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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Defense Facts of Life briefing has promoted considerable debate concerning basic questions in the defense decision-making and planning process. Do the positive attributes of high complexity weapons outweigh their negative qualities? What effect does our investment in technically complex weapon systems have on our perception of military capability and readiness?

Air Force Tactical Aircraft programs are analyzed in a case study that illustrates the tendency for high investment weapon systems to take an unacceptable

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered) toll on the state of readiness. Investment plans change dramatically from year to year and the pattern of these changes indicates that these plans embody optimistically low estimates of future investment costs. It appears that our plans do not account for the future consequences of current decisions. We advocate increased budgets because we perceive a growing threat, yet at the same time we project low readiness to meet the same growing threat. What is required is leadership that can make real national defense take precedence over interests that would advocate technical sophistication at any cost.

DEFENSE FACTS OF LIFE

Franklin C. Spinney

December 5, 1980

A

This staff paper represents the preliminary views and findings of the author. It has not been reviewed by the Department of Defense and therefore should not be construed as reflecting an official position of the Department.

OUTLINE

PURPOSE

EXAMINE DEFENSE PLANNING TO DETERMINE:

1. THE REALISM (OR LACK THEREOF) OF CURRENT PLANS
2. THE LEADERSHIP CHALLENGE FACING DECISION-MAKERS DURING THE COMING DECADE

SLIDE 1

Today, there seems to be general agreement on the need to strengthen our military. There is also considerable debate over just how this ought to be done. Defense Facts of Life is an attempt to make a constructive contribution to this debate. Before proceeding, I would like to make a few introductory comments.

(Slide 1) First, and foremost, this briefing presents an independent minority view. My colleagues and I believe that our nation faces a long-term defense problem of fundamental importance and our objective is to stimulate informed debate over the need for, and the shape of, basic changes in the collective process of defense decision-making and planning. In this spirit, this briefing is an attempt to determine the realism of our current plans, and to articulate the leadership challenge facing defense decision-makers over the coming decade. To do this, we will focus on the evolution of Air Force tactical fighter aviation. It would be a mistake to view this problem as being peculiar to the Air Force or solvable by the Air Force. A cursory review of the other services revealed similar, if not worse, problems.

All levels of decision-making in the executive branch, the legislative branch, and the private sector contribute to the pattern of behavior discussed in this briefing. Consequently, everybody is at fault and nobody is at fault. This lack of a neat structure, and an awareness that the problem has been building up for many years, lead to the conclusion that there are no easy solutions, quick fixes, or management gimmicks to make it disappear. The fundamental need is for strong informed leadership and a collective will to change. We hope that this can be achieved through a rigorous above-board self-examination.

Secondly, for the past two years, this briefing has been presented many times, and at many levels, within the defense department. Our experience has been that it is contentious and often evokes strong emotion. On occasion, in the heat of the moment, it has been interpreted as an argument for smaller budgets, or as an argument against advanced technology. This view is totally incorrect. We need more money to strengthen our military; however, we believe that unless we change the way we do business, more money could actually make our problems worse. Inextricably combined with the broad issue of how we spend our money, is the issue of how we should use our superior technology--specifically, should we continue to increase the technological complexity of our weapons? Do the positive qualities of high complexity weapons outweigh their negative qualities? Advanced technology and high complexity are not synonomous.

There may be ominous precedents for our current delemma. Would increased defense budgets in the mid-to-late 1930's have made any difference to the French in 1940? France entered the war with more tanks than the Germans, the world's most technologically sophisticated trench, and a fatally flawed strategy based upon a stagnant appreciation of World War I's lessons and an emphasis on using emerging technology to solve old problems.

Overview

(Slide 2) To discuss this complicated issue, we will start by articulating the basic nature of the planning task in terms of the uncertainties that must be faced by decision-makers. Next, we will take a general view of the pattern of change in our budgets, costs, and force structures over the last thirty years to gain insight into our actual decisions in an uncertain world. We will then examine the case of Air Force tactical airpower in detail to show that budget increases do not change the general pattern. Next, we will examine the uncertainty surrounding our investment plans in order to see how our desired future compares with past reality. Finally, we will examine our perceptions of military capability and evolve the long term consequences of continuing increases in the cost and complexity of our weapons.

Slide 2

I Nature of the Planning Problem

(Slide 3) The plans that we are concerned with in this briefing primarily consist of our financial plans (specifically the Five Year Defense Program or FYDP); and secondarily, those plans that link our war plans to the FYDP (specifically, the Air Force War and Mobilization Plan or WMP). These plans are intended to provide the forces in being needed to prosecute our war plans. To do this in the real world, decisions and plans must reconcile the tension between perceived threats and limited resources. Uncertain and menacing threats generate a long menu of requirements that can only be funded out of a limited pool of resources.

The bureaucratic process for reconciling the tension between desires and resources culminates in the publication of the January FYDP. The FYDP is the only document published by DoD that incorporates all the hard decisions between two covers; and consequently, it is the authoritative statement of defense policy. We are not saying that budgeting should shape policy; budgeting should reflect policy. If it does not reflect stated policy, then budgeting is determining real policy, and formal policy statements are meaningless. During our discussion, we will attempt to uncover what the FYDP says our policy is by examining the future consequences of today's decisions.

GOAL

PROVIDE A SUPERIOR FORCE

REALITY

DECISIONS AND PLANS MUST RECONCILE TENSION GENERATED BY

- PERCEIVED THREAT
- LIMITED RESOURCES

NOTE:
- PLANNING IS CONCERNED WITH THE FUTURE CONSEQUENCES OF TODAY'S DECISIONS
- JAN. FYDP IS THE AUTHORITATIVE STATEMENT OF DEFENSE POLICY

Slide 3

(Slide 4) Although the defense debate tends to focus on hardware procurement, a superior military force is a synthesis of men and machines. We want to develop and field technology that blends harmoniously with the patterns of human behavior under conditions of war. Ideally, this blend should be the fundamental criterion for evaluating the potential of an emerging technology. Unfortunately, as our hardware increases in complexity, this blend of the man and machines becomes more difficult to understand or predict primarily because the man-machine relation has also increased in complexity. We will see that this problem is compounded by unrealistic perceptions of weapons capability--e.g., perceptions that ignore human contributions.

A SUPERIOR FORCE IS A SYNTHESIS OF:

- PEOPLE
- IDEAS
- MOTIVATION AND PSYCHOLOGY
- SKILLS
- MACHINES

NOTE: MACHINES DON'T FIGHT WARS – PEOPLE DO!

Slide 4

(Slide 5) Moreover, we often do not have enough resources to simultaneously fund both our hardware needs and our people needs--a fact that raises the general question of how we should value our people and machines when we have to make this difficult choice. Only successful commanders can provide us with insight into the answer to this question. Napoleon once said: "The moral is to the material as three to one." Over a hundred and fifty years later, General Bruce Clarke, one of the finest armored commanders of World War II, made the statement shown in this slide to Congress. We note with interest that General Clarke's experience was in "industrial war" while Napoleon's was not, yet he is making the same basic observation: Machines are important, people are more important. Our historical research indicates that this observation seems to be a dominant attitude among successful commanders. Unfortunately, we will see that this profound truth can be forgotten in a decision process that tends to focus on hardware procurement.

> "WHAT CONSTITUTES THE EFFECTIVENESS OF THE ARMED FORCES OUR COUNTRY PRODUCES?
>
> I BELIEVE THERE ARE THREE FACTORS:
>
> FIRST: THEIR STRENGTH, ARMS, EQUIPMENT, SUPPLIES AND TRANSPORTATION
>
> SECOND: THEIR MORALE, ESPRIT, TRAINING, LEADERSHIP, INFORMATION, MOTIVATION, COMMAND, AND CONFIDENCE IN THEIR MISSIONS
>
> THIRD: THE ABILITY OF THEIR GOVERNMENT TO EMPLOY THEM WISELY AND EFFECTIVELY
>
> THE SECOND AND THIRD FACTORS ARE FAR MORE IMPORTANT THAN THE FIRST"

Bruce C. Clarke
General, U.S. Army, Ret.

Slide 5

(Slide 6) Since we will be using the term "complexity" throughout this briefing, it is appropriate that we define it precisely. This slide states our operational definition. The implications of increasing complexity are clear: increasing complexity runs up the number, increases the variety of arrangements, and complicates the coordination of the parts--and, thereby, decreases one's ability to comprehend the whole. Increasing complexity is a cost because it decreases our ability to understand, and consequently, makes it more difficult for us to adjust to, or shape, internal or external change. Put another way, increasing complexity increases our rigidity in a game where survival of the fittest makes flexibility a paramount virtue.

We have been willing to pay this cost of increased complexity because we believed that we were getting an increased capability that compensates for this increased cost. During the first part of the briefing, we will attempt to articulate the accummulating cost of complexity in terms of its impact on men and machines; in the latter part, we will discuss the nature of this perceived increase in capability. This discussion will be imbedded within the overall examination of the realism of our planning process. We will see that the two subjects are inseparable.

OPERATIONAL DEFINITION

COMPLEXITY IS A QUALITY OF THE WHOLE THAT

- RELATES THE NUMBER, ARRANGEMENT, AND COORDINATION OF THE PARTS

TO

- ONES ABILITY TO COMPREHEND THE WHOLE

Slide 6

(Slide 7) We face increasing difficulty in reconciling the tension between desires and scarce resources because our philosophy for using emerging technology has generated a cost structure that is growing at a much faster rate than our budget.

THE PROBLEM

TENSION IS MAGNIFIED BY INCREASING COMPLEXITY

BECAUSE:

COSTS ARE RISING FASTER THAN INCOME

Slide 7

(Slide 8) Uncertainty is compounding our problem of coping with the cost income squeeze. Although today's decisions can impose rigid burdens far into the future--e.g., we are likely to be facing the O&S costs of the TRIDENT SSBN appropriated in FY 80 in the year 2010--we face great uncertainty in predicting the future. To understand the planning problem, it is necessary to understand the impact that these uncertainties have on our perceptions and decisions.

The central impact of threat uncertainty to the planner is that when this uncertainty is combined with proliferating technological opportunities, it is easy to generate a virtually unlimited menu of desires or perceived needs. From a practical viewpoint, there will never be enough money to fund all these desires. As will be seen later in the presentation, the increasing complexity of our hardware increases our sensitivity to the long term threat uncertainty because the interaction of our emerging cost structure with our budgeting process leads to low readiness; and therefore, makes us more vulnerable to short-warning threats.

UNCERTAINTY COMPLICATES DECISIONS

TODAY'S DECISIONS IMPOSE RIGID BURDENS FAR INTO THE FUTURE

HOWEVER

IT IS DIFFICULT TO PREDICT:

- FUTURE THREAT
- FUTURE INCOME
- FUTURE COSTS

Slide 8

10- Blank

(Slide 9) Turning to the budget uncertainty, today there appears to be a national consensus to increase the defense budget. The crucial question facing decision-makers is how long this consensus can be maintained. In a democracy, consensus can change quickly and unpredictably. Moreover, this normal uncertainty is likely to be magnified over the coming decade by our economic problems. Our current plans for unprecedented peacetime growth in the Defense budget must be financed ultimately by a national economy that is in serious trouble. The GNP is growing more slowly than in the past and is becoming more unstable. The economic uncertainty that we face today may be greater than at any time in the post-war era.

Our nation faces a very serious long term productivity problem--the solution of which will entail a large investment of private capital. There is even talk of a national reindustrialization program. Since poor productivity performance implies that our ability to generate the needed investment dollars out of an increasing income is limited, there is likely to be increasing pressure to cut personal spending or government spending in order to free up the required capital. Compounding this problem are many disincentives complicating both private decisions to save and invest and government decisions to control spending and taxation--this slide lists a few.

In the near term, the basic uncertainty facing defense planners revolves around the question of how constraints on the growth of Federal spending will be allocated among legitimate competing needs. A squeeze on government spending will increase the constituent pressure on Congress, the President, and DoD and there is no guarantee that the pattern of constituent pressure will correspond to the needs of national defense. In other words, even if we obtain our overall DoD budget goal, we may have externally imposed constraints on our pattern of spending. For example, the constituent pressure for major hardware procurements is likely to be higher than pressure for increases in the training budget. If such pressures prevail, the effect would be an uncontrolled trade of combat skills for increased hardware procurement. This may be good or it may be bad--the point is that it is externally imposed.

We live in an uncertain world. Since we can not control this external uncertainty, our planning system should recognize it and hedge against it. In particular, our decisions and plans should anticipate the need to change and provide a strategy for reducing the real costs of responding to budget change. Admittedly, this is an abstract concept. During this briefing we will try to make it more concrete. The real costs caused by our pattern of short-term change are accummulating; they take the form of lost opportunities--e.g., reductions in training, reductions in supplies, deferment of maintenance, etc.

REAL WORLD OF BUDGET UNCERTAINTY

- OBSERVATION: PLANNED BUDGET GROWTH MUST BE FINANCED BY AN ECONOMY THAT IS GROWING MORE SLOWLY AND IS BECOMING LESS PREDICTABLE
  - BASIC PROBLEM: DECLINING PRODUCTIVITY REQUIRES LARGE INFUSION OF PRIVATE CAPITAL
    - COMPLICATIONS: DECLINING SAVINGS RATE, PERSISTENT INFLATION, OPEC, TRADE DEFICIT, TAXPAYERS REVOLT, UNSTABLE INTERNATIONAL FINANCIAL SYSTEM, DEMOGRAPHICALLY AGING POPULATION, PERSISTENT FEDERAL DEFICIT ....
  - NEAR TERM: UNPREDICTABLE IMPLICATIONS OF EMERGING CONSENSUS TO REDUCE FEDERAL DEFICIT
    - HOW DO WE ALLOCATE CONSTRAINTS ON SPENDING AMONG COMPETING NEEDS?
    - HOW DO WE COPE WITH INCREASING PRESSURE TO "PORK BARREL" IN A POLITICAL APPROPRIATION PROCESS?

DECISIONS AND PLANS SHOULD REDUCE THE REAL COSTS OF ADAPTING TO UNANTICIPATED CHANGES IN THE BUDGET.

Slide 9

(Slide 10) We will see that the increasing complexity of our weapons is magnifying this real cost of adjusting to change by: (1) increasing investment, operating, and support costs; (2) increasing the uncertainty surrounding our cost structure--particularly for our operating and support costs; and (3) stretching out the time horizon for the cost consequences of current decisions.

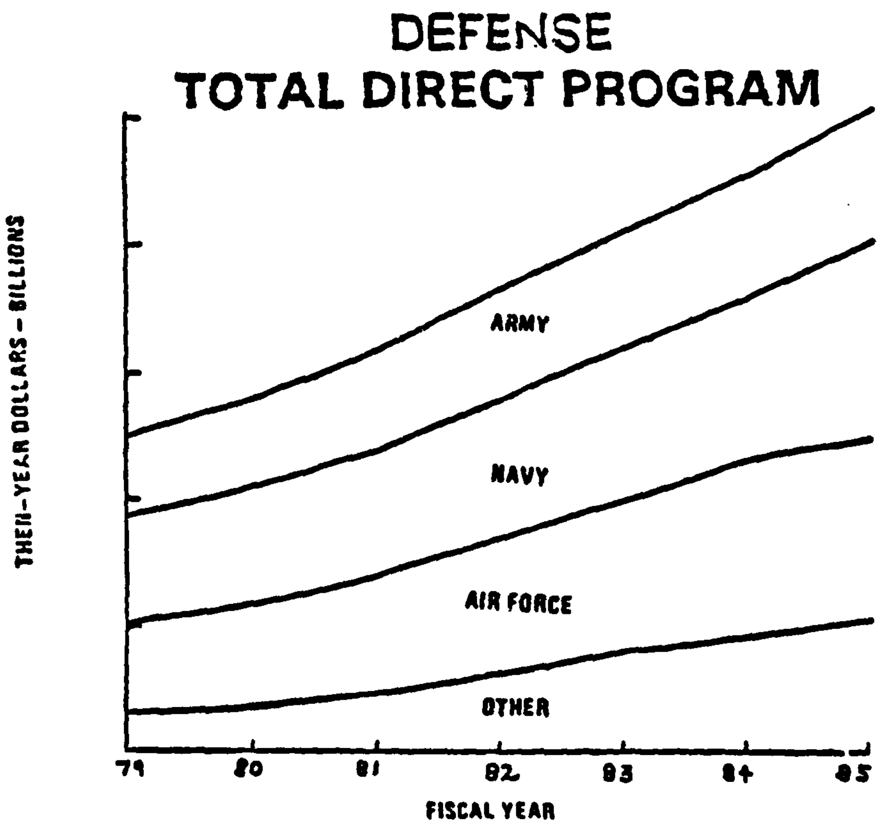
IMPACT OF COMPLEXITY ON FUTURE COSTS

- INCREASING COMPLEXITY <u>INCREASES</u> COSTS
- INCREASING COMPLEXITY <u>DECREASES THE PREDICTABILITY</u> OF FUTURE COSTS

INCREASING COMPLEXITY MAGNIFIES THE <u>REAL</u> <u>COST</u> OF ADAPTING TO UNANTICIPATED CHANGES IN INCOME

Slide 10

(Slide 11) Within the Pentagon, the bureaucratic mechanism that is intended to cope with these uncertainties is the Planning, Programming, and Budgeting System (PPBS)--a system that assumes certainty. Each year, we make a specific projection of overall budget growth for five years into the future. We also project detailed dollar costs five years into the future for over 2000 program elements. The PPBS has become so cumbersome and infected by bureaucratic gaming, that as we get nearer to the January budget deadline, we are responding more to the bureaucratic constraints imposed by the system rather than using the system as a tool to adjust to changing circumstances. This chart shows the PPBS results (in current dollars) from the FY 81 President's Budget--note the smooth growth in the outyears.



Slide 11

(Slide 12) Thus, we have a planning system that assumes certainty in future budgets and costs to cope with an uncertain real world of budgets and costs. This naturally raises a question concerning the realism of the plans produced by this system.

RAISES QUESTION

ARE CURRENT PLANS FOR SMOOTH GROWTH REALISTIC IN THE PRESENCE OF THESE UNCERTAINTIES?

- SIGNIFICANCE OF BUDGET UNCERTAINTY
- MEANING OF COST GROWTH
- THE IMPACT OF INCREASING COMPLEXITY AND COST UNCERTAINTY ON PERCEIVED VERSUS ACTUAL CAPABILITY

Slide 12

16-Blank

II A General View of Change in the Post-World War II Era

(Slide 13) In this section we intend to analyse the variability of the DoD budget over the last 30 years. We need to understand how our budgets have changed in the past because the pattern of behavior will provide insight into how our planning/budgeting system copes with the uncertainties discussed in the preceding section. We can then compare this historical pattern with the future pattern implied by our plans to gain an historical perspective of the realism of our plans.

This chart displays the DoD budget in constant dollars (i.e., the effects of inflation have been removed) since 1951. The major categories are: (1) O&S--or operations and support--this category represents our operating budget and it consists of the operations and maintenance accounts plus the military personnel accounts; (2) investment--this category consists of all the procurement and military construction accounts; (3) RDT&E--the sum of all the research, development, test, and evaluation accounts; and (4) retirement--the military retirement account. Concerning the behavior of this budget over time, the following observations are important for our analysis:

- There has been no tendency towards long term growth.

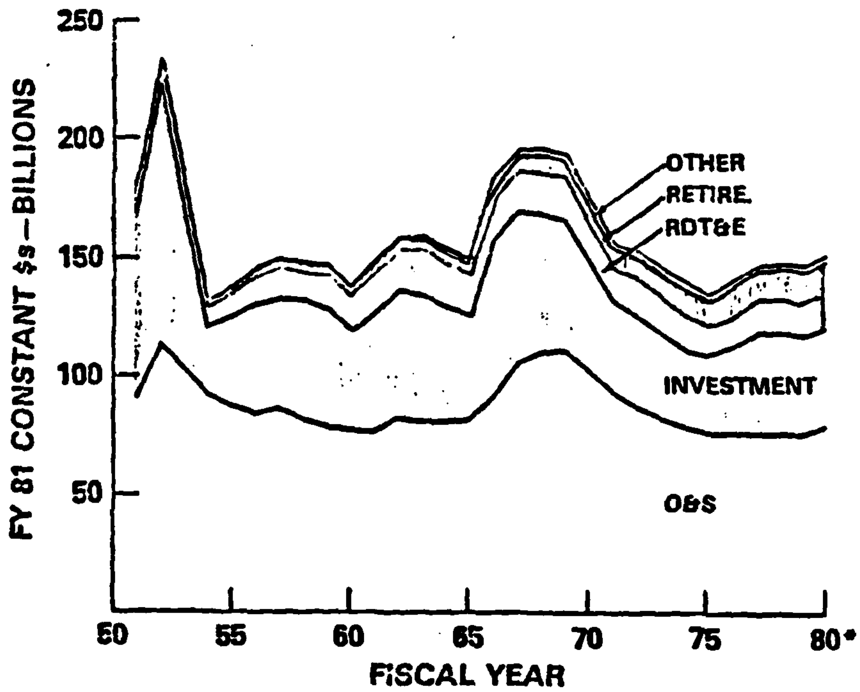
- The budget changes quite dramatically in the short term; some changes have been very abrupt; other large changes have taken place over a somewhat longer period.

- The causes of these budget changes fluctuate over time. We can loosely identify these changes with fluctuating political/economic conditions--e.g., Korea, the strategic build up in the mid-50's, the ICBM/SLBM build up and the improvement of the general purpose forces of the early 60's, Viet Nam, etc. Many of these causes are inherently unpredictable.

  The budget has a short term tendency to increase and then decrease. In this regard, the longest period of sustained real growth since the end of WWII has been three years. We haven't been able to correlate this pattern of behavior with any particular factor, it just appears that there is some type of internal compensating mechanism at work. It may suggest that consensus in a democracy is quite variable in the short term.

Today's budget levels are, in part, determined by past budget levels--the more recent past being more important than the distant past. We know where we are today, our real interest is how we get to our desired levels in the future. Therefore, in the next slide we will look at how the budget changes from year to year.

TOA HISTORY

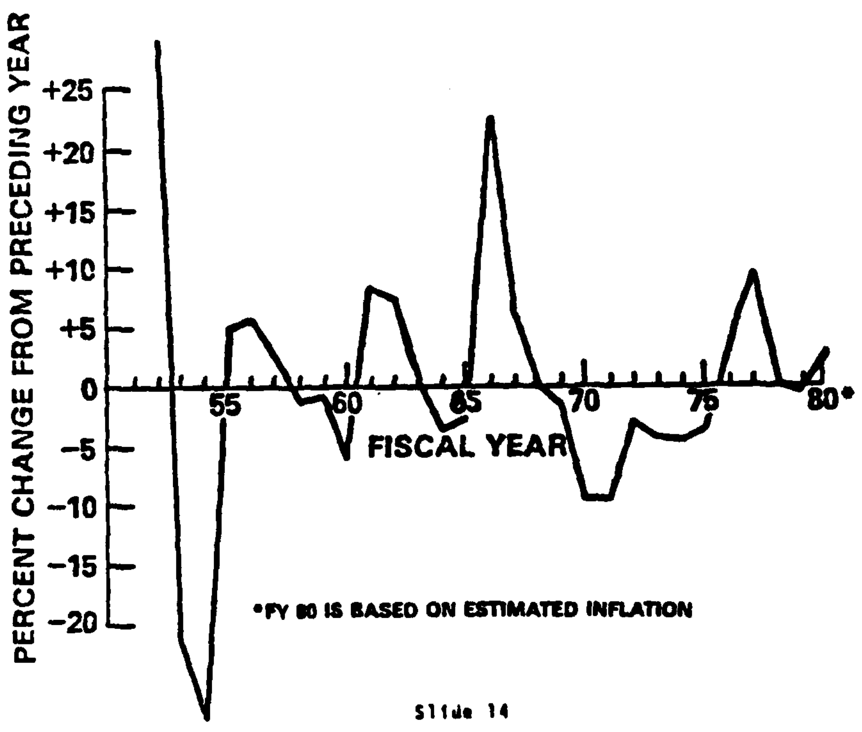


*FY 80 IS BASED ON ESTIMATED INFLATION

Slide 13

(Slide 14) This slide presents a time track of budgetory changes; each year, the PPBS process precisely predicts an almost flat five year future growth pattern (averaging 5% per year for the FY 81 budget) for this curve. The norm in plotting this curve is as follows: the point at FY 55 indicates that the FY 55 budget total was approximately 5% greater than that of FY 54; FY 56 was approximately 6% higher than FY 55, etc. The experience of our last 30 years shows frequent sharp changes in the rate of budget change; however, if we look at the smooth growth of our PPBS planned budgets, we see that we are planning for small changes in the rate of change. For example, 5% growth projected over five years would be a horizontal line. Plans tend to emphasize the horizontal dimension, reality tends to emphasize the vertical dimension--an observation that suggests a mismatch between plans and reality.

