And our view and we have benchmarked this again against best practices in commercial industry is you really need to do your risk taking before you declare something to be a program that you will put on a fixed schedule and budget.

So the place to experiment, then, is in the science and technology base, when you can explore, make mistakes, have failures and decide what is then in the art of the possible. The systems engineering discipline then gives you criteria that you can use to say when you know enough to actually commit to a schedule.

So I would say if we have a robust science and technology phase where you can actually push those technologies and weed out the doable from undoable, then I think you can have a pretty quick development phase for a system. For example, if you could tradeoff requirements so you get that match between mature technologies and requirements, I don't think it is unreasonable to think about a 5- or 6-year development phase, because you are focused only, then, on integrating the product and not worrying about technologies.

Mr. BARTLETT. Didn't we do it very much quicker than that with Mine Resistant Ambush Protected (MRAPs)? We kind of broke all the rules there, didn't we? And, I gather, a pretty successful procurement?

Mr. FRANCIS. Yes. To a large extent, the homework had been done on those vehicles, technology development, and the integration. So we did some modifications to them, but we were able to buy them largely off the shelf.

Mr. BARTLETT. Mr. Chairman, I just wanted to return to my initial question. This was obviously a very risky development and procurement protocol. And I was never apprised of the urgent field need, what enemy out there had capabilities that forced us to this very revolutionary protocol for developing and fielding this system. If there was that kind of thing out there, this had the urgency of the Manhattan Project, then I understand. I have some trouble understanding how we ever got started down this road with no really urgent field need out there that necessitated this kind of risk taking.

Mr. FRANCIS. Well, I think that would be a good question for the Army to answer. I do think a large part of it dealt with not so much a change in the threat, but the fact that the Army did have aging equipment and they were looking to replace it. But I think the Army should handle that one.

Mr. BARTLETT. Thank you very much. And thank you, Mr. Chairman.

Mr. ABERCROMBIE. Before I go to Mr. Marshall on that, just to make sure I am clear, what Mr. Bartlett is talking about and what has been alluded to here and what is specifically here in the slide that you had about best practices approach and the FCS approach, is that if there was such a need, equipment is coming to the end of its useful life, is there another generation of equipment that would prove useful in one situation or another?

The way to do that is what the Army already had out there. First you do technology development and you move toward technology readiness levels and you do preliminary design review. And do everything in order, right? There is a book.

Mr. FRANCIS. Yes.

Mr. ABERCROMBIE. This is not being made up now. You didn't make up this chart?

Mr. FRANCIS. No.

Mr. ABERCROMBIE. There is a book out there and you follow the book along how you do these things. You make sure you have your technology maturity and then you go to your low rate production, et cetera, et cetera. Right?

Mr. FRANCIS. Yes.

Mr. ABERCROMBIE. What we are seeing here is none of this was followed.

Mr. FRANCIS. That is correct.

Mr. ABERCROMBIE. Or it was cited in the breach. These phrases would be used, or these benchmark measurements would be cited, but they weren't cited in the order in which they were expected to appear had you been doing it in the ordinary course of events.

Mr. FRANCIS. That is correct.

Mr. ABERCROMBIE. And so that is where our difficulty is. It is not a matter of too fast or too slow. It is a matter of not following the procedures.

Mr. FRANCIS. In my view, they were about a phase off. We have this preliminary design review in 2009. We are right about the time you would have enough information to start a program.

Mr. ABERCROMBIE. Yes.

Mr. FRANCIS. But we did the cost estimate six years ago when we knew very little.

Mr. ABERCROMBIE. Right. So in some respects they are accelerating. What we are doing is accelerating right through what the book requires in terms of time and expense. It might take a little longer, but at least you would be dealing with measuring apples to apples.

Mr. Marshall.

Mr. MARSHALL. Thank you, Mr. Chairman. I guess I will stay with Mr. Bartlett's question as well. It is unfortunate the Army is not here with us. If the Army were here with us I think that the Army would be very easily able to make the case that having a system like this system available to it is hugely helpful in combat; that it is very appropriate for us to support the Army in attempting to develop a system like this, and very understandable that the Army would want to design it as proposed, just sort of given the way combat works.

I will bet the Army would say that unfortunately as its effort evolved, as it got into it and started working it, just time slipped. In the ideal world, it would have developed all the technology that was needed for this program before moving to the next stage or at least been confident that that technology was deliverable at a reasonable cost and it just didn't work out. It has been too difficult to develop, and so they just felt they had to move forward with the rest of it, sort of looking at their overall estimates, the limits of the budget, sort of cost creep that inevitably attends, pushing things off, those sorts of things.

I think probably one of the reasons the Army is not here, the Army sort of looks at this and says, you know, we started this thing with a very good plan, needed assets, needed development. And then all kinds of problems have occurred and we have gotten ourselves into a pretty untenable position.

So I have to believe that the Army will come back at some point with a suggestion for restructuring the program to take into account the obvious concerns that this committee and Congress will have in light of your report.

And so that leads me to—now that I have testified on behalf of the Army, Mr. Bartlett—that leads me to what I am interested in, and that is how you do you think the Army should restructure this at this point?

I apologize, I had to go out. I have had somebody that I have needed to meet with for some time and it conflicted with this hearing. And so I was just sitting out in the other room, but we had the television off.

Have you considered sort of what are the reasonable ways that the Army could restructure the program to sensibly move forward from where we are right now, as opposed to just abandoning the notion altogether? I think it would be a shame if we simply abandoned the notion altogether.

The MRAP vehicle has been a very nice addition, but it is a stand-alone item. The idea of having an integrated weapons system available to a BCT like the weapons system that is contemplated by this effort is great.

So have you thought about what you think the Army ought to be doing at this point, thinking about restructuring and moving forward so we don't lose this?

Mr. FRANCIS. We have thought about it, Mr. Marshall. It is not something we could subject to an audit. There is no book on this.

Mr. MARSHALL. Right.

Mr. FRANCIS. But in my way of thinking, the Army would first go back and look at their overall requirement, not all the details, but do they still have a requirement for a heavy system or a medium system; to keep their eye on what they are designing to.

And then I think in terms of near term, midterm and long term, in the midterm they have to make sure their current force is re-capitalized and kept current. And I would include in that any of the spin-outs from FCS that can make that current force better. That would be one thing I would think about.

Then I would think about the midterm. There may be some platforms from FCS that, with additional development, that it might make sense to field them. So, for example, there could be something like the Bradley replacement; maybe it would make sense for when that vehicle is ready to replace it, if it is not dependent on the network for its performance. So if it has a stand-alone capability, I would think about that type of thing for midterm.

Long term I think the Army should continue to invest significantly in its technologies in the network. It shouldn't stop and come back to that later. I think it needs to keep that science and technology going there to give itself options in the long term.

Mr. MARSHALL. Gentlemen, do you agree, disagree, have something to add?

Mr. GRAVELINE. I would just add, the largest cost driver of the program is the manned ground vehicles. Certainly getting to the production stage of them, that is where it is going to be really expensive. So that is the thing you really have to think hard about what portion of those may want to go forward.

I would agree with Mr. Francis on the network. There are some important things going on there and they are kind of getting to the point where they are really understanding what that network is all about and defining what they can do. There has been a lot of discovery on that part, and I would hate to lose that learning that they have made.

There are a lot of pieces that have been developed, including some of the sensors that were to be included in the manned ground vehicles. They may be applicable elsewhere. And there are a lot of valuable pieces, so I think it ought to be carefully evaluated as to how to proceed, not just let's dump the whole thing.

Mr. FERGUSON. I would like to add, sir, to what Mr. Graveline alluded to earlier. With the Army Evaluation Task Force in Fort Bliss, the tremendous potential areas were having a near brigade-size unit there testing actual prototype systems and providing feedback in that design process, getting an honest-to-goodness perspective from soldiers who have been in Iraq and Afghanistan providing feedback in that process, I think is tremendous.

Mr. MARSHALL. One more question. Part of the dilemma and one of the reasons why the Army probably would acknowledge that this has gotten all out of whack, the process that it had originally envisioned to develop this, again, having to do with the technology development. Can you imagine any circumstance in which the Army could produce evidence that is sufficient to persuade us that while

we haven't had PDR, Critical Design Review (CDR) at this point—well CDR for sure—that is okay, because we can establish to your satisfaction that in fact this technology will be there; that it can simultaneously arrive and we can go ahead and it makes sense, you know, costwise for us to just go ahead and go into production with regard to the hardware itself with the idea that the technology will be there when this hardware is there. And that, net, we will save a lot of time, save a lot of lives. Hopefully we will not really be dependent upon these systems, but if we are, save a lot of lives, save a lot of time and also save money.

