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The Doctrine of Command, Control, Communications, and Intelligence: A Gentle Critique
Hans Mark

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The Doctrine of Command, Control, Communications, and Intelligence: A Gentle Critique

Hans Mark

February 24, 2000

Dr. Hans Mark is director of defense research and engineering, U.S. Department of Defense. He was a professor of aerospace engineering and engineering mechanics at the University of Texas at Austin from 1988 to 1998, where he also held the John J. McKetta Centennial Energy Chair in Engineering from 1992 to 1998. Previously, he served as chancellor of the University of Texas system from 1984 to 1992. Prior to joining the university in 1984, he was deputy administrator of the National Aeronautics and Space Administration [NASA] in 1981, having served as the director of the NASA–Ames Research Center in Mountain View, California, from 1969 to 1977. From 1955 to 1969, he was associated with the University of California at Berkeley and at Livermore; and from 1954 to 1955, he served as acting chief of the neutron physics group at the Massachusetts Institute of Technology [MIT]. He is the author or co-author of more than 180 scholarly articles and numerous books, including Experiments in Modern Physics, The Management of Research Institutions, Power and Security, The Space Station: A Personal Journey, *and* Adventures in Celestial Mechanics. *He earned an A.B. degree in physics from the University of California, Berkeley, and a Ph.D. in physics from MIT.*

Oettinger: It's a great pleasure to introduce Hans Mark. I will not go into any detail on his long, distinguished, and multifarious career, since you have all had time to look at his biography. I trust that we may ask questions, or would you like to remain uninterrupted?

Mark: No. Please ask questions.

Oettinger: It's all yours, sir.

Mark: It is a pleasure to be here. Fifty years ago I started down the river here, at MIT, and it took me about five years at MIT to make one visit to Harvard. So every time I come here I am a little bit awed. It is still true: it is an awesome place for me.

I want to talk about the subject of command, control, communications, and intelligence—C3I, as we call it—from the viewpoint of a critic (**Figure 1**). I think that I can afford to do that, since I was in the Pentagon when it was controlled by Bill Perry and others who really invented the topic. I feel seriously enough about it that I'd like to have your critique of this little talk, because I may write a book about it at some point. That may or may not be a good thing!

Let me start by discussing the term "C3I," because I think part of the problem is that we have gotten so enamored of this acronym that we have forgotten what it really stands for. In.

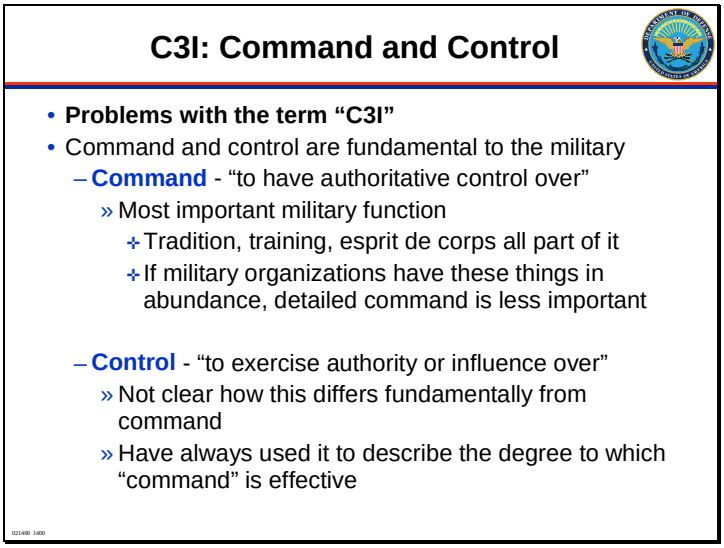

Figure 1

inventing the acronym, I think we mixed some things that probably should not be mixed in terms of the process and what has to go into it.

Command, of course, is *the* fundamental military function. Every military is a hierarchical organization, and, therefore, there is a commander at the top. Command involves all kinds of things, and I have listed some of them in the figure. The dictionary definition is "to have authoritative control over." Tradition, training, *esprit de corps*—all the things that make an organization disciplined and focused—are part of the business of command. We probably spend more time in the military selecting people for command and thinking about it than anything else. So, the first "C" is really a symbol for the central military function.

Now, if military organizations have *esprit de corps*, discipline, morale, and so on, in abundance, command becomes less important, because people tend to know what to do. It still has to be there, because the commander has to instill these things. But the point I am making is that, if you have a good commander, then the other letters in that acronym seem to become less important.

I have always wondered why we put in the word "control." I think it was put in to make the acronym sound better. I have always interpreted control as the feedback loop—as the information channel through which the commander knows that what he commanded actually happened. The dictionary defines *control* as "to exercise authority or influence over." It is not clear how that differs fundamentally from command, but I have put down how I have always regarded it, namely, that you have to have some way of knowing that what you commanded was in the end carried out.

Student: Sir, a quick question. Wouldn't you think that, perhaps, in this context, control would be a function of command?

Mark: Let me tell you why I do not believe that. I think you can command without control. If you have the tradition, the training, the *esprit de corps*, and that stuff, you issue the command and forget about it. Eventually, you would like to know whether your command was executed, but

you do not have to control it. This is why, of course, control is much less important than the function of command.

Communication is really just a technology (**Figure 2**). We added another "C," which is a technical thing. Much of the problem with our command and control system today—with this whole C3I business—is that the techies have taken it over. They think it is all about making transparent communications networks and so on, and they hardly ever think in really serious ways about the value of doing that.

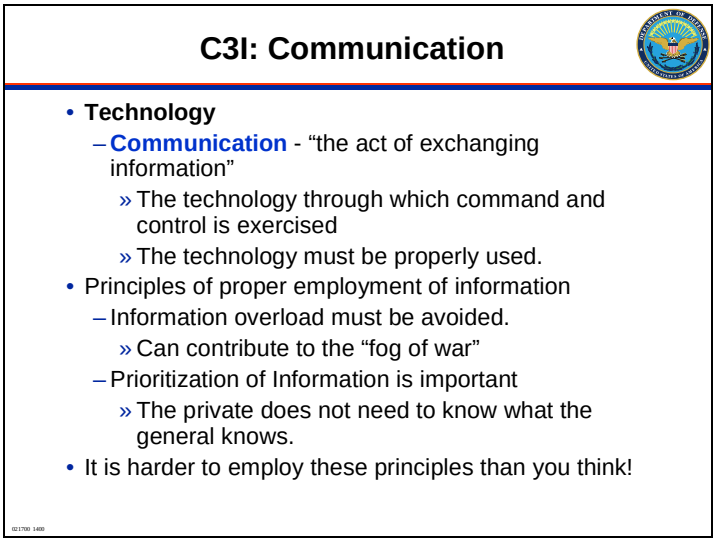

Figure 2

I brought with me a copy of the current *Defense News*, and I will just pass it around. I brought this because about half the articles have to do with problems in command and control systems. Part of the reason for that has to do with *when* we define a command and control system. For example, there is an article in here about the digitization of the Army's Fourth Infantry Division.[1] I have looked into this, and there are problems. Some of our people at the University of Texas are working with the Army on it. The reason there have been problems is that in the beginning few people thought through what they wanted. Of course, what happened then is that communication—the act of exchanging information—dominated, because it depends on the technology, which is easy to understand compared with the transcendental function of command.

What are some of the problems? Information overload is the worst. It is as bad to have too much information as it is not to have any. Both contribute to Clausewitz's fog of war. It is not good to have a completely transparent communications system. The private does not need to know what the general knows. In fact, if the private knew what the general knows, he might not want to go over the next hill.

Information has to be prioritized, and the initial digitization of the Fourth Division did not prioritize information. They spew it out to everybody. Believe me, I have looked at this system, and at first nobody knew what to do with it. One thing the Army did was to perform simulations, and if you prioritize information ahead of time, they work. They do exercises where the

[1]Colin Clark, "Coyle Chides U.S. Army Digitization," *Defense News* **15**, 8 (Feb. 28, 2000), 12.

information is prioritized ahead of time. It is kind of artificial. When you go to the Pentagon, they tell you this is great. The questions are whether you can do that in the field, whether you can do it under stress, and whether you can do it properly, and we are just beginning to do that. My last point here is that it is really harder to employ these things than you think.

I have always felt that "intelligence" should not even be in this acronym, because intelligence is a resource you use that is independent of C3 (**Figure 3**). You have units that do this, and sometimes you communicate intelligence, but by no means always. The dictionary definition, again, is "secret information about an enemy," and, as I have said, it is not in the same category as C3, but it is a resource that is sometimes used, via communications, in the act of commanding and controlling.

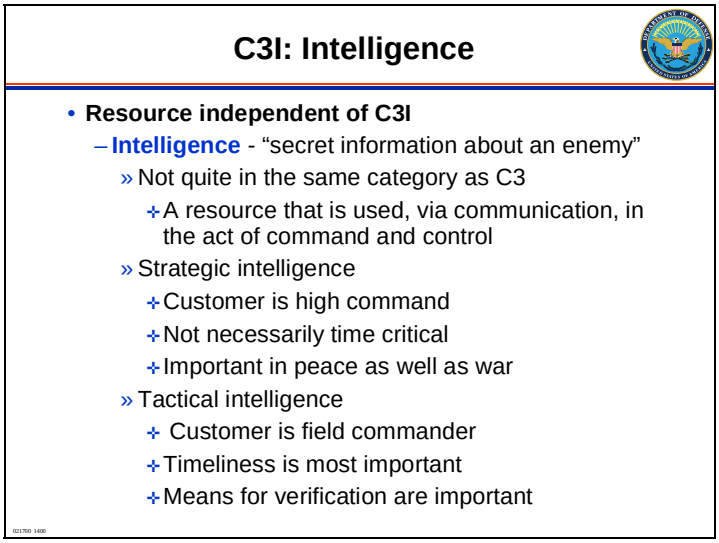

Figure 3

The important thing about intelligence is related to what we talked about at lunch, namely, the time sensitivity. The way you should think about intelligence is to think about whether it is something that is permanent—something you need to know for a long time—or whether it is of short-term value. I have called it long-term strategic intelligence, and the customer for strategic intelligence is really the national leadership. They are the people who have to decide on long-term strategies and where the nation is going.

Intelligence is not necessarily time critical. As a matter of fact, the better conceived your strategy is, the less dependent it is on time.

Student: The definition that you started with strikes me as being kind of a cold-war-movie type definition.

Mark: That's because I took it out of the dictionary.