ANNUAL CHANGE IN DoD BUDGET
(CONSTANT $s)



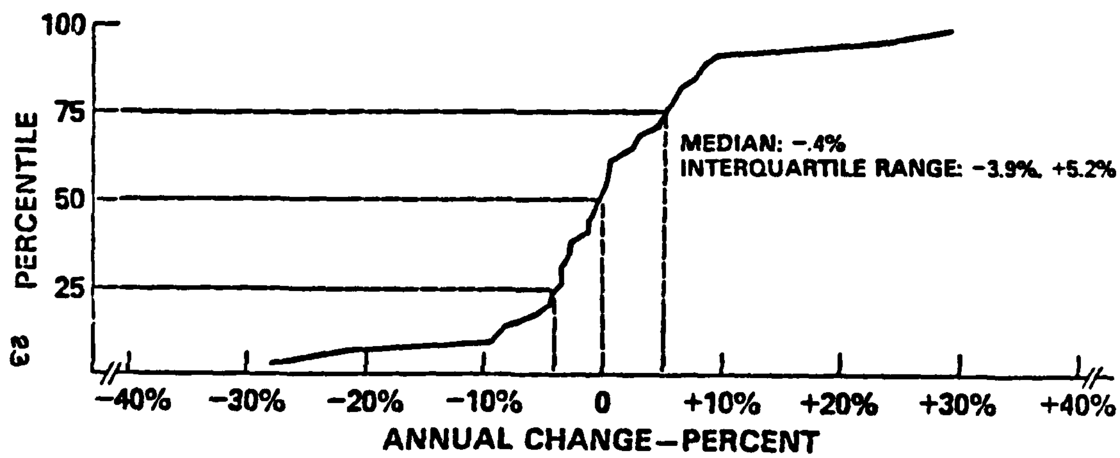
Slide 14

(Slide 15) Changes over time don't seem to have a predictable pattern. This slide ranks these changes in order of their magnitude from the smallest (on the far left) to the largest (on the far right), independent of when in time the changes occurred. The horizontal axis measures the positive and negative magnitudes of the changes. Since we are looking at 30 years, there are twenty-nine annual changes; rather than numbering the vertical axis from one to twenty-nine, it is numbered in terms of percentiles. The 50th percentile (i.e., the median) is the point at which there are an equal amount of larger changes as there are of smaller changes. It is analogous to an average and it represents the long term growth of our overall budget. The chart states the obvious: over the long term, a median of minus .4% growth means that the budget has shown no tendency towards sustained growth.

The interquartile range is the range of budget changes that represents the middle 50% of the data. The interquartile range distinguishes the more normal mid-range of values from the more extreme values (note: the middle 50% is an arbitrary choice, we could have just as easily selected the middle 80% without changing the essence of our analysis and conclusions). The central idea of a rational planning strategy designed to cope with these changes would be to expect and hedge against unpredicted change as large as this mid-range in order to reduce the "real cost" of adjusting to "normal" change.

We will now present a similar analysis for the different budget categories. Taken together, these different patterns of behavior are the key to understanding the intimate relation between the question concerning the realism of our plans and the question of how we should use advanced technology. The following slides have also had the effects of inflation removed.

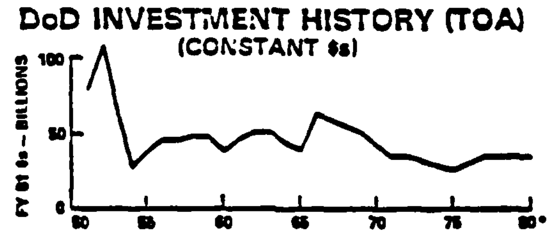
CUMULATIVE DISTRIBUTION: OVERALL DoD BUDGET REAL GROWTH IN TOA: FY 51-80

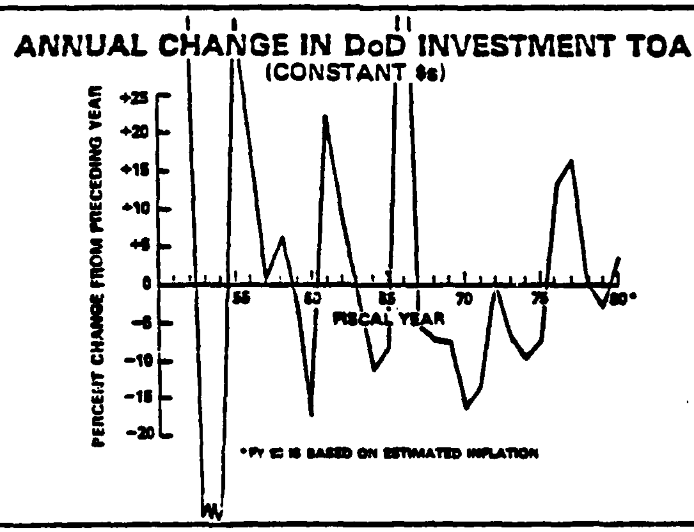


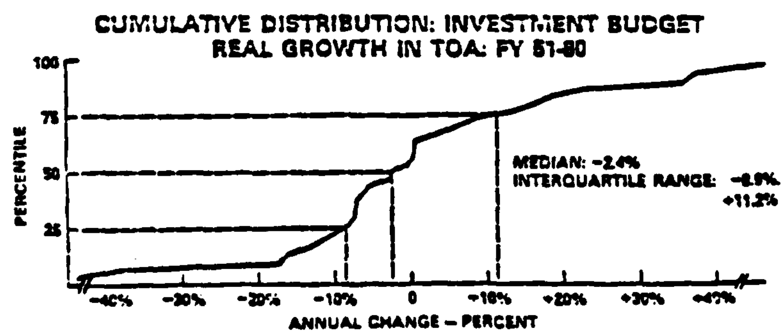
Slide 15

(Slide 16) Taking the investment budget first, we note the following important observations:

- Investment is a large account, generally running between 40 and 50 billion dollars (FY 81 $) annually.
- Annual change can fluctuate wildly from year to year. Each year the PPBS predicts a precise five-year projection of this curve.
- Over the long term, this account has shrunk more than the overall budget (i.e., the median = -2.4% versus -0.4% for the overall budget).
- Notwithstanding the long term shrinkage, the imbalance in the interquartile range indicates short term attempts to grow the investment account--there are occasional years large growth.







Slide 16

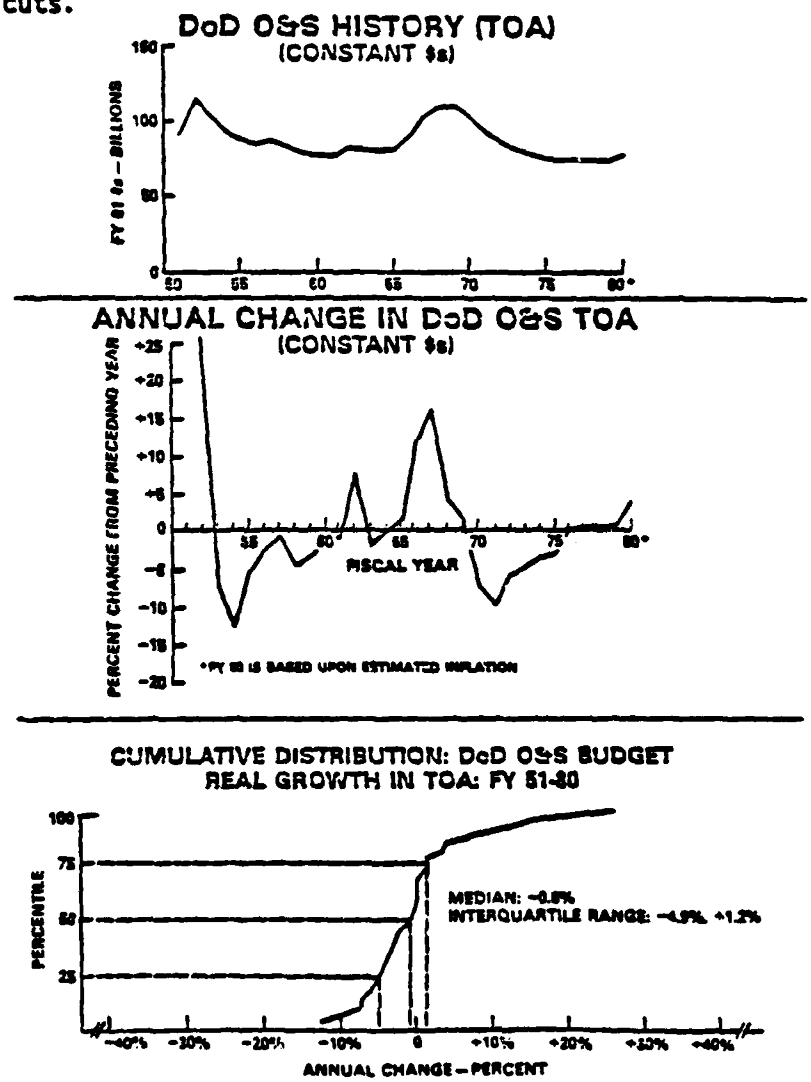
(Slide 17) Turning to the O&S budget, we note the following observations:

- It is another large account-approximately twice the size of the investment account.

- Its fluctuations are more moderate than the investment account changes.

- The median growth rate (-0.8%) is not appreciably different from the overall median growth rate (i.e., -0.4%). O&S has remained relatively constant over the long term while investment has shrunk and this has occurred despite the fact that DoD's total forces have shrunk significantly in terms of people and equipment over the long term. In other words, relative to the investment budget, and relative to each force unit, the O&S budget is growing.

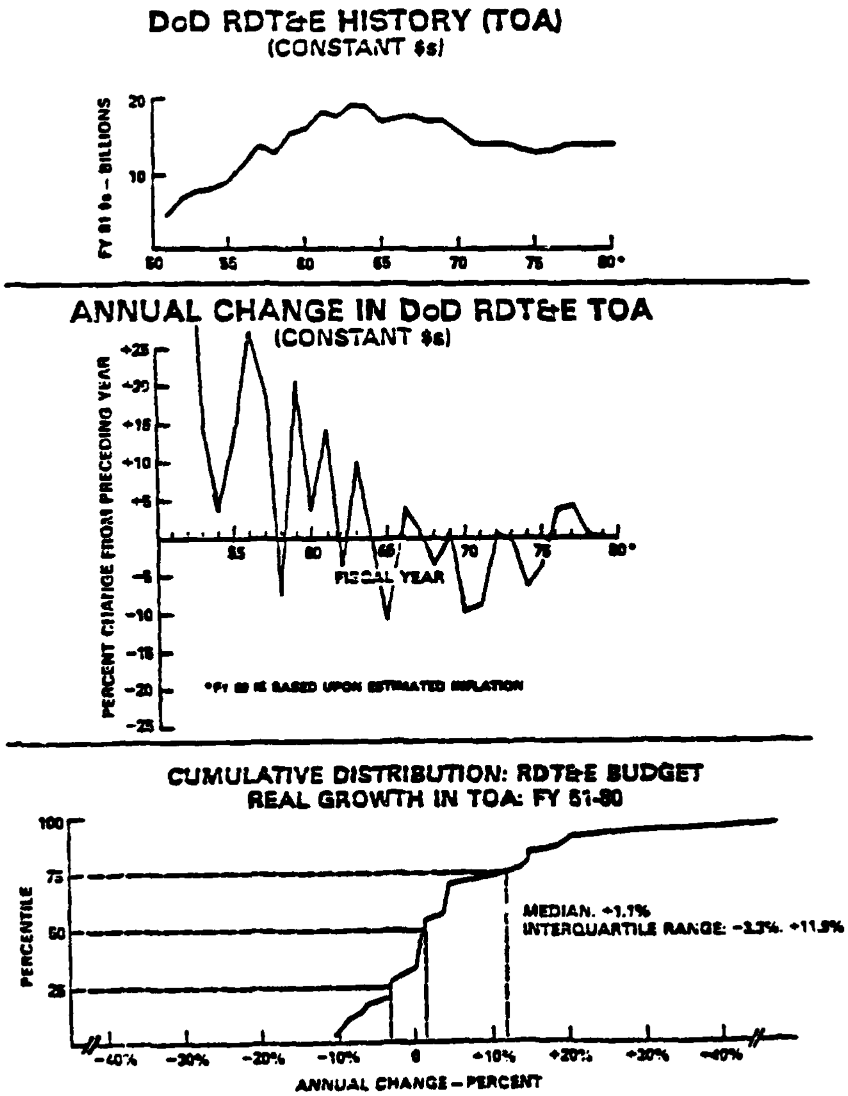
- The imbalance in the interquartile range indicates short-term attempts to shrink the O&S budget--there are occasional years of major cuts.



Slide 17

(Slide 18) Regarding the RDT&E budget, we note the following observations:

- Relative to Investment and O&S, it is a small account--although its leverage on Investment and O&S is, of course, enormous.
- RDT&E grew from around 1951 to 1964, then generally declined until 1971, and has remained roughly constant since 1972.
- The RDT&E account determines the type of technology and the resulting costs that we have to live with in the Investment and O&S accounts.

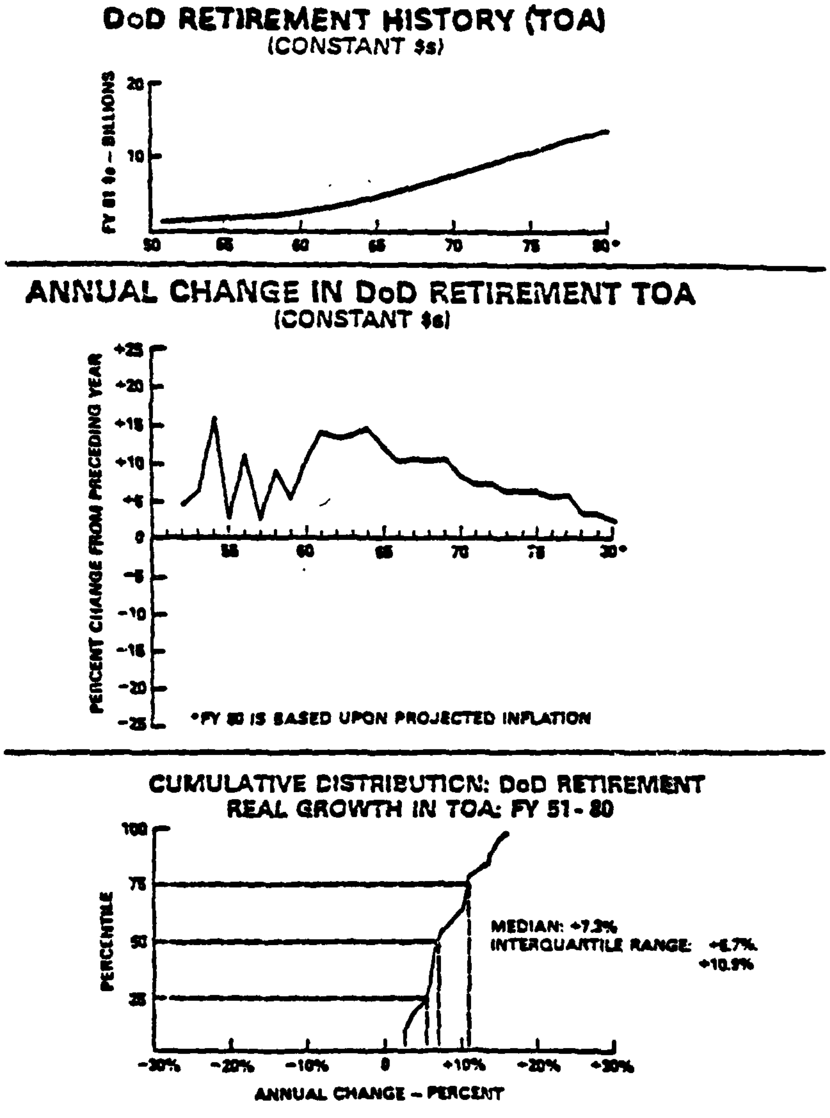


Slide 18

(Slide 19) Turning to Retirement we note:

- This account has grown steadily from an insignificant level to a level that is approaching the RDT&E account.

- The rate of increase has declined over time; but, we should note that we are still seeing significant positive growth, which while a low percentage by historical standards, is compounded on a much larger base than in earlier years.



Slide 19

(Slide 20) This slide summarizes the interquartile ranges and the medians for the overall budget and its different categories. The left end of the bar is the 25th percentile, the right end is the 75th percentile, the arrow indicates the median, and there is a line at zero to provide perspective. There is a cricial mismatch between the long-term and short-term dynamics of the O&S and Investment budgets. In the short-term we try to shrink O&S and we try to pump up Investment; however, over the long-term, Investment is shrinking relative to O&S. In other words, we have not been converting our short-term desires into long-term reality.

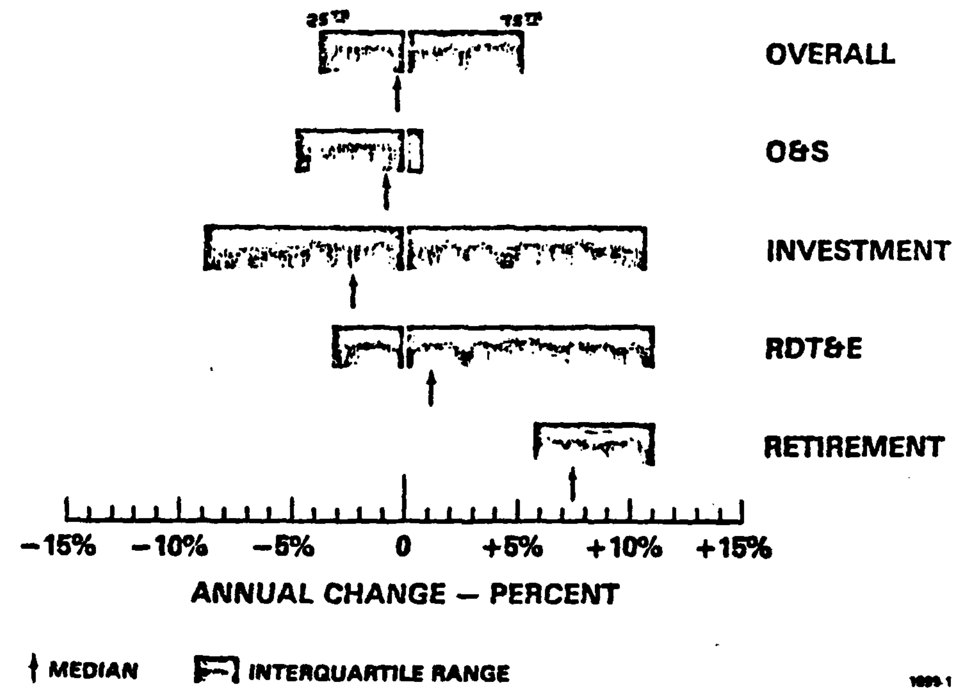
In a general sense, this pattern reflects a tendency to reduce our current readiness to fight in order to modernize for the future; however, because of rising operating costs, the price of even low readiness is rising inexorably over the long-term. We will see that this is happening despite a long term decline in the overall quantity of people and equipment. Moreover, modernization is being slowed and forces are declining because (a) the cost of replacement is increasing and (b) because the long-term budget constraint has made it necessary to squeeze total investment growth in order to relieve the unavoidable long-term growth pressures in the O&S and Retirement accounts. We should also note that, because of its large size, a small percentage of increase in the O&S account can put enormous pressure on the Investment account. This pattern of pressures may also explain the apparent cessation of growth in the RDT&E account.

We have uncovered a pattern of destructive growth--when some parts of the whole start growing faster than the whole itself, they start eating up the remaining parts. One could think of this as a form of organizational cancer. The short-term strategy of trying to hold down growth in the O&S account to pump growth into the Investment account does not cure the problem because although we have been able to hold O&S growth to a level approximating overall growth, we have reduced force size and we are accumulating a current readiness bill (in terms of deferred people and material costs) that is not reflected in the budget data. Sooner or later, this bill will have to be paid.

This pattern of behavior can be expected to continue as long as costs, particularly operating costs, grow faster than the budget. We need more money, but a planning strategy that depends on steady increases in budgets over the long-term to solve this problem is a high risk strategy because: (1) it ignores historic patterns of budget growth--i.e., it requires the occurrence of unprecedented and continuing budget increases; and (2) it ignores the long-term impact of the growing economic uncertainty. The challenge facing decision-makers is to shift the long-term and short-term behavior patterns depicted in this slide towards a more harmonious interaction--regardless and independent of overall budget levels. It is a leadership challenge because it requires the inspiration of a collective will to impose the interests of the whole on the activities of the parts. It is a bipartisan problem with no easy solutions because this pattern of behavior has built up over a long period of time and it will take a long time to change it.

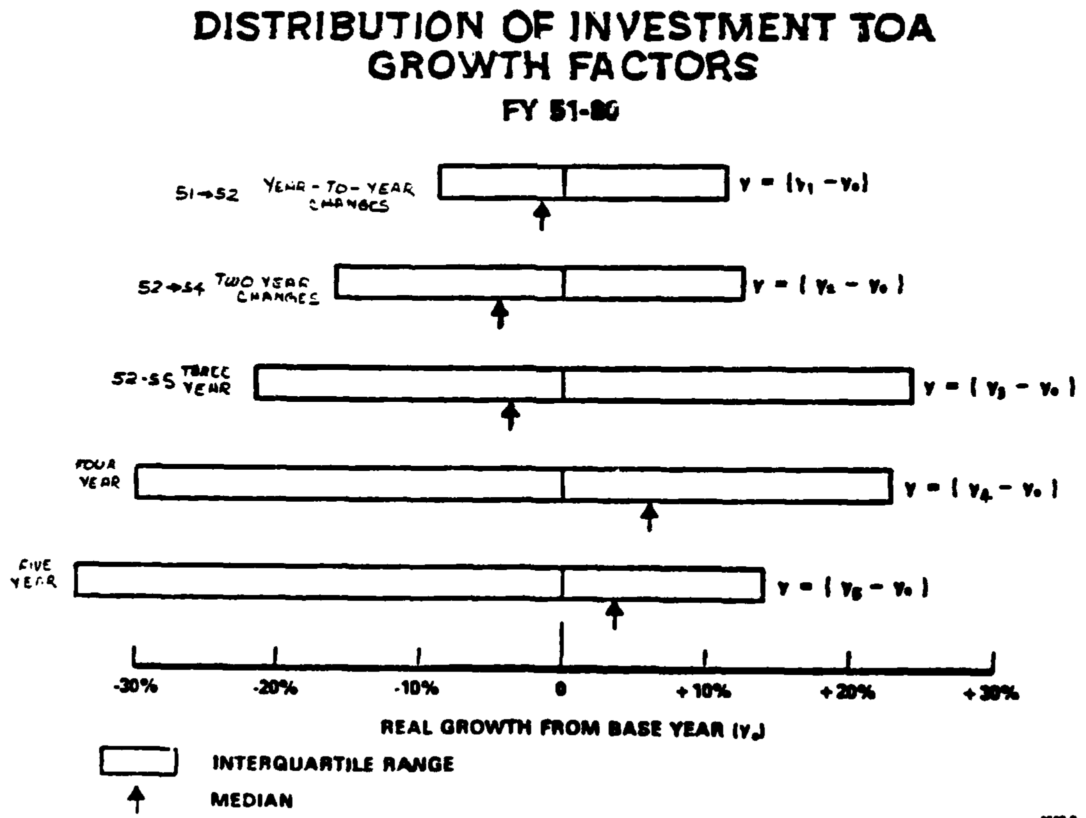
The remainder of this briefing is designed to: (1) support the points made in the preceding three paragraphs; (2) to show that budget growth, by itself, is not a solution; (3) to show that current plans for historically unprecedented growth (averaging 5% per year for five years after inflation is taken out) still display the same unrealistic short term tendency to hold down O&S while pumping up Investment--i.e., the same pattern of desires that we have been unable to convert into long-term reality in the past; and (4) to show that the way we are applying our superior technology (i.e., the RDT&E account) is a central cause of the continuing problem--i.e., the undesireable consequences of increasing technological complexity can be expected to grow if we continue in the direction implied in our plans.