Is it conceivable to you that they would be able to make the case that yeah, here is where the technology development is, but it will in 2012 be mature, be there, you can count on it?

Mr. GRAVELINE. I would say, looking at the potential things that could come out of this incremental approach they may come out with, they could start with a very basic vehicle which doesn't have a lot of the more exotic technologies on it, and try to build that first. And then as the technologies come along, keep adding to that basic vehicle as they go downstream. So that maybe the first version may not be satisfying to everybody, but that would be a starting point that you could stabilize and build on. And then down longer term, you get to where you really want it to be. That is not lacking risk involved in there, but I think that may be something—

Mr. MARSHALL. And I think you might be giving good advice to the Army at this point. But I have a different question, I might not have stated it very well.

If the Army simply wants for some reason to stay on the planned program, and it acknowledges that technology development is not yet complete and will not be mature almost until almost 2014, and CDR will not occur until 2011, nevertheless, Congress, you should permit us to go ahead and invest in system development and demonstration and actual production prior to that time, because it will all come together. And if we have to use it, the effect of it all coming together will be to save an awful lot of lives, and inevitably we will save money by moving forward as opposed to delay, and we will save time.

Can you imagine a circumstance in which the Army would be able to prove that case, to establish to our satisfaction that, in fact, technology development will wind up leading to a product in 2013, even though we don't have it right now, a product that is acceptable?

Mr. FERGUSON. To date, so much of what the Army has provided to decision-makers such as the committee to build confidence in what FCS is doing has been based on modeling and simulation. It is our view that modeling and simulation is good very early in a program, that modeling and simulation has to be validated through actual demonstrations with production representative hardware.

I think maturing technologies to a TRL six is a good start for the program, but the next step will be one getting those technologies validated by independent review time at the Department of Defense level. But then, actually netting some capabilities together and having some realistic demonstrations with the systems will

provide a lot more confidence, I think, for the committee as they deliberate the future of the program.

Mr. MARSHALL. We understand that is the ideal. I am just wondering is there a way for the Army to make its case without saying we can't do the ideal process here? No?

Mr. FRANCIS. Their programmer report shows they believe that now. They believe everything can go concurrently, that they don't have to build production representative prototypes. I think they would say their preliminary design review is so good, it is almost like a critical design review. I think they believe that they can do it all, even though it is unconventional. In fact, that is some of the discussions we have had. They believe that the model that we use to look at it is too linear and they are going to do this differently.

Where we come out on that is we have seen so many systems go through this process, FCS is not the first system that we have looked at or even the first Army system. So we can't see how they can do it. But I guess you always have to keep open the possibility that it is possible that they could do it. But I don't see any way analytically where we can see that that could happen.

Mr. MARSHALL. Thank you, by the way, for your expertise and commitment and the sort of help you are giving us here. This is great. So we obviously need to hear from the Army and have the Army explain what you just explained in trying to make its case.

Besides yourselves, your experts, but if you were us and you felt like you needed to pull in some experts to listen to the case or the two views or the two sides, who would you pull in to help us evaluate whether or not it is real, when the Army is suggesting is realistic?

Mr. FRANCIS. Well, I could think of a couple of organizations. One would be the Institute for Defense Analyses—

Mr. MARSHALL. We already have them on board.

Mr. FRANCIS [continuing]. Which has done some independent analysis. I would think also within the Department of Defense if you were, for example, to have the Program Analysis and Evaluation Office give you their views on things, because they see all programs across the board. Also, I think the Office of the Director of Defense Research and Engineering that does independent analysis of these technology readiness levels would also be able to give you a separate and expert opinion.

Mr. MARSHALL. If the Army is suggesting that your approach—and graphically you have laid it out in a way that suggests that you are linear and they are sort of proceeding along simultaneous paths, hoping that we will all arrive at the same time, at the right time, with everything working. Obviously greater risk to the second approach than the first approach. No question about that.

If we said to the Army, give us examples where your approach to this has worked, would they be able to do that, do you know? When I say "your," the Army's approach is what I am referring to. It was an indefinite reference.

Mr. FRANCIS. I don't know of any examples that I could cite, and would think the number of examples citing the opposite would be quite a few—Expeditionary Fighting Vehicle which the Marines are developing.

Mr. MARSHALL. You are talking about when procurement development lines up, getting—not going through this linear process, but follows a different route to the end result, there are lots of examples where it didn't work out too well?

Mr. FRANCIS. That is correct. So even on a single system, when a concurrent approach has been attempted where you try the design before your technologies are ready, those programs have not worked out well. So for me it is difficult to see—if you scale that up exponentially to assist on the systems and make it more complex, it is harder to see how that approach somehow involves less risk.

Mr. MARSHALL. Thank you, Mr. Chairman.

Mr. ABERCROMBIE. Do you have something at the moment, Mr. Kissell?

Okay. A couple of things. It reminds me when you are mentioning that, because it came out of this committee when Mr. Weldon was Chairman, the Presidential helicopter. I have just to remind myself that I wasn't imagining that I saw what I saw in my mind to say, you know, I was on that years ago. Well, it turns out I was, and the committee was, subcommittee was. It is a perfect example. They kept adding stuff.

We took a look at it and we said, you know, we are just sitting here; Mr. Massa is in the dairy farms, and Mr. Kissell is in the textile factory; and I am sitting at the beach at the Royal Hawaiian.

So it occurred to me that it you keep adding things into this helicopter, you change the weight and you change the way the thing has to be built. And that has to change and then the aerodynamics and so on.

I kept thinking if you keep doing that, how are you going to make this work in the time line that you set up? That is where it first came to my mind: Aren't you bending the laws of physics here? No, no, no, we are on schedule, we are on budget, and look what has happened now with it.

When you get it to the point where the President is supposed to be able to iron his clothes and have a spa treatment in the helicopter, it is going to change the way it works. In other words, I guess where I come down is that the one thing I think I have learned on the committee over these years is there is a book for a reason. You follow the book for a reason.

And that the interesting—I suppose it is paradox to some people—the reason the book exists is to actually support initiative. If you do things by the book you can actually exercise initiative, go into new programs and so on, but you are going to do it in a way that substantiates itself as it goes along and that is the reason you have the book.

Now in that context, on March 13th, after the GAO's report was generally circulated and you had finished your discussions with the Army, right—the report did not come out before you had gone back and forth with the Army or with drafts and so on, correct?

Mr. FRANCIS. Correct.

Mr. ABERCROMBIE. On March 13th a press conference was called, and then key Army officials at that time made a number of critical comments about the report and offered an Army perspective on the state of the FCS program. I am bringing it up now because they

are not here. So all I can go on is what was already out in the public domain from the Army, aside from the statement which I entered into the record, which begins with this quotation on the acquisition process and differences with the GAO report—that is the way it is stated here. “In many respects the FCS program is a model for the flexibility and rapid adjustment that the Office of the Secretary of Defense and Congress have called for in defense acquisition.”

That is the principal defense—I won’t even say “defense”—the initial offense here, the initial commentary, is that Congress called for this kind of approach as a model.

That being the premise, the foundational premise, here are the questions I have. Army officials have professed confusion about two specific cost estimates which have been used already today that the GAO used in its report, one on the possible cost increase of the core FCS program, \$19 billion, and the other on the cost of the FCS spin-out initiative, \$21 billion. Can you tell me, then, where the cost estimates came from?

Mr. FERGUSON. Mr. Chairman, I will answer that. The \$19 billion and \$21 billion were actually figures that were generated by the Army, specifically the Future Combat Systems program in an attempt to provide information for the Program Objective Memorandum (POM) process.

Mr. ABERCROMBIE. Explain the POM process.

Mr. FERGUSON. Program Objective Memorandum, which kind of lays out the requirements and funding for the next six years for the Army. That is where the numbers came from. And the 19 billion—2 billion was for additional system and development funding, and 17 billion of it would be for additional procurement money.

Mr. ABERCROMBIE. Where do those figures come from?

Mr. FERGUSON. The Army.

Mr. ABERCROMBIE. Why would they be expressing confusion as to why you used those in the report?

Mr. FERGUSON. I am really not sure, sir.

Mr. ABERCROMBIE. Did you use those figures in your discussions with the Army? Or did those figures appear in the back-and-forth discussions that you had, either in the development of the draft or in their commentary afterwards?

