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Air Force C^{3}I Systems
R. Thomas Marsh

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Air Force C³I Systems

General Robert T. Marsh
Commander, Air Force Systems Command

General Marsh is the man responsible for the kinds of technology the Air Force fields. He rose from the ranks and had early experience in nuclear weapons technology. His portfolio included involvement with ballistic missile development and command of the Projects Division in the Directorate of Space in the Pentagon before he returned to the Air Force Systems Command as deputy chief of staff for development plans. He commanded the Electronic Systems Division for nearly four years before stepping up to his present rank and responsibility in early 1981. Knowledgeable and outspoken, he brings us a fund of informed views on the nation's military purpose and the role within it of the Air Force and its rapidly advancing technology.

Marsh. Well, it's good to be here to talk about a subject I like to talk about. I'm not going to profess to be a professional in the C³I area; in fact, I'm definitely not that. I commanded the Electronic System Division at Hanscom Air Force Base in Bedford, west of here, for about three and a half years, but that didn't make me an expert; that just taught me how much I didn't know about it.

I'd like to begin by telling you a little about Air Force Systems Command and everything we do. I'll discuss our role in defining the technological alternatives against the user's needs, developing and acquiring systems to meet those needs, and testing their performance. I hope in the process to indicate some of the problems, the technical issues I think are associated with developing C³ systems.

The Air Force Systems Command is responsible for the technology base the Air Force pursues. We move technology forward, and try to figure out how to incorporate it into the systems that are planned for the Air Force. We do tradeoffs and sortings to arrive at new system capabilities. And then, finally, we acquire all of the Air Force's new weapon system capabilities, from new fighters to missiles, the Space Shuttle, C³I systems and so on (figure 1).

The users — the commander of the Strategic Air Command, or tactical force commanders — play an important role in defining their needs or requirements for future weapon systems based on the potential threat. But I think you know it's not as simple as that, because no field commander ever dreamed up the need for a ballistic missile, an atomic weapon or a laser. Instead the technologists brought them forward, and matured them to a point where, all of a sudden, they appeared as potential systems for the user to exploit. The user didn't express a need in those instances; rather, technology came forward and offered him a tool to perform his job better. So our new requirements and new systems evolve from both sides: a statement of need on the user's part, and technological opportunities that present themselves.

Generally we go through several phases as we proceed to acquire new capabilities. The first is concept exploration, in which we assess the alternatives, do the tradeoffs and the cost-effectiveness analyses, and then undertake advocacy of the system.

Sometimes concept exploration goes on ad infinitum and some systems never get beyond that. Those that do, then go on into validation. In this phase we try to knock down the long-risk poles, if you will. If there is a question of technical risk — getting so much thrust out of a new engine, or having a memory large enough to accommodate the data base, or whatever — we can go through a breadboard process to try to prove we can do that. We breadboarded AWACS — the fundamental there was proving that we could deal with the clutter

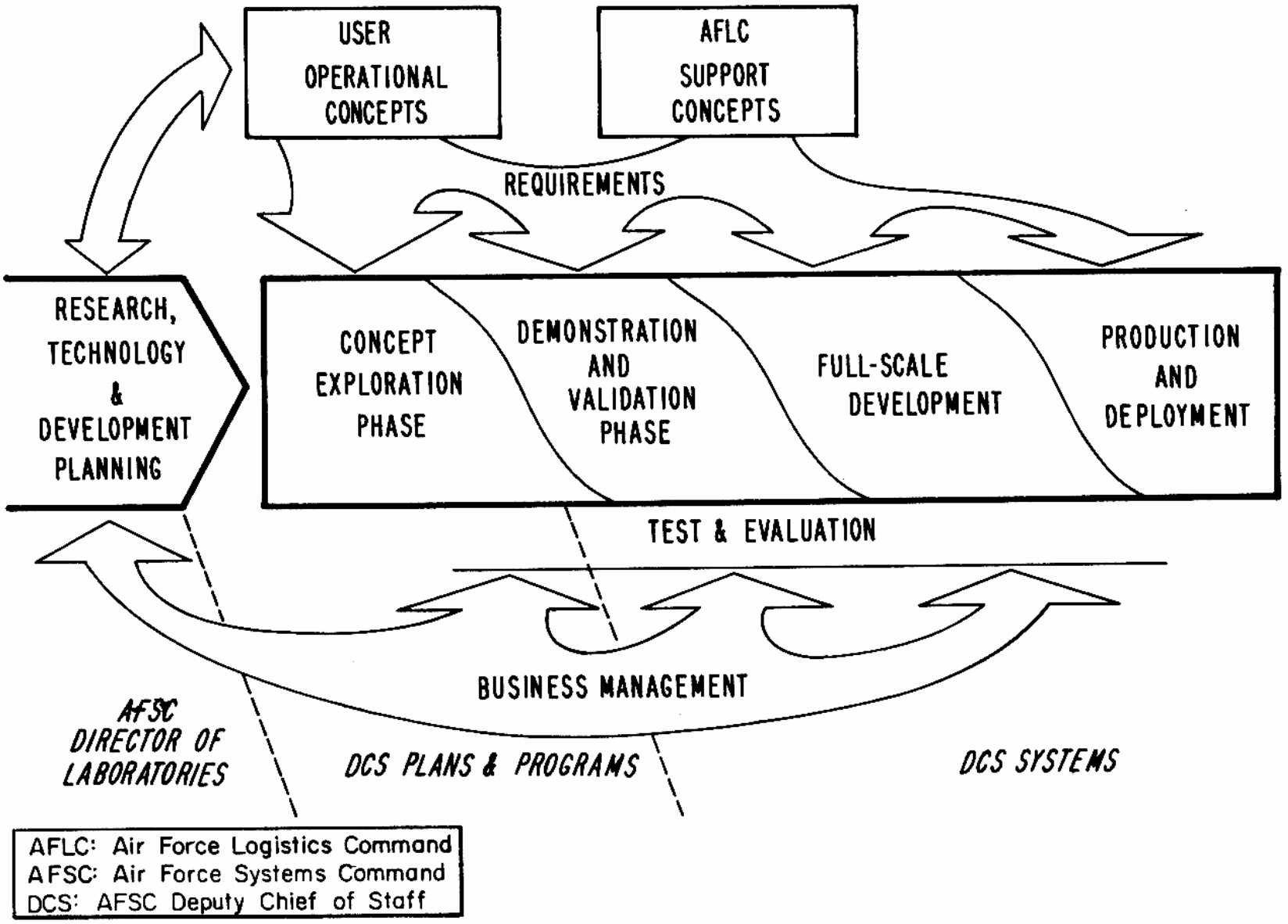

Figure 1. The Acquisition Process

rejection problem, and, in fact, we did prove that we could do it. Although we couldn't do it in real time, we were able to do it in a fashion that gave us confidence that we could go on and proceed with the next phase, development, and the final phase, production and deployment.

I must say it's hard even to think of a system that has exactly followed those phases. Some systems are born in the final phase — like the current C-5 strategic airlift procurement. Other systems are born in full scale development, like the cruise missile. Sometimes if our colleagues in the Department of Defense decide they want a weapon system, they issue it, and we start well down the road without ever having to advocate the system. On the other hand, many times we're trying to advocate one we think is best and we stay in the concept exploration phase for a very long time.

Testing and evaluation proceeds throughout the acquisition process, even back in the validation phase. We bring our independent test agencies aboard, and we really seek their advice, even in development planning. We try to determine if there really is true operational utility to this scheme that we're proposing to develop and procure. It is fairly independent of the rest of the process. The services have tried to split the testers from the developers, and have the testers report up to the chiefs of the services in an independent role, so that you don't have the fox in the chicken coop — a developer putting out a system that's really not ready to go into the inventory.

All of this takes quite a bit of good business management, and that's a variable, as you well know. I think we are getting better at it, but managing the development and acquisition of complex systems is still very "arty." We have super successes and we have dismal failures; we try to have fewer of the latter. We're continually refining our tools, and I think we are in fact getting better all the time.

Oettinger. I suspect the "user operational concepts" box in figure 1 may be a little bit abstract. This may be less of a problem in the Air Force, with NORAD and SAC being specified commands, but at the tactical air force level we've heard, as a recurrent theme, complaints about the lack of involvement of the end users, the unified or specified commanders. That seems to conflict with what you described a moment ago: this apex where the tester and the developer meet at the service chief level.

Marsh. That question gets right into the guts of things. I think the answer is especially crucial to C^3I because it differs from some of the other systems we develop. It's easy to find the user who talks about the new fighter he needs, and why he needs it, and so on. There is no question what forces are going to use it, you can even refine it down to the wings that are probably going to be assigned to you some day. Consequently we get right to the problem of defining the specific requirements: speed, altitude, payload and so forth. In the case of C^3I systems, though, you have a fundamental problem in defining what the system will do for specific users.

For instance, NATO's Allied Command Europe (ACE) has a command/control structure that starts with SACEUR, the Supreme Allied Commander, Europe, and goes all the way down to the fighter squadron that has to be prepared to go do a mission. Now when ACE needs a good runway-busting munition, we develop it and put it with the US forces in Europe. Now NATO has an ability, by way of the US forces, to bust runways. And so we had a problem, saw it, and solved it.

