

CURRENT STRATEGY FORUM, 1978

"NATIONAL STRATEGY AND NAVAL FORCE PLANNING"

AN ADDRESS  
GIVEN AT THE  
NAVAL WAR COLLEGE  
ON 28 MARCH 1978

BY  
THE HONORABLE JAMES WOOLSEY  
UNDERSECRETARY OF THE NAVY

INTRODUCTION

. . . managing editor of the Yale Law Journal all by the time he was 26 and he's held the pace ever since. In the last 10 years he's practiced law in a prestigious California firm, served as a U.S. Army officer, been a program analyst in the Office of the Secretary of Defense, served as a U.S. representative in the SALT talks in Helsinki and Vienna, has been General Counsel for the Senate Armed Services Committee, he's married a Harvard Ph.D who ranks as his equal in government service today, he has sired three sons and for over a year has been our Undersecretary of the Navy. I now present the Honorable Jim Woolsey.

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Thank you Jim. Ladies, Gentlemen, and distinguished guests. Since Randy and I did not collaborate on our addresses in spite of the fact that my wife's office is right next door to his and we see one another occasionally, note that my remarks address primarily the second topic he mentioned - strategy and how to think about it. Perhaps during the question and answer period views on the first and third issues, budget and management issues, can come up.

Forty-three years ago the great economist John Maynard Cain disclosed his general theory with the following words: "The ideas of economists and political philosophers, both when they're right and when they're wrong, are more powerful than is commonly understood. Indeed the world is ruled by little else. Practical men who believe themselves to be quite exempt from any intellectual influences are usually the slaves of some defunct economist. Mad men in authority who hear voices in the

air are distilling the frenzy from some academic scribbler of a few years back. I'm sure that the power of vested interest is vastly exaggerated compared with gradual encroachment of ideas. Not indeed immediately, but after a certain interval for in the field of economic and political philosophy there are not many who are influenced by new theories after they are 25 or 30 years of age. So that the ideas of civil servants and politicians and even agitators applied to current events are not likely to be the newest. Soon or late it's ideas and not vested interests which are dangerous for good or evil." Cain was in part, of course saying himself, lightly worded an indirect compliment on the future success of his own ideas, but he was in part doing something else as well. Today I want you to consider with me the implications of the principle message of that passage. Let's call it the Principle of Intellectual Stagnation From the Public Service, the implication that has for the Naval forces or at least for one convention of wisdom about Naval forces.

I say one conventional wisdom advisedly because if there's one thing I've come to learn about Naval forces in the last year it's that the number of offices, institutions, and influential individuals in Washington with different but firmly handled views about the proper future of the Navy is beginning to approach the number of ships in the Fleet.

The particular conventional wisdom about the Navy I want to discuss with Cain's principle in mind, is a rather widely

held one. It's bottomed on two views. The first is an assumption about future technology. It's roughly that, due to projected improvements and anti-ship missiles and the difficulty of defending against them, surface ships over the next 20 to 30 years will become increasingly unable to survive at sea. The second basis of this particular conventional wisdom is a bit harder to describe. It's a set of views that I call quantitative policy analysis; it's the notion that military forces should be designed almost exclusively to yield favorable outcomes from computer calculation to the outcomes of very specific military engagements using ordinarily complex models with many detailed assumptions. The particular conventional wisdom produced by these views as well as I can state it draw on something like this: Naval forces, particularly surface ships are becoming increasingly obsolete. Ever since the Israeli destroyer Allut was sunk in 1967 by a Soviet made cruise missile, this trend has been made clear and becomes more so each year. Cruise missiles make surface ships increasingly vulnerable to attack on all sorts of platforms; submarines, other surface ships and aircraft. The U.S. Navy has compounded this problem because it's become used to placing all its offensive power in a single platform - the large deck aircraft carrier. These ships are increasingly becoming so expensive it's going to be difficult for the Navy to maintain very many of them and they create added difficulty of having all one's eggs and very few baskets. Vulnerability in few numbers, mean

that carriers and other surface ships could not prudently be risked in a major war in the future.