Mr. FERGUSON. There is a comment period, and the Army has an opportunity to send us technical comments on the details of the report. No comment was raised about those numbers being in the report.

Mr. ABERCROMBIE. Okay, thank you.

Mr. FERGUSON. Yes, sir.

Mr. ABERCROMBIE. Did you want to say something, Mr. Francis, or were you just twitching at the moment?

Mr. FRANCIS. No, I was waiting for Marcus to get to that point. Those numbers were in the draft report. The draft report was with the Department of Defense and the Army for a month. They get a month to comment on it. So those numbers are well vetted.

Mr. ABERCROMBIE. Okay, second question. Army officials stated—now I am referring to the public commentary here. You may have read some of this commentary yourself in the general press. Hopefully we will still have newspapers in the next few months,

and we will be able to—we may have to look to them in order to get our information. “Army officials also stated that the GAO has mischaracterized what the Army has done in terms of testing to date, and claims that the GAO discounts the value of the Army’s modeling and simulation efforts.”

I realize you have talked about these things in the course of the hearing today, but my question then is can you summarize your perspective on these claims? One, that you have mischaracterized what the Army has done in terms of testing to date, which I presume is the way you put these slides together? And two, that you discount the value of their modeling and simulation efforts?

Mr. GRAVELINE. Oh, I will respond to that in a couple of different ways. One, first of all our purpose was to respond to the congressional direction for the milestone review, which talked about demonstrations rather than simulations. So kind of the standard there was beyond simulations. And it wasn’t that we were discounting simulations at all. It was the Congress was interested at a step beyond that.

And so our conclusion was, although they have been doing testing—we recognize that—the Army wishes we would recognize it more so. That is a matter of half empty, half full kind of argument there: How much do we recognize it?

Mr. ABERCROMBIE. Am I to understand that your answer would be that it was not that you are discounting the value of simulation; that is not what you were measuring?

Mr. GRAVELINE. Absolutely.

Mr. ABERCROMBIE. What about the question of testing to date?

Mr. GRAVELINE. Again, the Army would prefer that we go at great length to describe all the testing that they have done to date. We don’t discount that; we know of that. We would also say it is a matter of a challenge involved here in FCS, that it requires a lot of testing to demonstrate many of these technologies and systems and sub-systems. So it wasn’t that we were discounting them at all. It is a matter of how much credit do you give that of the piece testing to the whole and how well that demonstrates the whole concept.

Mr. ABERCROMBIE. Maybe I can—the reason I asked that question had to do particularly with the radio networks. And, again, this statement that was submitted to us last week under a section called “Alignment and Program Status of Complementary FCS Programs,” including the Joint Tactical Radio System and Warfighter Information Network Tactical Programs. The Army goes—again you are not questioning that they were testing; the point here was, was it not, as to whether that actually is advancing toward the maturity of the technology for useful test, whether it is critical testing time or whatever, right?

Mr. GRAVELINE. Uh-huh.

Mr. ABERCROMBIE. What they said here to answer was that the Joint Tactical Radio System and the Ground Mobile Radio and the hand-held man-packed small form fits and Warfighter Integration Network are complementary programs. Well, no argument there, right?

Synchronization of these programs, technical interfaces occurs through the use of the interface requirements documents and the

quarterly synchronization summits. No argument there. That is what takes place, right? This is where you talk about your reviews.

They describe system performance, technical interface expectations, programmatic gaps and schedule costs and performance between the programs are resolved at quarterly transport layer synchronization summits.

Are you familiar with that phraseology?

Mr. GRAVELINE. Yes, sir.

Mr. ABERCROMBIE. Programmatic gaps in the schedule, cost and performance between the programs are resolved at quarterly transport layer synchronization summits.

Now, I read that and I would think that what they are saying is that these programmatic gaps, the cost problems and the performance deficits have been resolved. And they did it at a summit where—which they synchronized all these things.

Am I correct that what they really mean here is they talked about these things?

Mr. GRAVELINE. It has been an elusive problem for the Army to solve since the start of the program, the coordination between FCS and its complementary programs. At times there are a few dozen that are considered critical, very vital for FCS' success, and then there are a hundred or more, I think, that at least have to be well-known to each other.

The synchronization of all those efforts together has been an enormous challenge for FCS and the Army as a whole. And they have devoted a lot of attention to it, and they are still finding that there are gaps. Some of the preliminary design reviews identified some more of those, that they are not quite synched up as to what FCS expects from these other programs, and what they are ready to deliver. And it has been quite a frustrating experience for the Army, and they are not there yet.

Mr. ABERCROMBIE. They characterize this—what you have just said is frustration—they say this facilitates continuous leadership awareness of achievable capability. That is a true statement too, isn't it?

Mr. GRAVELINE. Uh-huh.

Mr. ABERCROMBIE. That is a true statement too, isn't it?

Mr. GRAVELINE. Yes.

Mr. ABERCROMBIE. In other words, it doesn't work; and they are aware of that.

Mr. GRAVELINE. This has the—the top levels of the Army have been involved in this effort for some time; and it is still a frustrating, illusive thing to get these nailed down, that everyone is on the same plan and that they know their expectations and they are going out to meet them.

Mr. FRANCIS. Mr. Chairman, I would just add, these programs have been resynchronized several times. So they resynchronize. They make discoveries. Technologies don't behave very well. And when you learn more, then you have to resynchronize because the plan didn't turn out.

Mr. ABERCROMBIE. I am not reading this in order to be sarcastic. I am reading this in order to say this is how you can—speaking of mischaracterization or something, this is how you can delude yourself. This sympathetic magic that is going on here.

It reminds me of Norman Mailer's "Fire the Moon," when he did a biography, if you will, of the moon shot. At one point, he has a chapter on the psychology of machines; and he maintains in a metaphorical way—he talks about glitches, that there are things that happen and that is not supposed to happen. Everything has already been programmed. You know, the physics of everything. And yet he talks about the psychology of machines, that there is a certain dimension to all of this that simply isn't accounted for and has to be rigorously addressed in order to be dealt with.

One last question then. One of the people making commentary was Lieutenant General Vane. He stated that the Army has proven a variety of FCS systems on the battlefield in Afghanistan. I don't know if you are prepared to answer that, but I was not—I am not quite sure what that refers to. Given your statements on the status of the FCS program, do you have any idea exactly what is being referred to, that there is a variety of FCS systems that have been put into the battlefield in Afghanistan?

Mr. GRAVELINE. There have been several things. It is important to understand from the outset, though, that when FCS started in 2003, there was a great deal of it that was new development that was started. All the manned ground vehicles, that was a fresh start. But there was also a variety of things that were already in development elsewhere, and the Army just pulled those all together in this conglomerate program.

Mr. ABERCROMBIE. That is what I thought.

Mr. GRAVELINE. And some of these things have continued to mature.

And, also, I might add, too, that there are some pieces of FCS that were actually a commercial product. And I refer there to the small unmanned ground vehicle—actually, was it last year here? But they had the little robot, the remote control thing here, the Army brought it.

Mr. ABERCROMBIE. Yes.

Mr. GRAVELINE. That was, frankly, a commercial product, I believe. So early versions of these items, that robot for one, have been fielded and are used in Iraq and Afghanistan with good effect. No challenge there.

Now, the Army is continuing to develop those, for example, that robot, making it even smaller, adding the new radio on to it, adding additional capabilities. But the basic robot is already fielded there. And, likewise, there is this small unmanned aerial vehicle that looks like a little trash can type of thing.

Mr. ABERCROMBIE. I have seen the—and have gone to Fort Bliss that you mentioned.

Mr. GRAVELINE. That was something done by the Defense Advanced Research Projects Agency (DARPA), I believe, that worked on that program for some time. And the Marines had demonstrated, I want to even say in Hawaii, the 25th unit there.

Mr. ABERCROMBIE. The Army.

Mr. GRAVELINE. All right. That is something that they are also using over in Afghanistan and Iraq.

But the Army is continuing that within the FCS program. They are putting a new engine on it and adding additional electronics.

And so its FCS element will continue, and it is going to be ready in a few years. But early versions of these things are being fielded.

Mr. ABERCROMBIE. What it does show then is the efficacy of following the book on maturing technologies.

Mr. GRAVELINE. Yes.

Mr. ABERCROMBIE. In other words, if you do get started with something, well, then you can build on it.

Mr. GRAVELINE. U-huh.

Mr. ABERCROMBIE. Mr. Bartlett, you are fine?