SUMMARY
DISTRIBUTION OF ANNUAL REAL GROWTH RATES
FY 51-81



Slide 20

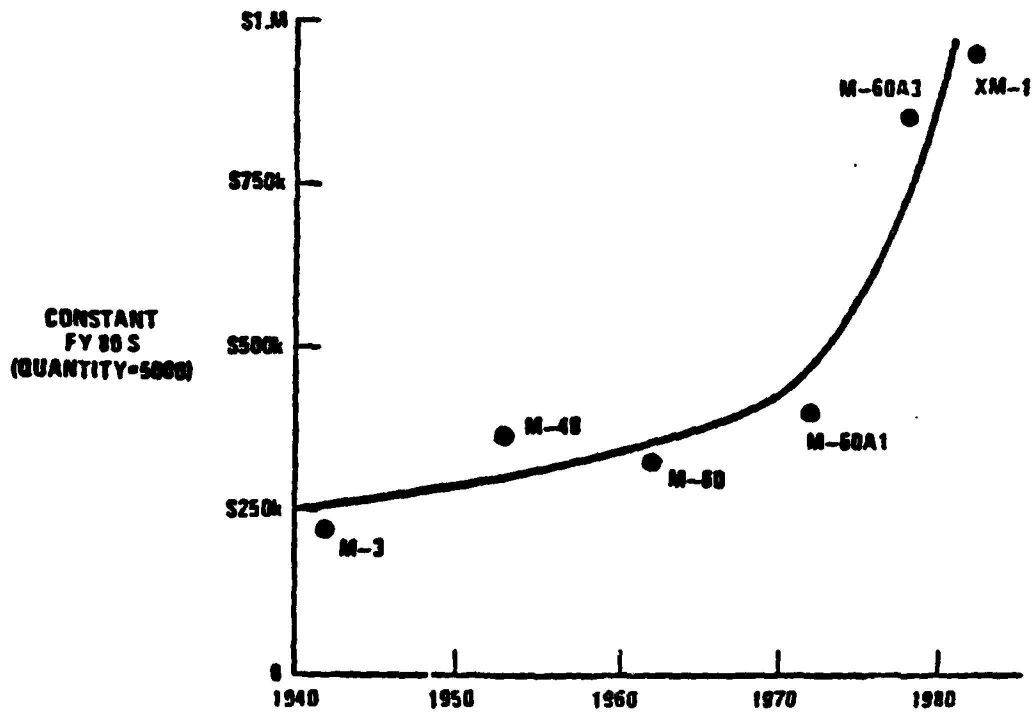
(Slide 21) Before proceeding with the rest of the briefing, this is the appropriate point to introduce and explain an analytical tool that we will use later on. This set of investment growth percentages for a five-year period was computed in the same way that the bars of the preceding slide were computed. The top bar on this slide is identical to the investment bar of the preceding slide--i.e., it displays the interquartile range and the median of the year-to-year budget changes. The second bar displays the interquartile range and median growth percentages for the group of two-year budget changes--i.e., for the set of data: (51-53, 52-54, 53-55, ..., 78-80). The third bar displays similar data for the three-year changes--i.e., (51-54, 52-55, ..., 77-80). The fourth and fifth bars display similar data for the four-year and five-year changes. These data describe the postwar historical pattern of growth for a five-year period. We will use this data to compare our five year investment plans to past reality. For example, if the third year of today's investment plan is at the 75th percentile of the group of three-year growth percentages, this would indicate that, in the past, only 25% of the time did we experience enough three-year growth to achieve the third-year investment level we are planning today. It says nothing about the first or second year of the plan.



Slide 21

(Slide 22) Essentially we have found that our overall budget has been relatively constant over the long-term, while it increases and decreases sharply in the short-term. Now, we will take a quick look at costs to gain a perspective on the magnitude of long-term cost growth. We will defer the discussion of the increased capability that we are getting for this increase in cost until the last section of the presentation. First, the cost of a tank. Note, that the cost is in constant dollars to take out the impact of inflation and is normalized for a constant quantity to take out the impact of learning in a production process. It was not possible to take out the effects of overhead for different production rates, so it is not a strict "apples versus apples" comparison. As a practical matter this abstraction does not affect the pattern of growth. Also, for the newer systems (e.g., in this case the XM-1) costs are based upon early production estimates and experience suggests they are likely to grow over the planning projections. The essential point is: costs are increasing at high, and perhaps increasing, rates.

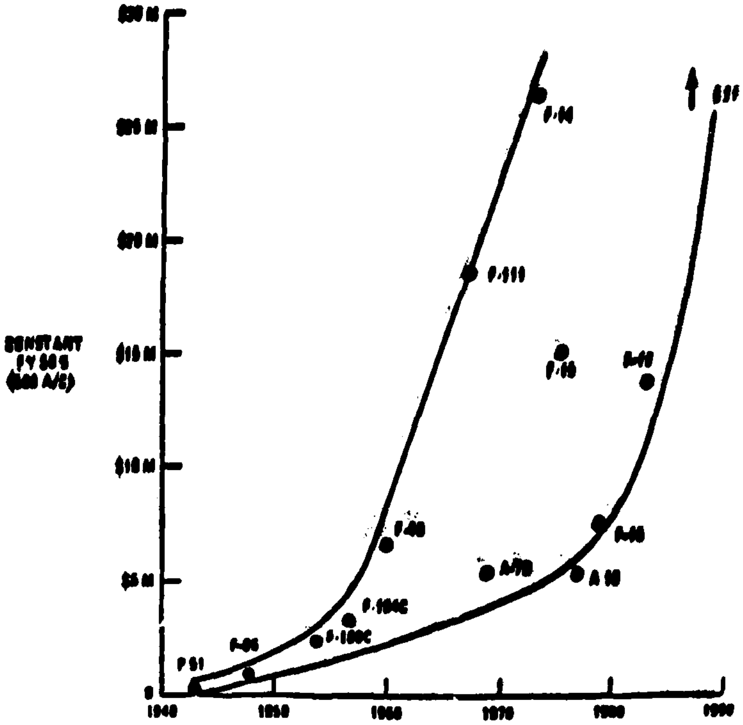
SYMPTOM — COST OF THE TANK



SLIDE 22

(Slide 23) Next, the cost of a fighter; we see the same pattern. Again, the costs are normalized for inflation and production quantities. Although there are some exceptions, this same pattern of growth generally applies to ships, helicopters, munitions, armored personnel carriers, missiles, etc. Moreover, as we stated earlier, operating costs are following a similar pattern of growth. For example, we will see that the F-15 costs almost twice as much to operate per flying hour as the F-4E.

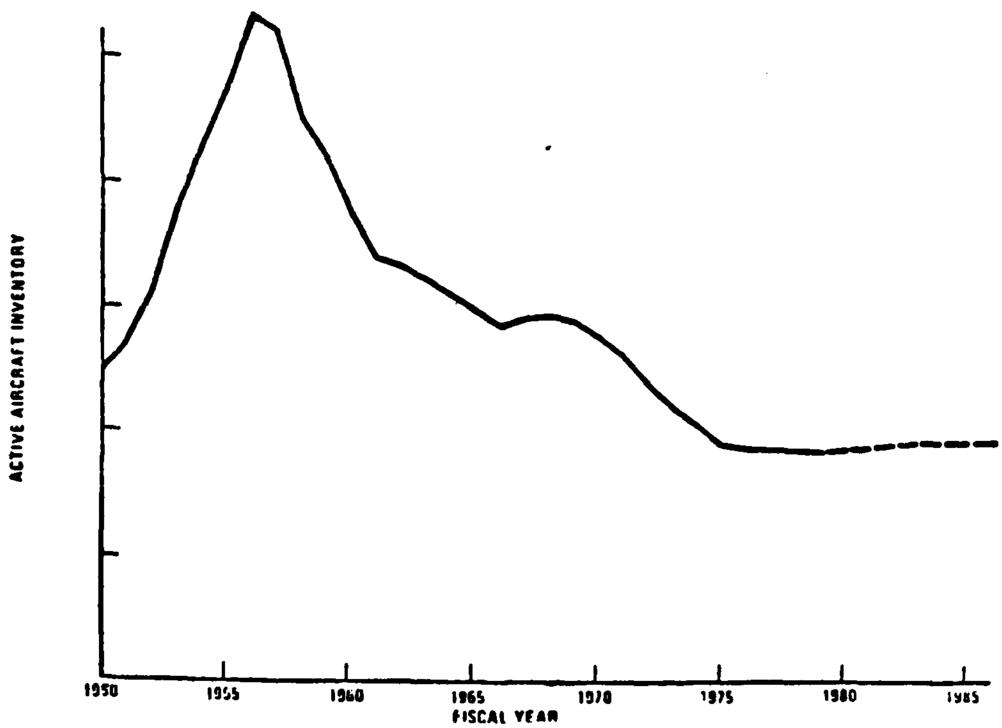
SYMPTOM — COST OF THE FIGHTER



SLIDE 23

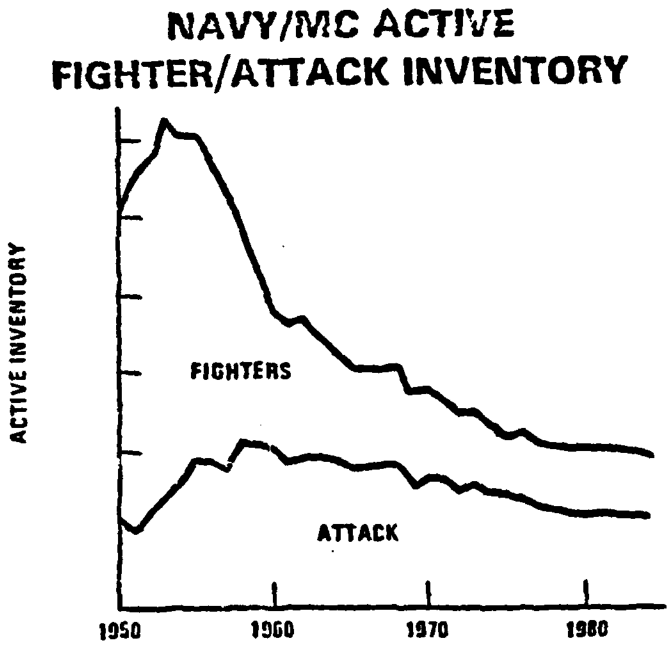
(Slide 24) Turning now to the interaction of a relatively constant budget and rising costs, we see that the Air Force has reduced its active inventory of aircraft dramatically. Now we have had a changing mix of aircraft--e.g., many bombers and transports have dropped out and ballistic missiles, which are not shown, have entered the inventory. So we are not saying anything about capability, we are just saying that overall numbers have declined dramatically. Note also, that our plans--i.e., the dashed line beyond 1980--indicate a slight reversal in this trend.

AIR FORCE ACTIVE AIRCRAFT INVENTORY



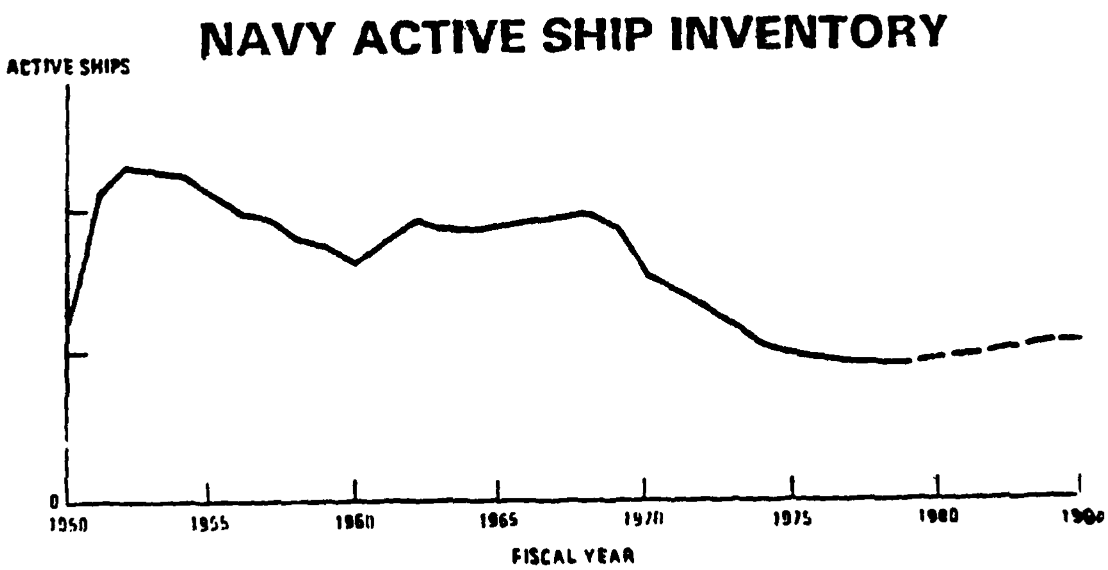
SLIDE 24

(Slide 25) Looking at the Navy's fighter/attack forces, we see a similar decline. Note again, our plans for the future imply a change for the better in the rate of decline.



SLIDE 25

(Slide 26) The story is basically the same for ships. This concludes our discussion of the general patterns of change in the post-war era. We are now going to do a more detailed case study of Air Force tactical fighter aviation to illustrate the general interaction of readiness and modernization.



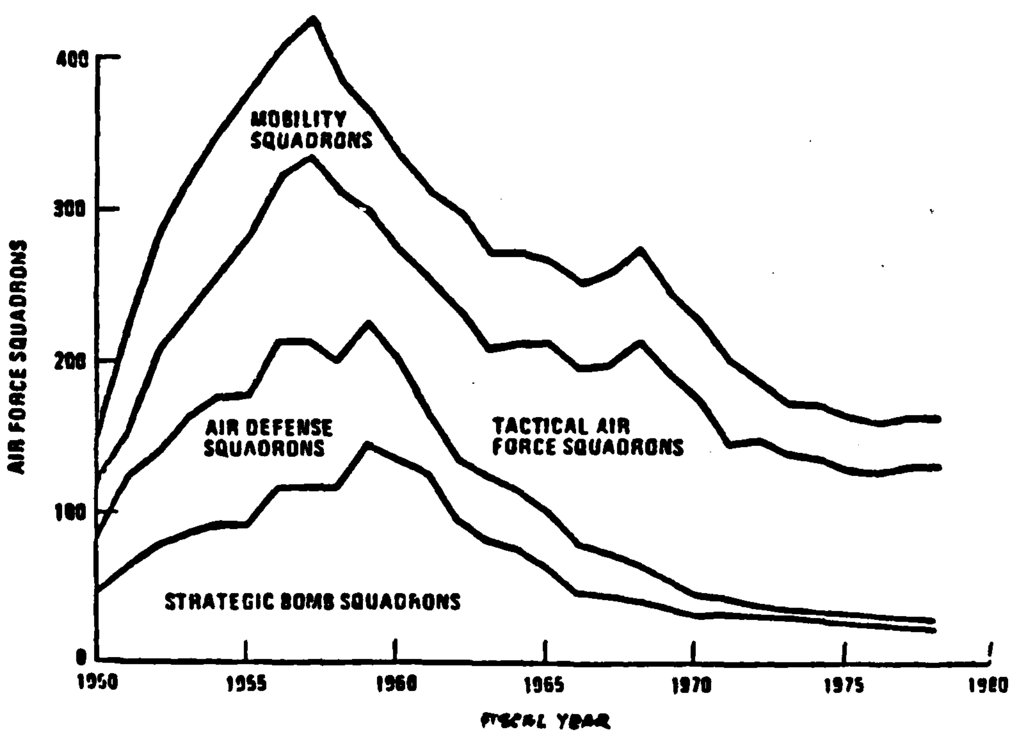
Slide 26

III Impact of Relative Budget Growth on Readiness and Modernization: The Case of Air Force Tac Air

(Slide 27) The case of Air Force tac air is particularly important to our understanding of the general problem discussed in the preceding section because Air Force tac air has been relatively free of the budget constraints affecting DoD as a whole. Even so, this section will show that tac air's problems today are qualitatively the same as other categories. This suggests that higher defense budgets, in themselves, are not the answer to our problems.

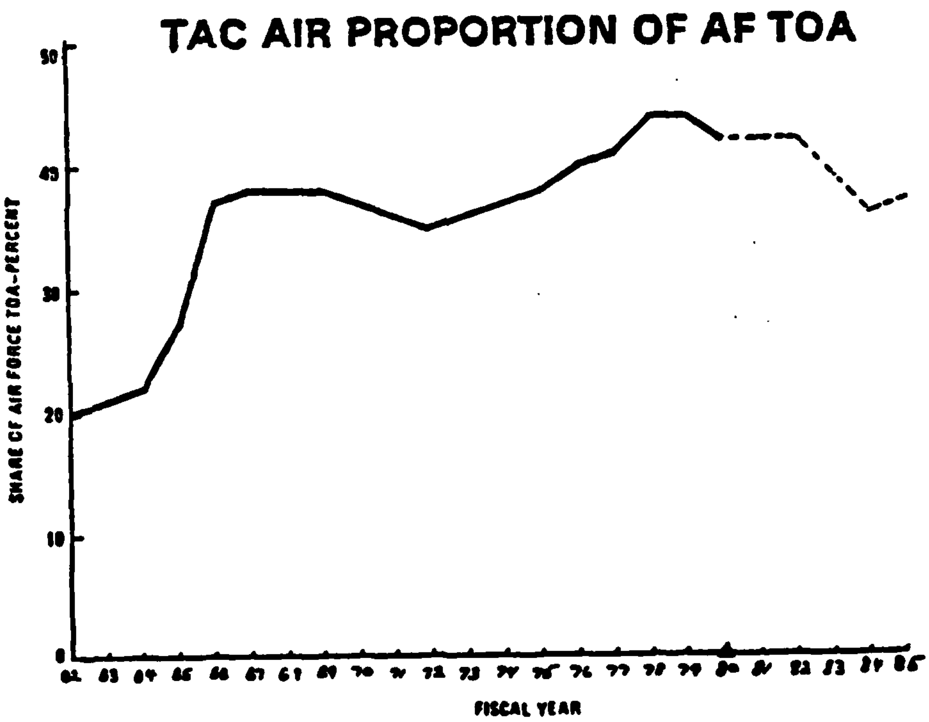
This slide displays the evolution in the Air Force force structure (for the moment we will neglect the ICBM) during the post-war era. We see that a profound shift has occurred. Up until 1960 or so, the Air Force was a strategic air force; today, as far as aircraft are concerned, it is a tactical air force. Tac air has avoided massive force structure declines by increasing its share of a shrinking pie. For whatever reasons--and this is a neutral statement--tac air has not been subjected to the degree of budgetary constraint affecting the Air Force and DoD as a whole.

ACTIVE AIR FORCE MANNED AIRCRAFT SQUADRON STRUCTURE



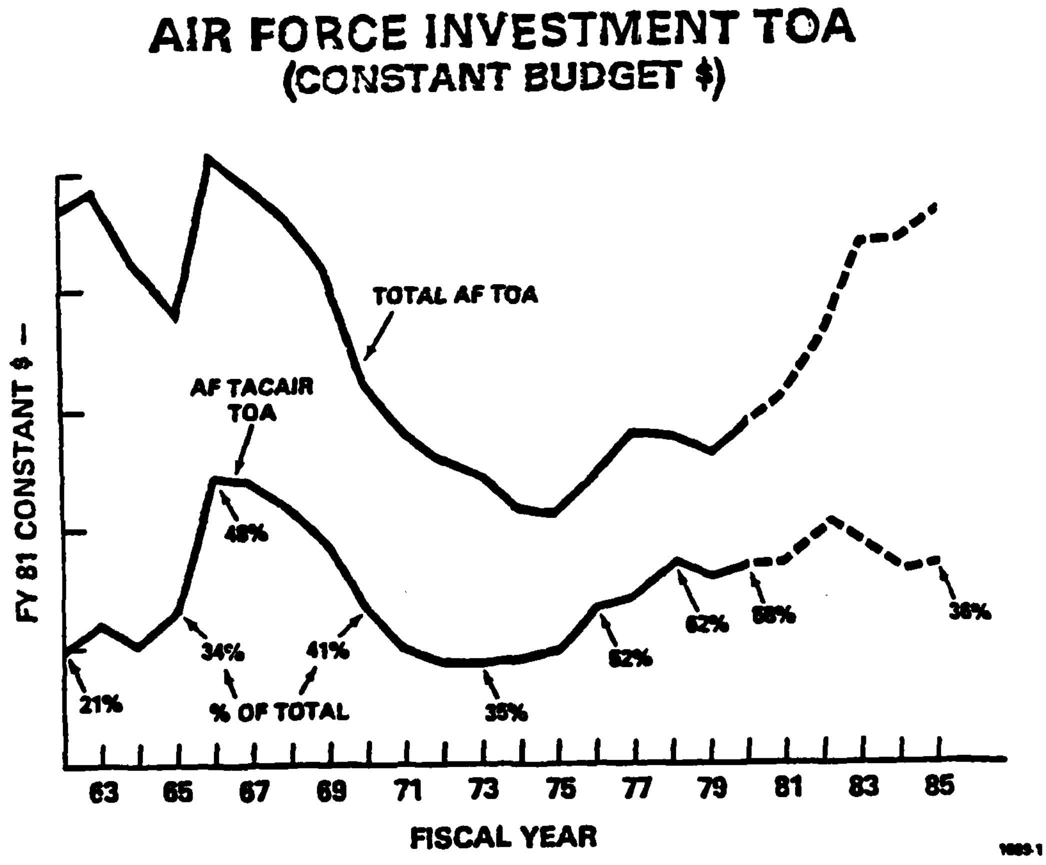
SLIDE 27

(Slide 28) Turning our attention to the input side, we see that this shift in force structure was accompanied by substantial increases in tac air's share of the total Air Force budget (and now we <u>are</u> including ICBMs)--over the last 19 years, tac air doubled its budget share. That share is projected to decline in the future due primarily to planned strategic increases. The budget went up and down during this period; this chart says that when the Air Force budget increased, tac air generally increased at a faster rate; and when the Air Force budget decreased, tac air generally decreased at a slower rate. In other words, tac air was generally less constrained than the Air Force as a whole--it had relatively higher budget growth.



Slide 28

(Slide 29) Turning to investment, we see this relation between changing budget shares and changing budget levels more clearly. In 1962, tac air had 21% of the Air Force budget; it was 58% in 1980. Although the Air Force as a whole declined precipitously after Viet Nam, tac air has made an impressive recovery. Between 1973 and 1980, tac air investment sustained an average annual real growth rate of over 10% per year. The current investment program (i.e., the FY 81 Budget) is planned to peak in FY 1982. So, by any reasonable measure, tac air has had a much stronger budget growth pattern--particularly in investment--than most budget categories.



Slide 29

(Slide 30) We will now examine readiness; we should recognize from the first that this is probably the most confusing area of defense to evaluate. There is no simple measure, and there never will be a simple measure, of combat readiness. Ultimately, when you talk about readiness to go to war, you're talking most importantly about esprit de corps, leadership, willingness, combat skill--that is to say, first and foremost the readiness of our soldiers; and secondarily, the readiness of our machines. The ambiguity surrounding readiness forces us to look at it from several perspectives. Our general, although by no means complete, picture of readiness includes perspectives of pilot readiness, material readiness, and readiness of the people and material in the support structure.

#1 READINESS OF PILOTS

Wars are fought in the present, not in the future. Generally, readiness should be viewed from a short term perspective. If there is one thing the crises in Iran, Afganistan, and the one brewing in Poland, should teach us, it is that we should be ready to go to war on short notice. Therefore, a crucial question in any assessment of readiness is: How long will it take to gear up our people and our machines for war? Although we can not answer this question in detail, the trends and patterns discussed in the following slides should be viewed in the context of this question.