Student: I understand that, and it is a popular perception, but not one closely aligned with how we actually use it in the Department of Defense [DOD] or in the U.S. government. We gather a lot of information on people who in many cases are not enemies, and oftentimes we gather information that is not secret.

Mark: I do not regard intelligence as anything that I can easily get out of the newspaper. Intelligence requires getting something that somebody else does not want you to know. Otherwise, the definition is infinitely broad.

Student: I guess I think of intelligence more in terms of the utility of the information and the degree to which it is really useful versus how hard it was to get.

Mark: You are really talking about information, not intelligence. I differentiate between information that you can get, and is voluntarily given, and intelligence, which is something that you have to work to get. That's really the only reason. But you are right. It does not have to be about an enemy.

Oettinger: It's an important point. You find a lot of arguments about "open source intelligence," which sounds almost oxymoronic, the point being precisely whether you have the broad or narrow definition. In the last analysis, you need both. The important thing is to be clear as to which, expansive or narrow, definition is intended, and you do not waste too much time over it.

Student: I think of useful information, well prioritized, as intelligence, regardless of the mechanism.

Mark: I disagree with that. I really do. That is knowledge. Look, I am dead serious here. You have to differentiate among intelligence, information, data, and knowledge. Knowledge is the synthesis of all the others, and it comes out of your head. It does not come out of papers. That is really an important point. As I say, I am coming here as a critic, so I want to get into arguments, and this is just right.

Student: In fact, isn't this part of the problem? To me, a lot of times I see that as kind of stimulating the confusion of the intelligence community. It is analogous to trying to put too broad a definition on intelligence, and thinking they should be the ones generating all the information, and they are not. They should be performing their specific function.

Mark: Strategic intelligence is not necessarily time critical, and it is important in all periods—peacetime, wartime, whatever. You're going to need strategies for doing things permanently, and that's what our satellites gather, for example, in their worldwide surveys.

For tactical intelligence, the customer is the field commander (**Figure 3**). He wants to know what is on the other side of the hill and if it is still there, so time is a terribly important factor. The last point is also terribly important in tactical intelligence. You need to have other sources that tell you if it is correct, because in a tactical situation lives might be at stake. In the strategic realm, lives are ultimately at stake, but you have time to think it through so you do not need verification right away.

Oettinger: Again, these definitional questions have considerable importance, because they reflect on organizational and utilization issues as well. The reason I want to call you to task here is that it looks as though your definitions of strategic and tactical are sort of from the user's point of view, according to the use to which the information is put. But you also said that strategic intelligence, for example, is what satellites collect. They collect both, and that's one of the sources of trouble: when different users quarrel over the same resource. Their view of the collector isn't necessarily strategic or tactical; it's the use to which the collected information is put, and that divergence of viewpoint can lead to months of quarreling.

Mark: Let me talk a little bit about that, because for many years I was personally heavily involved in this whole business. One of the things I used to do was head the National Reconnaissance Office [NRO] from 1977 to 1979. As many of you know, the existence of the organization and the names of the staff were classified. Anyway, in 1995 I came out of the closet, and so now I can talk about it.

Let me get to your point, Tony. Satellites are governed by the laws of orbital motion, determined by Newtonian mechanics. They are, therefore, peculiarly well suited to getting information that is not necessarily time critical, but they are not so well suited to gathering information when time limits are most important.

What has happened is that the people in the tactical world *ooh* and *ahh* about the great pictures we can take from 300 miles up. The truth of the matter is that the things that are really useful are the ones that you gather with airplanes and with vehicles where you can control the motion. Satellites, in spite of everything that has been done, have had marginal usefulness. I am not saying that they are totally irrelevant. In the Gulf War, they were pretty important, but not nearly as important as the airplane means of gathering—as the U-2s and SR-71s. That's why I make this definition. The parameter that defines the difference is time.

Anyway, if I were king, I would delete "intelligence" from the acronym C3I.

This is the final chart in this part of the talk (**Figure 4**). Good transparent communications are important, but they can transmit lies as well as the truth. They do both equally well. It all goes by the same bandwidth. Take Baghdad in 1991. We had the best communications system around in Desert Storm, but we did not have any intelligence about Baghdad. We did not know what to transmit. In the Battle of the North Atlantic, in World War II, things really came together. We had the breakthrough of decoding the Enigma code. We had good radar, so we could see submarines that exposed only their conning towers, and we had good communications. With all of this put together, it finally got to the point where we sank more submarines than the Germans sank transport ships. So, what I am saying is that it cuts both ways. In mathematical terms, good communications are a necessary but not a sufficient condition for a successful application.

The real message of the last point is that I would like to abolish the whole term. Language was invented to help clear thinking, and acronyms short-circuit it. We talk about C3I, and the DOD has an assistant secretary for C3I, but nobody knows what the hell he does. I am serious. We assign certain projects to him, but when you ask, "What do you really mean by this, and what are you really supposed to do?" it is mush. The guy, Art Money, happens to be a very good fellow, but I would not put C3I in a separate department.

Oettinger: Art Money's deputy, Chuck Cunningham, spoke here last year,[2] and in terms of the arguments over the coinage of "C3I," Ruth Davis, one of Dr. Mark's predecessor in the office, held perceptions that have changed or have not changed over the years.[3]

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[2]See Charles J. Cunningham, "Information Technology and Organizational Agility," in *Seminar on Intelligence, Command and Control, Guest Presentations, Spring 1999* (Cambridge, Mass.: Harvard University Program on Information Resources Policy, I-00-2, June 2000), [On-line]. URL: http://www.pirp.harvard.edu/pubs.html

[3]See Ruth M. Davis, "Putting C^{3}I Development in a Strategic and Operational Context," in *Seminar on Intelligence, Command and Control, Guest Presentations, Spring 1988* (Cambridge, Mass.: Harvard University Program on Information Resources Policy, I-89-1, March 1989), [On-line]. URL: http://www.pirp.harvard.edu/pubs.html

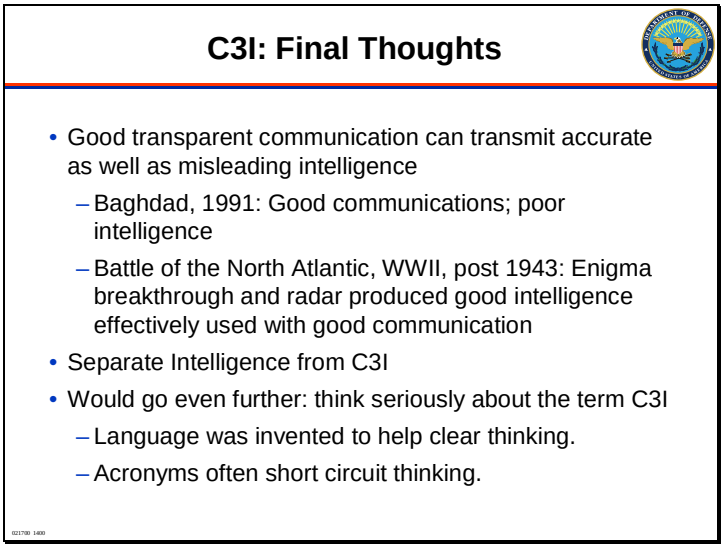


Figure 4

Mark: I freely admit that I was in the Pentagon when the term was invented. Bill Perry and Ruth Davis did it, and I am guilty. I thought it was a good idea at the time. The upshot, which is in the *Defense News* article I passed around, is that I think we have let it diffuse into something that is somehow all things to all people.

Student: I really agree with you, because I could never understand what C3I stood for, especially at the tactical level. However, we've got a dilemma right now, because, as you have mentioned, there is a generation of military people who have grown up with this. In the Army, for example, it is part of several battle operating systems. My question is, What will we replace it with? Or do you have a vision of something that would replace it so that we could fit it into the fighting formation?

Mark: The next set of slides will answer the question for you. But let me get ahead of the story. It is even worse than you say.

C3I was used effectively, generally speaking, in all our military operations. Certainly in the Gulf War it was terribly important. Because of the success we had in the Gulf War, we have tended to make icons of those things that helped this success.

Let me tell you why I think that is wrong. I am now getting at the whole point of this talk. We won the Gulf War because Saddam made a fundamental strategic mistake. He fought that war on our terms, not on his. Ho Chi Minh did not make that mistake, and all the C3 in the world did not help us. Ho Chi Minh fought the war in Vietnam on his terms. He forced us to do things that we were not good at, whereas Saddam thought of himself as a Western general, if you will, and tried to build tanks better than we do. There is no way in God's world he could have won that war. Ho Chi Minh said, "I don't need tanks." What he did was what I said about command on the first slide, and I will get back to this in a minute. It is the difference between a good commander and a bad commander.

I am going to turn to some vignettes and tell stories before I get serious again. May I do that?

Oettinger: Absolutely. It's yours.

Mark: How did this whole thing start? How did the military get into the business of what we today call C3I? Until about 250 years ago, most battles, certainly those on land, were fought within earshot and in the view of the general. He basically stood on the hill and saw the whole battlefield. Even Waterloo, which was a big battle, was pretty much within the sight of the commanders. The same thing was true of naval battles. They tended to be fought at close quarters.

Interestingly enough, the development of C3 is part of naval history, because at sea there are no mountains, no obstructions, no hills. The first real communications or signaling system was developed in the final years of the eighteenth century by a British admiral, Richard Howe. What he did was to invent a flag code signal. There were signaling systems before that; we had flags that had alphabetical meanings long before that. What Admiral Howe did was to say, "Okay, what kind of commands am I likely to be giving?" and then he assigned a command, such as "Turn left" or "Turn right," to one flag so that you could make signals easily, and the signals officers had codebooks in which the flag codes were listed (**Figure 5**).