Not so with C^3 systems. No nation can bring a command, control and communications system to Europe on a platter for NATO's needs. A C^3 system has to be specified and acquired for NATO use — not unilateral use. We could sit back here in the United States and develop a superb tactical command and control system for control of US forces in a war in Abyssinia, deploy it, and it would work well, it would control our forces. But we couldn't take that C^3 system to Europe and hand it over to SACEUR and say, "You can control the US, Belgian and Netherlands forces and so on with it." The only way you can upgrade the C^3 capability of NATO is through a laborious infrastructure and consensus of all the nations that NATO needs a better C^3 system — so everybody throws some money in the pot and provides specifications or parameter requirements to interface with its forces, and finally we get it, years too late, and it's usually obsolete by the time we get it.

That difference between national use and NATO use goes all the way down to deployment of forces. The US doesn't fight its fighter wings in the NATO environment; we "chop" our squadrons to the pertinent NATO commander. He commands them. It's his command and control needs that have to be satisfied, and he, I remind you again, has to control US squadrons, German squadrons, Belgian squadrons, Dutch squadrons, and so on. And all of those squadrons get their command and control by different means. A frag order to the United States forces is one thing — you look at paragraph 5 and instantly you know where you're going, at paragraph 6 and you know what you're sup-

posed to take with you, and so on. Not so the Belgians — they may not use the numeral 5. That's the dilemma.

Similarly for the unified command in Europe, US European Command or EUCOM. Once again, we can send over superb Air Force command and control systems, and the Army can send over darned good Army command and control systems; but that's not what EUCOM's commander wants. He doesn't want an Army command and control system and an Air Force command and control system and a Navy command and control system, he wants one command and control system for those unified forces. I will be the first to admit that the Department of Defense has not done very well in specifying the command and control needs of the unified commanders.

The specified commander isn't really a problem because we treat his needs as a unilateral service requirement. SAC comes to us, we give SAC its new capability; MAC comes to us, we give MAC its new capability. I don't know, but I doubt CINCSAC has been complaining about his command and control network from himself down. I'm sure he's worried about the command and control network from himself up to the national command authority. But he doesn't have any problem with his downward needs, those that he can specify, acquire and control.

Oettinger. That's consistent with the picture Dick Ellis gave us.

Marsh. Yes, I would assume so.

The void, then, is in how we are to satisfy the command and control needs of unified commands. Now, I don't embrace what some others say: all you have to do is give them a big pot of money and a whole bunch of engineers and let them invent their own. That's nonsense. What you ought to do — no matter whether it's the Air Force, Army or Navy — is have a good clear way for them to interact with a development agency, articulate their needs, iterate those needs back and forth and get them established, get the JCS' blessing, and then direct a lead service to work with the unified commander and satisfy his needs.

That simple process doesn't exist today. Unfortunately, JCS doesn't have the authority to direct that it be done. Command and control responsibilities go back to the Constitution, to the role of the military departments, and the way they train and equip their forces. Besides, JCS doesn't have any equipment. So somehow you have to close that gap, and get the military departments to provide the equipment for the unified command. That's a fundamental problem with C^3I. And I don't believe this nonsense that, "Well, those guys over there in those development white towers don't know what the hell we operators need, so the way to solve this problem is to let us operators build them." There's just no way. I've taken on General Cushman about that: "Do you mean you want SAC to go build a B-1 bomber, for example?" We have precious few scientific and engineering and acquisition skills in the services today. We shouldn't dilute those further by setting up another development agency.

Well, this is our technology organization (figure 2). I have a director of laboratories, a two-star general. He has command authority over the laboratories, and he wears another hat as my principal advisor for science and technology. These laboratories work weapons technology, people technology, the human resources — we have even developed new OERs, if you can believe that, officer effectiveness reports. At the School of Aerospace Medicine we do an awful lot, as you can imagine: physiology of flight and so on. The Air Force Weapons Lab works lasers and particle beam technology, the Rocket Propulsion Lab does what it says, the Seiler Lab at the Air Force Academy is a research lab, at Wright Aeronautical Labs we have flight dynamics, avionics materials, and turbine propulsion. Up at Rome Air Development Center is our C^3I laboratory. Geophysics at the Geophysics Lab — characterization of the atmosphere and space, as well as *terra firma*. And the Office of Scientific Research is the basic research organization that works with the universities and all. That's our laboratory structure.

We acquire our C^3I systems here at Hanscom (figure 3), our airplane systems at Wright-Patterson, our air-to-surface and air-to-air weapons at the Space Division on the West Coast; the MX is out at BMO, but the Space Division has all the Department of Defense space programs.

Our testing (figure 4) is all over the place. Our major east coast launch facilities are at Patrick, the major west coast facilities out at Vandenberg. You may not know much about Arnold Engineering Development Center, but it's the free world's greatest wind tunnel facility, and we're expanding it to give it even better capability. Edwards Air Force Base in California is where we flight-test all our new airplanes. Down at Eglin in Florida we do much of our munitions testing. At Holloman in New Mexico is a unique test capability: sleds, radar cross-section, and that kind of thing.

Finally, we're operators and developers: we have the Air Force Satellite Control Facility with its worldwide