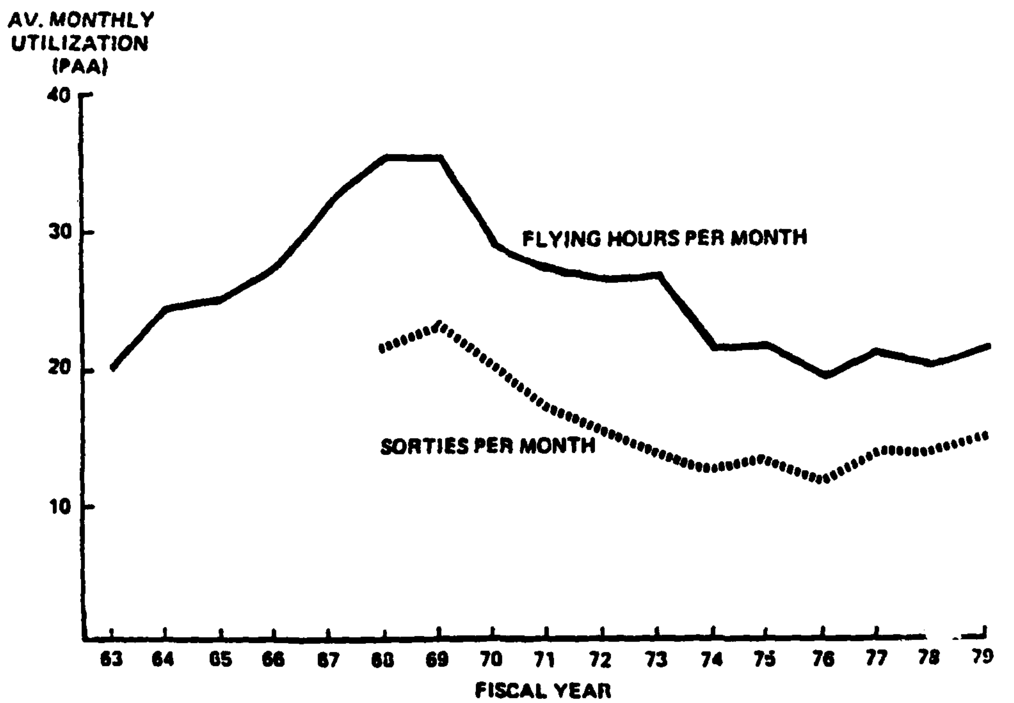
In the case of tactical fighter aviation, aircrew skill and tactical ecumen are probably the most important contributors to combat effectiveness. They are also the most difficult to evaluate. We know from historical analyses that pilot skills have generally dominated material differences in air war since World War I. We also know that we will never be able to predict the future environment of an air battle; and therefore, success lies in the pilot's ability to survive, learn, and adapt in an unpredictable changing environment. These thoughts suggest that we should train as much as possible, as realistically as possible, and in as great a variety of circumstances as possible. Finally, we know that realistic training is also an essential ingredient in the development of those moral qualities that contribute so much to success on the battlefield--e.g., leadership, esprit de corps, the spirit of self-sacrifice and soldierly virtue, etc.

The important factors when assessing aircrew readiness are the intangibles. This slide shows that since the Viet Nam peak in FY 1969, the opportunity to train has declined; it says nothing about the quality or variety of the training. It shows flying hours and sorties per aircraft. Since the number of aircrews per aircraft is greater than one, it overstates aircrew flying hour and sortie rates. Certain aspects of training improved during the seventies. For example, the initial Red Flag exercises introduced new aspects of realism into training. However, the average pilot only flew around 8 or 9 Red Flag sorties in FY 79. In air to air training, our pilots seldom get the opportunity to practice in air battles of greater than 2 versus 2 dimensionality. Yet, we know from the AIMVAL/ACEVAL tests that an increasing number of participants changes the nature of combat and the tactics required. And almost all combat involves 2 versus 2, 4 versus 2, 4 versus 4, or still larger numbers. Let's ask the pilots how they feel about current training.

PICTURE OF READINESS

#1 PILOT READINESS = PAGE 36/SLIDE 30
#2 MATERIAL READINESS = PAGE 41/SLIDE 34
#3 SUPPORT READINESS = PAGE 56/SLIDE 41

AVERAGE AIRCRAFT UTILIZATION FIGHTER/ATTACK FORCE
(Active)

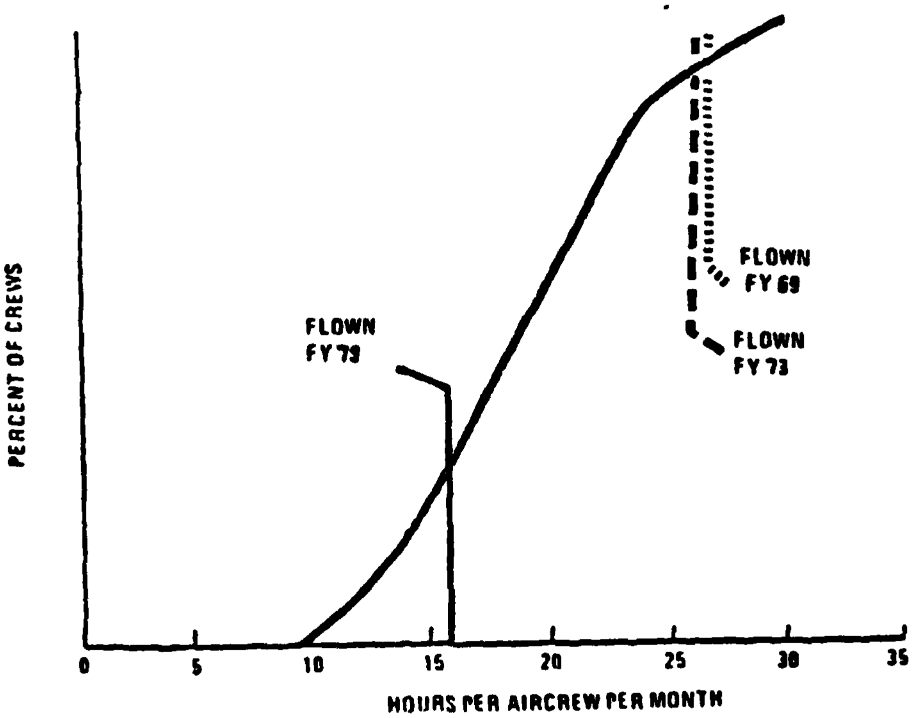


Slide 30

(Slide 31) This slide shows the results of an aircrew opinion survey taken by the Air Force in FY 1978. It is not the most scientific survey; this slide depicts the cummulative response of aircrews to the question: How many flying hours per month do you require to maintain combat readiness? In 1979, the average fighter crew member flew approximately 16 hours per month--generally, this represents 11-12 sorties per month. Now flying hours are not the best measure--one hour of cross-country flying does not have the value of one hour of air combat maneuvering. Even so, is clear that less than one-third of the interviewees were satisfied with 16 hours per month or less. In contrast, during FY 69, pilots in the United States training for Viet Nam were flying twenty-six hours per month--a rate than was sustained through FY 73. For purposes of comparison, it is our understanding that the average Israeli fighter pilot tries to fly somewhere between 25-30 hours and 35-40 sorties per month. Moreover, even on a cross country, Israelis are in a combat training situation and subject to being engaged shortly after their wheels are off the ground.

AIRCREW OPINION SURVEY

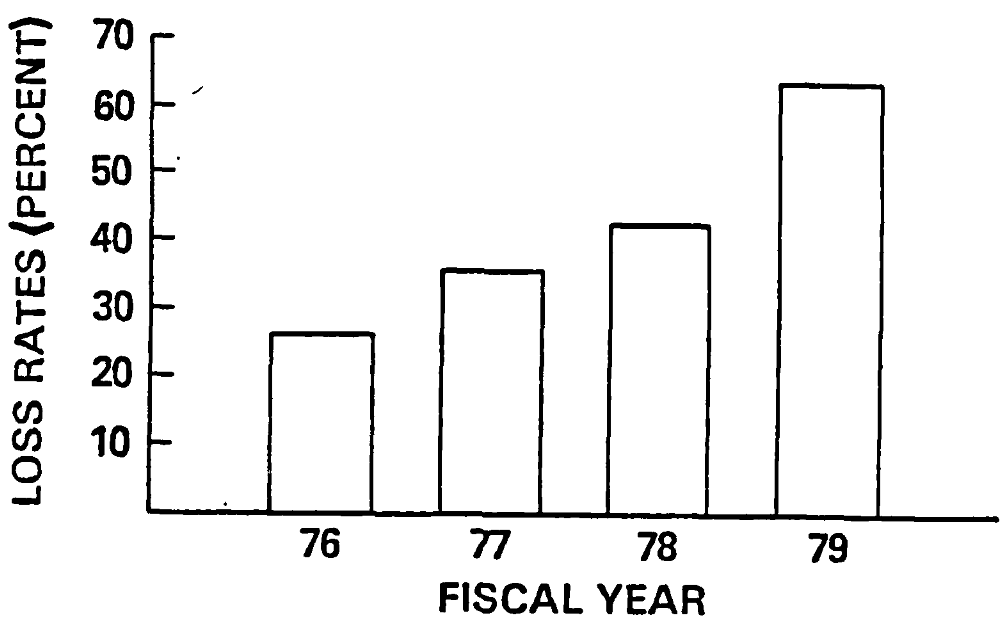
HOURS PER MONTH REQUIRED TO MAINTAIN COMBAT READINESS



Slide 31

(Slide 32) We also know that we face a serious pilot retention problem, this slide shows an increasing cumulative loss rate for those pilots with between six and eleven years experience (it is our understanding, although we have been unable to verify it yet, that the loss rate was somewhat lower in 1980). It is often argued that low combat readiness can be rectified in short order; however, when faced with this situation, we are forced to recognize that it takes eight years to get eight years experience. While a person can be trained to fly and fight in less than eight years, it often takes longer to develop the moral qualities mentioned earlier. We are losing hard to replace resources. Why are the pilots leaving the service?

USAF FIGHTER PILOT LOSS RATES
6-11 YEAR GROUP



SLIDE 32

(Slide 33) Again we have to turn to surveys--and surveys have serious problems. Often a word--such as "prefessionalism"--connotes different things to different people; however inaccurate, they are a major source of insight into what is essentially a non-quantifiable human problem. This slide displays the results of a survey sponsored by the Air Force Office of Scientific Research (it expanded the research of two Air Force Academy instructors) that was summarized by the Air Force Times newspaper in November, 1980. It indicates that there <u>may</u> be much more to the retention problem than pay and benefits.

Air Force Times

An Independent Newspaper Serving Air Force People

Why AF Pilots Resign: They Don't Fly Enough

Pilots' Reasons For Leaving Air Force, (n=950)

Frequency of Response	Age: Under 30	Age: 30-40
Cited Most Often	• Lack of Feeling of Professionalism	• Lack of Feeling of Professionalism
↓	• Flying is Secondary	• Leadership
	• Pay	• Flying is Secondary
	• Leadership	• Overall Benefits & Working Conditions
Cited Less Often	• Benefits & Working Conditions	• Pay

Most Consistent Finding:

Pilots Like to Fly and Dislike Non-flying Aspects of Air Force

Slide 33

#2 MATERIAL READINESS

(Slide 34) Shifting our focus to material readiness, this slide displays several FY 79 (the FY 80 data is in preparation) base level material readiness indicators for both the Air Force and the Department of the Navy. We have arranged the aircraft in approximate categories of relative complexity. Recalling that we defined complexity as a quality of the "whole," these categories account for more than the aircraft; they also account for the material and people in the support structure at the base level and at the depot level.

① SORTIES/MO -

It is appropriate that we make some general comments on this data before discussing it in detail. First, these indicators describe peacetime conditions; they do not represent what is possible in war. However, in a relative sense, the patterns are probably indicative of the relations that would prevail in war. For example, if one aircraft is consistently better than another in terms of a set of maintenance measures, we would expect that relationship to hold at higher levels of flying activity unless there are specific reasons to indicate the contrary. In addition, institutional incentives can materially affect the way certain data is

TACAIR MATERIAL READINESS INDICATORS

(FY 79)

A/C	Complex.	① Sorties/Mo	② NMC(%)	③ MFHBF	④ Maint. Events/Sortie	⑤ MMH/S	⑥ Cann-WR/100 Sorties	⑦ MH/Acft	①·④ / ⑦ ⑧ Workload
Air Force									
A-10	Low	19.6	32.6	1.2	1.6	18.4	10.1	17.3	20.9
A-7D	Med.	16.4	38.6	0.9	1.9	23.8	11.9	19.2	20.3
F-4E	Med.	16.9	34.1	0.4	3.6	38.0	15.4	22.4	28.7
F-15	High	16.3	44.3	0.5	2.8	33.6	44.0	23.3	23.5
F-111F	High	–	36.9	0.3	9.2	74.7	42.1	24.8	26.5
F-111D	High	8.8	65.6	0.2	10.2	98.4	58.5	28.4	30.5
DON*									
A-4M	Low	14.8	31.2	0.7	2.4	28.5	12.0	10.3	41.0
AV-8A	Low ?	16.8	40.0	0.4	4.3	62.4	13.4	14.2	46.1
A-7E	Med.	20.9	36.8	0.4	3.7	53.0	27.1	18.2	60.6
F-4J	Med.	15.4	33.4	0.3	5.9	82.7	22.2	17.3	77.4
A-6E	High	17.9	39.5	0.3	4.8	71.3	39.4	18.8	67.9
F-14A	High	14.0	47.5	0.3	6.0	97.8	69.6	18.9	74.5
			NOT MISSION CAPABLE	MEAN FLYING HOURS BETWEEN FAILURES	MAINTENANCE EVENTS PER SORTIE	MAINTENANCE MANHOURS PER SORTIE	CANNIBALIZATION AND WAR READINESS WITHDRAWALS PER 100 SORTIES + SPARES	MAINTENANCE MANHOURS PER AIRCRAFT	WORKLOAD

* DEPT OF NAVY

Slide 34

generated and reported. For example, if an organization's management were interested in maximizing peacetime sortie rates and mission capable rates (calculated on a seven day, 24 hour basis), this value system might affect the weekly activity pattern as follows: fly as much as possible in the early part of the week to run up the sortie count, decrease flying flying to reduce breakage and emphasize fixing during the latter part of the week, and then let the fully mission capable planes sit all weekend. It is probably a universal military fact of life that career maintenance personnel rapidly develop an exquisite talent for understanding and manipulating such institutional value systems. So, the data may be significantly affected by subtle influences that are imperfectly understood. Finally, it is very difficult to compare these data over time; definitions and incentives can change over time, and often these changes are not traceable.

With these reservations in mind, we will now describe the general patterns revealed by the data:

- (2) NMC(%). This factor measures the average percentage of aircraft that were "Not Mission Capable" during FY 1979. It is calculated on a twenty-four hour clock, seven days a week. It means that the aircraft type in question, e.g., an F-111D, was not capable of performing one of its primary missions; for that fraction of time, it may still have been flyable or capable of flying its missions in a degraded mode. As a practical matter, each aircraft has a list of mission essential equipment and this measure says that at least one of the items on that list is broken.

  These lists can change over time and they can arbitrarily vary between similar aircraft for similar missions. For example, the F-111D and F-111F would perform similar conventional missions in a European scenario; however, for the F-111F, a radar warning receiver (RWR) is a mission essential piece of equipment but the RWR is currently not on the mission essential list for the F-111D. Thus, the F-111D can be fully mission capable without an RWR, whereas the F-111F would be partially mission capable. The reason for this contradiction is that there are not enough RWRs to go around. Since the F-111F is higher priority than the F-111D, the RWRs were taken out of the F-111Ds and put in the F-111Fs. RWRs for the F-111Ds are now programmed for procurement in the future. In effect, the F-111D's definition of "Fully Mission Capable" has been materially affected by resource constraints.

  The NMC data indicates a rough relationship between complexity and NMC. It is not a perfect relationship, but it does seem to suggest that as planes get more complex, they tend to break more often--there are more things to go wrong on a complex aircraft.

• (3) MFHBF. The numbers in this column are actually the mean flying hours between maintenance events; we are using them as a surrogate for Mean Flying Hours Between Failure. It is a measure of reliability. It is an average measure that is derived from the total number of events and the total hours. The number does not mean that something breaks on an F-15 every 30 minutes; an F-15 may fly for a long time with no maintenance events; then suddenly, several can occur. The number represents the average for a year. As we would expect, we see an inverse relationship between complexity and reliability. Simple planes tend to have a greater overall reliability than complex planes.

• (4) Maintenance Events Per Sortie. This measure is roughly equivalent to the average number of maintenance actions needed to prepare an airplane for another flight once it has landed. Again, one sees a general relationship between increases in this number and increases in complexity.

• (5) MMH/S. Maintenance Manhours Per Sortie. This factor represents the total workload required to prepare the airplane for its next flight after it has landed. Again, we see the same general relationship. We also note that, in general, the Navy factors (particularly for low and medium complexity aircraft) are higher than the Air Force numbers. In part, this may reflect the increased stress of carrier operations, sea corrosion, and the more cramped working conditions of carriers. These numbers suggest that using technology to increase complexity may also increase the labor intensity of our equipment. In the aggregate, rather than substituting capital for labor, we may, in fact, be increasing the relative proportion of labor by converting to more complex hardware. In other words, increasing complexity may be contributing to a declining "tooth to tail" ratio. We will come back to this point.

• (6) Cann-WR/100 Sorties. Cannibalizations and War Reserve Withdrawals Per 100 Sorties. This factor measures relative shortages of spare parts. If operating stocks are short, maintenance personnel have the option of temporarily obtaining the spare parts from the war reserve spares kits (i.e., the WRSK) or of taking the parts off a aircraft that is temporarily grounded (i.e., cannibalization). For the Air Force the number displayed in this column is the average number of times either of these activities occurs per 100 sorties. The Navy numbers are just the average number of cannibalizations per 100 sorties. Since cannibalization contributes to maintenance manhours, this difference may contribute, in part, to the higher MMH/S numbers for the Navy.

Even shortages of spares appear to be related to increasing complexity. Several factors contribute to this phenomenon; however, we should first note a factor that does not relate to complexity. That factor is the age of the aircraft. Older aircraft (e.g., A-7s and F-4s), that are going out of the inventory, tend to have sufficient spares. On the other hand, newer aircraft (e.g., F-15s and A-10s) can be short of spares because we tend to defer procurement of some spares until we get experience with failure rates--the idea being that we can build a sounder inventory strategy over the long-run if we wait until demand patterns stabilize. Unfortunately, our experience has been that this deferral tends to be extended for a very long time--the F-111s being a case in point--an observation suggesting that "resource constraints" contribute to the deferral.

Increasing complexity contributes to spares shortages in the following ways: (1) The tendency to overestimate a system's reliability increases as complexity increases, and consequently, the tendency to underestimate spares requirements increases. This happens because the reliability calculation mathematically assumes that each part of a system has an independent failure pattern; however, in reality, interactions between the parts materially affect their failure patterns. The net result is that failures occur more often than expected and this generally gets worse as the number of interactions (i.e., complexity) increase. (2) Failure patterns tend to be more unstable over time for complex equipment than for simple equipment, consequently, it becomes more difficult to establish a stable inventory policy. For example, the semi-annual rates for the F-111 have fluctuated between 6.1 and 21.0 maintenance events per sortie; the less complex A-7 has fluctuated between 1.9 and 4.0. For the newer aircraft, the F-15 has fluctuated between 2.8 and 7.0 events per sortie while the relatively simple A-10 has smoothly declined from 4.7 to 1.2. (3) Finally, spares for complex aircraft are generally more expensive and therefore, the impact of funding shortfalls tends to be higher.

- 7 MM/Acft. Maintenance Manning Per Aircraft. This is the number of maintenance people per aircraft assigned at the base level. Again we see increasing labor intensity for more complex aircraft. There is also an increase in skill requirements. We see a big difference between the Navy and the Air Force. In part, this difference probably reflects the space constraints of the carrier.

- 5 Workload. This number is calculated from the data on this slide. It is a measure of the burden on the individual. It is calculated by multiplying (sorties per month) by (maintenance manhours per sortie) and dividing this by (maintenance manning per aircraft); the product (i.e., workload) has the dimensions of maintenance manhours per man-month. Now this does not represent the total activities of the individual, it represents his sortie-related maintenance activities. We see that the burden on the individual increases as complexity increases. This is particularly striking for the Air Force when one views the sortie data--the A-10 with a low workload, flew the highest sortie rate; the F-111 with the highest workload, flew the lowest sortie rate.

$\frac{1 \times 4}{7} = 5$

It is clear from the relations displayed on this chart that increasing complexity embodies increasing support costs. In peace, these increases translate to higher readiness costs; in war, these costs take the form of a more intricate/less flexible support structure--a support structure that is more vulnerable to disruption when the unexpected occurs. This peacetime cost/ wartime vulnerability does not exist just at the base level; increasing complexity ties us more closely to stateside depots and makes us more vulnerable to disruptions in the relationship between the base and the depot.

To get an idea of this emerging relationship, we will examine what appears to be a persistent anomaly in the general pattern of the base level material readiness indicators. The high complexity F-15 looks better than the medium complexity F-4 in many base level measures--i.e., MFHBF, Maint. Events/Sortie, MMH/S and Workload. It turns out that the F-15 embodies technology, that in effect, transfers some maintenance from the base to the depot. To get a view of the impact of complexity (remember: complexity is a quality of the "whole") on readiness, we have to include an examination of the relationship to the depot. We will use the example of the F-15 to illustrate a general phenomenon of high complexity systems--particularly high complexity electronics. We will discuss, first two specific relationships between the base and the depot; and second, a more general view of the impact of increasing complexity on the depot.

(Slide 35) The high complexity avionics of the F-15 was designed around the remove and replace concept of maintenance. This concept intentionally transfers some base level maintenance back to the depot. In a general sense the "black box" idea works as follows: The F-15 has onboard "built in test equipment" (i.e., BITE) that tells the pilot or the crew chief that a failure has occurred in a particular "line replaceable unit" (i.e., LRU). The flight line crew chief then removes the LRU--a simple task--and takes it to the Avionics Intermediate Shop (AIS) for repair; he then goes to supply and gets another LRU, puts in the F-15, and the F-15 is ready to fly. This concept enormously simplifies flight line maintenance of the F-15; and if supplies are available, it is possible to generate very high sortie rates.

If we are to understand the full impact of this maintenance concept, we must look first to the AIS, then to the depot. The F-15 contains 45 LRUs that require a computer to diagnose the fault in the LRU. Each of these 45 LRU's can be diagnosed on one, and only one, of three computers making up a set of automatic test stations. Moreover, each computer can only check out one LRU at a time. Physically, the LRU is a rack containing solid state electronic circuit cards. These cards are known as Shop Replacable Units (i.e., SRUs). In theory, the computer identifies the SRU that is the source of the LRU's problem; the technician then removes

COMPLEXITY MAGNIFIES MAINTAINABILITY PROBLEMS

EXAMPLE: IMPACT OF BLACK BOXES AND AUTOMATIC TEST EQUIPMENT

		Monthly Rate: Dec, 79 - June 80		
		Lowest	Median	Highest
BASE LEVEL AIS:	F-15 CND RATE (Cannot Duplicate)	25%	28%	41%
DEPOT LEVEL TEST EQUIPMENT:	F-15 RETOC RATE (Re-test OK)	24%	26%	29%

RESULT

- INCREASED SPARES REQUIREMENTS
- RISING CANNABILIZATION
- INCREASED MANPOWER AND SKILL REQUIREMENTS
- RRR WRSK CONCEPT
- INCREASED VULNERABILITY

Slide 35

the bad SRU and replaces it with a good SRU obtained from supply. The SRU is then shipped to the depot for repair--there is no capability to prepare SRUs at the base level. A wing of 72 F-15s (containing 72 x 45 = 3240 LRUs) is currently assigned two sets of three computers; a single deployed squadron of 24 F-15s would have one set of three computors to maintain 24 x 45 = 1080 LRUs.

While the concept looks simple and efficient on paper, it results in many subtle complexities in the support structure (at the AIS and the depot) that enormously complicate peacetime and wartime maintenance. First, the readiness of the F-15 is critically dependent upon the readiness of the computers in the AIS. In addition, the computers' maintenance and operation is very dependent upon highly skilled people--people that are almost impossible to retain because their skills are in great demand by civilian companies. Military technicians are often able to double or triple their salaries on the outside. It is our understanding (we have not yet obtained the official data to confirm this) that in the last quarter of FY 1980, out of a population of 33 eligibles in the TAC F-15 force, no AIS computer technicians reenlisted.

The availability of the computer test stations are a critical bottleneck to F-15 operations. (In FY 80, the computer was "mission capable" 80% of the time--up from 50% in FY 79.) Moreover, when the computer breaks, it can be very difficult to fix because of maintenance and supply problems. ● First, maintenance appears to be very dependent on the skill of the operator--skill that is in short supply. ● Second, although the computers have self-diagnostic capabilities, malfunction isolation is a difficult and time-consuming task. On occasion, it is only possible to identify the general location of the malfunction. If there are no shop standards available, the time consuming task becomes one of randomly changing the circuit cards until the faulty card is identified. ● Third, the computers are quite reliable; they contain a very large number (over 130,000) of extremely reliable parts. So when failures occur, they tend to take on a random pattern that is difficult to predict and stock against. Moreover, the parts are very expensive. The net result is that high costs preclude a low risk inventory policy when risk viewed from a peacetime money perspective at the base level; and often the computers cannot be fixed immediately because the spares are not available. Put another way, high costs generated by complexity has forced a high risk inventory policy when risk is viewed from a wartime operational perspective.