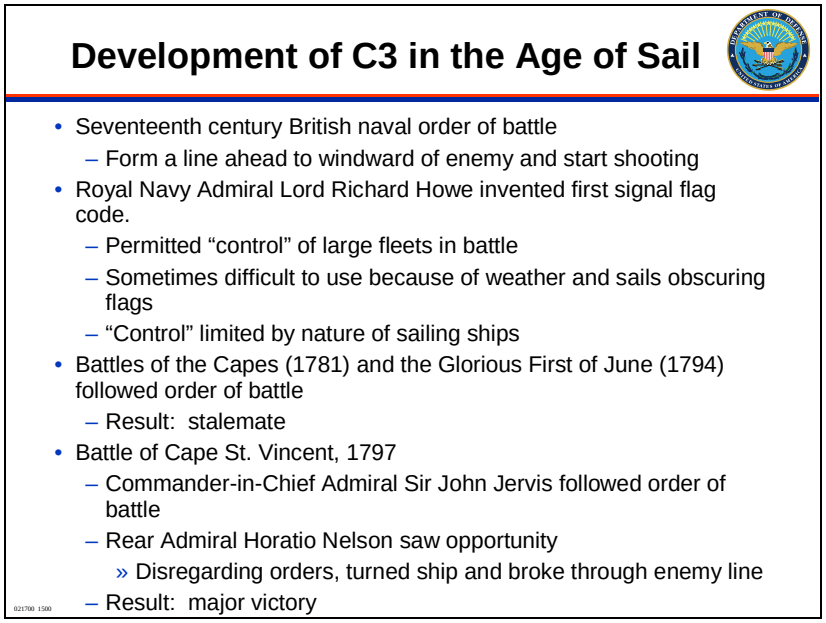


Figure 5

In the time when ships had their guns pointed perpendicular to their center line, the naval order of battle was always that you line up next to the other guy and shoot at him, because that was where you had most of your guns bearing. If you came at him perpendicularly, all of his guns could shoot at you and you didn't have anything to shoot back. So the order of battle was always, "Try to get to the windward of the fellow, then form a line ahead, bear down on him, and shoot at him." That really was how people fought. The flags, people thought, permitted the control of large fleets. That was the basic idea. It was difficult because of weather and smoke and haze and sails, but at least it gave people the impression that it worked. It was, of course, limited by the nature of sailing ships, because sailing ships can't go in every direction, so you had to be a little careful.

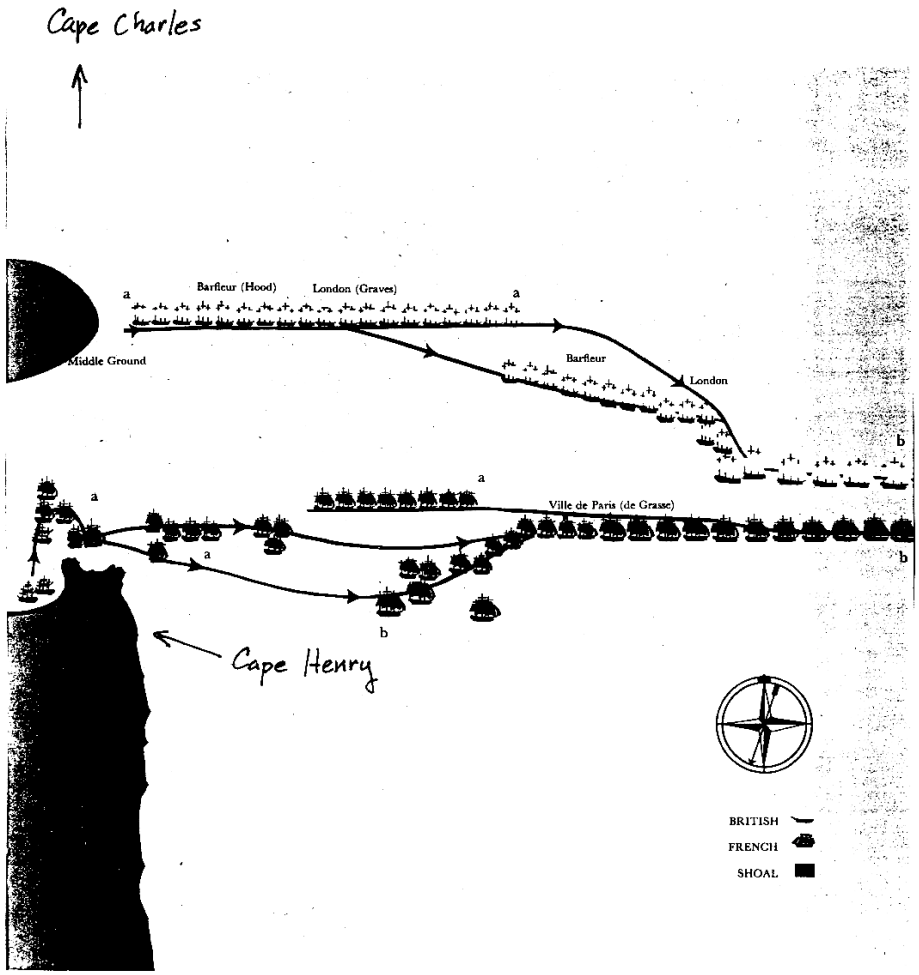
I have listed a number of battles during which these signal flags were used. The Battle of the Capes was fought in 1781 between the French and the British off the mouth of the Chesapeake Bay (**Figure 6**). It was when the British tried to come into the bay and reinforce Yorktown. The French fleet was commanded by Admiral de Grasse and Admiral d'Estaing. They sat in front of the bay, and they followed the line-ahead order of battle. The tactical result of the battle was a stalemate, although the French succeeded in keeping the British out of the bay. If you have two lines of ships of about equal number banging away at each other, nobody really wins in tactical terms. However, the battle was a strategic victory for the Americans and their French allies. The British were unable to reinforce General Cornwallis at Yorktown, which led directly to his subsequent surrender to General Washington.

The battle that was called the "Glorious First of June" (1794) followed the same order, and the result was also a stalemate (**Figure 7**). This was also a battle between the British and the French. Admiral Lord Howe was the commander of the British fleet. Actually, the admiralty wanted to court-martial him for not sinking the French fleet. He didn't lose any ships himself, so finally wiser heads prevailed and the admiralty said, "Look, he didn't win, but he also didn't lose."

Student: The things they call "glorious!"

Mark: They still call it the Glorious First of June. This battle is interesting. It is the only big sea battle that I have heard of that was fought by large numbers of sailing ships out in the open ocean, not within sight of land. Most of the naval battles with sailing ships were fought within sight of land, at most twenty miles or so away. What happened was that the French intercepted a convoy off the west coast of Ireland, and it was really fought over the ships that the British were convoying from the West Indies.

This approach was broken at the Battle of Cape St. Vincent (1797), between the Spanish and the British. The British commander in chief was Admiral John Jervis, who later became Lord St. Vincent and the first lord of the admiralty. What happened here was that the battle started the same way as the others: line ahead. This situation is shown in **Figure 8**. The British fleet approached in line ahead as shown (Phase 1). The Spanish fleet was scattered, and Admiral Jervis decided to attack the group of ships on the left side of the picture. He then ordered a turn "in line," which meant that each of the ships in line should turn at the same spot as the preceding ship. Captain Nelson's ship, the *Captain*, was the third from the rear of the line, labeled "a" in the figure. Nelson saw that the maneuver Admiral Jervis had ordered with his signal flags would take too long to execute. So he disobeyed the admiral's order, broke out of the line, and headed for the Spaniards (Phase 2). Thus, Nelson achieved the concentration of force, which is the fundamental military theorem. Once he had these ships disabled, the British outnumbered the Spaniards. If you cut through at the right place, you've got numerical superiority. That was really the beginning of the golden years of the Royal Navy, because by realizing that line ahead was not always the best way to do things, Nelson established a new way of doing business.



Movement from 'aa' to 'bb' shows how the British centre and rear remained largely out of the battle. Despite the disarray of the French fleet at 'aa', Graves's formal tactics allowed de Grasse time to compose his line

The Battle of the Capes (1781)

Figure 6

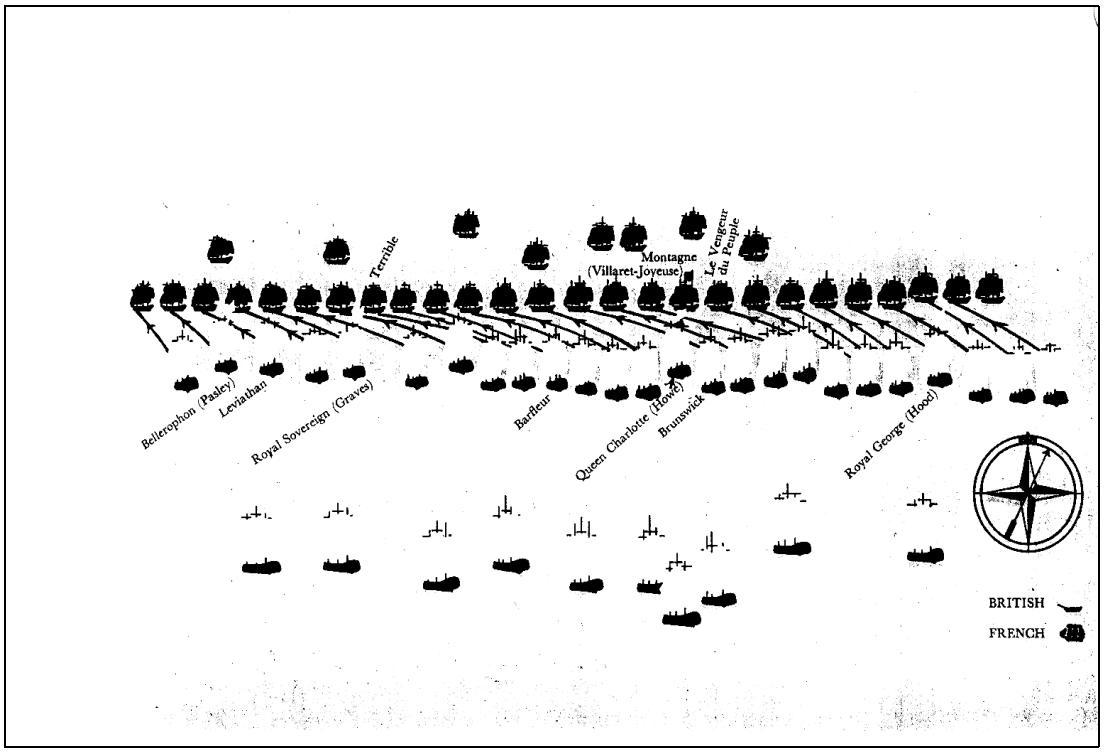
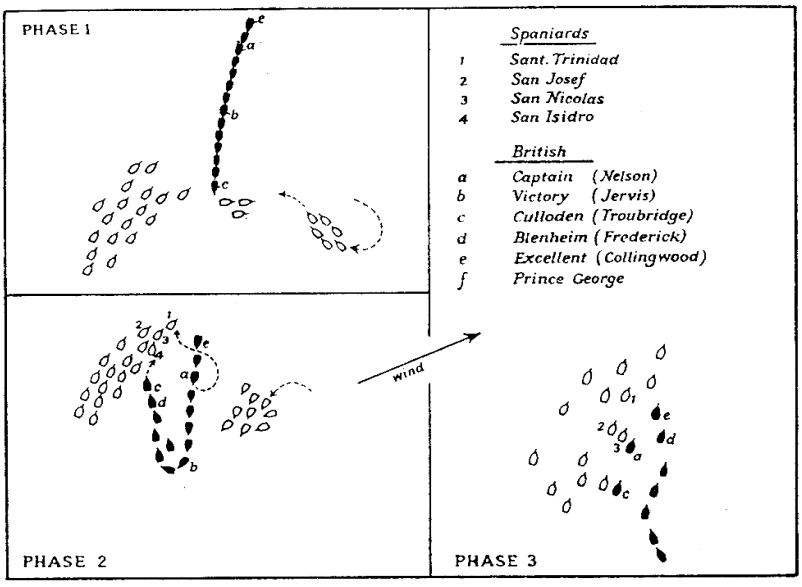


Figure 7

The Glorious First of June (1794)



The Battle of Cape St Vincent

Source: Ernle D.S. Bradford, *Nelson: The Essential Hero* (London: Macmillan, 1977).