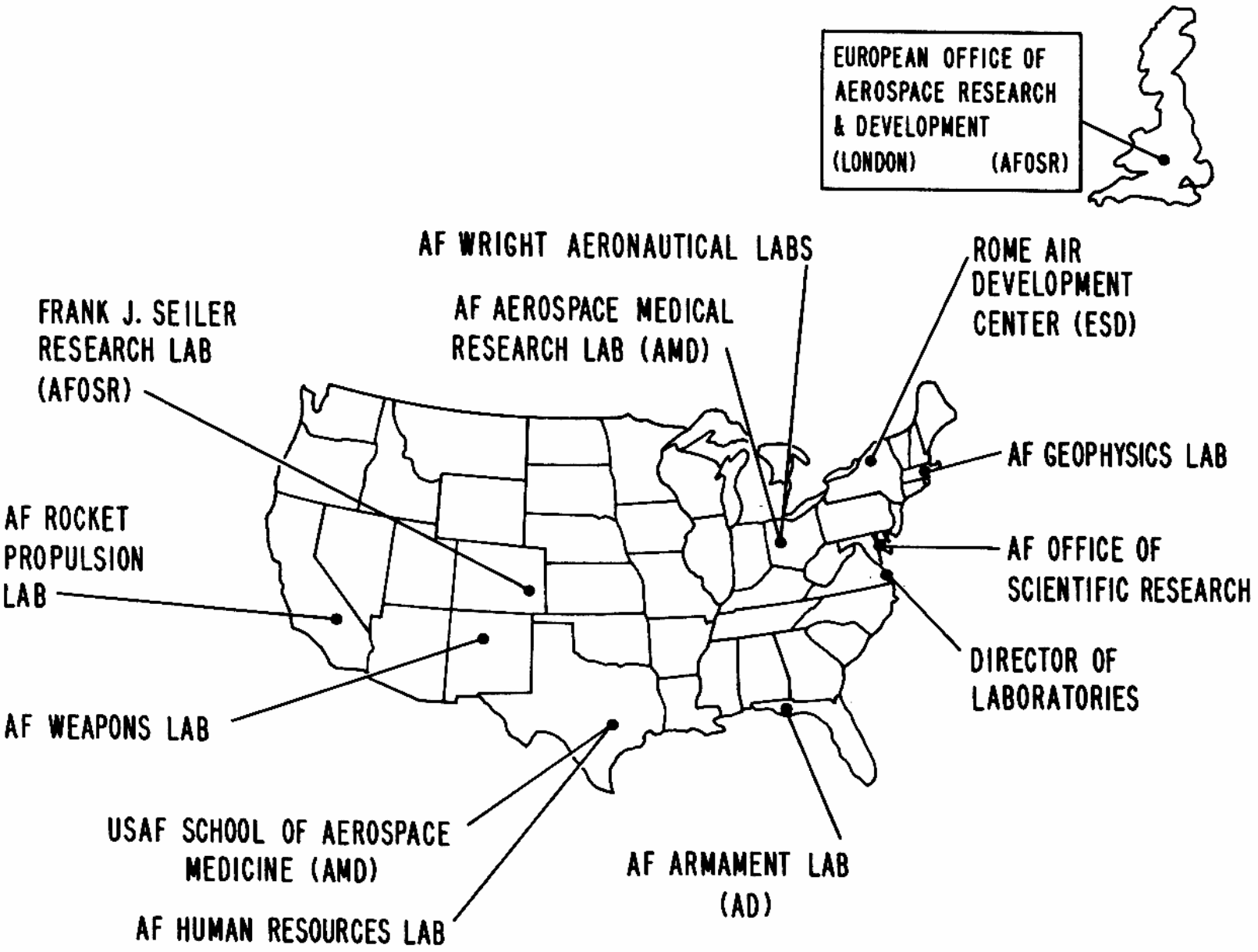

Figure 2. Air Force Systems Command Laboratories

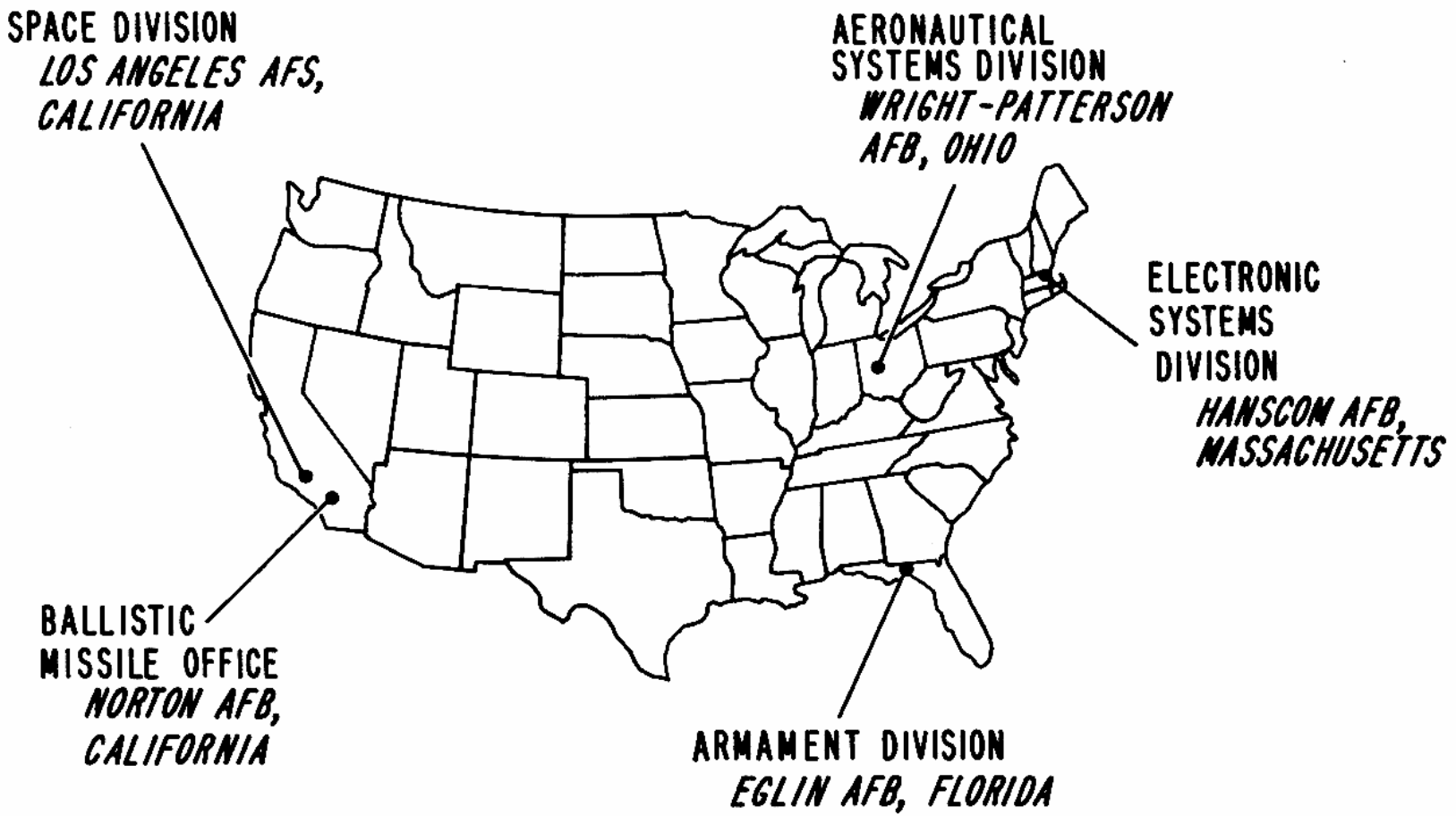

Figure 3. The Product Divisions

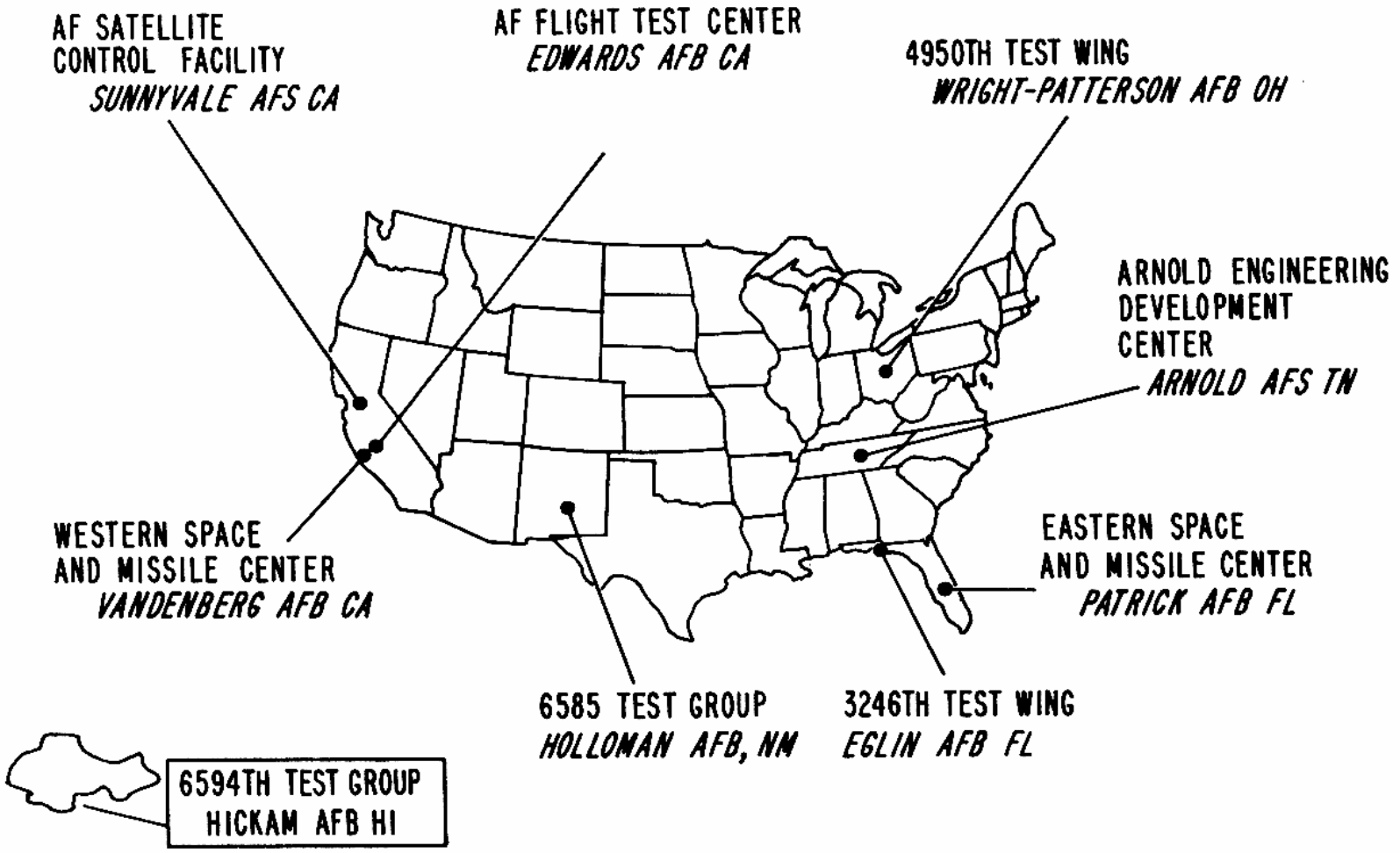

Figure 4. The Test Organizations

network of tracking stations. We take care of all the satellites in orbit that belong to the Department of Defense, looking after their health and care, replacing them as necessary, pulling them down when they're short on orbit, and handling the recoveries. The tracking stations that go with the satellite control facility are worldwide and are intended to give us good polar orbit coverage. Well, that's AFSC in a very slim nutshell. We're about 53,000 strong, about half military, half civilian.

Now let's look at C^3I for a moment. As I see it, C^3I systems have to meet three basic criteria. Number one, the command function has to survive, that goes without saying. Then, given that it can survive — in the person of the commander, his designated successor and so on — we've got to have sufficient information available to the surviving commander to enable him to determine the situation, know the status of his forces and the enemy forces, and decide on courses of action. So he's got to have information; survival of the commander alone is not enough. And finally, you've got to have communications capabilities and connectivity. The commander can know the situation thoroughly, be as healthy as possible, and still be totally ineffective if he can't communicate.

Now, achieving all that is a tall order. For command survivability, I think proliferation has to be the answer. Proliferated mobile systems is our solution, including airborne systems, the E-4 ABNCP airplane, the Looking Glass, and so on. All of those are intended to be able to keep the command function surviving. SAC is developing ground-mobile HERRT teams — headquarters emergency reconstitutable relocation teams — in an effort to proliferate the command function and help it survive. For the future we're looking at distributing the command functions in a way that will allow you to separate them, make them a more difficult target, and at least help elements of the command function survive. We're doing it first in the tactical area.