This means that surface ships should primarily be used for specific purposes; showing the flag in peacetime, projecting power ashore in contingencies such as Korea, Vietnam, where they can operate from an ocean sanctuary against third world countries that lack the sophisticated naval forces of the Soviet navy. But, for these peacetime and minor contingency purposes, the expense of operating carriers is unsupportably high. We could probably afford some reduction in large carriers and substitute, for example, amphibious ships since many of them large and impressive and roughly resemble carriers, they could be used for port visits and peacetime deployments.

The Navy's main and only vital mission in the U.S. - Soviet war is to protect the sea lines of communications from the East Coast in the United States the Western Europe. The war in Europe would be likely to be over quite quickly since it would either turn nuclear or not and more one side or the other would suffer significant defeat within the first 30 odd days. Sea-lift, thus, might not be a particularly significant factor, but to hedge against the war lasting longer some Navy sea lane protection is necessary. This could primarily be done by land based anti-submarine warfare aircraft such as the P-3, small surface ships such as frigates, and a few nuclear attack submarines.

In a big war any other mission for Naval forces, such as conducting operations within range of Soviet land based aircraft is too dangerous to plan for or at least too expensive to buy forces for.

Now, while I wouldn't suggest to you that this particular conventional wisdom is wholly in error, nevertheless I believe it has some serious flaws for the reasons Cain's described. Let me turn first to a key technical judgment that surface ships will become ever more vulnerable to anti-ship cruise missiles over the next two to three decades. It's instructive at least to know that the people who lost the Allut in 1967 have learned something. I recently darned an Israeli patrol boat and reviewed their 100% successful tactics for avoiding hits by a large number of anti-ship cruise missiles that were fired against them in the 1973 Yon Kipper War. Suffice to say that this is an area in which their and our similar advantages are far from irrelevant. For example, skill with electronic countermeasures, evasive tactics, intelligent and well trained crews and so forth. Moreover, even if a surface ship, particularly a large one, is hit by a conventionally armed anti-ship missile, the probability of the ship being put out of action much less sunk is certainly not unity. Defending ships that can move at sea and in a conventional war, that can tolerate a small number of hits is inherently an easier problem than perfectly defending a fixed, land based sight in a strategic nuclear exchange where the penalty for leakage to put it mildly is rather greater.

It's true that for a number of years in the 50s and 60s we constructed ships, in part, under the assumption that any large scale war would be nuclear and therefore hardening or passive protection was not thought ordinarily to be worth the money. However, the new sea based platform assessment done by the Navy at the request of the Congress has indicated some possible improvements. It's indicated that substantial improvement in the survivability of carriers, large or small, is possible by constructing new ships with more armor and more passive protection than has been used in recent years. Further, vertical and short takeoff and landing aircraft (VSTOL) significantly improved the capability of any carrier with whatever problems to conduct its mission after suffering damage because the aircraft can continue to operate even after the ship has been slowed, or for that matter, if it's dead in the water and even if the deck area where the catapults and the resting gear would normally be located has been damaged.

Most importantly however, there are systems now coming into our Naval forces which have been in development over the last decade and which will make very significant contributions toward reducing the number of missiles that might be able to penetrate; electronic warfare suits, THALLANEX close-in weapon system, electronically steered Gatling gun essentially, and particularly, most particularly, the Aegis air defense system.

Further, we either have endlessly have entering it soon or in development, systems capable of destroying the platforms

launching incoming missiles so that we're not beaten by gradual attrition. The F-14 fighter and the E-2C early warning aircraft give us a very good capability today against aircraft launching anti-ship missiles although that very very difficult job we dare to send is one in which we need to continue to work very hard in the future.