Figure 8

Oettinger: Creative insubordination seems to be the way of the navies of the world. For another illustration of the creative power of this, see Admiral Tuttle's presentation in a previous seminar.[4]

Mark: The point I am going to make is that really good C3 makes it harder to produce creative insubordination.

In the battle of Copenhagen, the Danes were in the harbor, and the British wanted to sink their fleet (**Figures 9** and **10**). Nelson picked out the British ships with the shallowest draft so that they could go into the harbor, and proceeded to bang away and sink the Danish fleet. His commander in chief, Hyde Parker, was sitting in his flagship outside the harbor. All he could see was smoke and thunder and flame. Around the middle of the battle he got worried. So he hoisted a signal ordering Nelson to come back. Nelson's signal lieutenant on the quarterdeck went up to the admiral and said, "Admiral, the flagship is flying the recall signal." Nelson had lost an eye at Calvi, in Corsica, so he said to the lieutenant, "Give me your telescope." He put it to his blind eye and said, "I don't see anything." Talk about creative disobedience!

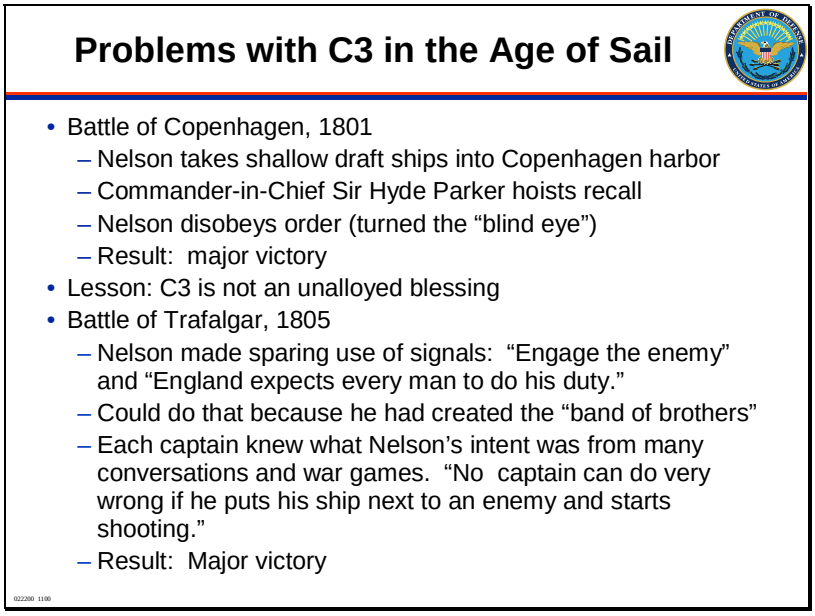
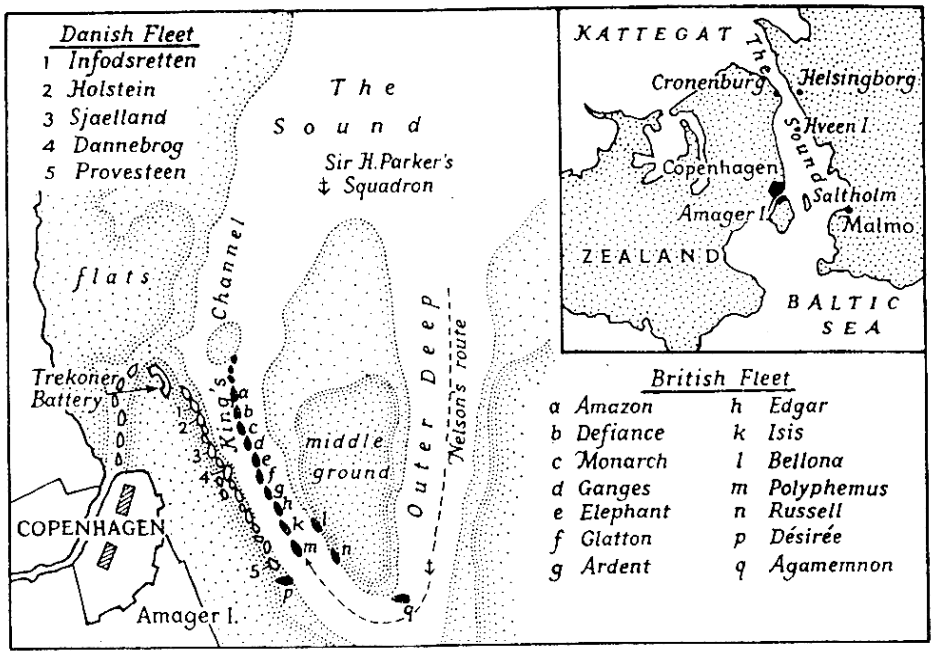


Figure 9

Lesson: C3 is not an unalloyed blessing. If you had had a commander with no imagination in the harbor, he would have turned and obeyed the order. Nelson's disobedience was actually translated into his methodology for fighting naval battles, and Trafalgar (1805) is the climax of that. By the way, Nelson actually never did command one of the major British fleets. He never made four-star admiral. He was killed at Trafalgar as a three-star.

What Nelson did at Trafalgar was something that he had planned for a long time (**Figures 9** and **11**). The idea was, essentially, that instead of waiting for a signal to disobey, he said, "Why

[4]Jerry O. Tuttle, "Tailoring C^{3}I Systems to Military Users," in *Seminar on Intelligence, Command and Control, Guest Presentations, Spring 1988* (Cambridge, Mass.: Harvard University Program on Information Resources Policy, I-89-1, March 1989), [On-line]. URL: http://www.pirp.harvard.edu/pubs.html



The Battle of Copenhagen, April 2, 1801

Source: Ernle D.S. Bradford, *Nelson: The Essential Hero* (London: Macmillan, 1977).

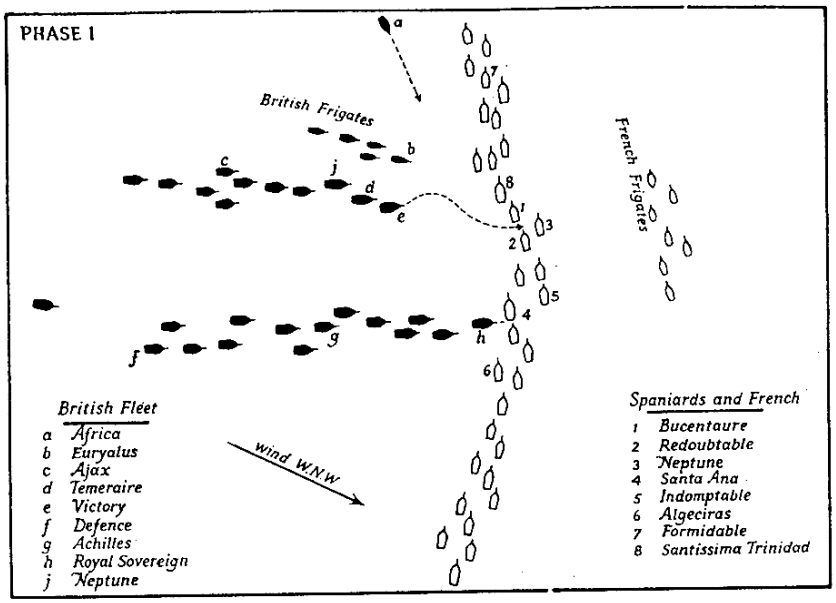
Figure 10

don't we do this in the beginning? Our tactics will be, as usual, to get to the windward." That was always important. Always have the wind coming in such a way that the other guy cannot come at you. He can run, but if you are faster than he is, you can catch up with him. Nelson's idea was to form two lines as shown, and then his order of battle was always that the first line goes through about a quarter of the way back from the front end and the second line goes through about a quarter of the way back from the rear of the line. Thus, as in the Battle of Cape St. Vincent, local concentration of force was achieved. The result was a decisive victory.

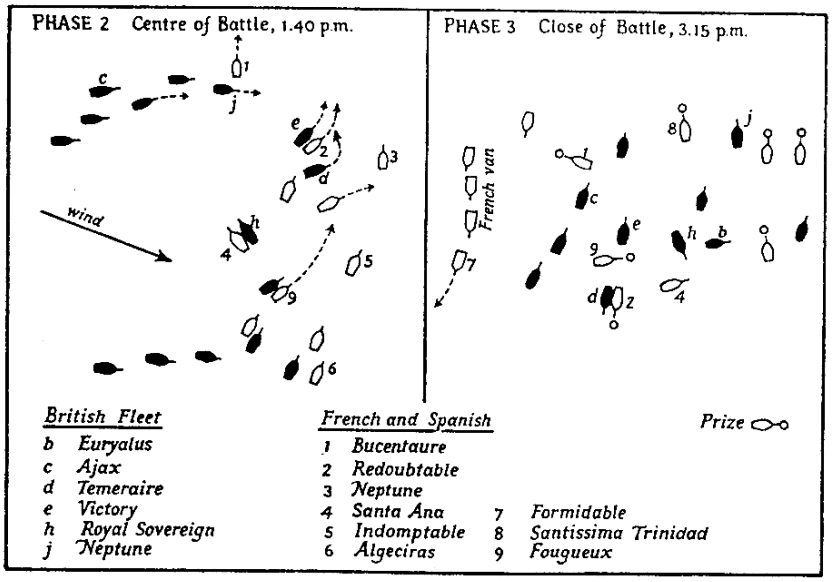
This was, basically, his battle plan. He worked it out in numerous meetings and talks with his captains. Nelson developed the habit of inviting his captains over to have dinner with him in his flagship. They had a dinner party, and talked about what they were going to do in the next battle. The upshot was that at Trafalgar, which was the biggest naval battle fought at the time, he essentially made only two signals. One was "Engage the enemy"; let's go fight. They all knew what to do and how to do it. The second one was, "England expects every man to do his duty," period.