Mr. BARTLETT. I want to thank you for calling this hearing, and I want to thank our witnesses for their diligent work. Thank you very much.

Mr. ABERCROMBIE. The work of the GAO is a constant revelation. And I want to state for the record that you gentlemen carry the tradition and legacy of the GAO, which I rank right there with the Library of Congress, as a matter of fact. The Congressional Research Service and the GAO are singular—set singular standards for public service, and your value to not just this committee but to the American people is very difficult to measure. I don't know what kind of metrics they put on that, but professionalism, objectivity, perseverance, and fidelity to the purpose of public service I think is manifest in what you have been doing, not just in this report but really in every single instance that I have dealt with the GAO; and I thank you very much.

Mr. FRANCIS. Thank you very much.

Mr. ABERCROMBIE. This will conclude the hearing. Thank you.  
[Whereupon, at 4:13 p.m., the subcommittee was adjourned.]



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**A P P E N D I X**

MARCH 26, 2009

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**PREPARED STATEMENTS SUBMITTED FOR THE RECORD**

MARCH 26, 2009

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GAO

Testimony  
Before the Subcommittee on Air and Land  
Forces, Committee on Armed Services,  
House of Representatives

For Release on Delivery  
Expected at 3:00 p.m. EDT  
March 17, 2009

DEFENSE ACQUISITIONS

Key Considerations for  
Planning Future Army  
Combat Systems

Statement of Paul L. Francis, Director  
Acquisition and Sourcing Management



GAO-09-410T

March 17, 2009

**DEFENSE ACQUISITIONS:****Key Considerations for Planning Future Army Combat Systems**

Highlights of GAO-09-410T, a report to Subcommittee on Air and Land Forces, Committee on Armed Services, House of Representatives

**Why GAO Did This Study**

The Future Combat System (FCS) program—which comprises 14 integrated weapon systems and an advanced information network—is the centerpiece of the Army's effort to transition to a lighter, more agile, and more capable combat force. The substantial technical challenges, the cost of the program, and the Army's acquisition strategy are among the reasons why the program is recognized as needing special oversight and review.

This testimony is based on GAO's March 12, 2009 report and addresses knowledge gaps that will persist in the FCS program as Congress is asked to make significant funding commitments for development and production over the next several years.

**What GAO Recommends**

In its March 2009 report, GAO suggested Congress consider not approving full funds for the program until several conditions are met, such as preparation of a complete budget for any program emerging from the milestone review. GAO also recommends the Secretary of Defense, among other things, ensure the program that emerges conforms to current defense acquisition policy, such as technology maturity; any spin out approach is based on fully tested results; and any incremental strategy involves free standing, justifiable increments.

View GAO-09-410T or key components. For more information, contact Paul Francis at (202) 512-4841 or francisp@gao.gov.

**What GAO Found**

The Army will be challenged to demonstrate the knowledge needed to warrant an unqualified commitment to the FCS program at the 2009 milestone review. While the Army has made progress, knowledge deficiencies remain in key areas. Specifically, all critical technologies are not currently at a minimum acceptable level of maturity. Neither has it been demonstrated that emerging FCS system designs can meet specific requirements or mitigate associated technical risks. Actual demonstrations—versus modeling and simulation results—have been limited, with only small scale warfighting concepts and limited prototypes demonstrated. Network performance is also largely unproven. These deficiencies do not necessarily represent problems that could have been avoided; rather, they reflect the actual maturity of the program. Finally, there is an existing tension between program costs and available funds that will likely worsen, as FCS costs are likely to increase at the same time as competition for funds intensifies between near- and far-term needs in DOD and between DOD and other federal agencies.

DOD could have at least three programmatic directions to consider for shaping investments in future capabilities, each of which presents challenges. First, the current FCS acquisition strategy is unlikely to be executable with remaining resources and calls for significant production commitments before designs are demonstrated. To date, FCS has spent about 60 percent of its development funds, even though the most expensive activities remain to be completed before the production decision. In February 2010, Congress will be asked to consider approving procurement funding for FCS core systems before most prototype deliveries, the critical design review, and key system tests have taken place. Second, the program to spin out early FCS capabilities to current forces operates on an aggressive schedule centered on a 2009 demonstration that will employ some surrogate systems and preliminary designs instead of fully developed items, with little time for evaluation of results. Third, the Army is currently considering an incremental FCS strategy—that is, to develop and field capabilities in stages versus in one step. Such an approach is generally preferable, but would present decision makers with a third major change in FCS strategy to consider anew. While details are yet unavailable, it is important that each increment be justifiable by itself and not dependent on future increments.

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Mr. Chairman and Members of the Subcommittee:

I am pleased to be here today to discuss the Department of the Army's Future Combat System (FCS), a networked family of weapons and other integrated systems. FCS is in the forefront of efforts to help the Army transform into a lighter, more agile, and more capable combat force by using a new concept of operations, new technologies, and a new information network, linking whole brigades together in a system of systems. Later this year, FCS faces a congressionally mandated go/no-go decision review to determine the program's future. This review is crucial, as production funding and commitments will build rapidly after that point, limiting the government's ability to alter its course.

My statement today is based on the work we conducted over the last year in response to the National Defense Authorization Act for Fiscal Year 2006, which requires GAO to report annually on the FCS program.<sup>1</sup> This statement discusses the knowledge gaps that will persist in the FCS program as Congress is asked to make significant funding commitments for development and production over the next several years. For additional information on these issues, please refer to our report released March 12, 2009.<sup>2</sup>

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## Background

The FCS concept is designed to be part of the Army's Future Force, which is intended to transform the Army into a more rapidly deployable and responsive force that differs substantially from the large division-centric structure of the past. The Army is reorganizing its current forces into modular brigade combat teams, each of which is expected to be highly survivable and the most lethal brigade-sized unit the Army has ever fielded. The Army expects FCS-equipped brigade combat teams to provide significant warfighting capabilities to the Department of Defense's (DOD) overall joint military operations.

Since being approved for development in 2003, the program has gone through several restructures and modifications. In 2004, the program re-introduced four systems that had been deferred, lengthened the development and production schedules, and instituted plans to spin out

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<sup>1</sup>Pub. L. No. 109-163, §211.

<sup>2</sup>GAO, *Defense Acquisitions: Decisions Needed to Shape Army's Combat Systems for the Future*, GAO-09-288 (Washington, D.C.: March 12, 2009).

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selected FCS technologies and systems to current Army forces throughout the program's development phase. In 2006, the Army again deferred four systems, among other changes. In 2008, the Army altered its efforts to spin out capabilities to current forces from heavy brigade combat teams to infantry brigade combat teams.

The FCS program began in May 2003 before the Army defined what the systems were going to be required to do and how they would interact. The Army moved ahead without determining whether the concept could be successfully developed with existing resources—without proven technologies, a stable design, and available funding and time. The Army projects the FCS program will cost \$159 billion, not including all the costs to the Army, such as complementary programs. The Army is also using a unique partner-like arrangement with a lead system integrator (LSI), Boeing, to manage and produce the FCS. For these and other reasons, the FCS program is recognized as being high risk and requiring special oversight. Accordingly, in 2006, Congress mandated that DOD hold a milestone review following the FCS preliminary design review.<sup>3</sup> Congress directed that the review include an assessment of whether (1) the needs are valid and can best be met with the FCS concept, (2) the FCS program can be developed within existing resources, and (3) the program should continue as currently structured, be restructured, or be terminated. Congress required the Secretary of Defense to assess the program against specific criteria, including the maturity of critical technologies, program risks, demonstrations of the FCS concept and software, and a cost estimate and affordability assessment, and to report on findings by the time of the milestone review.

This statement is based on work we conducted between March 2008 and March 2009 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.

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<sup>3</sup>John Warner National Defense Authorization Act for Fiscal Year 2007, Pub. L. No. 109-364, § 214 (2006).

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### Significant Knowledge Gaps in Key System Development Areas

Assessed against the criteria to be used for the milestone review, the FCS program has significant knowledge gaps. Specifically, the program has yet to show that critical technologies are mature, design issues have been resolved, requirements and resources are matched, performance has been demonstrated versus simulated, and costs are affordable. The Army will be challenged to convincingly demonstrate the knowledge necessary to warrant an unqualified commitment to FCS at the 2009 milestone review.