Bob Everett, president of The MITRE Corporation, once explained distributed communications and data bases to me in a way that has always stuck with me. If the database is swirling around in an endless loop on a very-high-capacity data link, fiber optics or whatever, then anybody can plug in on the thing. He can interact anywhere, both with the database and with other people that are connected to it. Notionally, that's what we mean when we say "distributed command function." I think we've essentially got to separate the functions of command and distribute them so that it can survive even a devastating attack.

That's the direction we're moving in tactical command and control, and I think technology is starting to make it really possible. Satellite communications and fiber optics are going to facilitate it. We're making information more widely available. On nearly all spacecraft that will take them we're now putting ionic devices for nuclear detection, burst indicators, making that information available by way of different kinds of downlinks and feeding them into the command and control systems so that we'll be in a position to assess the nature of the attack.

We will need to spread information availability even further. In the future we've got to move in the direction of internetted databases that are automatically updated. We're studying that, though I cannot honestly say we have a program now and I don't know if WIS, the updated WWMCCS, is going to incorporate it or not. I know they're going to look seriously at internetting databases, but whether or not they will feel it's practical I don't know. But we have got to ensure survival of the database. We're also seriously considering putting the SIOP (Single Integrated Operational Plan) database aboard the E-4 airborne command post — not have it just at SAC headquarters, but have it in the command post too, so that if it's the only surviving command unit it will have the database with it.

Communications, then — connectivity — I think is probably the most challenging area of all. The other missions lend themselves more readily to technology and investment, it's that simple; you just say you're going to do it, and go do it. Communications connectivity is tougher than that. I think you know we're very vulnerable today, and I don't think we make any bones about it. We have highly visible, highly vulnerable switching nodes throughout our communications environment. We put up big signs on our coastline, "Submarine cable, do not dredge here," and so on, and some of those are our only lifeline to important sensor stations. Now, we're doing a lot in this area. We're moving out on a proliferated ground wave system, GWEN, the Ground Wave Emergency Network. It's a low VHF network, a bunch of relays within line of sight all over the United States that enables you to get from A to B by many different paths. We hope that is an economical, straightforward way to assure connectivity even in the face of an electromagnetic pulse environment, which is not too damaging to a groundwave system. We are also moving aggressively in satellite cross-linking, to further the connectivity so that if we are denied the satellite-to-ground-station-to-CONUS linkup, we can get from one satellite over to another

and then down.

Student. Does that include Navy satellites?

Marsh. FLTSAT will not be linked because of its very nature, its position for connectivity purposes; but our early warning satellites will be, and some very high-bandwidth transmission satellites will be.

Oettinger. A moment ago you were talking about internetted databases. To go back to the question I asked you earlier, the technical problems may eventually be solvable, but I'm impressed with the recurring evidence that while the problems are easily overcome to the extent that they're technical, they keep coming down to control of the money on anything that goes into an interservice mission. You indicated earlier that the Cushman proposition of money for the CINCs and so on doesn't appeal to you. But there is nothing in place that would provide the joint chiefs or OSD with authority to control the money that is in the services. What might be a way of going at this problem, if you agree that it is a problem?

Marsh. Well, I agree it's a problem, and I think it's fairly straightforward. I think all the secretary of defense has to do is recognize it — and there have been a couple of DSB studies that have recognized it, one as recent as three years ago. I think all he has to do is saddle up somebody in OSD and give him the clout to enforce interservice integration. They've tried to do that with the C^3I position, but they've just never given it the authority and the responsibility to do it.

Oettinger. Do you mean Lieutenant General Dickinson's shop in the JCS office?

Marsh. No, not in the JCS, I meant USDR&E, Don Latham's shop, earlier Dinneen's, the Assistant Secretary of Defense for C^3I.* I think organizationally it's easy to solve. The problem is simply to achieve high-level recognition of this need, and then recognize that you've got to establish an office under the secretary of defense that has the authority and responsibility to make sure that the needs of the unified and specified commands are met. They tell us everything else to do, why in the world do they resist with a difficult thing to do? I don't understand that. Historically the DSB has reported that we ought to form a DC^3A, a defense command, control and communications agency, but I think people felt that we've got too much centralization already and that that one wouldn't sell, so they ended up doing nothing. They ended up doing nothing as a result of the Buchsbaum study. There were alternatives in that study. One was to establish the important focal point on the joint staff, and one was to establish an important position within USDR&E, and that's all it takes.

Student. Isn't that contrary to the perceived management style of the current administration? They're attempting to decentralize some of the decision-making process, and turn back to the service secretaries a good deal of the turf that has been soaked up at the OSD level. So the problem may not go away under this administration; in fact it may become more acute, in that the decentralization of management, as Secretary Weinberger seems to believe, will cause the services not to recognize the importance of solving the unified commander's problems in the C^3 arena.

Marsh. If I was in charge of the world, I would divest the unified staff of its involvement in the truly service-exclusive arenas. Nobody is inhibited in getting into my business on the B-1, I'll guarantee you, or on the MX missile! Yet that's strictly service-exclusive as far as I can see. I think that meeting the command, control and communications needs of the unified commander is the proper turf of the JCS and the OSD. And the improper turf, I would suggest, is questions like how we ought to redesign our uniform in the Air Force, what munitions we have under development, and so on.

In very candid terms, C^3I is a tough business to understand. It's tough to validate the requirements, it's tough to estimate what it's going to cost, and it's always been sort of in the range of the unthinkable. You don't have a C^3I problem until you really know that the bell's gone off; that's when C^3I gets tough. Now I would suggest that there are a lot of other arenas we haven't addressed about how we're going to behave and operate when the real bell goes off. When the EMP gets so tough that it destroys Ma Bell, and we've got to have other means of connectivity, for instance.

Oettinger. Those unaddressed problems come in smaller sizes, too. As, for example, in the Mayaguez crisis where the absence of adequate secure communications, even in a non-apocalyptic situation, cost a number of lives.

*See the Dickinson and Dinneen presentations in this volume.

Marsh. All right, I'll agree with that. That kind of thing needs to be fixed, and is being fixed. Satellite communications are fixing that at a very rapid rate, with the proliferation of terminals around the world. I think that's a fairly straightforward procurement. You put up either DSCS or AFSATCOM terminals, and you've got connectivity for those crisis needs. I don't think that's a real major problem. I believe what is a major problem is true war-fighting C^3I capability — enduring C^3 that we can use all the time. That's what we're after. And I'm saying that defining enduring C^3 and bellying up to the investment is a thing this country has just not faced up to very well. I don't think our problem is simply management. I think it's a matter of determination, policy and agreement that is deserving of very substantial investment. I think this administration is saying that, and I think they're grappling with how to get on with it.

Oettinger. At the strategic level, yes. But are you satisfied they are also doing that at the theater level, or in NATO, or Korea?

Marsh. No I'm not. I agree it's a bad state of affairs. Tactically we are highly vulnerable in our nodes, generally not jam-resistant, generally not secure. It needs much attention.

McLaughlin. Do you think your counterparts in the other services would agree with your assessment and your proposed solution? We've gotten the impression from past speakers within the services that there are competing priorities — people wanting a solution in terms of planes for the Air Force, tanks for the Army, and competition for resources.

Marsh. Yes. There will always be such priorities; I hope everyone will agree that we must have priorities. The Air Force is in desperate shape, in my judgment, for all kinds of things — war-fighting capability and the C^3 that goes with it. We've put a lot of rubber on the ramp over the last decade in F-15s, F-16s, A-10s, F-111s, you name it. But none of them were sustainable. We didn't have the logistic support to go with them because we couldn't afford it. We didn't have the air-to-air missiles to go with our fighters, we couldn't afford them. We didn't have the bombs. We had planned more precision-guided munitions that we could have put into production than you could shake a stick at, but we couldn't afford them. Now, try telling a tactical commander who's got 72 airplanes sitting out on the ramp but hasn't any munitions to go with them, no spares at all to keep them flying, that what he really needs is C^3. You know he won't go for it. It's a matter of priorities.

I think we're getting to the point now where we're ready to address C^3 in a serious way, and I think this administration recognizes it. But during the last two years — the 1981 supplemental budget, the 1982 amendment and the basic appropriations themselves — we really got working on sustainability for the first time. We poured billions into spares and munitions; that was the first order of business and incidentally still has very high priority. We've got to sustain that spending out into, say, 1985 or 1986 before we'll get to where we can conduct 90 days' worth of operations. I think you'll find the Air Force saying, "Well, now that we've got that well underway, we're ready to invest in upgrading our C^3." But yes, it is a matter of priorities, and C^3 has suffered.

Oettinger. Isn't there more to it than that? Over the last five years or so a good deal more has been declassified, particularly from the British experience in World War II. The impression grows stronger, especially with respect to fighter command in the Battle of Britain — not so much bomber command — that judicious use of radar and other (in modern terms) C^3I devices was decisive. Those sorts of devices were not unique to British fighter command; the Germans had comparable technology, and so did the rest of the British Royal Air Force. But the RAF fighters' judicious use of their command and control system enabled them to stretch a rather small amount of muscle into something that appeared to be a hell of a lot more. So it seems to me that the priorities are not necessarily as disjoint as I hear you saying.