Student: Which, I guess, was a mistranslation of what he actually said.

Mark: I think the word "expects" had to be spelled out, because Lord Howe had no flag for this word. But you're right, it was a hard signal to make.



The Battle of Trafalgar



The Battle of Trafalgar

Source: Ernle D.S. Bradford, *Nelson: The Essential Hero* (London: Macmillan, 1977).

Figure 11

The real point was that Nelson did not try to control the fleet exactly. What he did was to say, “I want my captains to use their initiative. I’m going to tell them generally what I want.” Then, if there were too many questions, he said, “No captain can do very wrong if he puts his ship next to an enemy and starts shooting.” In the end, that’s what it is about. I think that is the

epitome of a successful commander and of the correct use of signals, or C3, or whatever you want to call it, namely: “Now is the time to go”—he’s got to tell them that—and then boost morale.

Now I want to repeat the comparison I made before between the Gulf War and Vietnam. Basically, the message is that you learn from the defeats. In fact, what victories do to you is that you perpetuate the mistakes that are going to bite you. We would not have won the Gulf War as decisively as we did were it not for the lessons of Vietnam.

The British were very, very confident at the end of the Napoleonic Wars in 1815. The Royal Navy was at the top of the heap, and this did not stop with Napoleon. First of all, steamships came in, and now signal flags were even better than they were with sailing ships. They were also more necessary, because powered ships could maneuver and go in any direction they wanted (**Figure 12**). The flags were not obscured by sails, and they were flown from tall masts, where they could easily be seen. In the years following the Napoleonic Wars, the British Navy achieved two major victories: Navarino, against the Turks, and then in the Crimean War, where they fought fleet actions both in the Baltic, at the Aaland Islands, and in the Black Sea, and devastated Russian sea power.

This dominance led to overconfidence in the ability to control fleets. If you ask me, the one thing I fear—and I see it at the Pentagon every day—is overconfidence. There are too many people who count on C3 and assume that, with all this great technology, they can really control what happens on the battlefield. I submit that this is a delusion.

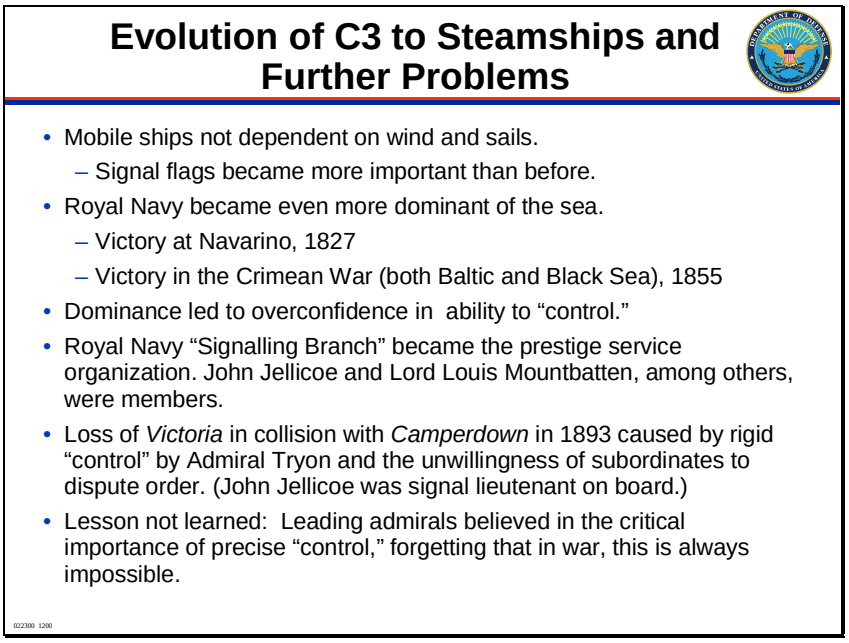


Figure 12

Student: Do you find this is a bigger problem among military people than among nonmilitary people?

Mark: Yes, because the consequences are more serious if the military does the wrong thing.

Oettinger: Take a look at the argument we had here in this class with Admiral Owens, who was one of the true believers in this.[5] It seems to me it went to an extreme almost of lunacy.

Mark: In the Royal Navy, the signaling branch became the elite specialty as the result of these successes. You did not want to sit in the engine room and shovel coal; you did not want to be a gunnery officer and sit on the quarterdeck wearing earplugs; you wanted to be up on the bridge hoisting signal flags. The officers I mention on this slide—Jellicoe and Mountbatten—were in the signals branch. A significant fraction of the leadership of the Royal Navy started out in the signals branch.

There was an incident that should have been a wake-up call. At the end of the nineteenth century the Mediterranean fleet consisted of about twelve battleships, and they used to make port calls. Admiral Sir George Tryon was the commander in chief of the Mediterranean fleet and he was visiting Beirut. Beirut is located on a beach, and you can anchor off the beach. He was coming in toward Beirut in two lines and wanted to turn the ships around and then drop their anchors simultaneously, so that they would be anchored in two lines offshore. He signaled, "Turn around within such and such a radius." They weren't moving very rapidly, but the radius was wrong. The radius actually was such that it led to a collision of the two head ships in each line.

Tryon's ship, the *Victoria*, sank as a result of that collision, and he went down with the ship. John Jellicoe was a signal lieutenant on board that ship. He was the one in charge of the signaling. The belief in the ability to control was so strong that nobody on that damn bridge, or on the bridge of the *Camperdown*, where the second-in-command, Rear Admiral Markham, was standing, had the wit to say, "Hey, there's a mistake here somewhere." They followed the signals.

Lesson not learned: leading admirals continued to believe in the critical importance of precise control, forgetting that in war this is always impossible. It really happened.

Oettinger: Can you shed light on whether the stories of Douglas MacArthur pretending that his teletype wasn't working were real or apocryphal?

Mark: MacArthur was a very successful general, so I think they were real.

Let me continue the story by talking more about Jellicoe, because by 1916 he was commander in chief of the British grand fleet. In 1916 the Battle of Jutland was fought. It was probably the largest fleet action that was ever fought, or will ever be fought, where the ships were actually in sight of each other. The Battle of Leyte Gulf, in October 1944, was a larger action, but it involved ships that were dispersed over broad ocean areas.

Let me talk a little bit about the strategic situation in 1916 (**Figure 13**). The Russian front had degenerated into a stalemate. The operation in Gallipoli had failed, and the Germans were slowly being choked off by the blockade that the British had put across the gap between Norway and Great Britain. The Germans in some desperation said, "Let us deploy the fleet and, at least, try to go out and see if we can sink enough British ships to break that blockade." The battle that ensued was called the Battle of Jutland. It was fought about 120 miles off the west coast of Denmark. The Germans sortied in late May 1916. The Grand Fleet left the ports where they were deployed—most were deployed at Scapa Flow, of course, where the battleships were held, some

[5]William A. Owens, "The Three Revolutions in Military Affairs," in *Seminar on Intelligence, Command and Control, Guest Presentations, Spring 1995* (Cambridge, Mass.: Harvard University Program on Information Resources Policy, I-96-2, January 1996), [On-line]. URL: http://http://www.pirp.harvard.edu/pubs.html

of them were down at the Firth of Forth, and others were along the east coast of England. About 300 ships, of all sizes, sortied to meet the Germans. They had about 30 battleships and a myriad others. The same John Jellicoe who was on the *Victoria* when she sank with Admiral Tryon believed that he could control these ships with signal flags and with the primitive Marconi radios that had just been installed on some, but not all, of the ships in the fleet.

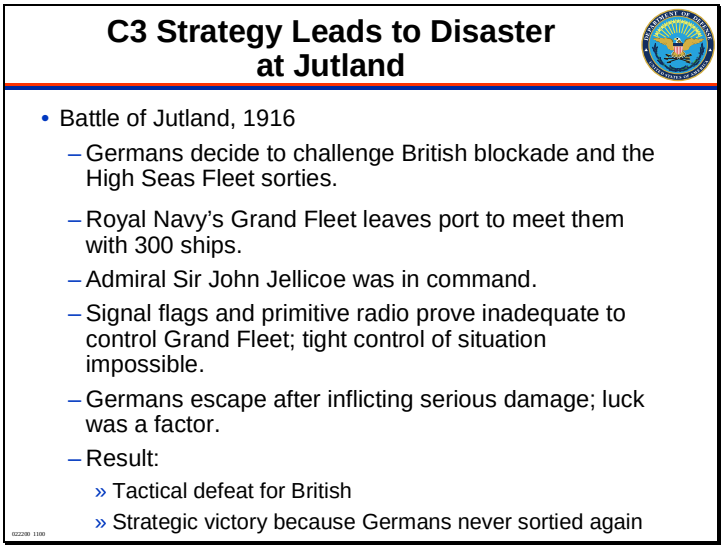


Figure 13

The fleets met. It was a totally confusing battle. The log books survived, so you can read the orders and what they said to each other. Of course, the ability to control 300 ships with signal flags and spark radios was way beyond the ability of the technology at the time. However, this point did not deter the commanders.

The Germans escaped after they luckily sank some British ships. The result was a tactical defeat for Great Britain, but it was a strategic victory for the British because the Germans never came out again; that is, they failed to achieve the strategic objective of breaking the blockade.

There has been an argument about this battle ever since, and scholars of all kinds have said all sorts of things. Let me give you my own opinion. I believe that if Jellicoe had simply done what Nelson did, which is say, "Go out there and shoot these guys, and I don't care how you do it," the British probably would have sunk half the German fleet or more, because their ships were better, their gunnery was better, everything was better. The Germans were not as good at sea as the British were. He just should have delegated and let them go do it. "No captain can do very, very wrong if he puts his ship next to an enemy and starts shooting." Had that happened, I believe the First World War would have been over in 1916, because if there was no hope of breaking the blockade, the stalemate was clearly something the Germans would eventually lose. I am guessing here. You cannot play history over again. But by rigidly believing that you can exercise the degree of control that he thought he had to have, Jellicoe missed the opportunity to end the First World War.