While best practices and DOD policy preference are for each of a program's critical technologies to achieve a technology readiness level (TRL) of 7 prior to entering development, the Army is struggling to achieve a TRL 6, the level required for the milestone review, after almost 6 years of development. Although the Army projects that TRL 6 will be achieved by the time of the review, the Army will be challenged to do so. Dates for several key demonstrations have slipped, and several ratings have yet to be validated by independent reviewers. Furthermore, the Army's experience with maturing FCS technologies does not inspire confidence that it will be able to execute the fast-paced integration plans involved with advancing technologies to TRL 7 before the production decision in 2013.

Design knowledge expected to be available at the time of the milestone review may not provide the necessary confidence that FCS design risks are at acceptable levels. The Army continues to set and refine requirements in order to establish system designs, particularly at the system level. Although the Army plans to have completed all system-level preliminary design reviews before the milestone review, the schedule to close out all the reviews may take more time than anticipated, key risk items will have to be addressed, and design trade-offs will be necessary. For example, the projected weight of the FCS manned ground vehicles has increased, which could have a number of effects on vehicle performance. In the coming months, the Army will have to address these and other design and requirements conflicts. It is important to note that DOD's updated acquisition policy calls for holding preliminary design review at or near the time of the decision to begin development, which in the case of FCS was in 2003.

The Army will be challenged to meet the congressional direction to demonstrate—versus simulate—that the FCS warfighting concept will work by the time of the milestone review. At this time, limited demonstrations of select capabilities, including manned ground vehicles and software, have been conducted, but no meaningful demonstration that the FCS concept as a whole will work has been attempted. A thorough demonstration of the

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FCS network, the linchpin of the FCS concept, will not be attempted until 2012. There have been some demonstrations of early versions of the lightweight armor and an active protection system, but the feasibility of the FCS survivability concept remains uncertain.

The Army is expected to update its cost estimate, currently \$159 billion, for the milestone review.<sup>4</sup> Last year, the Army indicated its notional plans to increase estimates by about \$19 billion, but has not said whether it would have to trade off capabilities to accommodate the higher costs. The Army has also indicated its willingness to reduce funding to current force systems in favor of FCS. While the updated program cost estimate will be a better representation of actual costs than previous estimates, the program still has many risks and unprecedented challenges to meet, and thus, the estimate will likely change again as more knowledge is acquired.

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**Army Plans to Proceed with Production Commitments before Solid Level of Knowledge Demonstrated to Decision-makers**

At the milestone review, DOD will have to evaluate at least three programmatic options to shape investments in combat systems for the Army, each of which presents challenges. The first involves the FCS program, which, as currently structured, has significant risks for execution. Second, the decision to produce spin out systems to current forces is expected to occur before full testing of production-representative prototypes. Third, the Army is considering altering the FCS strategy to follow an incremental approach, which is preferable to the current approach, but presents other challenges.

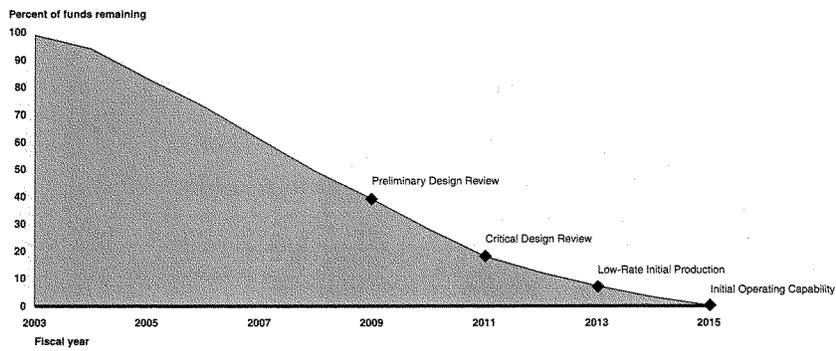
The FCS acquisition strategy is unlikely to be executable within current cost and schedule projections, given the significant amount of development and demonstration yet to be completed. The timing of upcoming commitments to production funding puts decision makers in the difficult position of making production commitments without knowing if FCS will work as intended. Under the current acquisition strategy, FCS decisions are not knowledge-based, nor do they facilitate oversight. For example, the Army has scheduled only 2 years between the critical design review and the production decision in 2013, leaving little time to gain knowledge between the two events. As a result, FCS will rely on immature prototypes for making the decision to proceed into production. Also, if the program receives approval to proceed at the milestone review this year,

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<sup>4</sup>These costs do not include the costs of the FCS spin out initiative, currently estimated at about \$21 billion.

the Army will have only 40 percent of its financial and schedule resources left to complete what is typically the most challenging and expensive development work ahead, as depicted in figure 1 below.

**Figure 1: Remaining FCS Research and Development Funding and Key Events**



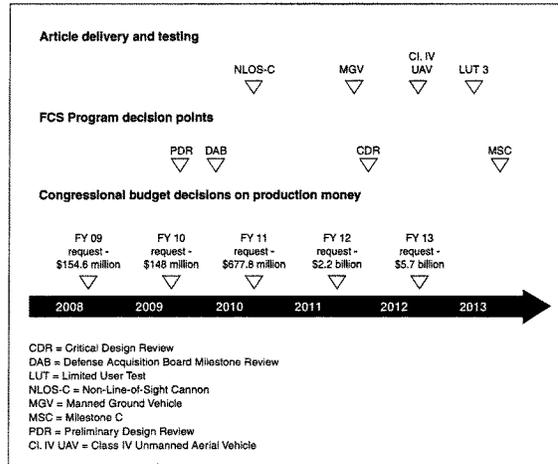
Source: U.S. Army (data); GAO (analysis and presentation).

Historical experience and recent independent cost estimates on FCS suggest that costs will grow beyond the Army's estimates. Our previous work has shown the development costs for programs with mature technologies increased by a modest average of 4.8 percent over the first full estimate, whereas the development costs for programs with immature technologies increased by a much higher average of 34.9 percent. Similarly, program acquisition unit costs for the programs with the most mature technologies increased by less than 1 percent, whereas the programs that started development with immature technologies experienced an average program acquisition unit cost increase of nearly 27 percent over the first full estimate. Our work also showed that most development cost growth occurred after the critical design review. Specifically, of the 28.3 percent cost growth that weapon systems average in development, 19.7 percent occurs after the critical design review.

Under the current strategy, the Army's plans for funding core production efforts put congressional decision makers in a difficult position in a number of ways. Facilitization costs begin in fiscal year 2011, the budget

for which will be presented to Congress in February 2010, several months after the milestone review and prior to the critical design review.<sup>5</sup> In fact, there could still be action items from the preliminary design review to complete at that time. Further, when Congress is asked to approve funding for initial low-rate production of core FCS systems, the Army will not yet have proven that the FCS network and the program concept will work, a demonstration that is expected as part of Limited User Test 3 in 2012. This situation is illustrated further in figure 2 below.

**Figure 2: FCS Program Events and Congressional Budget Decisions on Production Funds**



Source: U.S. Army (data); GAO (analysis and presentation).

<sup>5</sup>The funds requested in fiscal year 2009 and 2010, and a portion of that in 2011 are for Non-Line-of-Sight-Cannon production.

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Significant production funds will also be spent on the Non-Line-of-Sight Cannon and spin out systems between now and the FCS core production decision in 2013. To meet congressionally required fielding dates, the Army began building Non-Line-of-Sight Cannon prototypes last year, but has encountered some setbacks due to development issues and delays. The vehicles are planned to be used as training assets and will not be fieldable systems. The Army is planning for a seamless transition between these prototypes and production of the core FCS systems, but given the financial investment from the Army and consequently, the energized industrial base, this could create pressure to proceed into core production prior to achieving a solid level of knowledge on which to move forward.

Currently, the Army's efforts to field spin out systems relies on a rushed schedule that calls for making production decisions before production-representative prototypes have clearly demonstrated a useful military capability. A shift in focus on the Army's efforts to spin out capabilities to current forces from heavy brigade combat teams to infantry brigade combat teams resulted in moving the production decision from January 2009 to December 2009.<sup>6</sup> However, only one key test has been conducted under the new structure, and this event was a shortened version of an event that was originally planned to focus on the heavy brigade combat team. Additionally, testing completed to date has involved surrogate or non-production representative forms of systems, and the three tests scheduled for this year will follow the same practice.

Army officials have said that they are considering an incremental or block acquisition approach to FCS in order to mitigate risks in four major areas: (1) immaturity of requirements for system survivability, network capability, and information assurance; (2) limited availability of performance trade space to maintain program cost and schedule given current program risks; (3) program not funded to Cost Analysis Improvement Group estimates and effect of congressional budget cuts; and (4) continuing challenges in aligning schedules and expectations for multiple concurrent acquisitions. Restructuring the FCS program around an incremental approach has the potential to alleviate the risks inherent in the current strategy and is an opportunity to apply recent DOD policy updates, such as the creation of configuration steering boards, and provide

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<sup>6</sup>Heavy brigades are equipped with armor, such as the Bradley Fighting Vehicle. Light brigades are equipped with motorized infantry, such as the High Mobility Multi-purpose Wheeled Vehicle.