Marsh. And they're not. I'm just saying that C^3I has suffered prioritywise. I think some of it has been well justified, some has not. There is a force multiplication aspect to certain C^3I systems — not all of them, but certain ones — that you just have to invest in. Look, we've invested a lot in C^3I. I spent four years out west of here spending billions, so don't tell me we don't spend anything on C^3I. We spend a lot on it. But I think what we have not done is give it the facelift it badly needs. Much remains to be done.

Oettinger. The term "force multiplier" is a very common buzzword. One of our problems, sitting here in the university decoupled from classified information, is

that when we start searching for solid evidence about multiplier effects, all we can come up with are some historical records of the Battle of Britain and a few other anecdotal things. Now, is "force multiplier" just a buzzword, or is there some reality to it?

Marsh. There's some reality to it. I think that in a lot of discrete cases we've proven beyond the shadow of a doubt the force multiplication effect of certain C^3I systems. Take the interceptor problem with AWACS. You can conclusively show that, given a good data link to link those two systems together, you can knock down many more enemy aircraft than you can if you don't have those communications. You can go through the arithmetic, and I don't think any reasonable person would quarrel with it. In the broader sense, though, my experience tells me that one of the toughest aspects of C^3I advocacy is how difficult it is to quantify the benefit you will get from them, as we have to do with anything else we advocate in the Department of Defense. You can't begin to get a bomber or fighter started unless you prove its cost effectiveness down to the fifth significant figure. Not so C^3I, mainly because we don't know how to do it. It's binary. If you can't communicate you're ineffective, if you can communicate everything is rosy.

Oettinger. I suppose one might turn the tables and ask Congress to prove conclusively that it is a cost-effective command and control system.

Marsh. Yes. But that's a really big deficiency in the C^3 business. Measures of merit don't exist as they do in all other defense programs — though it's tough enough in any of them. Still, given a battle scenario or whatever, you can quantify munitions, weapon systems of all kinds. For C^3I systems it's very difficult to do.

We were talking about connectivity. I think we are making progress in facing up to electronic disruption. We're moving aggressively into the anti-jam area across the board. In the Air Force we are pushing it as hard as we can, it's almost at the top of our list of things that have to be done. We are developing a new air-to-air, air-to-ground, ground-to-air radio system, Seek Talk, which will be highly invulnerable to the enemy's jamming attempts. That will do much to correct the situation in the Yom Kippur War, when the fighters at the end of the runway couldn't talk to the tower, they were jammed up so badly. And no way could you call out to your wing man that a SAM was coming. We've learned — and I think we're taking the lesson to heart — that we've got to be able to communicate in our fighting business, so anti-jam is very much on the top of everybody's list. I won't go into it to any extent, but you know what it consists of: frequency hopping and spreading out the spectrum so it looks like noise to the bad guy. It's costly, but we know of no alternative unless you kill the jammers, and that's something to work hard on, since sophisticated C^3I is so costly: figure out how to eliminate the jammers.

To provoke your thinking, I've tried to ask myself what are some of the technical issues of C^3I. Interoperability is a tough one. First you have to determine what are your interoperability requirements, and, you know, people pull them out of their hats and say, "I want to be totally interoperable with the Navy." Well, I'm not sure you really do, not in all modes for all data links and all radios. So that needs further definition. With the Army, the Navy, our allies in Europe, our allies in the Pacific, you can burden the system with so darned much interoperability you'll never be able to get it to work. Why should the United States take on the burden of being interoperable with everybody else, when nobody takes on the burden of being interoperable with us? You can chase that dog to exhaustion.

But accepting that interoperability is a tough task, you have to define what you need and then get it. One of the problems with interoperability, and with C^3I systems in general, is: do we junk the existing system when the successor system comes along? We get rid of airplanes when we replace them with a successor system, yes. But you don't do that in the C^3I world; all that old stuff stays around, and you just put new stuff on top of it. Consequently interoperability is a heavy burden. You have to make new digital devices interoperable with their old analog predecessors, and so on. Software management gets to be a major undertaking.

Oettinger. Last week Dr. Dinneen pointed out pretty much the same thing. Interoperability has been around for so long that one wonders whether it's not being killed with kindness. Everybody is so much for it, and asking for such total interconnectivity, that people throw up their hands at the cost and the complexity — particularly Congress and the appropriations committees. So nothing happens — which may be a sophisticated way of reaching the end result desired in the first place, in keeping with service autonomy. Or is that too cynical a viewpoint?

Marsh. Well, I think it's a little too cynical. Look at JTIDS, the Joint Tactical Information Distribution

System. It's a radio really, but it's a data link radio, and it fires data back and forth, lots of it. We send the enemy's radar tracks across this data link, and you can display it on your scope, and you can see where the enemy fighter is, or whatever. The Air Force has one technology version of it, the Navy has another; but they're interoperable. We took it seriously. We wanted to be able to exchange tracks with the Navy, and they with us. And we made JTIDS interoperable. Air Force fighters want to be able to talk to the Navy fighters over our UHF radios. And Have Quick, the first anti-jam version of it, is interoperable with the Navy's version, and they're buying it. TACS/TADS ships radar data from the Air Force Tactical Air Control System to the Marine and Navy Tactical Air Defense System, and the computers talk to each other. We determined that was necessary, and we've made them interoperable.

So I think we looked hard at our interoperability needs. Now, we've looked at some of them and said, "We've got to have that," but we don't have it. We've got to have interoperability with the Army and their Hawk missiles; our guys don't want the Hawks shooting at us. And we don't have that interoperability yet. I don't think that's slipshod; I think that gets serious attention and gets worked pretty hard.

Student. This probably relates to software, but it also has to do with interoperability. You talked about the foreign-disclosure, reverse-engineering type of decision-making that has to be done. Does the Air Force come to Systems Command to help make decisions about sale of weapons systems, especially to third-world countries? You know, the Navy deals with people who are not part of NATO but who have basically been allied navies for a long time — for example, the Latin American navies, which now have all-modern escorts with AAW capabilities. Decisions were made by foreign-disclosure-type people that we didn't want to have an integrated tactical data system with them, but we may have become concerned about it after the fact. We certainly didn't think about it when they were out procuring their systems. Yet we don't seem to have any problem selling to Iranians or Saudi Arabians or people like that who became friends almost overnight because they had oil. Looking at it from the level of an operator who has to operate with these people, it didn't look like there were any really sensible engineering or disclosure-related reasons why we couldn't. I mean, if one ally had it, everybody could possibly have had it.

Marsh. Well, let me tell you. The process is that, yes, the first opinions on disclosure of any new system, or any aspect of a new system, are sought from the systems commands of the services. We get first chop. Our files are replete with recommendations: "Don't release this technology," for one or more reasons, and they're also replete with decisions to release technology. Those decisions are made principally, as you surely know, on a political basis. I'm not faulting that. I would, however, fault the general trend. I think we've given away too much technology, given away the state of the country and our technological status. I think we really need to start tightening down on it, and I think the current administration feels the same.

While it's nearly always a conscious political decision, though, let me assure you that it's considered in great debate whether or not to release a new IR technology, or CCD technology, or turbine blade technology. Every one of those is carefully considered, and generally the military departments (as you might expect, for goodness sakes!) recommend against releasing the technology.

Student. This seems to have a bearing on our domestic relationship between the intelligence community and the engineering and scientific community. History is full of our speculations, on the one hand, about what Soviet capabilities are going to be. We tend to expect them not to have certain technologies for umpteen years, and in fact they have it in half that time. On the other hand, once they have the technology or some semblance of it, and we know that they have it, we often end up speculating that the individual systems are far more advanced and more capable than in fact they prove to be once we get our hands on them.

Marsh. You're asserting that?

Student. Well, in some instances at least it appears to be the case. The MIG-25, for example, had technology that in some ways was advanced, but apparently some aspects of it weren't nearly as advanced as we thought — that's the impression the average man on the street has. In one little window in my life I had a chance to look at this, when the intelligence community was obviously interested in foreign technology and didn't have very many people who were aware of it. They came down to talk to the people in the engineering and science community about it. They were dealing in such a compartmentalized area, or were so reluctant to say what they really wanted to know, that they left never

knowing what we knew about the technology to begin with. Then they went off to make intelligence estimates and judgments about Soviet capabilities. They came for two weeks to learn everything the United States knew about mine warfare, but they never said why they wanted to know it, and what specifically they wanted to know, and then they packed their bags and went back to DIA and CIA as our experts on it, and they didn't know a damned thing. Or they knew a very small percentage of what the people in Charleston and Panama City knew about it. I wonder whether that's a widespread occurrence.

Marsh. Well, I don't think it is, but I can't speak for all the services. But you know, the Foreign Technology Division of the United States Air Force, out at Wright Patterson, is under my command, and I think it's one of the first-class technical intelligence organizations. It's out there sitting among all our laboratories and our product division, so it has a whale of a lot of engineering talent itself. And I think it does a superb job of estimating the Soviet aerospace threat, and keeping abreast of all their military aerospace developments. The Army has a similar organization down in Huntsville. I'm not familiar with the Navy setup. But I would say our technical intelligence capability in the Air Force isn't short on technical talent by any means.