Given that the computers are working, the maintenance task is aggravated by long test times and the "Cannot Duplicate" (CND) problem. To hook up an LRU to the computer, the LRU must first be plugged into an Interface Test Adapter (ITA) and then the ITA is plugged into the computer. This can be a time consuming task in itself--sometimes taking up to 30 minutes. The computer then checks out the LRU--again a time consuming task, averaging about three hours, but sometimes taking as long as eight hours. Since the computer is limited to hooking up and checking one LRU at a time, no other LRUs can be checked out during this period. Compounding this limited productivity problem is the fact that the LRU checks out OK a significant percentage of the time. In other words, the computer could not duplicate the fault indicated by the aircraft BIT and the test time was, in effect, wasted: during the seven month period of December 1979 through June 1980, the monthly CND rate for the entire F-15 fleet fluctuated between 25% and 41%, the median monthly rate being 28%. In this situation, the operater generally puts the LRU back into supply. A small percentage of the time, a particular LRU will repeatedly exhibit the CND problem (repeat and recur); in such cases the LRU is sent to the depot.

We face the equivalent of the CND problem at the depot where the SRUs and "repeat and recur" LRUs are tested and repaired. This is known as the Retest OK or RETOK rate; and for the same seven month period, the F-15s monthly RETOK rate fluctuated between 24% and 29% of the time. In most of these cases, the SRU or the LRU is sent back to the field. In short, the spare part has traveled through the pipeline for no reason.

These support problems have the following impacts:

1. Spares requirements are increased, if only to account for AIS downtimes, long test times and the pipeline effects; but because the spares are so expensive, shortages induce increased cannibalization. Moreover, increased cannibalization can increase the failure rates--those boxes that are working fly more sorties(failures tend to be sortie related) and cannibalization itself can increase breakage--and so the process can magnify itself.

2. While skills at the flight line are somewhat reduced, there is an increased dependence on "hard-to-retain" skills in the AIS.

3. Originally, the black box concept was justified in terms of peacetime economies and a standard 30-day war reserve spares kit (WRSK) was to be configured for war. In essence, this meant that we planned to stock 30 days worth of remove and replace (RR) spares; and theoretically we would not become dependent on the computers until the 31st day. However, in reality, high spares cost makes the cost of this option prohibitive, so a 30 day RRR (remove, repair, and replace) WRSK concept was adopted. Under RRR WRSK, only five days of RR spares are stocked, and the computer (and its support tail such as airconditioning and power generation equipment) must be deployed to, and set up at, the wartime operating location by the fifth day. Under the assumption of computer availability, enough SRUs would be stocked for twenty-five days operation. The cost incentive for adopting this increased early dependence on the computer is considerable--the 30 day RR WRSK kit for an F-15 squadron costs approximately $129M, whereas a 30 day RRR WRSK kit cost around $32M. We estimate that it would cost an additional $1.2B to convert nine CONUS based F-15 squadrons and two F-111D squadrons to RR WRSK. Moreover, RRR WRSK increases operational risk because: (a) there is less margin to absorb the unexpected at the base level; (b) dependence on a timely, well regulated flow of parts from the depot is increased; and (c) the AIS is a high value point target. RRR WRSK has been exercized in two overseas deployments (one involving 18 F-15s and the other, 18 F-111Ds) and the aircraft did, in fact, fly high sortie rates for a period of one-month at their overseas locations. These exercizes however did not represent the variety of stresses attendent to combat operations.

(Slide 36) The use of technology to transfer base level maintenance back to the depots is not limited to avionics, it can also occur in engines. For example, this slide depicts the F-100 engine's (i.e., the F-15's engine) fuel control to the equivalent fuel controls on the J79 engine that is used to power the F-4. The numbers speak for themselves. The only row needing explanation is NRTS/MTBF which is an acronym for Not Repairable This Station/Mean Time Between Failure. NRTS/MTBF is the average time between those failures that can not be repaired at the base level. There is very little base level capability to repair the F-100 Unified Fuel Control or UFC. When the item can not be repaired at the base, it is necessary to ship it to the depot. Consequently, NRTS/MTBF is a measure of the operating time between trips to the depot. This chart shows that the F-100 UFC is more closely tied to the depots and it illustrates the general operational cost of transferring maintenance back to the depot. We become more dependent upon the well regulated flow of high value items through logistics piepiines connecting a geographically dispersed support base. These logistics pipelines are very vulnerable to disruption resulting from enemy attack or from that always present villan in war--the unexpected.

COMPLEXITY DRIVES UP DEPOT REPAIR COSTS

EXAMPLE:

	F-100 UNIFIED FUEL CONTROL	*J-79 COMPARABLE CONTROLS
● UNIT REPAIR COST	$ 9,956	$ 2,298
● NR. INTERNAL COMPONENTS	4,541	999
● NRTS-MTBF	388 HRS	3,049 HRS
● STANDARD M/H TO REPAIR	328 HRS	47.8 HRS

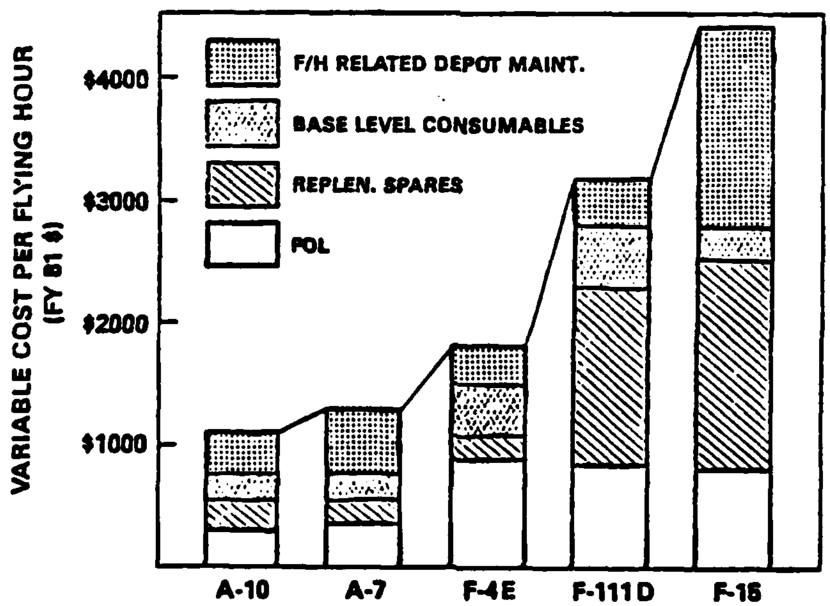
* J-79 COMPONENTS (MAIN FUEL CONTROL, AFTERBURNER FUEL CONTROL ** & NOZZLE AREA CONTROL)

** AFTERBURNER FUEL CONTROL 100% BASE REPAIR

Slide 36

(Slide 37) We can get a more general idea of the impact of increasing complexity on our support structure by relating depot costs and spares costs to the flying hour program in order to come up with a comprehensive measure of operating cost per airplane. To estimate these variable costs, we must allocate the overhead accounts (i.e., depot maintenance and replenishment, spares) to each aircraft. This slide displays Air Force estimates of these variable costs. There is a strong relationship between the replenishment spares and depot maintenance categories with increasing complexity. In a general sense, this implies an increasing dependence on the smooth functioning of the supply management system and the depots. It also implies a decreasing tooth-to-tail ratio. Moreover, our ability to forecast this burden over the five-year planning period appears to decrease as complexity increases. In other words, the uncertainty surrounding the planning of readiness-related activities (e.g., flying hours, spares support, etc.), and by inference, readiness improvements, appears to increase as complexity increases. To get an idea of this problem, we will compare the stability of these aircraft flying hour cost factors for the F-15 and the A-10.

COMPLEXITY INCREASES OPERATING COSTS



Source: AFP 173-13, Feb 80

Slide 37

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(Slide 38) Each year, the Air Force Program Objective Memorandum (AF POM) projects the depot costs and replenishment spares costs five years into the future. The AF POM, published in May, is the initial draft of the AF budget that is finalized the following January. For example, AF POM 79 is the first estimate of the FY 79 budget. The POM's cost factors (they are known as the "POM Typicals") are calculated by relating the projected depot maintenance and replenishment spares budgets to the projected flying hour program. Cost factors are in terms of dollars per aircraft flying hour. The cost factors are not true costs; they are derived by allocating overhead budgets--a process that is subject to considerable arbitrariness. It is clear from examination of the data that cost factors change considerably from year to year and, most importantly, these changes appear to be much larger and more unpredictable for the more complex aircraft.

FLYING HOUR COST FACTORS (CURRENT $)

	Fiscal Year							
	79	80	81	82	83	84	85	86
F-15 Depot Maintenance								
FY 79 POM:	267	300	306	313	321	-	-	-
FY 80 POM:	1431	1531	1616	1707	1803	1904	-	-
FY 81 POM:	-	914	954	985	1020	1058	1096	-
FY 82 POM:	-	-	1522	1609	1668	1731	1778	1827
A-10 Depot Maintenance								
FY 79 POM:	229	256	261	268	274	-	-	-
FY 80 POM:	309	330	349	368	309	411	-	-
FY 81 POM:	-	321	335	345	358	371	385	-
FY 82 POM:	-	-	355	375	389	404	415	426
F-15 Replenishment Spares								
FY 79 POM:	591	615	639	665	692	-	-	-
FY 80 POM	614	647	682	719	758	799	-	-
FY 81 POM:	-	1606	1693	1952	1636	1618	1483	-
FY 82 POM:	-	-	1290	1412	1506	1603	1701	1806
A-10 Replenishment Spares								
FY 79 POM:	398	415	337	293	244	-	-	-
FY 80 POM:	247	260	274	289	304	321	-	-
FY 81 POM:	-	207	218	230	243	256	270	-
FY 82 POM:	-	-	185	203	216	230	243	258

Slide 38

Several patterns are evident from the data in this slide:

- The data is in current dollars, so year to year changes in the estimates reflect uncertainties in projecting inflation. All things being equal for a specific year--say 1983--we would expect to see a gradual increase in the numbers as we went down a column because we tend to underestimate inflation; and as we get nearer to the year in question, we have to increase our estimates to account for the emerging inflation differential. However, it is clear that all things are not equal.

- F-15 Depot Maintenance: The estimate of future depot maintenance requirements changes dramatically from POM to POM. Each POM forecasts a smooth profile that grows slightly in current dollars during the out-years. However, the following year, the POM forecasts an entirely different profile. Clearly, it has been difficult to predict the future depot burden of the complex F-15.

- A-10 Depot Maintenance: In contrast to the F-15, the relatively simple A-10 has much less variability from POM to POM. The A-10's future depot burden appears more predictable.

- F-15 Replenishment Spares: There was a big change between POM 80 and POM 81 because, in part, the formula for the spares calculation changed; however, the F-15 was affected more than most aircraft. Also, comparing the FY 81 POM to the FY 82 POM for the years beyond FY 81, we see that POM 81 predicts declining spares requirements and that POM 82 predicts increasing spares requirements. Clearly, it is difficult to predict F-15 spares consumption.

- A-10 Replenishment Spares: Each POM predicts smooth growth during the outyears; there has also been a gradual decrease in requirements over time.

If we compare the cost factors for two older, more logistically mature, aircraft--e.g., the high complexity F-111D to the medium complexity F-4E, we see the same, albeit less stark, general pattern.

We now summarize our discussion of the impact of complexity on material readiness: Base level data suggest a general relationship between increasing complexity and decreasing material readiness. Increasing complexity increases depot costs, and appears to tie base level activities more closely to depot activities. Increasing complexity also appears to increase our dependence on responsive, well regulated distribution of high cost spares through the supply system. Since high value items are in short supply, the supply system (the informal as well as the formal) tends to track them individually and flows tend to be in response to precise demand requirements--this requires precise regulation based upon detailed data. Thus, we see an evolving support structure--from base to depot--exhibiting an increasing variety of more intricate man-machine relations that are becoming more difficult to coordinate. As one would expect from our definition of complexity, there is evidence suggesting that our ability to comprehend these emerging relations, and to predict future needs, decreases as complexity increases.

(Slide 39) The Warsaw Pact threat is the main threat to be countered by our tactical air forces; however, the basing structure in Europe is not adequate to support the deployment planned in the AF WMP. Base support consists of our permanent European bases--i.e., the Main Operating Bases or MOBs--and European bases that normally do not support US aircraft--i.e., the co-located operating bases or COBs. This chart compares the scheduled (as of FY 85) WMP deployment to the current MOB and COB support capability as a function of time. It gives an idea of the increased support that is needed to support the deployment. The COB support is increased after M-day by moving limited supplies to designated COBs. The decline in support after D-day is due to consumption of COB stocks. We estimate (roughly) that it would take an additional investment of $1.6 billion to build up and harden the COB/MOB infrastructure to a point were it can support the deployments in the AF WMP.

In addition to spare parts and infrastructure shortfalls, we are short of munitions. The full funding of the munitions objectives (goals that are determined, in part, from the activities embodied in the WMP sortie rates) would require an additional investment of approximately $4.4 billion.

SLIDE 39
MISSING

(Slide 40) The capability to repair battle damage is a major contributor to tac air readiness. During Viet Nam, the ratio of damaged aircraft to lost aircraft fluctuated between 3 to 1 and 6 to 1; in the 1973 Arab Israeli War it was 3 to 1. Rapid battle damage repair is a major contributor to the Israeli AF's combat capability. During Viet Nam, the depot backlog of damaged aircraft reached a point where it took two-years to get an F-4 repaired. As equipment becomes more complex; battle damage becomes more difficult to repair. However, with the exception of the A-10 battle damage repair kits, this major contributor to combat readiness currently funded at an unrealistically low level. The battle damage repair problem is generally not considered (with the exception of the A-10) in the design of our aircraft.

This concludes our discussion of material readiness. We will now turn to our final readiness category; namely, the readiness of the people in the support structure. We will focus on maintenance personnel.

FACT

- AF PLANS LIMITED AIRCRAFT BATTLE DAMAGE REPAIR CAPABILITY

  - AF POM-82 — $-MILLIONS

	82	83	84	85	86	TOTAL
✓ A-10 B/D REPAIR KIT:	21.6			75		96.6
✓ ALL OTHER A/C:	3.0	3.0	3.0	3.0	3.0	15
						$111.6M

- INCREASING COMPLEXITY MAGNIFIES B/D REPAIR PROBLEM

- DAMAGED AIRCRAFT MAGNIFY REAL LOSSES

  - E.G., DURING VIET-NAM, F-4S REACHED A TWO-YEAR B/D REPAIR TURN AROUND TIME

  - E.G., DURING 1973 ARAB-ISRAELI WAR, FOR EVERY AIRCRAFT LOST, THREE WERE DAMAGED

Slide 40

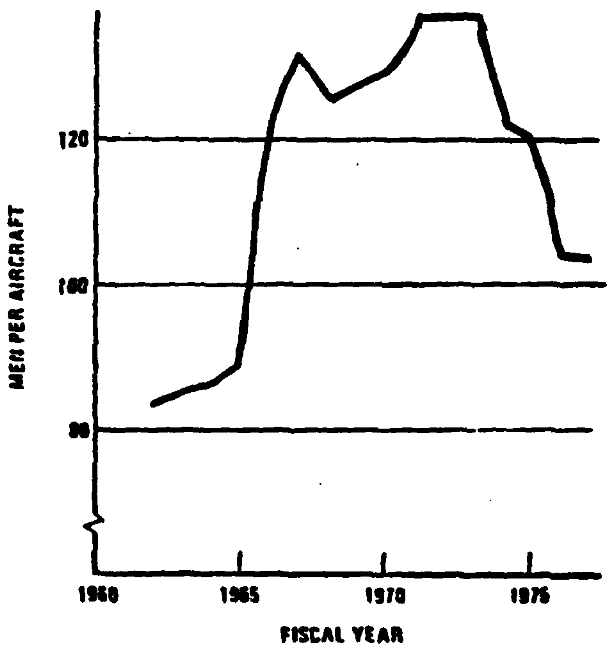
#3 SUPPORT READINESS

(Slide 41) The number of people needed to support a fighter is increasing over time. This chart displays the change in direct and indirect manning per fighter over time. Indirect manning is an allocated estimate of the contributions of those people in the overhead activities. The change over time is more important than the absolute magnitudes. We note the following patterns in this chart:

- Looking at the endpoints, and neglecting the Viet Nam hump, we see that manning has increased by a factor of about 40%.
- When we went to war in Viet Nam, a huge increase in manning occurred. Part of this increase was caused by the pipeline effects of the rotation policy limiting Viet Nam tours to one year. Nonetheless, it is clear that the increased wartime activity required more people per aircraft.
- The reduction in activity after Viet Nam is accompanied by reductions in manning.
- Although not shown, we note that, notwithstanding general increases in direct manning per fighter (i.e., maintenance personnel), the requirements for technical specialists have increased at a faster rate during the 1970s.

The WMP assumes a short warning war, and projects a surge to very high monthly activity rates for the first month. As we have seen, the labor intensity of our force is increasing and we are becoming more dependent on the smooth functioning of a geographically dispersed support base. In view of these trends, this chart raises a general question of whether or not we have enough people in our system to satisfy the short term demands of the WMP.

AIR FORCE DIRECT & INDIRECT MANNING PER FIGHTER 1/



1/ INCLUDES: COMBAT CREWS, BASE AND DEPOT LEVEL MAINTENANCE, CENTRAL SUPPLY, TRAINING.

SLIDE 41

(Slide 42) In addition to needing more people per aircraft, we noted that our force is becoming more skill intensive; however, during the 1970s, we cut training times significantly. Training has become more task oriented, with less general theory; and, although the individual may be initially more productive in routine activity, he has less general background to fall back on when the unexpected occurs.

Training reductions in the presence of increasing skill requirements are concrete examples of how the real costs of adapting to budgetary change can be magnified by increasing hardware complexity. This is a specific example of general short term tendency to reduce growth in the O&S account by shifting the costs to non-budgetary categories--i.e., reduced personnel readiness, and, because OJT is less efficient, reduced material readiness.

INCREASING COMPLEXITY REQUIRES HIGHER SKILLS

BUT:

- FORMAL TRAINING TIMES HAVE DECLINED

- CAREER FIELD	AVG COURSE LGTH (WKS)* FY 75	FY 80	CHANGE
31XXX Msl. Elec. Maint.	25	14	-44%
32XXX Avionics Systems	23	18	-22%
34XXX Training Devices	32	20	-38%
39XXX Maintenance Mgt.	7	7	-
42XXX Aircraft Systems	13	11	-15%
43XXX Aircraft Maint.	11	9	-18%
46XXX Mun./Wpn. Maint.	13	9	-31%

- FOCUS IS NOW ON PROVIDING SKILLS FOR FIRST JOB ONLY
- TRAINING IS MORE TASK ORIENTED, WITH LESS GENERAL THEORY
- OJT HAS BEEN INCREASED

IMPRESSION

INTRODUCTION OF QUESTIONABLE ECONOMIES TO SLOW GROWTH OF TRAINING BUDGET

*NOTE: FY 75 WORKDAY: 6 CLASSROOM HOURS, 2 HOURS STUDY
FY 80 WORKDAY: 8 CLASSROOM HOURS

Slide 42

(Slide 43) Declining experience levels are compounding the problems caused by reductions in training. This chart summarizes the declining reenlistment rates for the three tactical air forces--i.e., TAC, USAFE, and PACAF. Loss rates are much worse than implied by this chart because reenlistment rates quantify the reenlistments as a percentage of those eligible to reenlist. It turns out that eligibility rates may run as low as 50% of the entering population. The decline in second term reenlistments is particularly disturbing because these are experienced people making career decisions. The impact of these declines is being magnified by the increasing personnel requirements increasingly complex equipment and the need to fill out a growing force structure.

In contrast to the pilot retention problem, it appears that pay is a crucial issue in the retention of maintenance manpower. Highly skilled maintenance technicians are doubling and in some cases tripling their salaries when they go to the private sector; moreover, this salary increase is combined with better working conditions, higher status, and shorter hours. Often they get jobs doing contract maintenance on the same equipment they were working on while in uniform.

TAF EXPERIENCE LEVELS ARE DECREASING

- MAINTENANCE MANPOWER AUTHORIZATIONS ARE INCREASING
- FIRST AND SECOND TERM REENLISTMENT RATES ARE DECLINING--FASTER THAN OVERALL AIR FORCE RATES

REELISTMENT RATES BY FISCAL YEAR

	Fiscal Year	Avionics Sys. (32XXX)	A/C Sys. (42XXX)	A/C Maint. (43XXX)	Mun/Wpns (46XXX)	TOTAL AF
First Term	75	42.9	35.7	49.9	38.0	40.1
	76	34.9	36.4	45.2	38.4	37.5
	77	26.5	38.9	39.7	34.3	39.0
	78	28.8	41.8	36.4	35.2	41.1
	79	32.6	35.8	31.2	28.9	38.0
Second Term	75	67.6	77.0	71.9	70.7	75.4
	76	66.6	71.1	66.5	70.3	67.8
	77	65.0	77.0	69.3	76.6	68.9
	78	56.2	68.5	63.3	74.0	64.7
	79	51.0	61.1	56.6	63.2	60.1

Source: AF/MPPP, April 1980

Slide 43

(Slide 44) Declining retention offsets part of the expected savings from reductions in training time by increasing training quotas. We are currently short of technicians in the higher skill levels. Over the long term, this retention problem will be compounded by demographic changes.

To summarize, we face an increasing scarcity of people and skills that is being magnified by shortages in the present and by increasing demand in the future. Throughout the 1980s, the tactical air forces will embody labor intensive technology (when viewed from the perspective of the total support structure); consequently, we should expect personnel and training costs to increase significantly during the coming decade. We see how the O&S budget can increase over the long term, even though we try to cut it in the short term.

CURRENT SITUATION - TAF MAINTENANCE MANNING

- DECLINING RETENTION INCREASES TRAINING QUOTAS (I.E., COST)
- SHORTAGES IN HIGH SKILL LEVELS

% OF AUTHORIZATIONS *

SKILL LEVEL	F-15	F-16	A-10
0	18% SHORT	-	6% OVER
9	22% SHORT	37% SHORT	19% SHORT
7	11% SHORT	22% SHORT	-
5	5% SHORT	22% SHORT	10% SHORT
3	10% OVER	22% OVER	17% OVER

- OUTLOOK: DECLINING RECRUITMENT BASE (18-26 YEAR-OLDS)

IMPLICATION

INCREASING SCARCITY WILL DRIVE UP MAINTENANCE COST

* MAY 1980

Slide 44

(Slide 45) We will now summarize our entire discussion of AF tac air modernization and readiness, and relate it to our plans for the future. Compared to other DoD categories, AF Tac Air has been relatively free of budget constraints. In particular, tac air has undergone a vigorous post-Viet Nam modernization program. Between FY 73 and FY 80, the tac air investment budget grew at an average annual rate of 10.4% after the effects of inflation were taken out. During the last eight years (i.e., FY 73-FY 80), the AF tac air investment program totaled approximately $52 billion (in constant FY 81 $); this compares to a tac air investment of $66 billion (in constant FY 81 $) during the eight years of Viet Nam (FY 65-FY 72). This comparison is particularly impressive when one considers that much of the Viet Nam investment was in consumables, military construction, and other war-specific programs; whereas, the post-Viet Nam investment has been concentrated in the procurement of weapon systems.

The 1970s were also characterized by steady reductions in personnel and material readiness. Readiness related investments in spare parts, infrastructure, and munitions stockpiles were deferred and training tempos were reduced. This slide summarizes some of the trends we have discussed. Our modernization program has resulted in a force that is more costly and difficult to operate--particularly when viewed from the perspective of the entire support structure. Increasing complexity has increased also the uncertainty in our support cost structure.

When one considers that the emerging tac air force is more expensive to operate in terms of people and material costs, that we are currently at a low level of personnel and material readiness, and that the force is programmed to grow in size, it is clear that increases in combat readiness require major increases in the funding of readiness-related investments and particularly in the O&S budget. This gives us a simple policy question to ask the FYDP: What is our policy towards increasing tac air readiness? To answer this question, we will look at the funding growth that is programmed for the next five years in the FYDP. In this sense, the FYDP is an authoritative statement of our intent.