Winston Churchill, who was first lord of the admiralty up until Gallipoli, defended Jellicoe. At the time of Jutland, Churchill was actually serving as a battalion commander on the western

front, and he was asked by the newspapers what he thought of the Battle of Jutland. He defended Jellicoe, because, he said, “Jellicoe was the only person in our military who can lose the war by being defeated by the Germans.” He didn’t say that he could also have won the war. That’s why I respectfully disagree with Winston Churchill. I think Jellicoe could have won it had he understood the nature of command, the nature of delegation, the nature of training, and the importance of living with your captains while you are in command.

Student: Sir, after Jutland, did the British learn the lesson about centralized command and naval engagements?

Mark: Let me get to that in a minute. There were no major naval engagements after Jutland. So the answer to your question is that during World War I they did not. In World War II, the decisive battle was the Battle of the Atlantic, which I have already mentioned. There the British had a very, very decentralized command structure. They had an admiral who commanded the western approaches; Admiral Max Horton had that job. The command then devolved on escort groups. These usually consisted of maybe one or two 1,200- or 1,500-ton destroyers, and then the British had literally hundreds of corvettes that were no larger than fishing boats. Three or four of these would be assigned to each escort group.

At first, of course, these were not terribly effective, because they did not have the intelligence, the communications, or the radar. But Horton never commanded a given group to go after a certain submarine. That was all left to the junior officers. The people who commanded these groups were usually in their twenties. They were out there with the convoys, and their job was to sink as many submarines as they could. Eventually, the technologies to sink submarines became available. Sonar was important, but the decisive factor was air power deployed on many small (“Jeep”) carriers. Finally, by 1943 or 1944, the British sank more submarines than the Germans sank merchant ships. During World War II, the highest casualty rate experienced by any branch of the military was the German submarine service. They lost about 80 percent of their people.

Another good example of delegation is the Battle of Midway (**Figure 14**). The United States had an advantage in the beginning, because E.T. Layton’s Navy Intelligence people broke the Japanese naval code. When I say “broke the code” I have to be careful, because you never completely break a code. The way cryptology works is that you have to start with a guess at what the message is. The big breakthrough was the high-speed computer, because if you start with a random selection of letters to match the message and you can change the selection fast enough, then eventually you need an algorithm that recognizes English or recognizes words and thus breaks the code. If you have a fast enough computer you can do that repeatedly and quickly. That’s basically the way it works. By 1942, we had such machines.

However, all codes, of course, change periodically. The whole secret of the German Enigma machine was that they had a method of changing the code every two or three weeks. So you had to have computers that could break the codes faster than the other guys could change them. That was the point. By May 1942, we had that, so we pretty much knew what the Japanese were up to. They wanted to invade Midway, which they saw as an unsinkable aircraft carrier. Midway, as you know, is the island at the very western end of the Hawaiian chain. The islands are kind of scattered in the northwesterly direction across the Pacific starting with the big island, and Midway is the very last one.

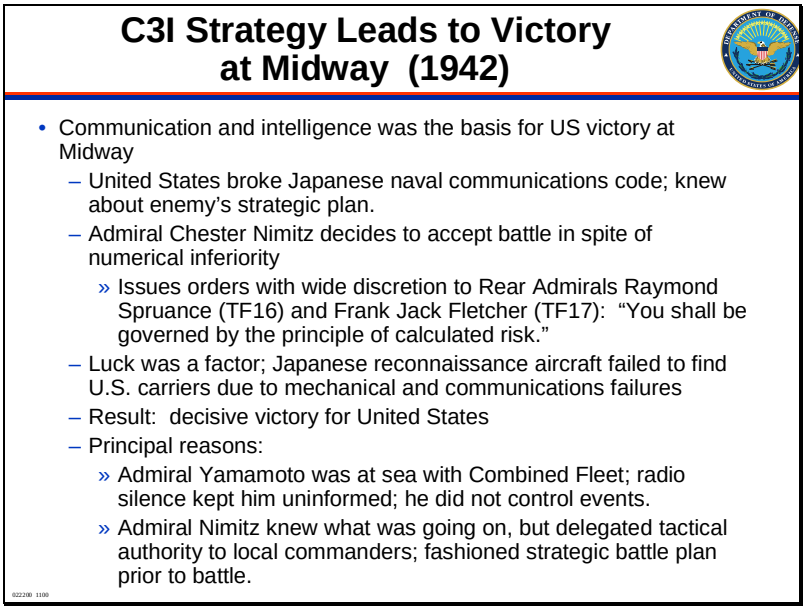


Figure 14

Nimitz again did what a good commander does. He issued an order that is a classic in the way that I think a high-level commander has to do business. He had two task forces, commanded respectively by Admirals Spruance and Fletcher. Spruance had the fleet carriers *Enterprise* and *Hornet*, and Fletcher had the fleet carrier *Yorktown*. The reason the force was split was that the *Yorktown* was damaged at the Battle of the Coral Sea and they had to fix it. So Fletcher came out a day later, and that is why Spruance gets credit for winning the battle, although Fletcher was the senior officer. Spruance was there and Fletcher was trying to catch up with him.

Nimitz started the order by saying, "You shall be governed by the principle of calculated risk." Then he said, "What I mean by that is that if you see the opportunity to inflict more damage on the enemy than they can inflict on you, go to it." Then he said, "The rest is up to you. I'm going to bed."

That was a large factor, which is usually not emphasized in the histories. But the Japanese had bad luck, because their reconnaissance aircraft had technical problems and failed to find the American aircraft carriers before Spruance found theirs. So a combination of a correct command approach and luck was really what won this battle.

The Japanese, or Admiral Yamamoto personally, made another mistake: he went with the fleet. I do not know why he did that, because he was a very, very smart guy. What that meant was that he didn't know what was going on. He could not command because he was on a ship and radio silence was important, so he was in the dark. Nimitz sat in Pearl Harbor. Everybody knew it, so there was no problem with his communicating and knowing what was going on. Here's the lesson: Nimitz knew what was going on, he delegated tactical authority to local commanders and fashioned his strategic battle plan prior to the battle, and then issued the correct order—a proper use of C3I.

Oettinger: May I risk a counterargument? Maybe you're getting to this, but I think one of the arguments for the whole C3I idea and the importance of control, et cetera, was the notion that nuclear weapons were different.

Mark: Yes. As a matter of fact, the reason we developed the technology, the C3 system we have, is because the law says, "The President cannot delegate to anyone the authority to use nuclear weapons." In a way, this is coming back to bite us. I am going to come to that in just a minute.

Now I want to tell a story of an incident in which I was personally involved when I was secretary of the Air Force, and that was an operation called Eagle Claw. Does anybody here know what Eagle Claw was?

Student: The attempt to rescue the hostages in Iran.

Mark: Let me just tell the story about what happened (**Figure 15**). The hostages were taken late in November 1979, right after Thanksgiving, and I was briefed on the mission by General Charlie Gabriel, who was the deputy chief of staff for operations in the Air Force. He told me what we were going to do. The idea was that we would fly eight helicopters into a site about sixty miles southeast of Teheran in the desert, and that these helicopters would land at the same time as four C-130s from Egypt. We had a base in Egypt, and the C-130s would be carrying troops. These troops would be airlifted into Teheran by the helicopters and would rescue as many of the hostages as they could, go back to Desert One, and then fly out on the C-130s. That was the plan for the mission.

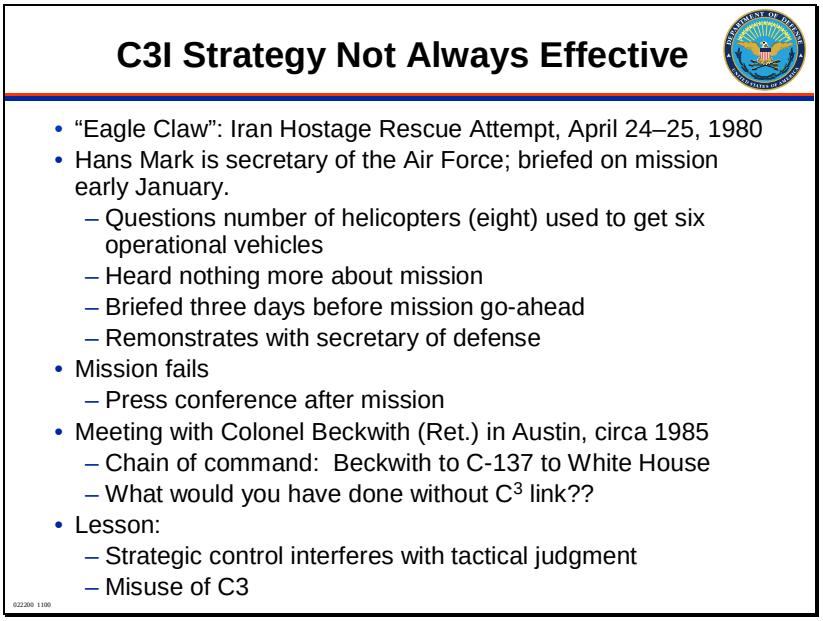


Figure 15

The rules said that in order to carry out the mission, six helicopters out of the eight had to be operational at Desert One. The reason for this was that helicopters are notoriously difficult machines. I know, because when I was director of NASA at Ames, we did a lot of work on helicopters during the Vietnam conflict. We lost more helicopters there from mechanical failure than we ever did from having them shot down.

I told the general, “Look, this is not a good idea, because I do not think you are going to get six helicopters there.” I based that on the experience that we had with the helicopters in the Vietnam conflict. I said, “If you really want to have six there, you ought to fly twelve in. Give yourself some margin.” He said, “Okay, I’ll think about it.” After that briefing, I heard nothing more about this mission. I tend to be pretty naïve, and I thought they had listened to me and to the technical arguments that they would not be able to get six helicopters in if they only had eight to start with. In any event, I remember going to visit Keesler Air Force Base in Mississippi. I made a speech about something or other, and, at the end of the speech, a newspaper lady asked me, “Have you considered going in to rescue the hostages with helicopters?” I said, “Yes, that has been considered but rejected.” This statement appeared in the Biloxi newspaper.