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decision-makers with more information before program commitments are made. On the other hand, an incremental approach entails its own oversight challenges. First, it presents decision makers with another FCS strategy to consider, possibly after the fiscal year 2010 budget is submitted. Second, the approach must ensure that each increment stands on its own and is not dependent on future increments.

As DOD considers the current strategy, an incremental strategy, and its production commitments, it will also have to continue to pay close attention to the role being played by the FCS lead system integrator. We have previously reported that the role of the integrator posed oversight challenges. Since then, the Army has committed to using the integrator for initial production, potentially a larger role than initially envisioned.

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## Concluding Remarks

The 2009 milestone review is the most important decision on the Future Combat System since the program began in 2003. If the preliminary design reviews are successfully completed and critical technologies mature as planned in 2009, the FCS program will essentially be at a stage that statute and DOD policy would consider as being ready to start development. In this sense, the 2009 review will complete the evaluative process that began with the original 2003 milestone decision. Furthermore, when considering that the current estimate for FCS ranges from \$159 billion to \$200 billion when the potential increases to core program costs and estimated costs of spin outs are included, 90 percent or more of the investment in the program lies ahead. Even if a new, incremental approach to FCS is approved, a full milestone review that carries the responsibility of a go/no-go decision is still in order, along with attendant reports and analyses that are required inputs. In the meantime, a configuration steering board, as required by DOD policy, may help bridge the gaps between requirements and system designs and help in the timely completion of the FCS preliminary design reviews.

There is no question that the Army needs to ensure its forces are well equipped. The Army has vigorously pursued FCS as the solution, a concept and an approach that is unconventional, yet with many good features. The difficulties and redirections experienced by the program should be seen as revealing its immaturity, rather than as the basis for criticism. However, at this point, enough time and money have been expended that the program should be evaluated at the 2009 milestone review based on what it has shown, not on what it could show. The Army should not pursue FCS at any cost, nor should it settle for whatever the FCS program produces under fixed resources. Rather, the program direction taken after the milestone

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review must strike a balance between near-term and long-term needs, realistic funding expectations, and a sound plan for execution. Regarding execution, the review represents an opportunity to ensure that the emerging investment program be put on the soundest possible footing by applying the best standards available, like those contained in DOD's 2008 acquisition policy, and requiring clear demonstrations of the FCS concept and network before any commitment to production of core FCS systems.

Any decision the Army makes to change the FCS program is likely to lag behind the congressional schedule for authorizing and appropriating fiscal year 2010 funds. Therefore, Congress needs to preserve its options for ensuring it has adequate knowledge on which to base funding decisions. Specifically, it does not seem reasonable to expect Congress to provide full fiscal year 2010 funding for the program before the milestone review is held nor production funding before system designs are stable and validated in testing.

In our report released March 12, 2009, we raised several matters for congressional consideration. We suggested Congress consider restricting budget authority for fiscal year 2010 until DOD fully complies with the milestone review requirements and provides a complete budget justification package for any program that emerges. In addition, Congress could consider not approving production or long lead item funds for core FCS until after the critical design review is satisfactorily completed and demonstrations have provided confidence that the FCS system-of-systems operating with the communications network will be able to meet its requirements.

We also made several recommendations to the Secretary of Defense including ensuring that the FCS program that emerges from the milestone review conform with current DOD acquisition policy and directing the Secretary of the Army to convene an FCS configuration steering board. We recommended that if an incremental approach is selected for FCS, the first increments should be justifiable on their own as worthwhile military capabilities that are not dependent on future capabilities for their value. We further recommended that spin out items are fully tested in production representative form before they are approved for initial production. Finally, we recommended that the Secretary reassess the role of the lead system integrator, particularly with respect to any future role in production efforts.

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Mr. Chairman, this concludes my prepared statement. I would be happy to answer any questions you or members of the subcommittee may have.

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**Contacts and Staff  
Acknowledgements**

For future questions about this statement, please contact me on (202) 512-4841 or [francisp@gao.gov](mailto:francisp@gao.gov). Individuals making key contributions to this statement include William R. Graveline, Assistant Director; William C. Allbritton; Noah B. Bleicher; Tana M. Davis; Marcus C. Ferguson; Carrie W. Rogers; and Robert S. Swierczek.

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RECORD VERSION

STATEMENT BY

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DIRECTOR, ACQUISITION CAREER MANAGEMENT

MAJOR GENERAL JOHN R. BARTLEY  
PROGRAM MANAGER  
FUTURE COMBAT SYSTEMS

BEFORE THE

SUBCOMMITTEE ON AIR AND LAND FORCES  
COMMITTEE ON ARMED SERVICES  
UNITED STATES HOUSE OF REPRESENTATIVES

STATUS OF THE FUTURE COMBAT SYSTEMS PROGRAM

FIRST SESSION, 111<sup>TH</sup> CONGRESS

MARCH 17, 2009

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**Introduction**

Chairman Abercrombie, Ranking Member Bartlett, distinguished Members of the Committee, thank you for the opportunity to appear before you this afternoon. In my invitation to appear before the committee, you asked me to address five topics:

- Differences of Opinion with the GAO report on FCS
- Technology readiness levels for all FCS critical technologies
- Status of the FCS Spin Out 1 fielding planned for FY 2011
- Outcome of recent Program Design Reviews on major FCS components, including FCS vehicles and the FCS network
- Alignment and program status of complementary FCS programs, including the Joint Tactical Radio System and Warfighter Information Network-Tactical programs

This response addresses all these topics. However, there is slight overlap due to the fact that the GAO report also addresses some of the same topics listed. My testimony relates to the current state of the program. Throughout the report GAO continually focuses on the Milestone B timeframe in 2003. The Army has worked directly with GAO for over four years and we believe the analysis tools and methodologies being used are out dated.

**The Acquisition Process and Differences with the GAO report**

In many respects, the FCS program is a model for the flexibility and rapid adjustment that OSD and Congress have called for in defense acquisition. Gone are the days when a defense program could be planned against a well defined enemy, and then developed and managed through a rigid, sequential set of milestones offering limited flexibility and stretched over long development timelines. The FCS acquisition model is responsive to the constantly changing operational environment. Building military platforms that are modern and versatile is an operational and economic necessity.

*Phased Approach*

The Army restructured the program in 2004, largely based on GAO assessments and recommendations, to pursue a phased development approach. With this approach the FCS program has balanced key operational requirements with Warfighter needs. To ensure proper integration and maturity, the FCS Program Manager has carefully scrutinized technologies brought into the program in a less than mature state, but that still met initial requirements. The integration phases inherent in the revised approach were specifically designed to reduce program risk, provide for more experimentation and systems' verification, and build knowledge and inform subsequent developmental phases. The GAO uses classic (monolithic System Development and Demonstration), single system development metrics as benchmarks for assessing the Future Combat Systems program. This approach does not give credit to the fact that verification of integration activities are occurring within each of the program's integration phases, which minimizes cost and risk later in the program.

Developing technologies in a phased approach has allowed the Army to provide FCS capabilities in the form of Spin Outs to the current force. The first of these are the Spin Outs to the Infantry Brigade Combat Teams. If we had taken the traditional approach suggested by the GAO, these spin outs would not have been possible. The Secretary of Defense said he supported the move "in part because it focuses on what they can do near-term to help the infantry brigade combat teams and to get new technologies into their hands." Many of these key capabilities would still be in laboratory had we not put Soldiers in the loop evaluating the systems as they develop.