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SUMMARY

- FLYING HOURS AND SORTIE RATES ARE DOWN
- AIRCREWS FEEL CURRENT TRAINING RATES SHOULD BE INCREASED TO ACHIEVE COMBAT READINESS
- SPARES STOCK LEVELS APPEAR TO BE INADEQUATE
- COSTS OF ENGINES AND BLACK BOXES HAVE INCREASED
- MANNING PER AIRCRAFT HAS RISEN
- REQUIRED SKILL LEVELS HAVE INCREASED
- TACAIR FORCE STRUCTURE IS INCREASING

INCREASING COMBAT READINESS REQUIRES SIGNIFICANT INCREASES IN THE O&S BUDGET

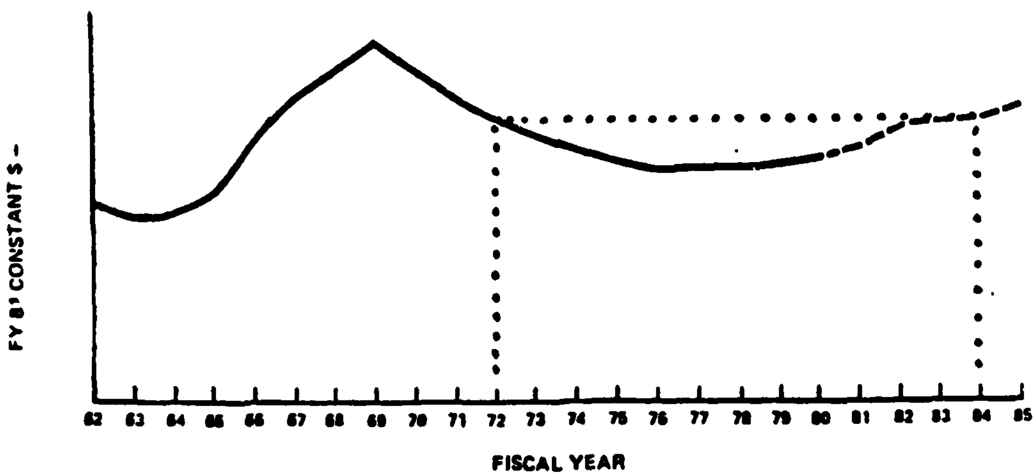
SLIDE 45

(Slide 46) Turning first to the tac air O&S budget, this chart shows the historical track and future O&S program (i.e., FY 81-85) in constant FY 81 dollars. We note that there is an average annual real growth rate of roughly 4% programmed into this account for the next five years. The total Air Force budget is expected to grow at about 5% per year-so tac air O&S is not quite staying even in terms of budget share. More importantly, this budget is only programmed to get pilot flying hours up to an average of 20 hours per month fy FY 84. In addition, this funding profile assumes no real growth in operating costs per plane--clearly an optimistic assumption in view of the uncertainties we uncovered in our discussion of the support base, particularly the flying hour cost factors. Significantly, twenty hours a month and 4% real growth drives us to the same level of resources (in constant dollars) that was required in FY 72 to fight a war in Viet Nam, fly 26 hours a month in the states, and fly somewhat less in Europe.

AF TACTICAL AIR OPERATING AND SUPPORT PROGRAMS

FY 81 President's Budget, January 1980

(Constant Budget $)

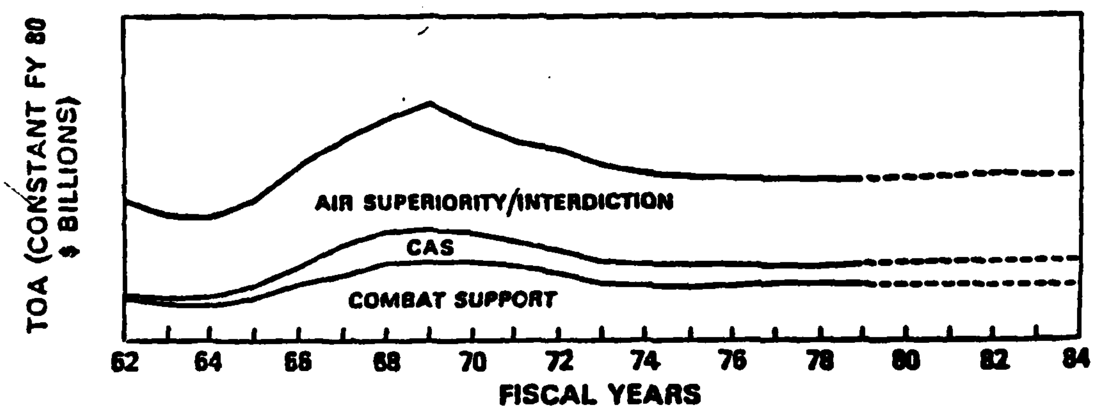


Slide 46

(Slide 47) The O&S increases were new in the FY 81 budget as evidenced by the five year funding profile programmed in the FY 80 budget. In FY 80, we programmed no significant growth for the outyears even though the overall AF budget grew at an average real growth of 3% per year. This no growth pattern was also reflected in the preceding five year plan of the FY 79 budget. In other words, the five year programs of the past three tac air O&S budgets all reflected a desire to hold future O&S growth to a lower level than that programmed for the total Air Force budget.

AIR FORCE TACTICAL AIR OPERATING & SUPPORT PROGRAMS FY 80 PRESIDENTS BUDGET

(FY 80 CONSTANT $)

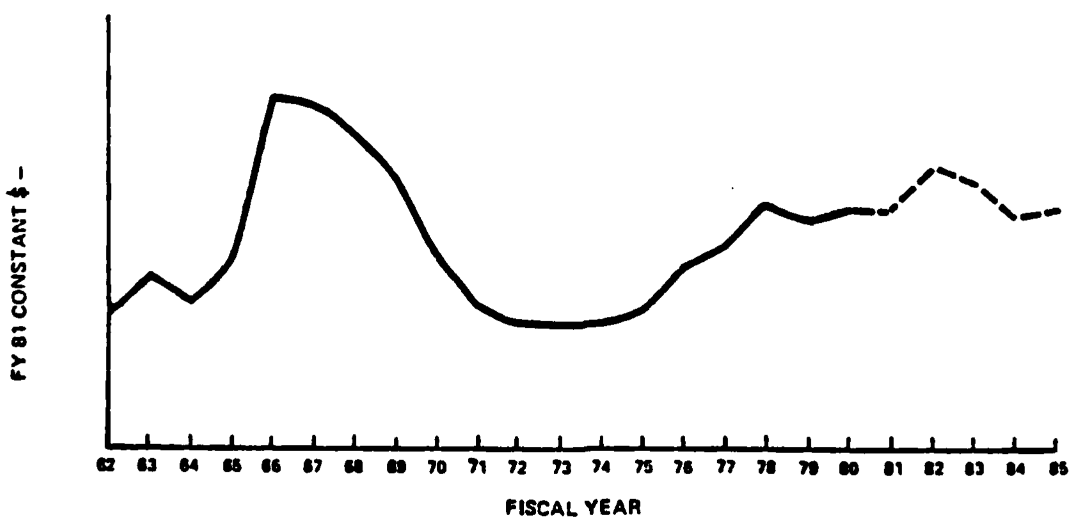


Slide 47

(Slide 48) Looking at investment, this chart shows that although the impressive post Viet Nam growth is tapering off; the budget is programmed to remain at a <u>high</u> level for the next five years. Despite this high level of funding, this investment program underfunds the replenishment spares required to support the flying hour program because it assumes spares will be delivered with one year lead time. Delivery lead times are currently averaging two years, and because the flying hour program is growing, delivered quantities will fall short of those needed to support the planned increases. The annual funding totals do not reflect these lead time induced shortages nor the additional funding required by the inflation differential. This problem will become particularly acute with regard to the large increases in flying hours now programmed for FY 84 and FY 85. In these circumstances, implementation of the growing flying hour program (an effort to improve pilot readiness) is likely to reduce material readiness by increasing cannibalization or war reserve withdrawal rates. This budget also does not fund the deferred readiness related investments in infrastructure or munitions stockpiles. (Note: air-to-air missile stockpiles are an exception. Current plans program very large increases in these particular stockpiles.)

The FY 81 five year investment plan peaks in FY 82--i.e., it peaks in the year after the budget year--but it stays at a <u>high</u> level for the entire program period. This behavior occurs in an overall environment of 5% real growth programmed for the Air Force.

AIR FORCES TACTICAL AIR INVESTMENT PROGRAMS
FY 81 President's Budget, January 1980
(Constant Budget $)



Slide 48

(Slide 49) Last year, in the FY 80 budget, the planned five year investment peaked in FY 81--again, the year after the budget year--and the investment budget declined in the years after the peak. The FY 80 DoD budget was programmed to grow at 3% per year. In the FY 79 budget, the peak occurred in FY 80. The moving peaks and the overall increase in the investment budget between FY 80 and FY 81 depict the investment "bow wave"--a phenomenon characteristic of investment programs. The "bow wave" is a reflection of the interaction of the short term tendency to pump up the investment budget with the long term tendency to shrink investment: Growing operating costs are squeezing the investment budget over the long term; we don't fulfill all our near term investment desires, so we defer some of them until next year. This process of deferral slows production and is a source of cost growth in the out-years of the investment budget. A further complication arises because we are continually adding new items to our menu of desires, but we seldom cancel existing programs. The net result is that we are continually under pressure to try to grow the investment budget. This process is being magnified by the growth in our operating and investment costs. If our plans assume that the out-year overall growth rate increases (as it did between FY 80 and FY 81), the investment budget tends to expand into the "vacuum." It is significant that tac air still exhibits the "bow-wave" phenomena--the continued existence of which suggests that "budget constraints" may not be the source of its existence.

Even after the impressive modernization of the mid-to-late 1970s, tac air plans still do not contain major increases in readiness-related investments and the O&S budget. In view of tac air's emerging cost structure, 4% O&S growth in an overall budget that is planned to grow at 5% does not represent a major financial commitment. It does represent a large quantity of money. Twenty hours a month is less than our pilots were flying in FY 73. Furthermore, given the uncertainties in flying hour costs, support personnel readiness, and in the increasing complexity of the support structure, it appears that 4% real growth is a very optimistic estimate of the resources needed to move from our present state of 16 hours per month to 20 hours per month. Finally, readiness-related investments in spare parts are insufficient to support 20 hours a month and the shortfalls in war reserves and infrastructure will persist through 1985. This evidence suggests that the price of low readiness has increased dramatically and that a high readiness posture will be very expensive.

It therefore appears that the FYDP does not embody a policy commitment to significantly increase the readiness of the AF tactical air forces during the next five years. The impact of 4% real growth is diluted by increasing operating costs. The downstream consequences of increasing complexity are not being faced by our planning system. This observation raises the question of what we expect our forces to do if we have to go to war during the next five years.

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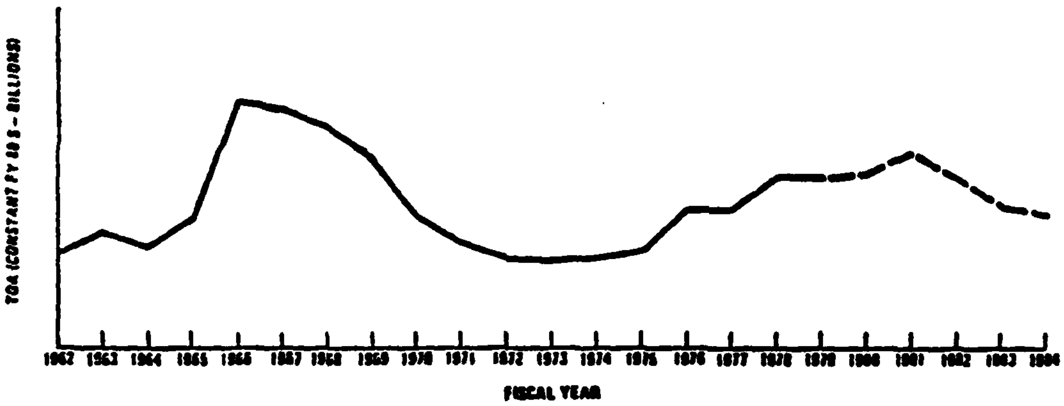
AF TACTICAL AIR INVESTMENT
FY 1980 PRESIDENT'S BUDGET

(1980 CONSTANT $)



Slide 49

(Slide 50) If a NATO/PACT war were to occur in FY 82--i.e., next year--the Air Force WMP lays out the activities we would perform in general terms of forces deployed, sortie rates, and loss rates over time. Recall that the WMP is the link that translates our war plans into financial "reality." This chart is an attempt to put these WMP projections for FY 82 into perspective by comparing them to the two "best" months of performance in the European theater of World War II. June, 1944 represented the most intense month of operations in the ETO in terms of sorties per aircraft; March, 1945 was the month of maximum total effort in the ETO. Since we are making a gross comparison of very different conflicts, it is easy to read too much into this chart. Interpretation of this chart should be limited to the following points.

- The WMP assumes a short warning war; in contrast, June 1944 was 30 months, and March 1945 was 39 months after the declaration of war. In WWII the national economy was mobilized for total war; during the first month of a NATO/PACT war the US economy will not be mobilized for total war.

- The WMP plans to have less aircraft in theater for the first month than were in the ETO in either June or March.

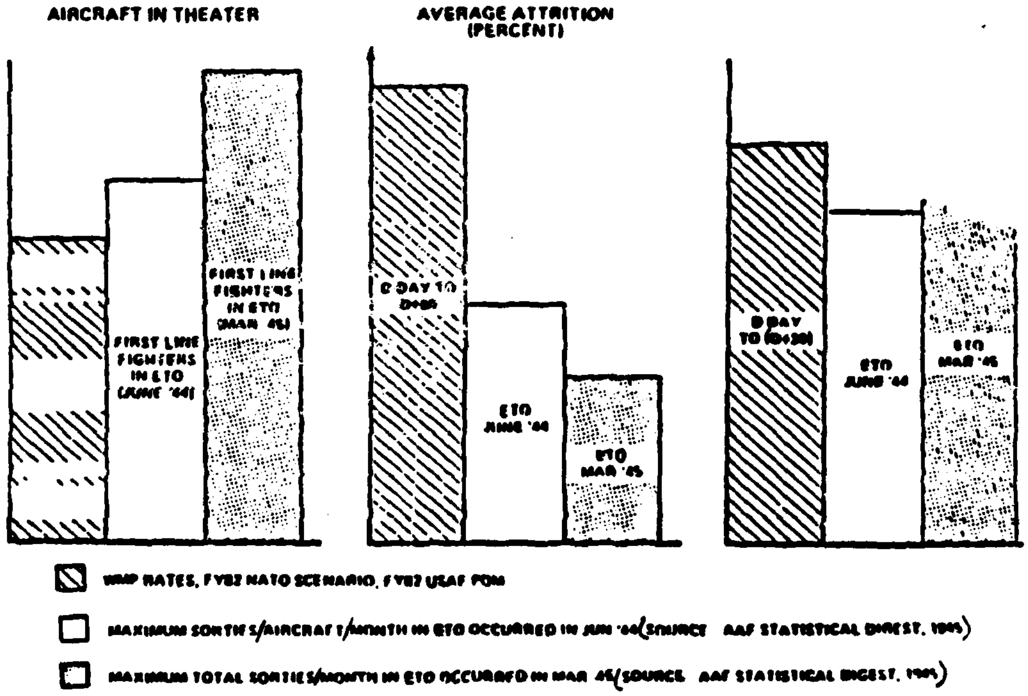
- The WMP also plans for higher attrition in the first month than we suffered in either June 1944 or March 1945 Since damaged aircraft outnumber lost aircraft; presumably, this differential implies that the WMP plans for a greater occurrance of battle damage in the first month than occurred in either June or March 1944.

- Notwithstanding a smaller force, a shorter preparation time, and a higher loss rate, the WMP envisions that we will fly more sorties in the first month of a European War than we did in either June 1944 or March 1945 and it envisions that we will be able to do this by next year!

Our historical research suggests that the main reasons for the low sortie performance in WWII were lack of spare parts and an inability to repair battle damage--problems that will exist next year. Sortie rates were also lower in WWII because of the longer fighter escort missions--missions that lasted up to 9 hours as opposed to 1 to 1½ hour average of today's sorties. On the other hand, during World War II, depots were located in theater and we were operating from secure bases--luxuries we probably would not have in a NATO/PACT war. Caveats such as these could go on for ever; however, they do not change the central point: the WMP envisions a near-term capability to conduct an incredible number of sorties on very short notice.

Thus, Tac Air financial plans embody short term decisions to hold down growth in the readiness accounts; yet, we see that these plans are linked to a WMP that assumes very high current readiness. This observation suggests a planning system that is not tied to reality.

? CURRENT PLANNING ?



Slide 50

(Slide 51) Looking at the overall financial plans of each of the services, we see the same general short-term pattern projected for the next five years. Each service is trying to hold down O&S growth while pumping growth into investment. Moreover, the weapon systems planned in these programs are much more complex than the weapons being replaced.

To understand why the Tac Air O&S account is held to 4% real growth when the overall Air Force budget is growing at 5% per year (after inflation), we also need to look at modernization in other mission areas. During the 1970s, modernization of the strategic and mobility forces was deferred; most of the budget growth went to tac air. This was necessary to absorb rising Tac Air investment costs. Consequently, as we enter the 1980's, we need to modernize these other mission areas. In general, these modernization plans in these other mission areas envision to modernization with more complex systems; and therefore, we are faced again with increasing unit costs as well as the downstream support problems that come with high complexity equipment. Although, AF plans for 5% per year annual in the total budget growth for five years, overall AF O&S growth is held to 2% per year because these high cost modernization programs require 10% annual growth. This is the environment in which tac air was able to squeeze out 4% O&S growth.

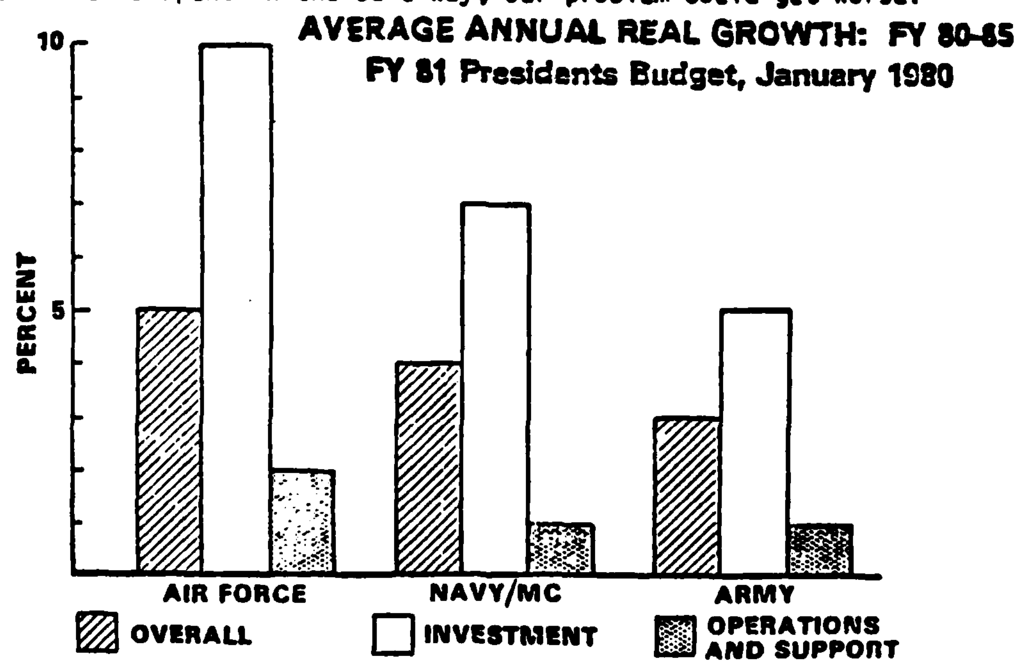
The Army and Navy plans show the same general pattern of trying to hold down O&S in the short term while pumping up investment, albeit at different budget levels. There is slight evidence suggesting that as budget growth increases, the disparity between short term O&S and investment increases. Furthermore, both services are in a state of low readiness, are experiencing increasing personnel and operating costs, and are faced with growing complexity in their support structure. Consequently, there is reason to expect long term increases in their operating costs--increases that are not accounted for in these plans.

The behavior pattern depicted in this slide is evidence of our desires and we see that these desires match up to our historical short term pattern. Unfortunately, our budget analysis revealed that we have not been able to convert our short-term desires into long-term reality. Is there any evidence to suggest that the future will be any different from the past? These plans, if implemented, ensure that readiness will remain at a low level for the next five years because the O&S accounts and the readiness-related investment accounts do not reflect the in place and emerging growth pressures in our support structure.

The increasing complexity of our hardware has generated the growing cost structure that stimulates the mismatch between our short-term and long-term behavior. Notwithstanding the short-term tendency to pump up investment and hold down readiness, the increasing complexity of our hardware leads to long-term growth in the cost of low readiness--i.e., unavoidable costs--which, in effect, squeezes the modernization budget. Modernization is further slowed because the cost of replacement is increasing so rapidly. Finally, overall growth in the investment budget has not come to pass over the long term due to an uncertain, but real, budget constraint.

Many argue that the answer to this dilemma is a budget that increases continually and reliably--a budget that must grow at least as fast as the cost of replacement weapons plus the cost of operating them. Unfortunately planning on this solution is not realistic in the long-term because the budget is dependent on an unpredictable long-term factor--the democratic political consensus. Furthermore, even if it were possible to ensure long term growth, our review of tac air does not support the belief that a growing budget will solve our problem. In the last five years Tac Air implemented a budget profile that is very similar to that shown in this chart (5% overall real growth, 12% investment growth, and 0.3% O&S growth) for a total investment of $38.5 billion (in FY 81 constant $). Although growth of the modernization budget has now tapered off, the budget is programmed to remain at a high level. In fact, in the next five years, the tac air investment budget is programmed to spend $44.3 billion (FY 81 constant $) or 15% more than was spent in the preceding five years. In other words, the successful implementation of a budget profile similar to that depicted in this slide--a budget profile that effected a drawdown of other mission areas--did not solve tac air's modernization problems: we are still trying to hold down readiness-related expenditures in order to modernize

The short term strategy of reducing readiness and pumping up investment treats the symptom, not the cause, of our planning problem. Our bias towards short term investments in weapons of increasing complexity is the cause of the long term cost growth. The interaction of long-term cost growth with long-term uncertainties in the budget (a reality of our political process) and the threat (a reality that makes an increasing menu of desires psychologically acceptable), when combined with special interest pressures, has resulted in short-term behavior patterns that magnify the long-term readiness-modernization squeeze. The case of tac air is more one of how we spend our money than one of how much money we spend. The Department of Defense needs more money in the short-term, but if it is spent in the same way, our problem could get worse.



Slide 51

IV The Uncertainty Surrounding Investment Plans

The interaction of the short-term bias towards investment in high complexity weapons with the long-term budget uncertainty is a central feature of our discussion. We can examine this interaction by comparing our short term desires (as depicted by our investment plans) to the long term pattern of change uncovered in our budget analysis. This historical perspective will enable us to perceive the distance between our desired future and past reality. The question of planning realism then becomes one of judgment as to whether or not it is reasonable to assume that current factors will generate enough pressure to overcome this distance.

We intend to ignore two major factors affecting the uncertainty surrounding our investment plans. ● The first is inflation: we will examine the uncertainty in terms of constant dollars. However, the Congress appropriates current dollars and our plans exhibit a chronic tendency to underestimate future inflation. Consequently, when the true inflation emerges, our budget is smaller in real terms than was anticipated. Since inflation is currently high and unstable, this problem is getting worse. Moreover, the inflation estimation problem is magnified in the more complex weapon systems because these systems generally have longer spend-out periods.

● The second factor relates to the current state of low readiness. The investment uncertainty calculated in the budget analysis reflects an interaction with readiness changes. However, the 1970s witnessed a steady draw-down of readiness. We are currently in a state of low readiness, we have fielded equipment that is much more difficult to maintain (when viewed from the entire support base) at a high level of material readiness, and we face unprecedented manpower problems--particularly in the high skill areas. Although in the past, short-term modernization growth could be "financed" out of short-term readiness reductions; this may be much <u>less</u> feasible in the future. Even if low readiness were deemed acceptable for the next five years, the <u>rising cost</u> of <u>low readiness</u> could require either decreases in investment growth or unplanned increases in the overall budget.

Inflation and low readiness combine to make the planning problem worse. Because we will ignore these two factors, the ensuing discussion should be viewed as being optimistic in the sense that the degree to which we perceive our investment plans as being unrealistic is <u>underestimated</u>.

74-Blank

(Slide 52) This slide overlays the planning range that we developed in the budget analysis (i.e., the dashed lines) on the five-year investment program projected in the FY 81 President's budget. The solid lines are budget lines that depict each service's budget and they are additive-the top line of the Air Force budget is also the sum of the three budgets. The planning range is projected from FY 80 because at the time of this charts' construction, FY 80 was the latest appropriation. In essence, FY 80 tells us where we are, the top solid line tells us where we want to go, and the dashed lines tell us how we moved forward in the past.

Recalling the budget analysis, the planning range summarizes the historical pattern of DoD's investment budget growth over a five-year period. To understand its meaning, we will describe the 75th percentile line (the same interpretation applies to the median--i.e., 50th percentile or the 25th percentile):

- FY 80 is the starting point--it represents an achieved budget level. We want to estimate the chances of change from this level if history were to repeat itself.