Student. Is the group that you just mentioned basically analytic, rather than one that gathers information in any shape or form?

Marsh. Right. It's a technical intelligence organization. It gathers only in the sense that it takes the materials and articles and all that, but it doesn't collect intelligence, with very few exceptions.

I just wouldn't want the record to show that in general the intelligence community has estimated more Soviet capability than really exists. It would be an interesting thing to take another audit of, one of these days. But as far as I'm concerned, the Soviet threat projections I have seen over the years have been fairly well on the mark — in terms of the things I looked at, new aircraft capabilities, new missile capabilities and so on. If anything I would fault our people for underestimating in a number of instances.

Student. Well, I think that there's certainly been a tendency to underestimate force levels, and when things are going to come on line. But in terms of what the equipment can actually do, sometimes you find out later on that you've been defending against a threat that wasn't even there. We did it against surface missiles for six or seven years before they were really there.

Student. Since we're talking about technology transfer or exchange of technology with our allies: in 1975 NATO formed a consolidated effort to exchange technology and share R&D costs in developing weapons and C^3 systems. To what degree do our development agencies work with that group, if at all?

Marsh. I can't answer the question. Frankly I don't know. It's not a high-visibility effort, at least as far as my command is concerned.

I want to say a word about software. You can, I guess, talk about it for days. But as related to C^3I, whenever I have thought about the difficulties of acquiring C^3I systems, I've thought one of the characteristics that made it so difficult was the systems' software-intensive nature. Radio is an exception; but generally the systems are software-intensive — particularly those in the command and warning kinds of centers. I did a study to try to understand where I was really encountering software difficulties, what was the problem. It turned out that it depended on the type of system. The first time we invented a phased-array radar, we had a tough software job. But every time we did a phased-array radar after that, even when we went from tubes to solid state, the software was a piece of cake. Even when we did the Pave Paws radar, software wasn't a glitch, we didn't have a single problem.

On the other hand, I found out that I could narrow down all my software difficulties to the decision-aiding systems, where we were trying to assist the commander with his decisions. That opens up a whole Pandora's box. Where the commander had tried to foresee what his information needs were, in what order he would want them, how he would rank them, how you'd correlate them, and what do you do then with all the fancy correlation schemes, how you'd fuse the information and all — that's where we really met our nemesis. We just bit off way, way too much in trying to automate human decision-making.

I'm overstating this slightly, too, when I say "automate." We didn't quite try to automate decision-making, but we damn near did. We tried to present the commander with all that stuff out in front in simple terms, and just sort of walk him down the checklist and bang, there's a decision. But it's just not that easy, and I don't think we've arrived yet. My study shows where we've had these troubles.

It looks to me like the solution has to be that, as you play out advanced C^3I systems, especially those that are command centers or principal decision-aiding systems — national military command posts, advanced airborne command posts — you ought to try and specify the absolute bare-bones minimum essential capability that you want this software to have: access to the database, call it up, and so on. Don't try to do his thinking for him, just get it for him fast. Then, as the team assembles and starts to use this new capability, as it gains experience with it and determines what we could do better with automation and so on — you add that in some sensible, orderly, programmed way. And do the software architecture so that it lends itself to modular growth, size the computer for growth, put the timing in there that will accommodate all kinds of interactions and so on, but do it in an evolutionary way. I think that's what Bob Everett means when he talks about evolution, and that's really what I mean. I don't mean go evolutionary on an OTH radar or Pave Paws or radio, I mean go evolutionary on the big, complicated, software-intensive C^3I systems.

Oettinger. That correlates back to last year's discussion with Dr. DeLauer, when Everett and Norm Waks joined us, talking about evolutionary systems.*

Marsh. It also goes for another class of systems — the big, complicated automatic switching capabilities. We're having quite a time on these fancy communication switches. If you take a hit out here, the system will automatically reconfigure. Even Bell hasn't done that. We in the military bit it off like it was going to be a piece of cake, and we did it at NORAD in Cheyenne Mountain, and that was a bear. We did it on ATEC for the DCS, and that was a bear too, and we did it at the CNCE for TRI-TAC and that was a bear. Understanding what lines are degrading and which ones are out, and how you ought to redo the network to accommodate the really sophisticated communications switching capabilities, is tough business; and software is a challenge too.

Student. From the human engineering point of view, are the senior decision-makers who have to make use of this automated decision-making equipment sufficiently familiar with the equipment themselves to be able to make the best use of it in the command center, for example? The guy who stands the watch duty at the console day in and day out probably understands what it's telling you and what it isn't. But does that break down when senior-level decision-makers who don't spend all their time in there suddenly need to work with the system? Or do you find in the Air Force that you don't get as much use out of the system, simply because people haven't had training or sufficient experience on it to be able to make the best use of it?

Marsh. I think the answer to your question is yes. That is, I think there's a lack of acceptance of automated systems that support management decisions and decision-making. I'm really ashamed to admit this, but I've had that terminal taken out of my office, simply because I won't mess around learning it. Maybe I'm old-fashioned, but if I want to know something I call a staffer and ask him. I don't trust the database; generally, if I want to know the value of the contract on the B-1, I call a guy and he'll tell me, and I'll know it in seconds. I can punch it up on the computer and find out, but I don't know the last time the guy updated the database.

So yes, there is a natural reluctance on the part of decision-makers to use it, and I'm not sure how you're going to overcome that. Maybe this sounds dumb to say, but I believe that even getting to the step where we can verbally communicate to the computer will go a long way toward breaking down that barrier. There are just a lot of people who are not going to stand there and punch the darn keyboard, you know, and get it screwed up on the screen, and have to erase it and start over.

Oettinger. Aren't there perhaps two different problems there? One might be covered by the old aphorism that where there's death there's hope — that as we pass away, the generation that is now playing with Atari games in the video parlors will find that congenial and not worry about it.

Marsh. I think that may well be.

Oettinger. But while that may be just a generational problem, the lack of confidence in the database, regardless whether you access it happily or have to hack away at something unfamiliar, may well remain. I don't think that you have anything to be ashamed of — I share the feeling with you. Twenty years ago I recom-

*See "Seminar on Command, Control, Communications and Intelligence," Program on Information Resources Policy, Center for Information Policy Research, Harvard University, Cambridge, MA, December 1981, especially pp. 80ff.

mended that the first thing to automate would be the telephone directory, so that you can find the guy — never mind the data — find the guy who knows, and you can get from him a sense of the accuracy, validity and updating, and the guy knows that by way of his background. I remain puzzled by the fact that, whether in military or civilian organizations, the simple-minded notion of finding the guy, rather than finding the database, still seems to be in disfavor. I may be paranoid on this, but I sense that the problem has to do with trying to keep the walls up between organizations. Because if you allow access, not to a database but to an analyst or a horizontal counterpart in some other organization, you louse up the chain of command, and you louse up the prerogatives. Is that too cynical?

Marsh. No, there's some truth to that. We've got a big procurement database in our command, and they wired it up to the third floor of the Pentagon, and I was damned upset, because I figured I'll get queries back about why I haven't done this or fixed that or whatever. I agree, I think there's that concern.

Oettinger. There's another element. Back in the early 1960s, I was on leave, working for the Office of Manned Spaceflight, and I remember seeing guys there occupied fulltime keeping their bosses off the critical path of the PERT system. But the top bosses would get on the phone, call the middle bosses and say, "What the hell is going on?" and pay no attention to the PERT chart. Do you see any way out of this? That may not be generational, but the problem remains.

Marsh. Well, more flexibility would help, I think. By flexibility I mean — how many times have you all gone and looked at a big computer demonstration, or an advanced ADP demonstration? They'll tell you all the things it'll do for you, and you're just flabbergasted; you can put your whole income tax on it and all that kind of thing, it's striking what it will do for you. But the thing that never comes to mind is what it won't do for you. My guys invented a big procurement database, and I went down the first day to view it. They were going through the magnificent things it would do, and I said, "Well, ask the damn thing what my seven biggest overruns in the command are." "We haven't got a program for that, General." "Well, what are the top values of all the cost reimbursement contracts, those are the dangerous contracts." "It's not arrayed that way." And so on and on. My problem was that those guys invented a system that evidently suited their purposes,but didn't suit my purpose at all. So I suppose managers are somehow going to have to sit down and articulate their needs. I don't think people out there inventing those ADP systems know what the hell management needs. And I'm not sure management has ever sat down and gone through whatever it takes to articulate its needs. Maybe if we did that we'd get systems that are responsive to our needs.

McLaughlin. Let me pursue that for a minute because I think it raises a higher-level problem. Over the last couple of years this seminar has collected a number of war stories about someone in the national command authority at some point asking, "Where is the ship?" or, "What are the forces closest to that point?" and finding that WWMCCS and the other systems weren't programmed to answer that question. So the deputy secretary of defense, or the secretary, walks out of the room. At the ESD C^3 symposium last October, I believe it was General Scowcroft who was saying that the national command authority does not exercise the system. The problem is how to get a president to play the game. It seems to me that unless the game is played we'll never anticipate what they are going to need.