Improvements in anti-submarine warfare forces, towed arrays and a number of others make the job of engaging the missile launching submarine a more reasonable enterprise. This seemed to be the case a few years ago when conventional wisdom I described was being born. Hostile surface ships can now, of course, be engaged by carrier based aircraft and soon by the Harpoon missile just now coming into the Fleet.

What about the problem of all our offensive eggs being locked into a few large carrier baskets? I believe there are two ways open to us for packing some of our offensive punch in the Navy which are a much larger number of platforms. They're not mutually exclusive. The first, of comparatively low cost, is to equip as large a number as possible of combatant platforms for cruise missiles. I mentioned the Harpoon for which the program is already underway to equip all sorts of combatants as well as the number of aircraft and submarines. Over the long haul, the cruisers and destroyers could be equipped with considerably longer range Tomahawk cruise missile as good attack submarines. Both for a conventional anti-surface ship mission and for a limited number of conventional land attack

missions; those where it's possible to have a significant military impact by delivering only a relatively small number of very accurate conventional warhead weapons. This, of course, depends on significant improvements in guidance for cruise missiles. It's by no means today, a far-fetched proposition.

The second way to spread out our offensive punch is to disperse our aviation eggs around in more baskets by developing VSTOL aircraft for deployment on small carriers and on other air capable surface combatants. This may well prove expensive but it's a road that we should at least explore vigorously in research and development in the next two to three years. We're going to have, even if we build no more of them, at least 12 large deck carriers in our Naval forces virtually into the 21st century. The only investment required to insure this is to conduct a series of very thorough overhauls called the Service Life Extension Program on the carriers beginning in 1981. Because of this any transition to VSTOL would not, and need not be a sudden proposition. More can, in my mind fill evolving increased reliance on solar power in place of fossil fuel than if it can, for example, replacing on rifle with another.

Well, alright, the Navy's saying. Suppose surface ships are not becoming quite as vulnerable as conventional wisdom might indicate. Suppose there are ways to spread our fire power on the more platforms than the 12 large deck carriers. You still haven't told me what you want to use the Navy for. Are you interested in power projections? Are you interested

sea control? You can't afford to do everything. Shouldn't we be concentrating, for example, on protecting the sea lines of communication in the event of a NATO war using the most cost effective systems possible? Tell me the scenario you want to operate in and I'll help you design and size your force. I'll help you discover how much is enough, but the Navy has to get it back together and decide what war it wants to fight. Those sorts of questions, claims and advice, are the bread and butter of what I described earlier as quantitative policy analysis, method of decision-making that relies heavily in the military field on designing forces to cope with very specific scenarios.

Since I'm going spend the rest of my time this morning talking in one way or another, about the limitations of this analysis, I want to be clear what I mean by it. Some of you might be sitting there saying, come on, if you mean systems analysis, why not say so. Well, I do and I don't. Systems analysis is named for both the original office, established in the Defense Department by Secretary McNamara, and the decision-making methods that it involves throughout government becomes identified in many peoples minds with a number of issues that I have no intention of addressing today. So, I'm not referring here to that office itself, nor am I addressing the role of particular individuals who have worked there or work there; I used to work there myself and have a high regard for many others who have, for those who led it and for those who lead it today. What I am describing is an admittedly rather single-minded

attachment to a specific field of decision-making. A single-mindedness I would attribute to no one all of the time, but to lots of us some of the time, and to some of us most of the time.

Now, one of the oldest and most honorable strains in the analytic discipline is the principle that one must always, as an analyst, tell the client or the decision-maker who asked the question, to set up the analysis whether or not the question is irrelevant. It's in the spirit of an analyst suggesting essentially, how much is enough, and its cousin question may not be the right or at least not the most important questions that I want to pursue.