*Actual hardware demonstration versus modeling and simulation*

Another area where our acquisition approach differs from the GAO is in demonstrations of FCS hardware and software—versus modeling and simulation (M&S) efforts. The GAO approach would discount modeling and simulation efforts when the DOD 5000 mandates them by stating that test planning shall consider modeling and simulation. The Army has recognized that FCS will rely heavily upon M&S technology in order to

achieve the systematic conceptualization of the complex FCS System of Systems (SoS), both within specialized technology areas and at the broader SoS level. FCS uses M&S to yield four significant benefits to the Army: Reduced total ownership costs and sustainment burden for FCS fielded systems throughout their service lives; reduced time required to explore concepts, develop and field systems; increased military worth of fielded systems as we simultaneously optimize force structure, doctrine, tactics, techniques and procedures; and concurrent fielding of the FCS systems with their training devices. M&S allows FCS to investigate and verify performance at the FCS Brigade Combat Team and Infantry Brigade Combat Team scale. Data from system and component level testing of actual hardware is utilized to Verify and Validate the M&S used at the SoS level. An example is found in FCS reducing risks associated with the Joint Tactical Radio System (JTRS). PM FCS is working with PM JTRS to Verify and Validate a high fidelity model of the network called the Communications Effects Server. This simulation is utilized with the FCS Simulation Environment to apply realistic network performance constraints on FCS network nodes during events such as our Integrated Mission Tests. This approach allows the Army to consider the effects of many more nodes in the network than would be practical using the actual network hardware available at this stage of the program.

The creation of the Army Evaluation Task Force (AETF) is the first time the Army dedicated a brigade-sized unit for the purpose of evaluation and testing. The AETF is responsible for the evaluation of FCS systems before Low Rate Initial Production thus reducing program risk. There are 1,000 Soldiers dedicated to this effort, testing both Spin Out and Core Program hardware and software. Soldiers from the AETF will support Verification, Developmental, and User testing in 2009 and 2010. During these events, AETF Soldier will test Unattended Ground Sensors, Class 1 UAV, Class 4 UAV, and C4ISR Hardware/Software. In FY2011, the AETF will also support the Integrated Operational Test and Evaluation (IOT&E). Upon completion of the IOT&E, fielding will occur.

FCS continues rigorous testing to reduce procurement risk. There are 203 tests events scheduled in FY 2009; 27 are completed, 31 are in progress, and 145 are planned. In 2008, 178 test events occurred in the program. In 2007, 217 test events occurred in program. Each of these events provided data to support FCS risk reduction.

#### *Network Performance*

The GAO contends that network performance is largely unproven. The FCS program is taking an incremental approach to network development. This is the industry standard and will allow the Army to install network capabilities on platforms as the capability is matured.

The Army employs small incremental software builds to greatly reduce potential programmatic risks as opposed to a high risk, big-bang approach. While wary of the aggressive pace of the program, last year the GAO acknowledged "the Army and LSI have implemented disciplined software practices for developing the network and software."

The FCS network is being developed in four phases, each allowing for more capability to be added, with full network maturity achieved by 2015. This also allows complementary programs such as Joint Tactical Radio System (JTRS) and Warfighter Information Network-Tactical (WIN-T) to be developed in the same fashion. This approach allows Soldiers to be part of the testing and evaluation for all phases of network build. This risk mitigation step allows Soldiers and leaders to provide valuable input to software developers which creates a useable end product.

Today, limited network capability is being evaluated by the Army Evaluation Task Force at Fort Bliss, Texas and White Sands Missile Range, New Mexico. As part of the Spin Out to the Infantry Brigade Combat Teams, this software, through vehicle based network integration kits, will allow the transfer of FCS sensor data from unattended

sensors and unmanned ground and air vehicles to Soldiers at the squad, platoon and company levels that need the information the most.

These AETF Soldiers are also evaluating more advanced stages of network software build as part of the Integration Mission Tests. During recently concluded Integrated Mission Test 1, Soldiers from the AETF evaluated the next phase of software development.

#### *Software Lines of Code*

GAO's analysis of software, counting source lines of code (SLOC) as a direct indicator of software cost, is also at odds with the way in which the FCS acquisition is structured. The GAO mindset worked reasonably well in years past, when all of the software was coded by hand specifically for an acquisition program. Based on Total SLOC, less than 20% of FCS software falls into this category. The rest of FCS software is commercial off the shelf (COTs), for which FCS purchases licenses. A much different set of metrics needs to be used when selecting, purchasing and integrating COTs. If the GAO's approach were valid, individuals trying to decide between purchasing Windows or the Mac OS would be deeply interested in how many SLOC each OS contained. Of course, most individuals making this choice have never heard the term SLOC.

In order for the FCS program to aggregate all of its software into a consistent measure, we use the industry best practice of measuring software in effective source lines of code (ESLOC). This approach is also advocated by academics (Dr. Boehm at the University of Southern California), Federally Funded Research and Development Centers (FFRDCs) (Software Engineering Institute at Carnegie Mellon University), as well as OSD.

When evaluating COTs software, the engineers assess many technical factors that determine how much effort/work will be required to integrate each COTs package, based upon the same sort of factors that the Windows/Mac OS acquirer would use.

Does it meet my requirements? What are the licensing costs? Does my computer have enough memory to run it? Is it easy to integrate (install)? Since this analysis and the work to integrate even the best COTs product have a cost, the FCS program captures the cost in terms of ESLOC.

Past attempts to use COTs in Army acquisitions assumed that COTs was "free" and their failure to take the approach used by FCS led to unexpected costs when the other programs began to integrate COTs into their systems.

One line of ESLOC is not the same amount of work required to write one line of custom SLOC. An example of what this means is when FCS selected the Red Hat Operating System, which has 22.5 million lines of code, the GAO equated this to a cost driver equivalent to writing 22.5 million lines of new code. Clearly FCS is not writing this code, but merely purchasing a license and integrating it.

In our discussion with GAO in December of 2008, they indicated that they were coming to understand this distinction, but did not have time to substantially update their report before the March, 2009 publication.

#### *Cost*

The GAO maintains that tension between program costs and available funds seem only likely to worsen, as FCS costs are likely to increase. We differ from that conclusion because the program employs an integrated cost containment strategy to ensure that life cycle costs are managed. While cost estimates from multiple agencies have differed, many times these differences stem from accounting for different elements inside and outside the program. The Army's cost estimates have been consistent and updated as the program added or removed systems.

**Technology Readiness Levels for All FCS Critical Technologies**

One of the key Future Combat Systems tenets from the time of Concept Technology Demonstration was to accept the reality that FCS will continually define requirements. FCS is bringing technologies to readiness in an approach allowing Soldiers to evaluate the equipment during the development phase and refine requirements based on this evaluation. This has allowed risk mitigation, created a better end product, and has also allowed for the Army to 'spin out' ready and tested FCS technologies into current force Brigade Combat Teams.

The GAO has consistently recommended that, in order to minimize cost and schedule risk, all system critical technologies be at a TRL 7 (functional prototypes tested in an operational environment) before a program is permitted to enter the System Design and Development phase, known as Milestone B. This is not an entrance criterion for Milestone B in the DoD 5000. The technology maturity that GAO is advocating is more typically achieved in a Limited User Test near Milestone C, or during the user evaluation portion of a Joint Concept Technology Demonstration program. And, in any event, it is not where the program is today. At this time 35 of 44 critical technologies meet the DoD requirement for maturity and the remaining 9 will be assessed prior to the FCS Defense Acquisition Board review this summer. Risk mitigation plans have been established beyond TRL 6 and are monitored on a regular basis by FCS program office.

**Status of the FCS Spin Out 1 fielding planned for FY2011**

PM FCS is scheduled to begin fielding Early Spin Out (SO) equipment to the first Infantry Brigade Combat Team in July, 2011. This fielding is on track with a Limited User Test this summer at Ft. Bliss/ White Sands Missile Range, and follow-on joint PM FCS and Joint Tactical Radio System (JTRS) Limited User Test in the summer of 2010. Production Early Spin Out equipment will go through a sequence of verification and field tests in FY11 prior to the Integrated Operational Test and Evaluation (IOT&E). Upon completion of the IOT&E the first fielding will occur. The insertion of FCS technologies

and systems will significantly enhance the combat effectiveness of IBCT's. This fielding is synchronized to ensure the E-IBCT fielding date will meet the Army Force Generation (ARFORGEN) Model. PM FCS will field SO equipment as a fully integrated networked System of Systems (SoS) unit sets

**Outcome of the recent Program Design Reviews on Major FCS components, including FCS vehicles and FCS network**

Over the past 16 months, the FCS program has conducted a series of preliminary design reviews for each of its systems. A total of 10 reviews were held with robust representation from the capabilities/requirements community, test community, product management, science and technology representatives and industry. As of today, we have held preliminary design reviews for all of our major systems including all manned and unmanned vehicles, sensors, the FCS network and the centralized control device. The Manned Ground Vehicle PDR was preceded by a series of 11 detailed design reviews that covered all phases of integrated MGV platforms. All systems were passed to proceed to the detailed design phase and will be presented at the System of Systems Preliminary Design Review in May 2009. Most important, we have shown that network development is progressing on pace with hardware development.