I didn’t hear anything more until three days before the mission, when Harold Brown, the secretary of defense at the time, called us in and told us that we were going to go ahead with this mission. I picked up and I said, “Harold, you know, I’ve been going around the countryside saying that this thing wouldn’t work.”

Oettinger: Great cover and deception!

Mark: That’s what Harold said! It was great cover! So I said, “For God’s sake, you could have told me.” Then, of course, the mission failed, and there was this terrible press conference that Harold had to go through. The three of us—the three service secretaries—sat behind him, and I prayed that nobody had picked up this goddamn piece in the Biloxi newspaper, but about the sixth or seventh question came out, “Dr. Brown, you know that Dr. Mark, your Air Force secretary, said that this had been considered but rejected, and in his speech he said the reason was that helicopters are not very reliable.” (By the way, five helicopters did arrive, so we almost made the mission rules, but not quite. I should have said that earlier.) Then Harold said, “Dr. Mark was talking about a different mission and kind of got mixed up.” Of course, he was right to put off the reporter. What was really bad was that once the mission was canceled, one of the helicopters ran into one of the C-130s, and several people got killed. The whole episode was really a disappointment.

The way the command was arranged here was also awkward. The helicopters would come from the aircraft carriers in the Sea of Arabia and were commanded by a Marine Corps colonel. The C-130s coming in from Egypt were commanded by an Air Force colonel. They would all meet at Desert One, and the command there on the ground would devolve to an Army colonel by the name of Charles Beckwith, “Charging Charlie.” I do not know how many of you remember him. He was a heroic figure. He was the kind of person who ought to command something like this.

The Desert One Force also had a direct satellite link to the Situation Room in the White House. Why did that happen? The answer was what Tony said earlier, and I was going to say, but he stole my thunder. The reason is that those systems were set up for the control of nuclear weapons. As I told you, the law says that in order to release a nuclear weapon, the President of the United States has to make the decision. That means the Situation Room at the White House has to be connected to any military operation around the world. Now, was it necessary to connect this mission to the Situation Room? Hell, no! But because we could do it, it was done.

Oettinger: When you write your book, I will make available to you the record of the seminars for the last twenty years or so, because there are pieces of these puzzles that keep emerging, and the

aim would be to distill it so that there are some intelligent and well-informed lessons rather than speculation. There's a bunch of folks who were involved in things like the Korean tree-cutting incident and others where, little by little, as a result of the experiences with Lyndon Johnson's or with Carter's control, the lessons got learned and folks got more clever at disconnecting themselves before, during, or after.[6] Therefore, this whole matter of measures and countermeasures applies not only to the enemy, but also inside an organization: learning what works and what doesn't, and what screws you up and how to avoid it. It's an intricate story.

The other footnote I want to add is that when Colonel Snook comes here to talk about the helicopter shootdown in northern Iraq, listen for those same themes—this chain of mixed commands and how they jibe and the cultures and so on—and look for them when you read Snook's book.[7] These are important themes that have to be better understood.

Mark: I left Washington in 1984 to become chancellor of the University of Texas system. Charlie Beckwith retired in Texas somewhere, and I met him once or twice. On one occasion I asked him: "What really happened? Was this communication link used and so on?" They didn't tell me a thing about this when I was secretary of the Air Force. I only found that out later on.

Let me tell you what he told me, the way he tells the story, with maybe different words. He said there was a conversation between him and General Jones, and President Carter was right there with Jones. Beckwith said, "I've got five helicopters left," and Jones asked, "What do you recommend?" So Charlie told me that he said, "The mission rules, sir, are that I need six to go in." Jones said, "Then we'd better cancel the mission." Beckwith said, "Well, sir, okay." He interpreted that as an order. Then I asked him, "Charlie, what would you have done if you didn't have that link?" and the answer was pretty clear: "I would have gone in."

This is the kind of operation where the high command picked the best colonel they had, and they should have said, "Go in there and get out as many people as you can, and, by the way, best of luck!" and left it up to the local commander. I close with a statement that this is a misuse of C3. Strategic control here interfered with tactical judgment.

This is not new. This is a copy of a letter that Arthur Wellesley, who shortly before had become Viscount Wellington, wrote to the British Foreign Office in August 1812. (Do you know where the name Wellington came from? W-e-l-l was for Wellesley, which was his family name, and the family name of his mother was Mornington, and so Wellington became the name between Mornington and Wellesley.) I have to confess that the letter may be apocryphal, but there are those who say it was written:

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[6]See, for example, John Grimes, "Information Technologies and Multinational Corporations," in *Seminar on Intelligence, Command and Control, Guest Presentations, Spring 1986* (Cambridge, Mass.: Harvard University Program on Information Resources Policy, I-87-1, February 1987), [On-line]. URL: http://www.pirp.harvard.edu/pubs.html

[7]See Scott A. Snook, "Leading Complex Organizations: Lessons from a Tragic Organizational Failure," in *Seminar on Intelligence, Command and Control, Guest Presentations, Spring 2000* (Cambridge, Mass.: Harvard University Program on Information Resources Policy, I-01-1, July 2001). See also Scott A. Snook, *Friendly Fire: The Accidental Shootdown of U.S. Black Hawk Helicopters over Iraq* (Princeton, N.J.: Princeton University Press, 2000).

Gentlemen,

Whilst marching from Portugal to a position which commands the approach to Madrid and the French forces, my officers have been diligently complying with the requests which have been sent by His Majesty's ship from London to Lisbon, and thence by dispatch to our headquarters. [That was the communication link.]

We have enumerated our saddles, bridles, tents and tent poles, and all manner of sundry items for which His Majesty's Government holds me accountable. I have dispatched reports on the character, wit, and spleen of every officer. Each item and every farthing has been accounted for, with two regrettable exceptions for which I beg your indulgence.

Unfortunately, the sum of one shilling and ninepence remains unaccounted for in one infantry battalion's petty cash, and there has been a hideous confusion as to the number of jars of raspberry jam issued to one cavalry regiment during a sandstorm in western Spain. This reprehensible carelessness may be related to the pressure of circumstance, since we are at war with France, a fact that may come as a bit of a surprise to you gentlemen in Whitehall.

This brings me to my present purpose, which is to request elucidation of my instructions from His Majesty's Government so that I may better understand why I am dragging an army over these barren plains. I construe that perforce it must be one of two alternative duties, as given below. I shall pursue either one with the best of my ability, but I cannot do both:

1. To train an army of uniformed British clerks in Spain for the benefit of accountants and copy-boys in London, or perchance

2. To see to it that the forces of Napoleon are driven out of Spain.

Your most obedient servant,

Wellington

Source: Document available at URL: http://www.netfunny.com/rhf/jokes/88q1/13785.15.html

Student: That was great!

Oettinger: For the benefit of the class, if you would, Hans, you might perhaps elucidate a bit more the remark you made regarding Desert One, about you as secretary of the Air Force being somewhat uninformed, because I have met with blank stares a couple of sessions ago where they were trying to explain the relationship between the services and combatant commands and so on. Coming from the mouth of a professor, it sounds like gobbledygook. Coming from the mouth of an incumbent, it might be a little bit clearer. You've hinted at it; would you explain it a little bit more?

Mark: The secretary of the Air Force, or the secretary of any military service in our organization, is the statutory, legal head of the service. The function of the civilian secretary and the military service chief is to train, equip, and organize the forces of the service. The operational control of U.S. military forces is lodged with what we call our commanders in chief [CINCs] around the world; I think there are about seven or eight. There is one in Europe, there's another one in the Pacific, there's another one in Southern Command, the Strategic Command in Omaha, and so on.

When forces are actually deployed, the chief of staff and the secretary of the Air Force, the whole ball of wax in the Pentagon, are out of it, and the chain of command goes from the President, who is commander in chief, to the secretary of defense, who is one of two civilians in the Pentagon who actually commands military forces (I'll tell you about the other one in a minute), and then to the commander in chief in the field. Even the chairman of the joint chiefs of staff is not in the loop. So there was no reason, given that command structure, for me to know anything. It was, in fact, a courtesy on the part of Lew Allen, who was Air Force chief of staff, that he asked the three-star who was his operations chief to brief me in on this. He did not have to do that. That is the relationship.

Let me talk a little bit about the other individual who actually is in command of military units as a civilian in the Pentagon. I know this because I held the job. The director of the NRO commands military units in the field—all our satellite ground stations and our Air Force or Navy facilities. Written into the charter of the NRO is the explicit statement that the director of the NRO is responsible for the conception, development, fielding, and operation of all reconnaissance centers. "Operation" is the key word. I could and did issue orders to do X, Y, and Z. So only the secretary of defense and the head of the NRO actually have command authority over military folks in the field.

Student: Do the directors of other independent DOD agencies, such as the Defense Intelligence Agency [DIA] or the National Security Agency [NSA], have similar authority over their respective folks? Does the NSA director have that authority, although he's not in the Pentagon?

Oettinger: I can address that. The director of the DIA explicitly does not. He relies on the services. In fact, there is an interesting chapter that needs to be written. If you read General Clapper's presentation here a couple of years back,[8] he initiated a thing called the Military Intelligence Board, where he tried by strength of personality to pull together the chiefs of the service intelligence functions in order to get some coordination and so on. That miraculously

[8]James R. Clapper, Jr., "A Proposed Restructuring of the Intelligence Community," in *Seminar on Intelligence, Command and Control, Guest Presentations, Spring 1996* (Cambridge, Mass.: Harvard University Program on Information Resources Policy, I-97-1, Jan. 1997), [On-line]. URL: http://www.pirp.harvard.edu/pubs.html

survives to this day by the sheer force of personality and continuity, rather than by statute. It could be ended at any time.

These are interesting questions about optimal organizations. It is not an accident, I think—although it would be interesting to hear your views—that the two places where there is a strange deviation are high-tech things thought to be of strategic importance: nuclear weapons and satellites.

Student: Is the NSA in the same realm?

Mark: I do not think so. I think that the NSA stations are run by the local commanders.

Oettinger: My guess is that they have to go through the chain of command.

Mark: I do not know whether this is still true, but in my day the NRO stations worked under cover; that is, we always had some cover story. It is probable that is why this "operation" was in the charter of the NRO, because if you did anything else, you'd have to blow the cover. The NSA stations are, in fact, not under cover. They sit out in the open. Of course, the NRO stations are no longer under cover either.

Student: But I'd offer that the issue is at least unclear, just from my experience on the Pacific Command staff, where we also have an NSA office as a counterpart at the same level. The Pacific Command staff's own people who deal with signals intelligence fight with the NSA people like cats and dogs on a regular basis. This is kind of a symptom of unclear command.