The first and most important reason such questions may well be the wrong or at least not the major ones that need to be asked has already been indicated by the Secretary of the Navy yesterday. Designing a Navy around specific scenarios requires one to look too far into the future to be realistic. Ships or platforms, more like capital investment from like specific weapons. Over 70% of the ships that will be in the Fleet in the year 1990 already exist or have already been authorized. The carrier that we will authorize in the next or two is going to spend well over half its service life in the 21st century. For example, let's look at the year in which such a carrier that would enter the Fleet in the mid 80s would just be entering respectable middle age. That is, the year in which such a carrier would be coming out of its major service life extension overhaul and would be looking forward to another 15 years in the

Fleet. That would occur around the year 2010. Well, we have no better idea today what specific wars or crises we're going to have to deal with between now and 2010, thirty-two years from now, than in 1946, thirty-two years ago, we had any idea about the crises of today. Who of you here foresaw, in 1946, if indeed you'd been born then, that in 1978 our thinking about how and when we might need Naval forces could be significantly influenced by, for example, commitment to Israel, the need to protect sea line communications to Persian Gulf oil, the split between Communist China and the Soviet Union, and U.S.-Soviet parity in strategic nuclear weapons? Do I need to point out that in 1946 the state of Israel was two years short of existing? Persian oil was just beginning to be discovered, Persian Gulf oil? That the People's Republic of China was just being born? And that neither the United States or the Soviet Union had ever heard of either an inter-continental ballistic missile or a submarine-launched ballistic missile.

What makes anyone even remotely confident that the National Security problem of the 21st century are any clearer to us today than the forces that drive Naval planning in 1978 were clear in 1946.

It is neither lack of effort nor a temporary and remediable lack of will power that leads the Navy to not being able to tell now just what sort of war it was to fight thirty years from now. Secretary Claytor said, "Assuming we can plan on such a basis is like designing Cook's tour. Next month I'll be in Belgium;

it'll be March so I'll need a raincoat. Designing a Navy is more like forming up a Lewis and Clark expedition. We have to be prepared for a much wider range of problems and we have to design for flexibility. How we can best do this is itself a massive subject, but I think three points are wrong. First, since ships, our capital investment, last such a long time in peacetime, and since the pace of technological change for weapons and sensors such as radars and sonars are so rapid, we must build design ships to be able to accommodate change and modernization and accommodate it readily. Carriers are inherently capable of doing this. As the suits of aircraft are changed the ship can thereby accommodate major operations and missions over the years. Carriers have indeed done this many, many times since World War II; especially carriers which have been in the Fleet since immediately after World War II, such as the Midway. Another way to promote flexibility is to build even small surface combatants to take some aircraft. Our destroyers and frigates took on important new capabilities when we put anti-submarine warfare helicopters aboard them a few years ago and will evolve further as more advanced helicopters replace these in the 1980s.

This interest in the flexibility provided by multiplying the number and type of platforms that can use aviation at sea is the very key reason for our support of the development of VSTOL aircraft. A third way to make it easier for ships to accommodate the change is to build surface ships in such a way

that their weapon suits, guns, radars, missiles, and so forth can be changed far more readily and cheaply than is now possible as new weapons and sensors become available, almost as if one were changing modules. We're working hard on this. I certainly think it's a very promising concept, but there's still a lot to do.

In addition to the need to design a Navy for flexibility over a long period of time, there's another major reason why I would suggest rejecting the precise quantitative scenario dependent method of designing a Navy. It's that Naval forces are particularly vital for dealing with the dynamic problem of the transition - a transition we of course want to prevent - from peace to war. Any specific scenario whether it's protecting the sea lines of communication to Europe in the event of a NATO war, or projecting power in a certain type of crisis in the third world in the absence of Soviet intervention, or any other, have to be a slap shot in time. One doesn't want to ask only the question that's really convenient for quantitative policy analysis to answer, What might things look like at a specific point in time? But the much harder question, What are the problems of going or being forced from one position to another, and how can I control that process to avoid risk? The President and his advisors need to know what sorts of forces can best help them manage the perennial danger of crises escalating in the war and to manage them in such a way that the other side will know that at each step of the road we are in control.