Marsh. I think you're absolutely right.

McLaughlin. And how much of a problem is that?

Marsh. I think it's a real problem. It's been talked about as an NCA problem for years — that we've got to get the NCA to play the game, so that we do understand their thought processes and information needs. I agree with that, and I think we're seeing more of that being done. But I suspect it translates right back to what we're talking about. The CINCs' day-to-day life is wargaming, so I think they do try to anticipate.

Oettinger. Well, but you see that takes us back to the heart of everything, which is money and priorities. Nobody would disagree with what you said earlier about the need for priorities. I guess we're groping among what seem to be perennial problems with the priority-setting mechanism — in this instance, the imbalance between the muscle procurement and C^3I systems procurement and exercise money. Do you have any sense as to why, despite some changes in the last few years, C^3I remains such a perennial stepchild?

Marsh. I guess it's easy to kill. It's like a poker chip. You don't have to cancel the program or take anyone

off the payroll, you just cancel the exercise, so it's ready money in the till. This year's money is already laid out, and it's getting caught up in the readiness initiatives these days. We're doing a lot more of all kinds of exercises than we've ever done in the past. So I think C^3 is being recognized. Software is still a big problem.

Oettinger. Remaining alive is a problem.

Marsh. It sure is.

Oettinger. But I remember hearing similar remarks from General Power years ago, so not that much has changed.

Marsh. No, it really hasn't, although, you know, a little bit has changed. I think we've got a lot of software tools in our bags now. We know there's an orderly way one ought to go about constructing software, and we shouldn't turn the coders loose until we get the architecture and the design done, and we ought to do it in modular fashion, and we sure as hell ought to keep good books. I think we've learned a lot. I think that the software challenge — the wherewithal of software, with its hardware — is outstripping us, it's way out ahead of us and we can't catch up. We talk about VHSIC, and all these great things that are coming along, and all that's got to be programmed and wrung out, and I don't know where the people are going to come from.

McLaughlin. Let me pick up from your last comment about improvements in hardware and software. I guess one of the things that we keep sensing, fairly or unfairly, is that the amount of time and money to field a major system has been increasing — I won't say geometrically, because I don't know what the curve looks like. It seems puzzling to hear, in the C^3 world, despite the trends in cost development cycles, consumer electronics, office automation, the civilian side of the information revolution, if you will, stories about Army units out there having to go out and buy TRS-80s and Bearcat scanners and doing their own fixes at the battalion level.

Oettinger. I've heard of some folks on the flight line doing the same thing.

McLaughlin. And, aside from the conceptual complexities, is there justice to the charges of resistance encountered in getting the new technologies through the system? Do you find a turning to the Norman Macrae solution: "Go contract it to Sony?" Is the problem just growing faster than the new technology?

Marsh. Well, I don't really know. Some thoughts on your first statement: You're absolutely right, our weapon system acquisition cycle is cumbersome and too damn long. I'd almost characterize it as bankrupt; the system's almost constipated in trying to get a job done nowadays. Endless reviews, checkpoints, the way we do things serially — complete this phase, stand down and chew on it, and then the next, then test, retest, and so on — that's terrible, and must be reversed. If we're ever going to make any significant strides forward in our overall acquisition business we simply must reverse this trend. And in Systems Command we are working very hard to get that story together, and see if we can't get the attention of our betters to turn this mindless thing around. You know the test community has been responsible for a lot of the problem. Goodness knows I believe in testing things, but I don't believe in standing everything down until you have bandaided it, fixed it and retested it. I believe you ought to chronicle the test results very carefully, determine a get-well plan and how to accommodate it to keep the program's momentum going, and produce and fix simultaneously, the way any sensible production organization would work.

As to the electronic technology, I don't know. Could it even be close to true that we in the military are reluctant to incorporate advanced technology in electronics? I've felt we've been out on the point on it. By golly, laser communications, VHSIC, large scale integration, you know — don't the services share a great deal of the credit for moving all of those things forward?

Oettinger. I don't think John is quarreling with the notion that the Air Force and the other services have been quick to adopt new technology. We're talking, really, about the procurements process, and I want to hammer a bit more at what you said about mindlessness. I used to think that stupidity was involved, but it's been going on for so long over so many administrations, with so many incumbents in various offices, many of whom have been very smart people, that stupidity is too weak a hypothesis. So you look for something else.

Marsh. It's bureaucracy at its finest.

Oettinger. You begin to see that if something persists that long it must be functional, it must do something for somebody, and the next target is to say it's the bureaucracy. But you know, in Pogo's words, "We have met the enemy and he is us," so it isn't altogether the bureaucracy. How and why did we get into this swamp in the first place? Among the reasons there were failures, there were some interesting things, there were procurement irregularities. Do you have any sense of where the perversions came from, and how, with whatever good or bad intentions, maybe porkbarreling, making sure things were adequately reviewed, whatever — your installations are so nicely gerrymandered the way NASA installations are, which is of political value but doesn't necessarily speed up the process? Could you look beyond the bureaucracy blanket and give us a sense of what original functions were served, what current purposes? Why does this persist? If we had a sense of that, maybe we could gain greater clarity about what one might do to change it, whether it means bowling somebody over, paying them off, opening their eyes, or whatever it takes. But the "bureaucracy," or "people are stupid" view seems too simplistic. It's been around too long and it's too deeply entrenched.

Marsh. Well, back in the late 1950s and the early 1960s I think we, at least in the Air Force, did a pretty darn good job of acquiring systems. The B-52 is a pretty damned good weapons system. The C-141 is held up by many as the finest acquisition the Air Force ever did on cost and schedule, and it worked like gangbusters. I would say that the ballistic missile program was well managed; it spilled a few dollars, but the nation wanted it in the worst way. We brought it in in fine fashion. It worked as advertised. I think Minuteman is certainly good.

Now, about that time Mr. McNamara came in. There were, sitting around, examples of systems that didn't work as well as they should and, perhaps, systems that people didn't think we ought to have. "Why do you need this one?" or, "You've got too many on your platter." We started institutionalizing: front-end planning, sorting things and getting them well defined before you move, and once you move you go all the way. Well, we got the C-5 as a result of that, and the F-111. Great deliberation went into laying those programs out right, but as far as I'm concerned that started the cycle. Those programs didn't work out, and from then on we continually tried to bandaid the process. We said, "Well, it didn't work out, and we didn't know it until it got all the way down to the end. So we won't do that again. We'll put more checkpoints in this process, and to make sure our design is coming along as advertised, we'll build some prototypes, test them ... we're going to put really tight control on this process, detect our mistakes earlier."

We took the risk-reduction approach to life, and I think it's grown from that. And nearly every new administration has put further checks on it, has refined the process. Instead of single production decisions or development decisions we'll have three or four, we'll call them DSARCs and we'll even have a zero point before you start thinking about it. We'll say, "It's a good system to think about, and to study," and then when you finish your studies we'll have another one and say, "It's a good system to explore further with some hardware," and then we'll go through that "explore" door and determine if it's a good system to develop.

Now, believe me when I say a bureaucracy builds up around this process. You get secretariats, you get special cost estimating groups — they don't estimate costs, they check the services' cost estimates — you get other offices that do nothing but develop the concept papers. I'm telling you, it gets well entrenched. And nobody stands back and says, "But what's happening to the process?" It's an elegant process, and it looks good on charts: "Who in the world would develop anything and produce it without thinking about it first? We ought to do that." So it looks super, and it takes fifteen years, and by the time you get into the field the system's obsolete.

So I think we must go back to where we acknowledge and concur. Do you know that if you go out into a factory, every person you see costs the taxpayer a hundred thousand dollars in round numbers by the time you load him with his support and all? If you load him with overhead it's more than that. A hundred thousand dollars — count up ten of those folks, and it's a million dollars.

Now what happens if you slow down? We're spending, on the B-1, 30 million dollars a day. If we run a test and something goes bad on it, and somebody says, "Hey, hold everything, we want to go check on this, the landing gear's got a little shimmy in it and we're not going to approve your going into the next phase till you fix it," we're ringing up 30 million bucks on your tax register for every extra day, and that cost isn't going to go away. That's what's happening in these 15-year-long cycles. We're keeping the whole industry team together to do a job that can be done in half the time, or a third of the time. That's a fundamental problem with the process, in my opinion. People cite — and it makes good copy — how much you spent after you should

have known better. And you're going to send some systems out into the field with big retrofit kits. But retrofit kits are cheap compared to keeping the weapon system in an idle mode for a year under contract.

But the question you were asking was a little different from that. There is the problem of how you cope with the acquisition cycle, now that the half-life of technology is down by an order of magnitude or more. That's a tough one: how to keep our system technologically abreast.