- The 75th percentile point at FY 81 represents the 75th percentile of the historical groups of year-to-year percentage increases, based on the last 30 years' budgets. It has been normalized to FY 80 so that the dashed line at FY 81 depicts a budget level that corresponds to a "75th percentile change" from the FY 80 level. In other words, if history were to repeat itself over and over, we could expect that, 75% of the time, the actually achieved level for FY 81 would be less than or equal to the dashed line level indicated on the chart.

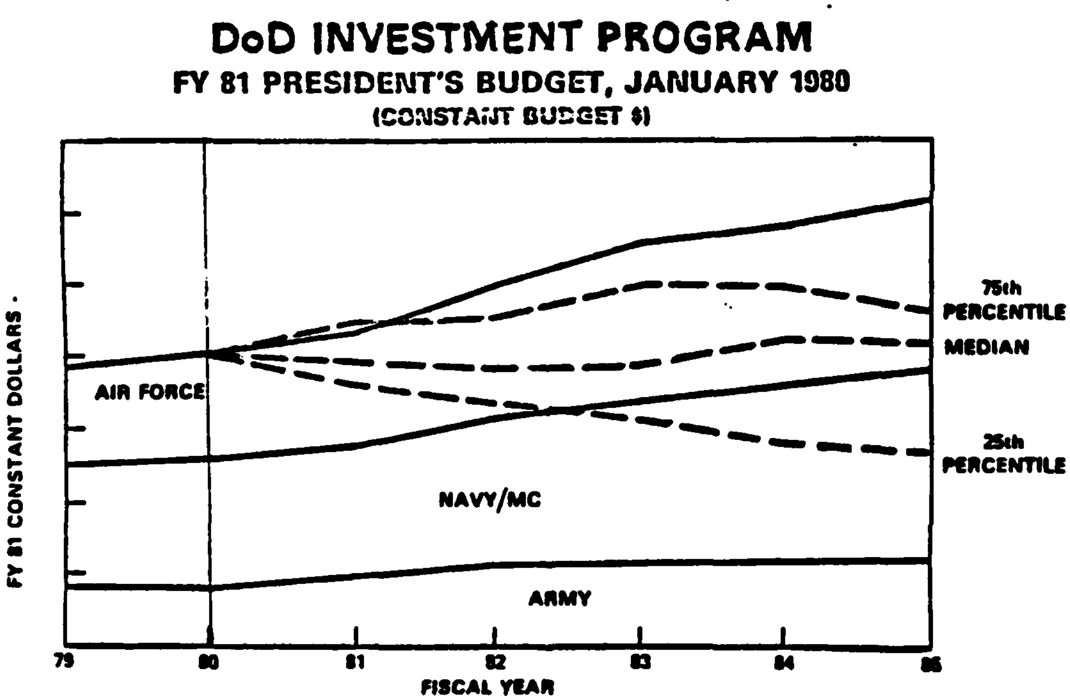
- The 75th percentile at FY 82 represents the 75th percentile of the distribution of the historical groups for two-year percentage increases. Recall from the budget analysis that this change makes <u>no</u> assumption about the intervening first year change. This point has also been normalized to the FY 80 budget level. It should be interpreted as follows: If the changes of the last 30 years were to repeat themselves, we should expect that 75% of the time the actually achieved FY 82 level would be less than or equal to that indicated on the slide

- Similarly, the 75th percentile at FY 85 represents the 75th percentile of the group of five-year percentage increases. This point makes no assumptions about the intervening four years and it is normalized to the FY 80 level. If history were to repeat itself, 75% of the time the actually achieved FY 85 level would be less than the point indicated by the 75th percentile.

- This portrayal is <u>optimistic</u> in the sense that it reduces the distance between our plans and past performance because it ignores the short-term tendency to increase and then decrease. It is very unlikely that a 75th percentile increase would be followed by another 75th percentile increase.

This understanding of the planning range enables us to use it as a norm to evaluate the investment pressure of each service's budget as well as the total investment budget. We are going to ignore inter-service patterns, and apply the DoD-wide planning range to each service. This pressure can be viewed as being directly related to the distance by which the budget top line exceeds any one of the percentile lines.

Looking at the DoD Investment Program as a whole, we see that we are under less pressure in the near term than we are in the far term. All years are well above the 50th percentile and the pressure builds up steadily over the five-year period. This is another reflection of the "bow wave" phenomenon; and from a historical perspective, it means that our plans embody very optimistic assumptions about future budget growth. Towards the end of this section, we will calculate the percentiles of each service's budget top-line. We will now examine each service budget.



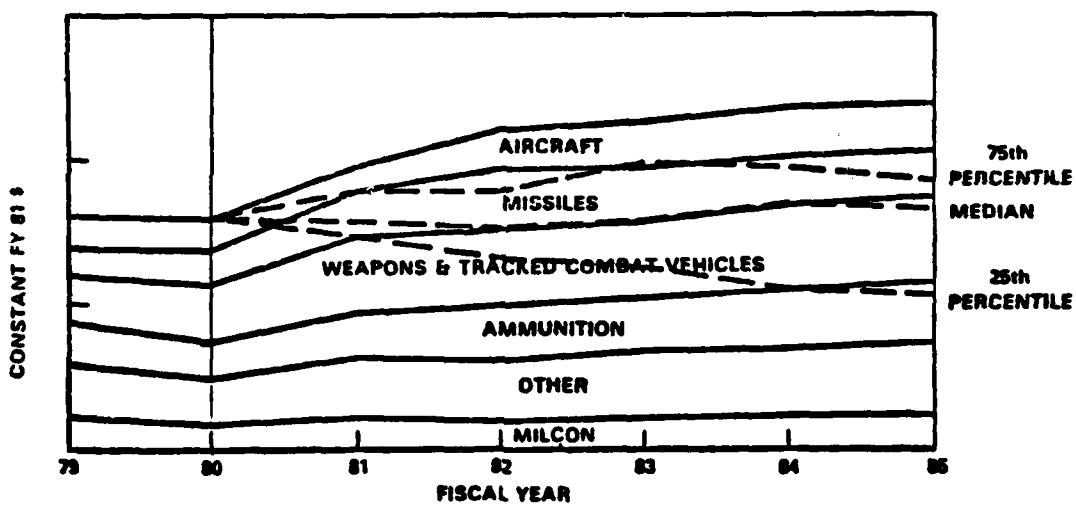
Slide 52

(Slide 53) We see that the Army is under high pressure over the entire period. The Army is planning major increases in the complexity of its hardware; it faces severe readiness problems, particularly in the area of skilled manpower; and it does not have the tradition of handling complex equipment that the Air Force has. In view of the pattern revealed in the case of AF tac air, these observations suggest that the Army may be laying the foundation for similar, if not worse problems, and that these problems are likely to persist well into the 1990's.

ARMY INVESTMENT PROGRAM

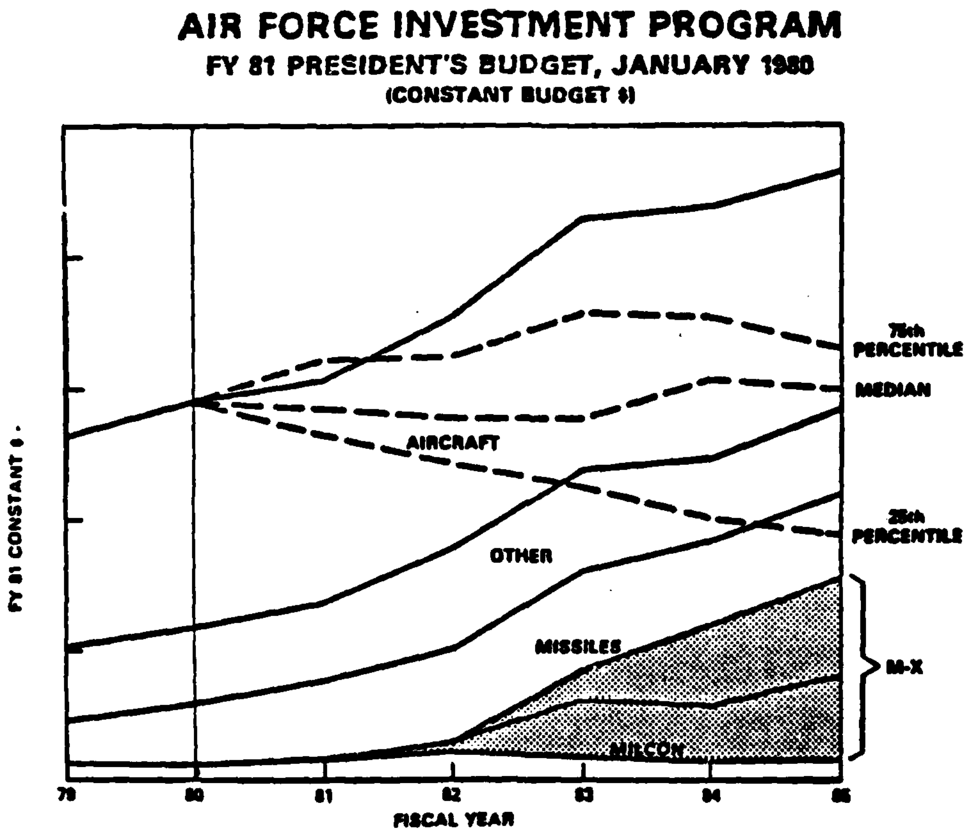
FY 81 PRESIDENT'S BUDGET, JANUARY 1980

(CONSTANT BUDGET $)



Slide 53

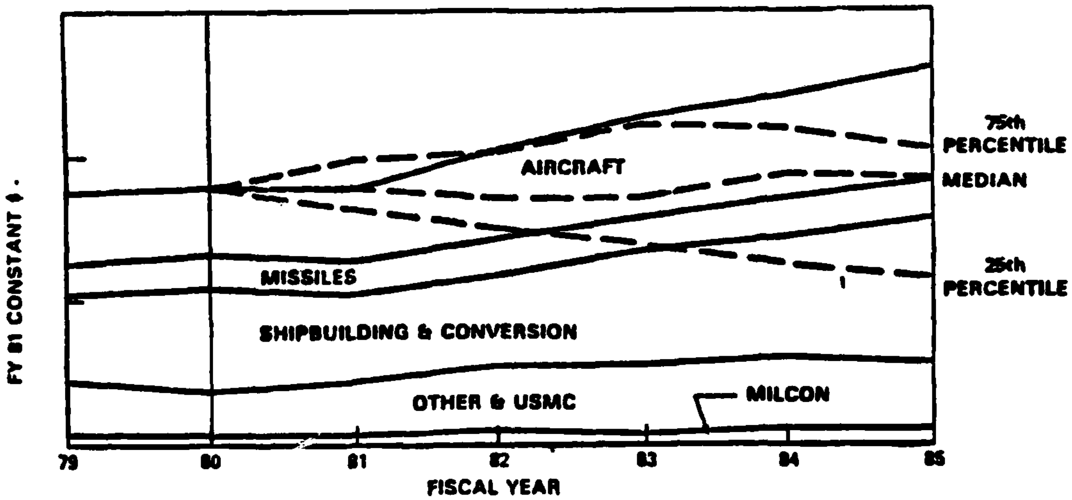
(Slide 54) The Air Force is under less near term pressure than the Army, but Air Force investment pressure explodes in the outyears. The main source of this growth is the M-X program which has funding implications well beyond FY 85. Note that this program contains <u>no</u> investment funds for a new manned bomber or a new fighter.



Slide 54

(Slide 55) The Navy is under less near-term pressure than the other services, but the pressure builds up steadily in the outyears. In fact, this depiction is somewhat misleading because it does not reflect the long-term implications of the Navy's modernization program. Whereas the Army investment program is smaller than those of the Air Force or the Navy and the source of the Air Force pressure can be traced to a few causes, the Navy has the largest investment program and there are many sources of long-term pressure. In particular, we will see that the pressure to grow the shipbuilding and fighter procurement accounts is likely to remain with us into the 1990s. The Navy currently also faces severe personnel and material readiness problems, perhaps even more serious than those of the Air Force. Moreover, the Navy is modernizing with high complexity hardware, so we should expect that long term increases in the cost of Navy readiness will continue for the forseeable future. These comments suggest that even if the Navy implements its current modernization plans, its readiness-modernization squeeze could worsen during the coming decade. This issue will become clearer in our discussion of aircraft procurement and shipbuilding accounts.

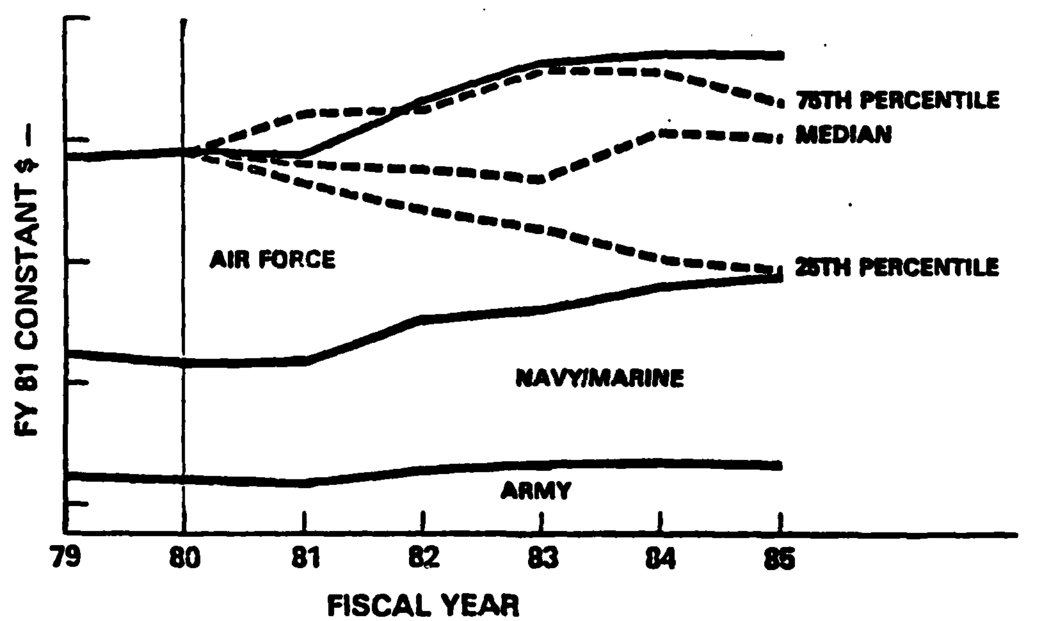
NAVY/MC INVESTMENT PROGRAM
FY 81 PRESIDENT'S BUDGET, JANUARY 1980
(CONSTANT BUDGET $)



Slide 55

(Slide 56) We will now examine some interactions between these accounts. It is important to realize that there are no simple cause and effect relations governing these interactions. The overall investment account is under enormous pressure. There are all sorts of individual programs competing for limited funds; and since we exhibit a tendency to avoid hard decisions to cancel programs, this bureaucratic competition results in what might be characterized as a "leveling process." Consequently, individual programs or entire budget catagories can change quite unpredictably from year to year. We will observe this interaction (at a very superficial level) by examining the aircraft procurement programs of the DoD budget. To start, we note that the overall aircraft procurement program is under considerably less pressure than DoD investment taken as a whole.

AIRCRAFT PROCUREMENT
FY 81 PRESIDENT'S BUDGET, JANUARY 1980
(CONSTANT BUDGET $)



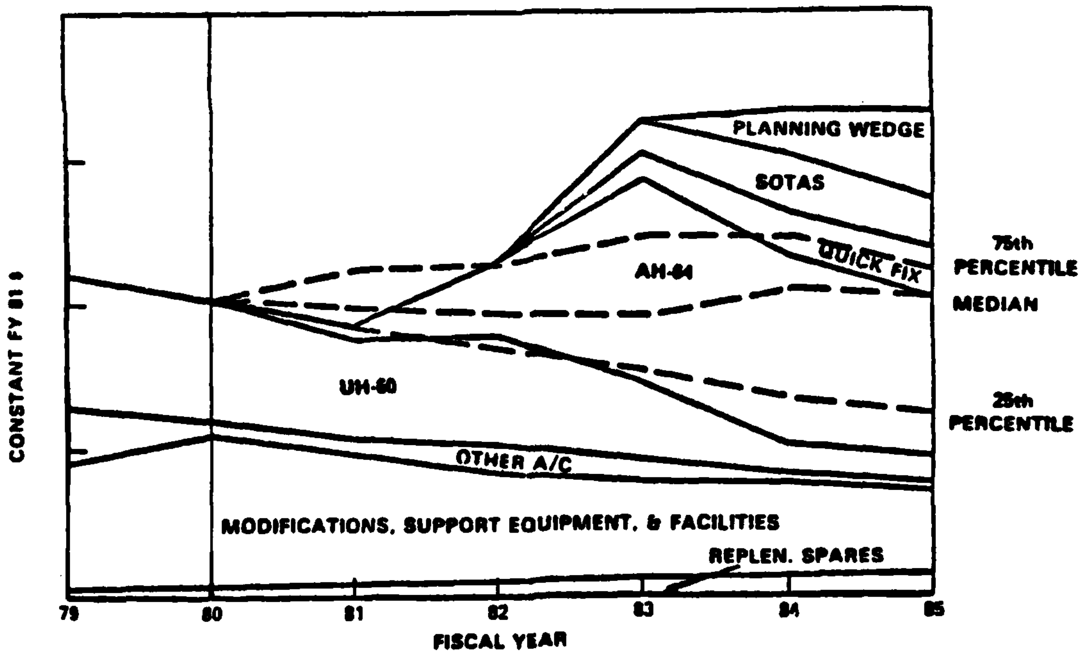
Slide 56

(Slide 57) Army aircraft procurement is under very little pressure in FY 81, but it explodes in the out-years. The source of this explosive growth is the Advanced Attack Helicopter (i.e., AAH or AH-64) program. Although the UH-60 program appears to be winding down in FY 84 and FY 85, we should note that only about one-half of the planned UH-60 force structure is procured by FY 85. This low level of UH-60 funding in FY 84 and FY 85 will result in an unrealistically low production rate. Note also that replenishment spares are funded at a very low level for the entire five-year period.

ARMY AIRCRAFT PROCUREMENT

FY 81 PRESIDENT'S BUDGET, JANUARY 1980

(CONSTANT BUDGET $)



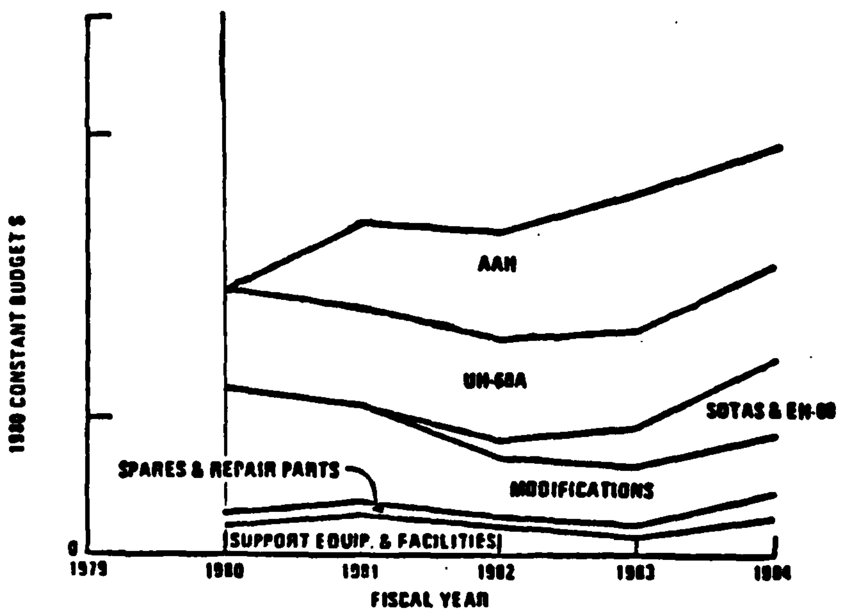
Slide 57

(Slide 58) If we compare the FY 81 Army aircraft procurement program (shown in the previous slide) to the FY 80 program, depicted in this slide, we see a very different profile. (Note: these programs have been aggregated differently; this difference does not affect our discussion.) In the FY 81 budget, major funding for the AH-64 begins in FY 82; there is very little funding planned for FY 81. However, we see in this slide that the FY 80 budget projected major funding in FY 81. The UH-60 program has also changed quite dramatically: in the FY 81 budget, there was a major draw-down of funding in FY 83 and FY 84; however, this slide (i.e., the FY 80 budget) shows that no such draw-down was envisioned as recently as a year ago. So, plans are subject to considerable year-to-year change over the entire five-year planning horizon.

ARMY AIRCRAFT PROCUREMENT

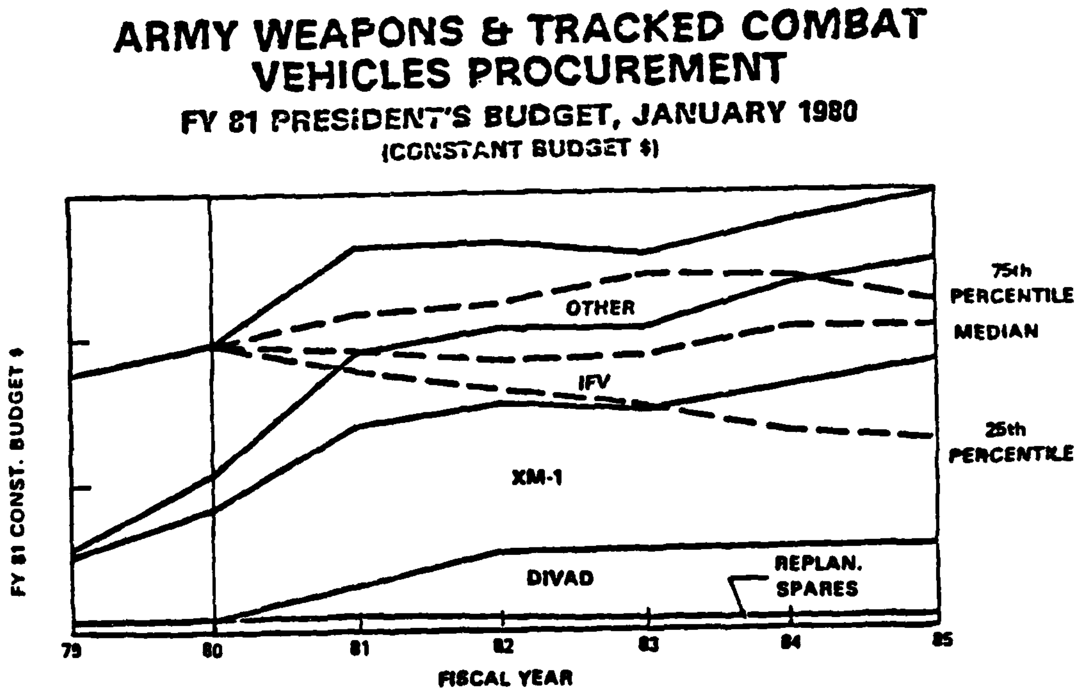
FY80 PRESIDENT'S BUDGET, JAN 1979

(CONSTANT BUDGET $)



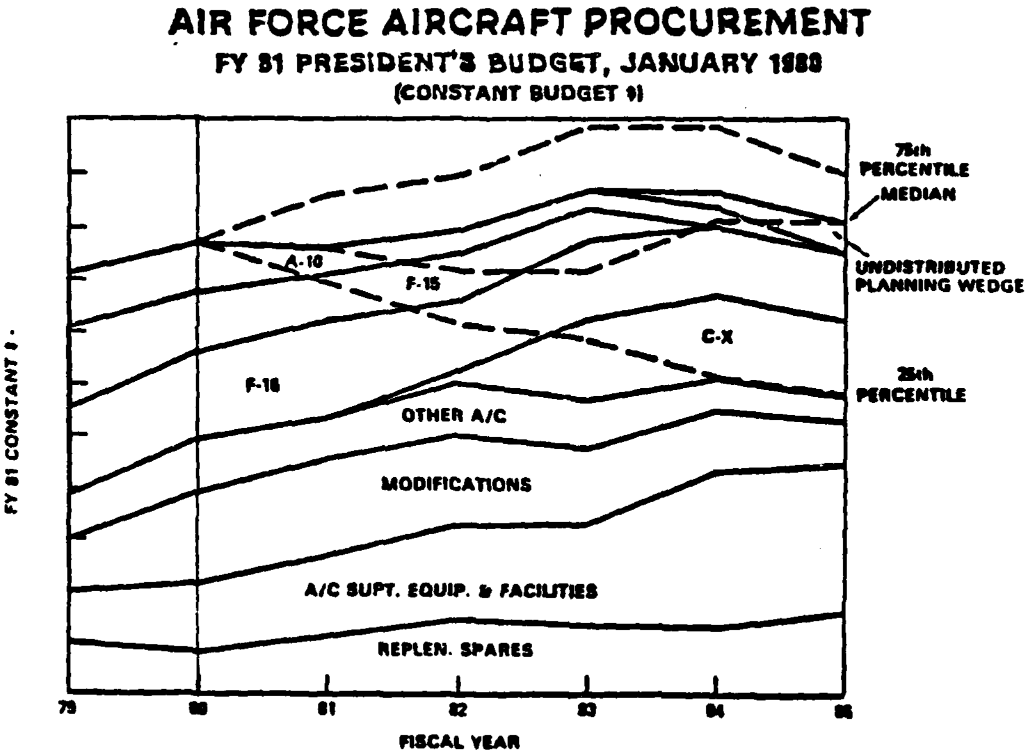
Slide 58

(Slide 59) This slide gives us one reason why it may be necessary to hold down the near-term pressure in the aircraft account. The weapons and tracked vehicle procurement program is under enormous near-term pressure; this observation also applies to the Army's missile procurement account. Again, note the level of replenishment spares funding depicted in this slide.