Unfortunately to the analyst it's in the complexity of the evolving and dynamic situation such as this, peace threatening to evolve into war, that Naval forces are the most relevant. That makes them messy to analyze, in one or two mission or one or two scenario formats. Naval forces are highly relevant to this delicate transition from peace to war because they can do three kinds of things. They can help maintain stability in peacetime through forward deployments and perceptions of their potential power; they can help contain or manage crises as they evolve; and they can help deter general war by being clearly better abled to fight it than their foreseeable adversaries. These tasks, I think, are in a very real sense a seamless win. Let me walk through them very briefly.

Naval forces can help maintain stability in peacetime by forward deployment. We maintain today two carrier task groups, battle groups we call them, in the Mediterranean, two in the Western Pacific, and several Marine amphibious units deployed in both areas as well. Since 1945 the U.S. has used such sea power for the means of affecting the behavior of decision-makers of other nations in peacetime, a very large number of time. These forward deployments are intended to demonstrate U.S. interest in resolve, to reassure allies, deter enemies, insure quick response. So one important question in designing a Navy is, How do force structure decisions have an effect on these deployments? The issue is not whether a permanent reduction in our Naval forces would affect our forward deployment

and therefore our foreign policy, but rather in what ways and how much such affect would occur.

Another part of the picture of assessing the overall contributions of the Naval forces to peacetime stability is the perception of the U.S.-Soviet Naval balance. It's not inevitable that the U.S. conceded the Soviet parity in all military capabilities, they don't enjoy it now. The forward strategy linking the U.S. to other continents requires us to use the seas and makes any perception that the Soviets could deny us control of the seas particularly damaging. Such perception is not warranted by the projected trends in technology if we had the will and the skill and can find the money to proceed to deploy what we've developed.

Another major task that national decision-makers must face in the spectrum between peace and war is the containment or management of local crises. In some crises the President may wish to commit U.S. troops immediately to preempt certain potential moves by an adversary; to evacuate Americans in jeopardy, to carry supplies rapidly to a friend or ally. Naval forces aren't the only possible means by any means. Quick responsive airlift, for example, provides the President with a very valuable tool, but airlift has limitations and in a number of cases Naval forces may be prepared for good reasons. For example Naval forces can be deployed to crisis area without being committed to battle and without committing allies. Such demonstrations manifest both U.S. concern and U.S. capabilities. In over 200

crises large and small since 1945 in which the U.S. was involved in some way, U.S. Navy and Marine forces were deliberately employed in 177 cases. U.S. land based air or ground forces alone were demonstrated in fewer than 90 cases.

Naval forces may be the most acceptable form of military presence in crises situations. They can convey, if the policy maker chooses, calculated ambiguity, calibrated responses. The presence does not irrevocably commit the United States to a given course of action. They do, however, seriously complicate the calculations of opposing parties.

U.S. fighting forces can be assembled for action without using bases in other nations. Indeed, Naval forces can help make us comparatively indifferent to the vicissitudes of other nation's policies about base rights for us or for hostile countries. The Naval forces help make us more able to tolerate shifts in political winds without feeling that our vital interests are threatened. The crisis is resolved satisfactorily, Naval forces can be withdrawn with limited fan fare, and some to provide a policy maker with important flexibility and a tool for orchestrating events. To be able to successfully support U.S. policy in a crisis, Naval forces require several things. They must have striking power to affect events ashore; they must have local superiority over potential adversaries. The benefit of Naval superiority is that it signals to the Soviets and others that their adventurism occurs against a backdrop of U.S. forces that are capable of fighting and winning and both

sides must know this. In a crisis we want it to be the other commander on the scene, not our own who is forced to tell his National command authority that he must back down or risk escalation. There must be sufficient forces to permit coverage of different crisis areas so that responding to a crisis in one area doesn't involve the risk of being unable to deal quickly with a new outbreak somewhere else. This does not imply that we must be everywhere all the time, it does mean that reductions in force levels will increasingly constrain our credibility. Most of all we must always bear in mind the possibility that a crisis could escalate to actual fighting with some losses to U.S. forces. As I said at the beginning, I think our forces are becoming more rather than less capable of responding to a sudden attack, but any prudent planning would require that we recognize the possibility of some initial losses. We need to consider, in light of this, what total forces we need to maintain our position.