Now, you might ask why you want to do that. If it's effective, why do you give a damn whether it's state-of-the-art or not? Well, usually it's in the logistics area. The guys out there are prima donnas. If they want to shut down a chip line, bang, they shut it down, and they're gone; and unless you had the foresight to stockpile a bunch of them (and then they may not have a shelf life, so that may not be a good idea anyway) you're sitting there with a major problem on your hands. Now that's a real problem. It happened to us on AWACS. Motorola just said, "We're not going to produce these chips any longer" — a real sophisticated chip that implemented our clutter rejection algorithm. And they stopped producing them. We finally got some outfit to do it, put a lot of money into them, and got them up to where they could handle it. But coping with the shortened half-life of technology, especially in the electronics area, is a hell of a problem. What we try to do is focus on "form, fit and function." We put a bunch of little modular boxes in, and when this box gets obsoleted, throw it away and replace it with another box. The housing may be only half full, but it's got the new technology in it, and the rest of the system doesn't know you have replaced that box.

Oettinger. There's a chicken and egg thing here. One of the reasons some of the speakers last year from the industry side pointed up their desire to get out of the chip business is that again, with the delays in procurement and one thing or another, they can't afford to put their own money into it indefinitely to wait for the US government or a particular service to make up its mind about a procurement. So we've created a monster that feeds on itself. Again, what's your sense of how one might get out of it?

Marsh. Well, we're thinking about that on VHSIC. If we develop some of these really highly capable chips, the kind that are needed for real fast operation on, say, waveform analysis, that have fairly exclusive application to the military, we may have to set up a government-owned, contractor-operated plant. Or we may have to reach an arrangement with some manufacturer that we'll come in and buy one of his lines, and keep it manned up. This has been discussed before, and we've almost done it in certain instances. We've almost had to do it in the space business, where we need an element — a transistor, you name it — that's say, a hundred times more reliable than the run-of-the-mill version. We've almost decided we ought to produce these things ourselves in a government facility or contract, and I think that's the answer. If industry won't accommodate to us, we'll have to do it.

Now, there's another solution: multiyear procurement. Rather than go to the manufacturer once a year and ask for seventeen items that he can produce in three days and then shut down for the rest of the year, if we get multiyear procurement through, we could order our foreseeable quantity for the next seven or eight years, let him produce them all at once, and then shut down. It's our crazy procurement system that keeps us in the annual ordering business, which isn't good for the military, obviously.

Student. I'm interested in the issue of multiyear procurement. We've contracted things like the B-1 bomber, and that's going to spread over several years. Then you talk about the whole procurement system being built into the congressional cycle — I'm not clear on what the snag has been in allowing the B-1 procurement to be a multiyear system. I know it has been done at the state as well as the federal level. Multiyear procurement seems to make such great sense. Are you trying to press it as something that would be helpful, and even make financial sense?

Marsh. We are, and we intend to do it on the third buy, starting with the eighth airplane. We're buying one airplane the first year, seven the next. Then we really come up to speed, and that's when we'll institute multiyear procurement. But what is the hangup? It's Congress mortgaging away the future. If Congress, or even the Defense Department says it's going to produce this airplane for the next four years, the people say, "Well, I'm not sure about that," and a two-year Congress has trouble. A new Congress will be coming in, and there's a whole defense program laid out to them, and they don't have any authority over it; they aren't going to be very happy. That's the root cause of the problem.

Student. But I'm curious about how they can make commitments for periods beyond their term — subma-

rines, airplanes, all kinds of things require a much longer commitment than the annual one — not being able to transfer that into long-term programs that really make more sense.

Marsh. I agree, it doesn't seem to make much sense; but those are different problems. When they buy the three-year airplane (that's the time it takes to build an airplane), they put all the money up front in that year, in other words they authorize and appropriate the full $25 million to buy this airplane that we won't see for three years.

Student. Except for the cost overrun.

Marsh. Except for the cost overrun. But multiyear procurement is not as simple as it sounds, because it still tries to preserve the prerogatives of Congress. What it really does is authorize. It says, "We intend to procure four years' worth of airplanes, and we just sign the contract for 120 F-16s a year, for a total of 480, four-year multiyear procurement. The first year we put up more obligation authority, more money, and tell them to go out and buy. If you can save a lot of money buying landing gear in a big lot, you go out and buy 480 sets of landing gear — or canopies, if the guy can turn out canopies like that, go buy all of those. But you have to plan that out very carefully and determine the highest-payoff items that you want to buy in lot quantities. You buy those, and you take the savings that accumulate from them. But you still only ask Congress for the money for those 120 airplanes. So you have to go back next year to get the 120 — but if you don't pick up those next 120 airplanes it's going to cost the government some money, so you have some termination liability. So there's some leverage to continue a program once you start, because it's such a complex process. But you don't want to get everything on a multiyear basis, obviously, because you lose all your flexibility. You have to be selective. And on those programs that have high stability, you've got a consensus between the Department of Defense and Congress, and they're not controversial.

Student. But generally the chairmen of the committees that these programs are going through will have some longer-term understanding. They're generally in Congress longer than two or four or six years, and it would seem that working some kind of arrangement might make a good deal of practical sense.

Marsh. It does. The military departments really pushed this multiyear process and got it through, and we save a lot of money. We estimate that on the F-16 we'll save about 10.5 percent, which on those 480 airplanes is, I think, something like 350 million dollars.

Student. It's like buying on sale.

Marsh. Exactly.

Student. The Carlucci initiatives were counted on to offer some solutions through the procurement cycles. How have they in fact been turning out? Are they successful?

Marsh. The Carlucci initiatives are what we in the services served up when they asked what we could do to improve the process. We all proposed the things we felt really needed to be done, and many of them were adopted; not all were. How are we doing on them? I'd say some progress is being made. I think this DOD administration is truly trying to delegate authority and responsibility, I've seen some evidence of that — not as much as is touted, maybe, but some. The multiyear procurement is one of the initiatives, and that's gotten started. It's still got problems in implementation, but it's moving. With the increased competition and all, that's a hard one to work, and it's hard to measure real great progress. You don't do it by step function, you just have to hang in there at it and try to achieve economical production rates. In the case of the Air Force, Carlucci put his money where his mouth was, and put more money on the F-15 to beef up that program rather than have it take a very serious dip down to a totally uneconomical rate of production in one year.

So I would say they're doing well, except where they have to put money up to make it happen successfully. On those initiatives that were aimed at the industrial base, manufacturing, technology, those kinds of things, though, I haven't seen much happening, beyond what we had planned.

Student. There's a lot of interest here in academia about the strategic system's vulnerability. Could you comment on General Graham's proposal for the costly and technologically feasible alternative, the technology and the high-frontier 300-some satellites he's proposing the administration should be looking at for command and control with the weapons system?

Marsh. Well, I think we're moving at about the right pace on space systems. We've made dramatic steps. We don't make headlines every day, but if you stand back and look at what's happened in the military utilization of space in the last ten or fifteen years there's been a dramatic increase. In fact sometimes it's scary. Our increasing dependence on space for communications, warning, navigation and all kinds of information is dangerous — that is, unless we do something to assure survivability. I think that we're proceeding about the way we ought to. We try and define the military task that needs to be undertaken, sort through the options that are available to us, including any space-based capabilities, and choose the most cost-effective approach.

Now, space isn't cheap — don't let anybody tell you it is — it's terribly expensive and it's getting more so, because we're going to shift to the Shuttle, and the Shuttle's going to be a very expensive operation for us. When you talk about a single space operation — putting up a satellite — you're talking in terms of hundreds of millions of dollars; you don't start down at 5 or 6 million dollars and build.

The people who talk about getting a true war-fighting capability in space, furthermore, haven't done their homework technically. I just don't think it's here yet. We've got to solve the power problems in space, and power in space is a big problem for potent killing-type systems, high-powered lasers and so on. You've got to work out the acquisition and pointing jobs to be done in space, and those are challenging. We ought to approach a space solution just like any other, by proving its cost-effectiveness. So far it's just a notion, like, "The moon's high ground and therefore we ought to be there."

Student. Is there any consideration of interoperability of the software systems? Do the three services' computer systems work completely separately, or are there interconnections? There's not just one massive computer sitting in the Defense Department.

Marsh. There's a lot of standardization in software, directed at the OSD level. The languages are directed and mandatory. Currently, I think, we have six authorized languages, and we cannot depart from that. There are all kinds of standards out, military standards on interface requirements. There are standards on documentation of software that we have to put on contract, and so on. I would say it's a very well-regulated effort now. But interoperability? I really can't answer that. I think there's still a big deficiency in having to reinvent software, time and again, for new systems. We ought to be able to figure out ways to better utilize existing software; I don't think we've done a good enough job on that.

Student. You mentioned the Space Shuttle. What kind of interface do you have with the civilian area? Does the military develop packages with them? Is there a lot of joint activity?

Marsh. That's not clear. Right now NASA does all the interfacing. When we complete the launch complex at Vandenberg in October 1985, and begin to launch DOD satellites from there, I suppose there will be an arrangement to accommodate civilian payloads on various flights. Frankly we just haven't worked out the details yet. I think NASA will continue to be our interface, and the DOD will probably not interface directly with the civilians.

Student. You're not really thinking about joint projects.

Marsh. No, we're not, we're leaving that up to NASA, at least for now. On the other hand, I suspect in the future NASA may want to, or be directed to, get out from under the Shuttle. I don't know who would take it over, but one candidate, I suppose, is the Department of Defense, and if so we might have to get into that business. We don't plan to do it now.