Mark: Yes, I think they fight over tasking. They do not really fight over command. If you look at who takes care of the military people in the NSA station, it is the CINC of Pacific Command. On the other hand, if you ask who tells them what to do, that's what the fight is about.

In the case of tasking, I had no authority at all. I was told by the director of central intelligence, or by a number of people, "Point your satellites at X," and then we would put the programs into the computer and point the satellites.

Student: I realize that this question might be difficult because of the freshness of it, but can you shed any insight on the bombing of the Chinese embassy in Belgrade?

Mark: I do not know anything about it. In my current job, I am even less in the loop than I was when I was secretary of the Air Force. I do research and development [R&D] and so on. I am not involved in the operations. For the not quite two years I have been in the Pentagon, I have not had one operational briefing.

Student: I have a question about the R&D budget. I know that in the lean years of the DOD budget it got smaller and smaller. This year the DOD budget will be increased. Is there going to be a similar increase in R&D, and have those low numbers affected our ability to procure the right kinds of technologies and capabilities that we need in the twenty-first century? What's your perspective on a healthy outlook? Is the glass half full or half empty, or where are we with that?

Mark: If you look at federal spending on R&D, which takes you up to what the military calls by the account number 613 or something like that, then the number is $78 billion for all agencies, total, in FY01. In 1945, Vannevar Bush put out a paper at President Roosevelt's request, in which he was asked to study the justifications for public funding for basic research. It was called

Science: The Endless Frontier.[9] In that paper he said that the first justification is national security, the second justification is public health, and the third is everything else. Today, of the $78 billion, $38 billion are in the Pentagon, so fifty years later, national security is still priority one. Another $14 billion is public health, and $30 billion is everything else. By the way, "everything else" includes NASA, which is at $14 billion, and I personally put that in with the military, but the way the Feds do the budget it is civilian. Much of what NASA does has a lot of military applications.

The priorities have not changed. There have been changes at the margin. Our military, since the end of the cold war, has been cut back by about 35 percent, while our research budgets have been cut back about 25 percent, so research budgets have been treated a little better than the operational forces. We have also consolidated and cut back on our infrastructure and put more money into universities and industry than we used to. That has had a salutary effect, because we brought people into the system who were not there before.

In terms of technology, I think that today we are far, far ahead of anybody else in the world. That does not mean that we are going to win wars. It means we have the weapons to do it, if we are smart enough to pick the wars that we can win, and there are wars that even the best weapons in the world cannot win. Vietnam was an example. You've got to choose objectives that are achievable with the means that you have at your command.

Oettinger: This underscores something Hans said earlier, which is also evident from his biography and his talk. His message, if I hear him correctly, is that science and technology are a small piece of the puzzle, and the organizational, behavioral, et cetera, elements dominate. That is 180 degrees off from what the military and the civilians believe. I commend to you, since you understand that he's representing a caricature, that article by Admiral Owens and Dean Nye in *Foreign Affairs*.[10] You ought to take a look at that, because it gives you a sense of how two very intelligent people, one of them the dean of the Kennedy School, the other the vice chairman of the Joint Chiefs, got into this mode of total faith in technology that would somehow eliminate all of these uncertainties that Hans has documented so painstakingly. It is weird, but it has become kind of a dominant mode, and it takes a certifiable techie to say, "This emperor has no clothes!" The tools are only as good as the people and the organizations who use them.

Student: That's fabulous, because this really brings it to a culmination. If you look at it, in 2,500 years we haven't changed much from the time of the span of control of Alexander the Great, and how he dealt with his captains, to where we are today. It brings me to the point how fundamentally important training is and battle drills, as we call them. Despite technology and all those great things we have, we go back again to the fact that what we do in training is in essence a key determinant of success on the battlefield, with or without any type of continuous command. For example, you mentioned the digitization of the Fourth Infantry Division. That's very clear, and it's coming out in all the after-actions in almost a subtle way. But the battle drills remain at the forefront of the concern that we have when we go into a fight.

Mark: Let me tell you an interesting thing about this digitization, because I got into an argument over this at the Pentagon. The fact is that the equipment that came out of the digitization effort is

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[9]Vannevar Bush, *Science: The Endless Frontier: A Report to the President by Vannevar Bush, Director of the Office of Scientific Research and Development, July 1945* (New York: Arno Press, 1980).

[10]Joseph S. Nye, Jr., and William A. Owens, "America's Information Edge," *Foreign Affairs* **75**, 2 (March–April 1996), 20–36.

better than anything that the Army ever had before. We went to Fort Hood, and I talked to a number of bright kids sitting at those consoles, in the wagons, and in the Bradley armored vehicles, and they were delighted with all this stuff, only it isn't completely finished. It didn't meet the specs. It didn't do what we—the techies—said it would do, and so the newspapers said, "It's a failure. It's dumb, it's stupid." We do not do incremental things. When I came back to the Pentagon, I said, "Quit! Let's just put a cap on this thing for some years and learn how to use it." I do not know if my advice was accepted.

Student: At the Tenth Mountain Division I was carrying that equipment around, which gets to be a challenge, too, we understand, down at those levels. I know that FBCB2 [Force XXI Battle Command Brigade and Below] is good to send reports up. My executive officer could stay all day on the radio, sending a matrix for the supplies that we need, or we could send it on one of those reports and it is done quickly. There is good reason to automate those tasks. But when the boss starts sending me orders back down on it, it gets right back into the command part, and it has me countermarching back and forth, and that becomes a significant problem. The main part about it is that, back at the schoolhouse where all the leaders are being trained, we do not ever even reach these subjects about what these new systems are doing.

Mark: I was not told this, but what I sensed is that the people at Fort Hood pick the brightest young kids who come in. The kids we talked to were nineteen or twenty years old. They were computer nuts, so they really understood how this stuff worked. The colonels basically told us, "We now have the equipment here that we want, and we want you to stop fooling with it and let us integrate it in and let us work it." However, there happens to be a story about this in the *Defense News* article I mentioned. It is actually a pretty good story, and it says, "Faster tactical network is on the U.S. Navy's horizon." The thing that interested me about this story was that it says Phil Coyle "chides U.S. Army digitization."[11] But the burden of the story is that our test and evaluation guy looked at the specs and said, "Hey, guys, we haven't met the specs!" He worries about what we pay the contractors, because when a contractor does not meet his spec we are not supposed to pay him. The fact that the equipment, according to the people who are using it, is better than anything else they ever had gets lost in this. That is the problem. I dearly love Phil Coyle. I worked with him at Livermore for many years, but he is wrong about this.

Oettinger: There's another phenomenon that I think has to do with where—at what end of the spectrum—the technology helps. That's hard to define. I wish it were more definable and easier. You can look at the arguments over the French way of handling crises on the Airbus: when all hell breaks loose, leave it to the automatic pilot. On the Boeing, when all hell breaks loose, you leave it to the pilot. That's an argument that continues. The closer you get to the ballistic end of the world, the more you leave it to the machine, because, hell, when you're following a trajectory, you do not want anybody to mess with it. The thing knows where it is going, and the laws of physics take care of it. The closer you get to these intricate situations that involve intentions, and who's going to do what, and what's the morale, and so forth, the less any kind of equipment is going to do for you. I wish one could *a priori* characterize problems like that so you'd know where to make your relative investments in tools and people.

Mark: Let me be very precise on what my own view is about this, and let me also say that is how I have shaped my own life, because I have spent almost fifty-three years in this business, having gone into the Naval Reserve in 1947.

[11]See note 1.

I have paid attention personally to weapons, not to command, control, or any of these things. The reason is very simple. I am not a military man. I am a technical man, a technical expert. What I have tried to do is to make better weapons: weapons that are superior to any other weapons in the world. If I were a general, I would not say that.

Now, what am I talking about? For instance, I have been heavily involved in the creation of the V-22 tilt-rotor aircraft. It was a NASA project at first; we started that at the NASA Ames Research Center. The Army picked it up, then the Marine Corps picked it up. This aircraft will give us capabilities that no one else has. We will be able to transport things faster and into places that no one else can get to.

Night vision goggles mean that we own the night because of the infrared technology. The goggles are a sensor, but they're really a weapon because they enhance other weapons.

I started working on lasers in 1967. In a few years, the Air Force will be fielding an airplane with a big laser on it that will shoot down ballistic missiles. It is not so far in the future. Moreover, you can move the airplane around the world and you can protect any territory you want. So, from a strategic point of view, this is going to be a weapon of great importance, and I am grateful for the opportunity I have had to participate in this effort.

I started out in the nuclear weapons business, so I do not want to mention that. But the point is that I have personally tried to do what I can, and if you ask me what you can contribute to success, then do whatever you can.

We have a big project at the University of Texas working on electromagnetic guns. I had been working on electromagnetic guns for six years before I came to the Pentagon. If we could do that, we would have artillery that is superior in range and muzzle velocity to anybody else. Within a fifteen-year time span, we will have that, and we will be the only ones. We are the only ones with a high-energy laser on an airplane. We are the only ones with a tilt-rotor aircraft. These are things that we know how to do very well.

In the end, the result is up to the political system, and some of my friends say, "Why are you spending your life doing this when you know that some politicians are stupid?" The answer is that for 200+ years they have been better than most of the others around the world. I am a refugee. I came to this country in 1941 from Europe after getting kicked out and shot at, and I made up my mind then that I was never ever going to be in a position again where I cannot shoot back. That is why I have done what I have done.

So, the answer to your question is that, first and foremost, if we want to maintain the position we have in the world, we must have the best weapons. After that, I hope we will have the wisdom in the political leadership and the wisdom among our field commanders not to make some of the mistakes that I have talked about.

Oettinger: On that note, may I thank you for a splendid conversation with this group. We are deeply appreciative. I want to present you with a token of our gratitude, which you can use to demonstrate that you're now also a Harvard man as well as an MIT graduate.

Mark: Look at that! That's the Harvard medallion! My brother was a Harvard graduate, and I was always infinitely jealous. I'll treasure this, Tony.

Oettinger: Thank you again.

Acronyms

C3	command, control, and communications
C3I	command, control, communications, and intelligence
DIA	Defense Intelligence Agency
DOD	Department of Defense
MIT	Massachusetts Institute of Technology
NASA	National Aeronautics and Space Administration
NRO	National Reconnaissance Office
NSA	National Security Agency
R&D	research and development

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