**Alignment and program status of complementary FCS Programs, including the Joint Tactical Radio System and Warfighter Information Network-Tactical programs**

The Joint Tactical Radio System (JTRS) Ground Mobile Radio (GMR), JTRS Handheld/Manpack/Small Form Fit (HMS) and Warfighter Integration Network-Tactical (WIN-T) radios are complementary programs for FCS. Synchronization of these programs' technical interfaces occurs through the use of Interface Requirements Documents (IRD) and Quarterly Synchronization Summits. The IRDs describe system performance and technical interface expectations from the three parties that enable an integrated network communications solution. The programmatic gaps in schedule, cost, and performance

between the programs are resolved at quarterly transport layer synchronization summits. This facilitates continuous leadership awareness of achievable capability delivery dates to support the verification and operational testing timelines in FCS, JTRS, and WIN-T. The result is a continuously updated process of alignment of short-term requirements for FCS Spin Out demonstration and mid-term requirements in support of FCS core program verification test and fielding.

This process has been useful in two ways. It has enabled FCS to find ways to support recently mandated JTRS capability demonstrations, such as the Wideband Networking Waveform (WNW) 30 node test requested by Director of Defense Research and Engineering (DDR&E). Second, it has allowed the JPEO JTRS program to accelerate capability deliveries for near term FCS Spin Out (SO) test events driven by a recent Army decision to focus on the IBCT.

WIN-T, while separate from the JTRS JPEO, uses these same mechanisms, i.e. the IRD and quarterly transport layer synchronization summits. The WIN-T IRD process has enabled the Army to identify gaps and fully resource expected WIN-T performance described in the IRD. The summits have allowed the FCS program to incorporate revisions to capability delivery timelines associated with the FCS-specific WIN-T Increment 3. A plan to reach agreement between programs on the baseline IRDs defining the WIN-T radio, GMR radio, HMS radio, SRW waveform, and the WNW waveform is on track for 3QFY09 between FCS, JTRS JPEO and WIN-T.

The FCS program is getting equipment out to the Soldier, testing it, refining it and working to deploy it to those that need it the most. The systems and technologies found within the FCS Program will provide our soldiers in the near term with the combat advantage they need across the spectrum of conflicts we face now and in the future.

As always, the Army thanks the members of this committee for their support. I look forward to your questions.

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**DOCUMENTS SUBMITTED FOR THE RECORD**

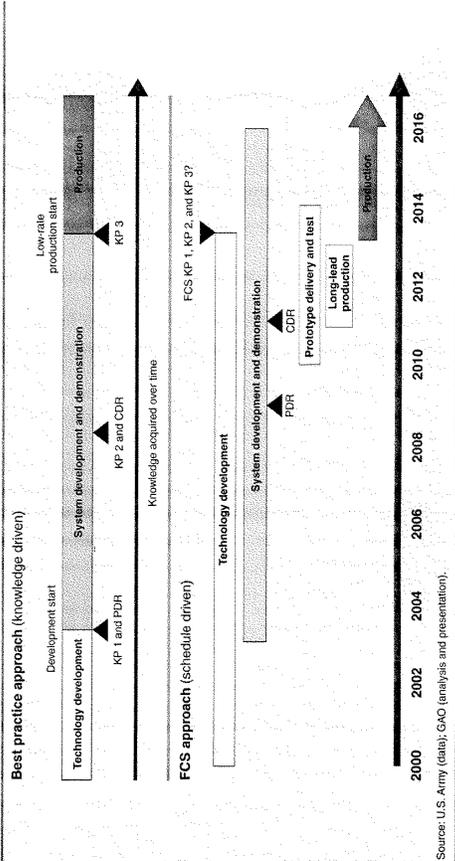
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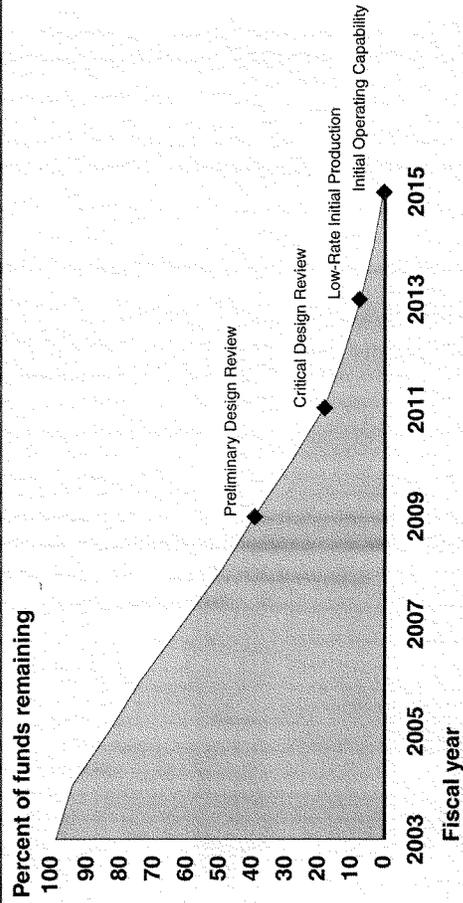


# Differences between Best Practices Approach and FCS Approach



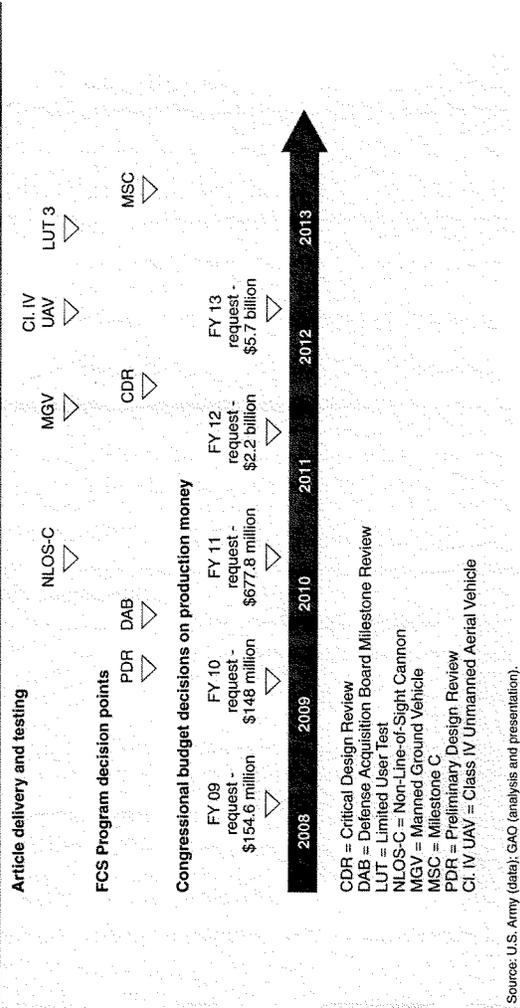
Source: U.S. Army (data); GAO (analysis and presentation).

# Remaining FCS Research and Development Funding and Key Events



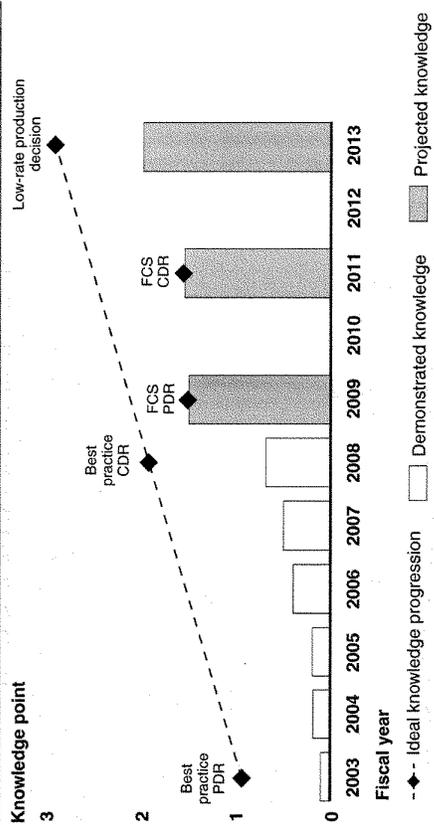
Source: U.S. Army (data); GAO (analysis and presentation).

# FCS Program Events and Congressional Budget Decisions



Source: U.S. Army (date); GAO (analysis and presentation).

# FCS Demonstrated and Projected Knowledge



Source: U.S. Army (data); GAO (analysis and presentation).