Continuing along the section from peace to war, another major task of the National decision-makers is the deterrence of major war. We have to recognize that deterrence of conflict will depend upon a credible war fighting capability. Maintaining such a capability is complex and difficult for a whole series of reasons, but I think two are serious. First, our allies are overseas, many of the most important ones are close to the borders of the Soviet Union. If there is effective sea and air by both sides, we simply mirror image the Soviet's

land-based air power and small missile bearing ships for example, both sides deny the use of the seas, we lose. We have to be able to use the seas to maintain our alliances and our security. Second, It's not longer the case that the threat to our use of the seas only occurs in near coastal waters of the Soviet Union. The increasingly capable blue water Soviet Navy, and particularly, the long range backfire bomber now going into the Soviet Naval aviation forces, makes all the world waters of interest to us a potential theater of conflict. The backfire, for example, can range from Soviet bases in the Soviet Union to the environ of the Azors and the Atlantic and Pearl Harbor in the Pacific.

Should deterrence fail, we simply have to be able to fight and win. One of our most immediate concerns in deterrence and war fighting must be the defense of sea lines. No matter what the scenario, minimum warning or long warning, short war or extended war, we are going to have to be able, and the other side is going to have to know that we're able, to move large amounts of material by sea. This is usually viewed strictly in the context of the North Atlantic but we can't forget that we must continue to support Hawaii, our Western Pacific allies by sea, and also, increasingly importantly, insure continuing flow of vital overseas resources, particularly petroleum.

Naval forces contribute, I think, to deterrence and the ability to fight a global war, by a clear demonstration of ability to support allies with strategic trends on the flanks

of the Soviet Union. Sea lane defense by itself does not protect flanks. NATO's a collective alliance relying on the commitment of all its members to the common defense. If any of these members doubted America's commitment or capability to support them, it could generate serious pressures on the cohesion of the alliances all over. In a general U.S.-Soviet war, our Naval forces must be capable of flexible options worldwide. A major conflict will almost certainly be conducted on a global scale. We must be able to destroy Soviet forces wherever we find them and complicate Soviet planning forcing them into a defensive posture. Whether or not a national leader chose to exercise that option, the capability to conduct offensive operations against an enemy fleet is crucial in order for these forces to be useful to the nation. I'll cite only one authority a predecessor of Jim Stockdale's as President of this War College, Alfred Thayer Mahan hammers his point home throughout the influence of sea power on history, and offensive capability pointed out was a central difference over the years, over many years, between the British and French fleets and the key over that time to British success.

All these questions that have to be answered in managing dynamic situations, maintaining stability in peacetime, providing tools to manage crises, deterring war by being able to fight it, require a broad range of types of Naval forces. Managing stability, managing crises, and deterrence means being able to conduct military operations where needed, on, under and above

and along the shores of 70% of the earth's surface. This is simply too complex a task to be accomplished by one or two specific types of platforms or systems.

I want to suggest a final reason in addition to the need for flexibility over time and the need for balanced forces to help maintain stability in dynamic situations; a final reason why I think it's unwise to design a Navy to prevail only in certain specific scenarios. This is, if anything, the most fundamental reason of all. It's that quantitative and very scenario dependent analysis used as a tool for designing and sizing Naval forces risks leading us into a fundamental misunderstanding in the nature of war. It's often said that such analysis focuses attention where it should be focused and marginal changes. Now, in one level concentrating on the margin, that is on the costs and benefits of the next decision, not some overall historical average, is just common sense. Ignoring some costs is the first principle of most successful business men and all successful polka players. A fixation on marginal change can be stultified if it so narrows an analysts imagination that he never moves his gaze from the byways after the horizon. A focus on changes of the margin and on quantitative questions cannot too often produce an attitude that innovation is suspect, that the only changes of interest are to buy several fewer of these or slightly increase the number of those, a sort of strategic instinct for the capillaries. Military breakthroughs don't come that way; they come by approaching things

from a new perspective. By devising a different way, for example, to exploit the effect of mass or shock or the way to use surprise or concealment to accomplish what was previously accomplished by a ponderous force, or a way to disperse and then concentrate for battle that confounds the enemy's planning.

Quantitative scenarios specific analysis often misses this fundamental truth about military matters. It does not take each element, for example, of Naval warfare, anti-air warfare anti-surface, anti-submarine and so on, and ask how in each type of combat we might most readily make a potential enemy's past investment in weapons worthless. Such analysis does not ask, How can I exploit my advantages? How can I destroy the will of an enemy commander? Chinese strategist Sun Tzu wrote long ago, the least desirable way to achieve victory is to destroy an enemy's cities, the next least desirable is to kill his soldiers, better to destroy his alliances, but best of all is to destroy his plan and never have to fight at all. Only intellectual audacity permits this most humane type of victory and intellectual audacity is not normally found at the margin.

I suppose another way to say it is that the reason we should not become locked into designing or sizing a Navy for one or two specific scenarios on marginal change is because this capacity for asking the right question, capacity for intellectual audacity is not a talent that is foreign to totalitarian society, a society that might become our enemy.

One needs only to recall Hans Guderian's development of tank warfare in the blitzkrieg in Germany in the late 1930s to realize that we simply cannot afford to be the only ones of the two super powers on this planet which is only asking the question "How much is enough?" We must ask many, many other questions too or we risk very ugly surprises.

I want to close with a description of one example of such a surprise that occurred long ago. In the late 18th century, during a reevaluation that defeat always forces on a country's military establishment, fresh armor is developed to cannon barrel and that for the first time made artillery light enough to be pulled by horses rather than oxen. The implications of this development were not immediately clear. There was some experimenting but most commanders used horse drawn artillery as they had oxen drawn artillery to make ponderous sorties from fixed forts and magazines to fight in the rigid 18th century manner. Viewed in this context, horse drawn artillery was a marginal improvement of sorts. I rather doubt that it was cost effective. The development was only fully exploited during and after the French Revolution, in particular by a young Caucasian corporal of artillery. Doubtless his success depended heavily on his own tactical genius and on the social effects, especially that of the French Revolution, which permitted the levy on mass making possible the 19th century version of the human sea attack. Accurate horse drawn artillery opened for him, radical and unforeseen new possibilities of organizations mass, maneuver,

and surprise and enabled his armies to shatter 18th century concepts of warfare and the armies to practice them. New units called divisions were formed under aggressive young commanders, each division given its own artillery. Forts and magazines were bypassed, the Alps were crossed in rapid marches. Fire power was masked quickly to destroy opposing armies before they could concentrate on the battlefield. In other mens hands a lighter cannon barrel had been just a lighter cannon barrel. In his it was a major element in the conquest of Europe. So risks are becoming rigid in our thinking about military forces; of designing forces to fight the way they've always fought; of concentrating on only how much is enough at the margin are very great. Together we all have to try continually to prove Cain's wrong, to show that we're not perpetually the slaves of vulnerability calculations of the late 1960s or analytical tools of the early 1960s. So we can learn something after we're 25 or 30. The risks of doing otherwise are clear and we will all learn a bit much more painful. For example, it took the rest of Europe 20 years to learn enough from that artillery corporal to defeat him and even then his ultimate conqueror said, "It was a near run thing." Thank you.