Slide 59

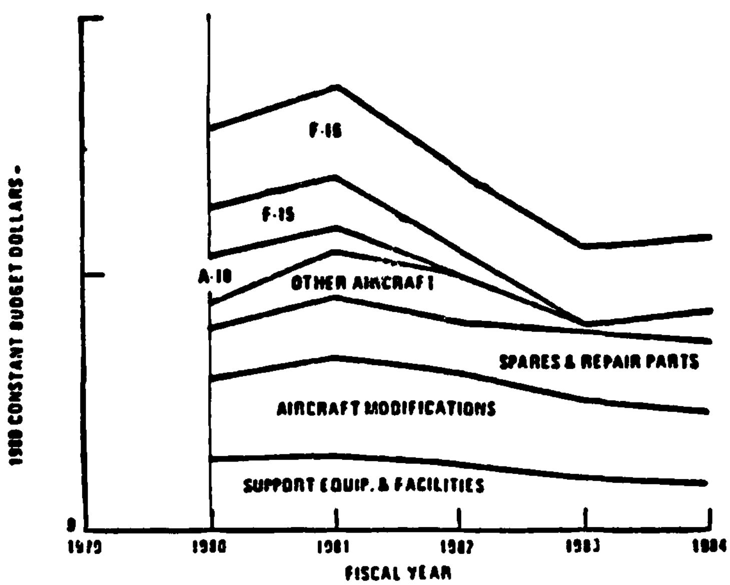
(Slide 60) Turning to Air Force aircraft procurement we see that it is under much less pressure than the Air Force investment program as a whole--only modest growth is planned. The source of Air Force growth is in the missile account.



Slide 60

(Slide 61) In contrast, last year's budget planned for steady declines in aircraft procurement after FY 81. Recall that the FY 80 DoD budget assumed 3% annual real growth and the FY 81 budget assumed 5% annual real growth. This relief of the five-year top-line constraint enabled the out-year aircraft account to expand via near-term FY 81 budget decisions. The C-X was added in the FY 81 budget, there were major increases in aircraft support equipment and facilities and spares were increased (recall however, that spending assumptions still underfund spares). Notwithstanding this overall increase in the five-year program, the procurement plan for A-10s and F-15s was slowed and stretched in the FY 81 budget. The A-10 has had an interesting history of programmatic changes: The FY 80 budget projected the last year of the 733 aircraft procurement program would be in FY 81. In the FY 81 budget, the rate was slowed and extended to FY 84; however, an additional 96 airplanes were procured to compensate for higher than expected peacetime attrition. In the FY 82 budget (currently in preparation), it appears that there will be no procurement in FY 82 (and beyond); the total buy is now reduced to 687. (Note: it is possible that 24 aircraft could be added in FY 82 bringing the total to 611.) Increased budget growth does not necessarily stabilize investment planning; the Air Force changes illustrate the short-term tendency to add new programs when planning pressure on out-year expenditures is eased.

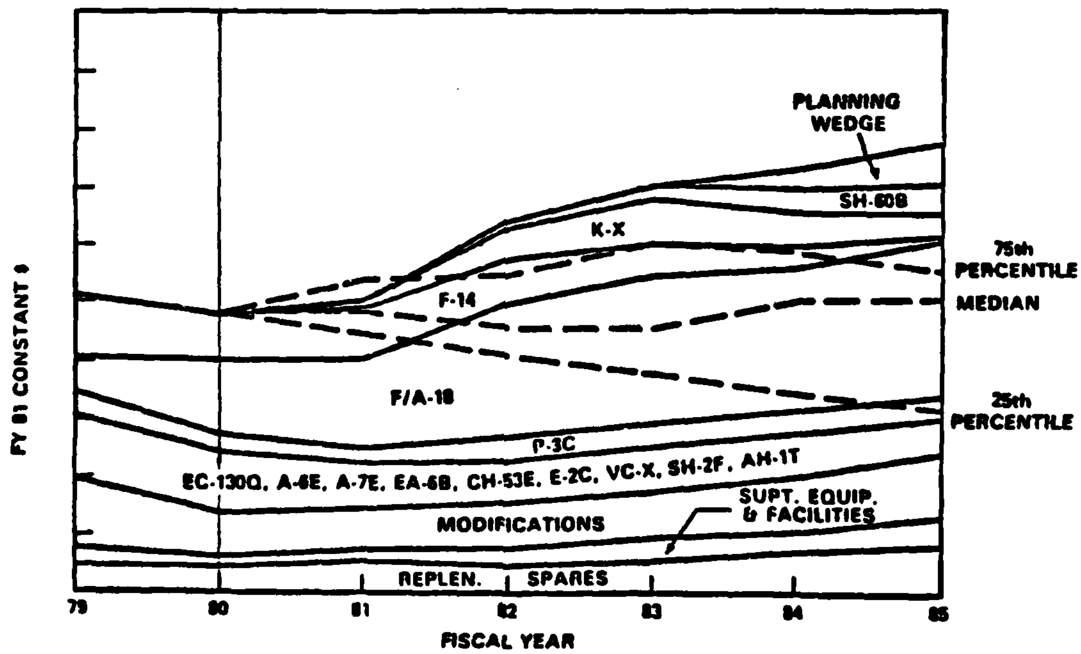
AIR FORCE AIRCRAFT PROCUREMENT
FY 80 PRESIDENT'S BUDGET, JANUARY 1979
(CONSTANT BUDGET $)



Slide 61

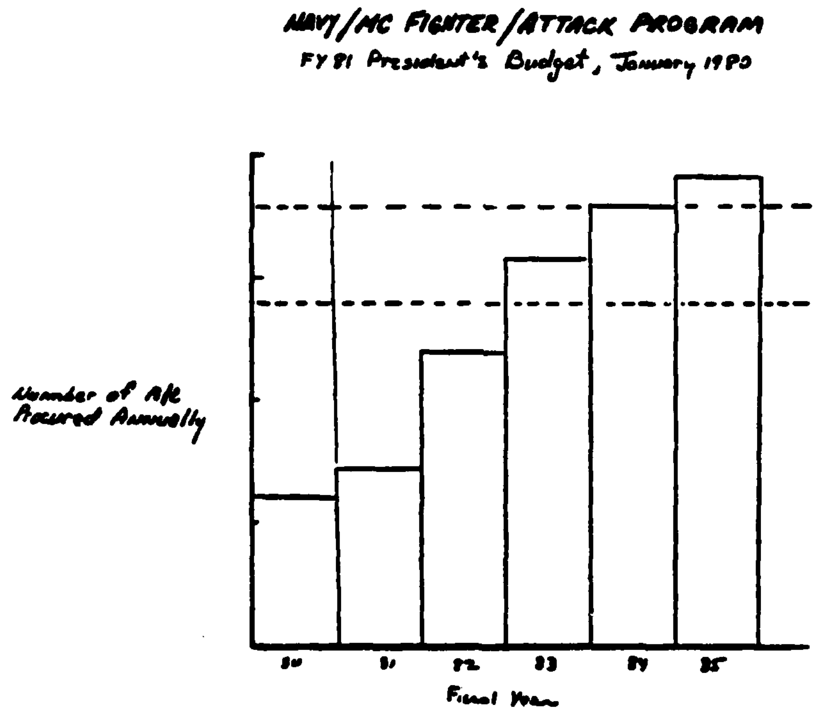
(Slide 62) The Navy/MC aircraft account is under modest near-term pressure, but it builds up in the outyears. The average annual real growth for the five-year period is 10.4%. Note that this account does not contain the AV-8B; and with the exception of the F/A-18, this program tends to focus on low-rate procurement of a large variety of complex aircraft. Although the F/A-18 is currently planned for high rate procurement, it is also a high complexity aircraft.

NAVY/MC AIRCRAFT PROCUREMENT
FY 81 PRESIDENT'S BUDGET, JANUARY 1980
(CONSTANT BUDGET $)



Slide 62

(Slide 63) Even with 10.4% real growth, the Navy is not procuring enough aircraft to maintain its force structure. The dashed lines on this chart are estimates of the upper and lower bounds of the number of aircraft required annually to make up for losses through aging or peacetime time attrition. The bars depict the number of aircraft procured in each year of the FY 81 budget. In spite of the fact that the Navy's aircraft procurement plans are extremely optimistic from a historical perspective, the successful achievement of these plans will still result in an accumulating shortage of airplanes until the mid-1980s.



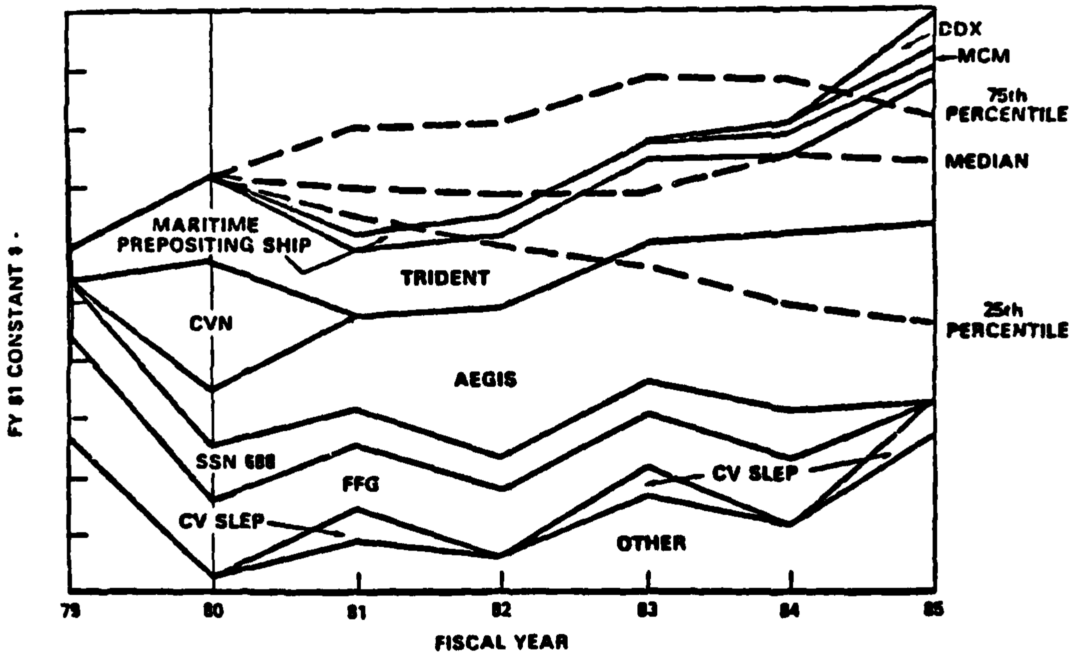
Slide 63

(Slide 64) The shipbuilding account is a major source of long-term pressure in the Navy budget. This pressure is one reason why the Navy cannot pump more growth into the aircraft account. Although in the near term, it is under very little pressure, it builds up steadily in the out-years. Moreover, the declining size of the Navy fleet coupled with the concentration of modernization funds in small numbers of very complex ships (e.g., Trident, and Aegis) imply a long-term Navy force structure problem. The rising operating costs of high complexity aircraft and ships can be expected to magnify the Navy's readiness-modernization squeeze for the forseeable future.

NAVY SHIPBUILDING AND CONVERSION

FY 81 PRESIDENT'S BUDGET, JANUARY 1980

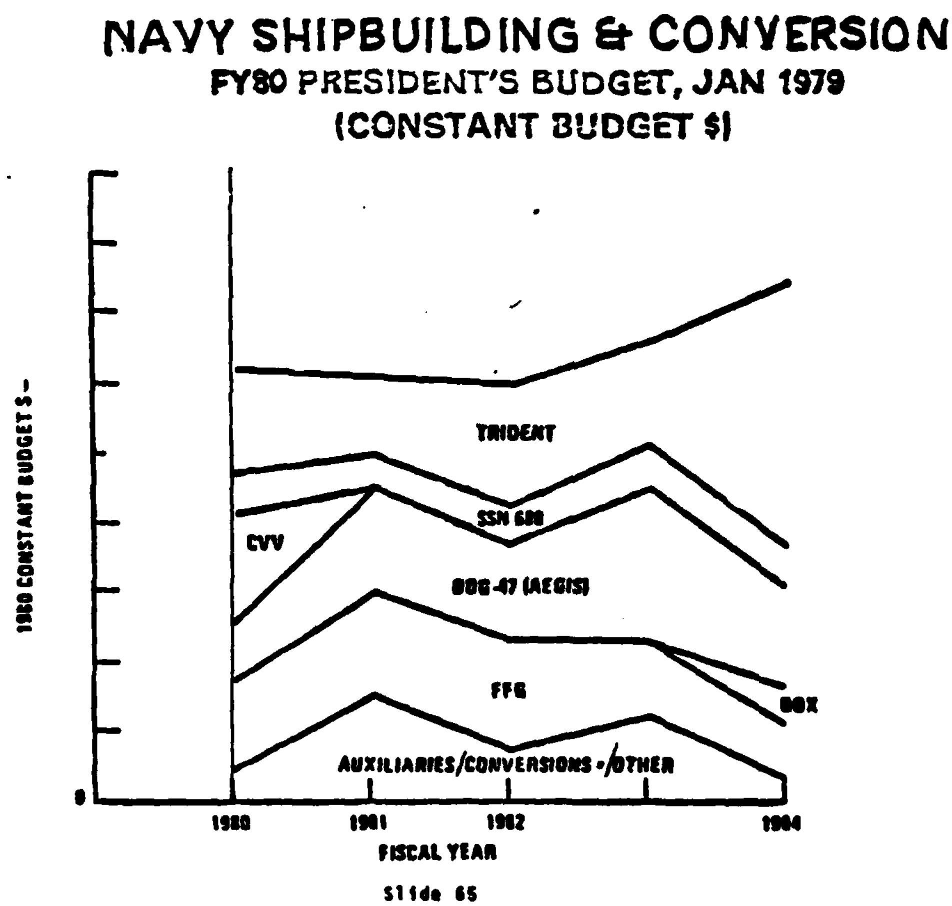
(CONSTANT BUDGET $)



Slide 64

(Slide 65) The five-year shipbuilding program is also subject to short-term change. The FY 80 program is markedly different than the FY 81 program.

Thus we see that our five-year procurement programs have changed markedly from year-to-year, that increases in out-year funding do not guarantee program stability, and that funding profiles appear optimistic in an historical perspective. This short-term tendency to change our five-year program raises two questions concerning the uncertainty surrounding our current plans. ● First, what is the likelihood that current plans will change markedly in the near term? ● Second, what form might these changes take?



Slide 65

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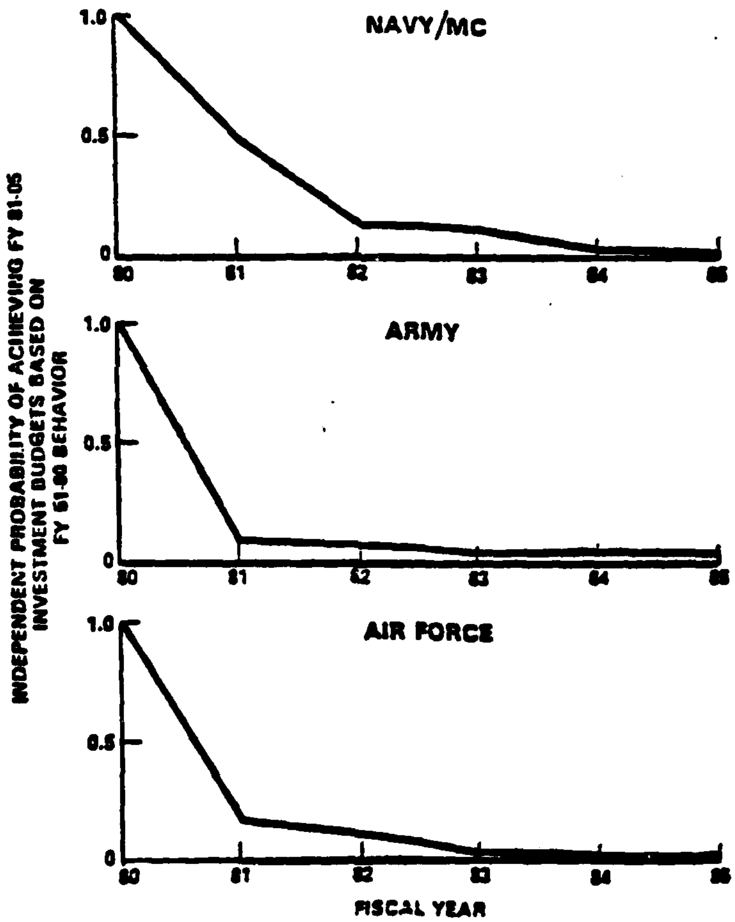
(Slide 66) This slide addresses the first question by translating the percentile of the investment top-line for each service into a historical probability of achieving our planned growth. For example, if the investment top-line is at the 95th percentile of the historical pattern of change, then assuming history repeats itself, there is a 0.05 probability that sufficient funds will be available to fund the program in the particular year in question. This chart displays these probabilities for each year of each service's five year program. In simple terms, this slide says our investment plans are historically very optimistic--to the point of being unprecedented. If history repeats itself, the liklihood of not obtaining the funds required by our plans is so great, a conservative planner should assume it is inevitable.

Do foreseeable factors warrant this planning optimism? Can we realistically make short-term decisions to commit ourselves to programs having long-term consequences when this commitment presumes a long-term future budget environment that is so different from that of the past 30 years?

Perhaps current political externalities have generated a consensus to increase the defense budget in the near term; however, the curves in this slide embody the long-term "budget growth" effects of similar political externalities in the past such as: the Korean War, those perceptions leading to the strategic buildup of the mid-50s, the Hungarian Revolution, Sputnik, the missile gap, the Berlin Wall, the Cuban Missile Crisis, the Viet Nam War, and Czechoslovakia. It is obvious that the cumulative effect of these political externalities has not been able to generate a growth pattern that is compatible with the growth pattern in our plans. Other factors also influence the defense budget. For example, our nation faces severe economic problems; and if solutions to these problems conflict with defense expenditure plans, it is quite conceivable that defense plans would be adjusted according to the needs of the national economy. Finally, internal defense-related factors may affect investment plans. For example, even if we received our planned overall budget growth for the next five years, the current low state of personnel and material readiness coupled with the rising cost of increasing readiness could dictate a substantial shift of funds from investment to readiness related accounts.

We are dealing with an environment that is prone to change; our problem is that we have a rigid planning system that assumes we can predict the future. The problem is compounded by the fact that the future we predict is radically different from the past, and by the fact that we do not formulate a hedging strategy to cope with an emerging reality that is different from our predictions. Since we do not plan for change; when it occurs, we respond on an ad hoc basis. This brings us to the question concerning form of the changes that we have to face in the future.

INVESTMENT PLANS:
HOW DO FUTURE DESIRES COMPARE TO PAST REALITY?



Slide 66

(Slide 67) This slide compares the FY 81 budget to the November 1, 1980 estimate of the Basic level of the FY 82 budget. (Note: Although current estimates are somewhat different due to the ongoing budget process, the overall pattern is unchanged.) These changes assume a budget level of $204 billion (FY 82 $) level in FY 82--represents 10% real growth over the FY 81 budget. It compares constant dollar and quantity changes projected for the four common years of both budgets. This slide depicts how a five-year program can decrease when the budget grows.

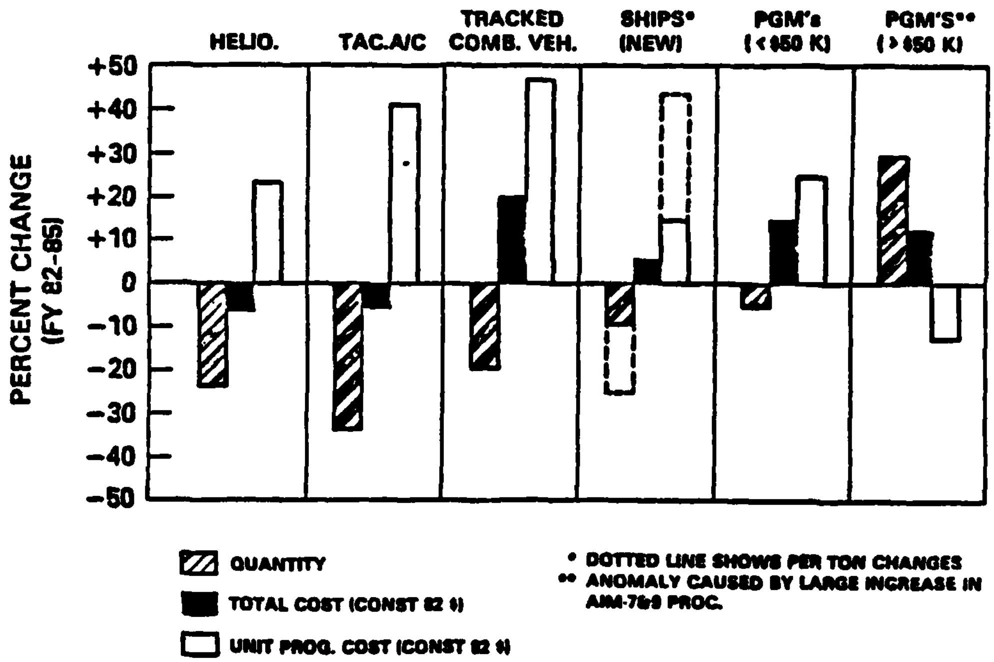
The procurement quantities of helicopters and tactical aircraft are programmed to decline by 20%-30%, this will result in less than a 10% reduction in total program cost and growth in the program unit costs of 20% to 40%. Tracked combat vehicles, ships, and precision guided munitions (PGMs) costing less than $50,000.00 all show quantity reductions, total program cost increases, and substantial program unit cost growth. Although PGMs costing greater than $50,000.00 appear different, the cause of this anomoly is a large quantity increase in the procurement of missiles at the lower end of the price spectrum. The changing mix is the principle cause of the depicted change pattern.

We have uncovered one form of change: Projected budget increases are accompanied by reductions in procurement quantities and growth in unit cost. It is important to realize that these changes occurred after the effects of inflation were taken out. One reason underlying these changes is that individual programs tend to grow in cost over time--this year's cost estimates for the next five-years tend to be higher than last year's estimates. The effect of cost growth in time is one of underfunding out-year procurement quantities in a given five-year program. When the out-years get closer in subsequent budgets, it becomes necessary to either reduce quantities or increase overall funding. Furthermore, overall funding increases do not guarantee a solution because, as we have seen, there is a tendency to initiate new investment programs when our-year planning constraints are changed in the direction of increased future growth. In this way, short-term decisions (with long-term consequences) in the presence of cost growth and uncertainty are a source of continual pressure to expand the investment budget.

Summarizing this discussion, we have seen that our five-year investment plans can fluctuate unpredictably from year to year. These plans project overall growth requirements that are exceedingly optimistic from a historical perspective; moreover, they are accompanied by unrealistically low projections of growth in the readiness accounts. Finally, the uncertainty surrounding the magnitude of the future cost growth implies an investment funding requirement that is even larger than the one projected in our investment plans.

In effect, our desires are expanding unpredictably against a constrained environment that is changing unpredictably. Even though our short-term decisions try to pump up the investment budget, the long-term interaction of these internal and external uncertainties result in reduced procurement quantities--i.e., slower modernization--and declining force structure--as well as low material and personnel readiness.

UNIT COST GROWTH
MAGNIFIES COST OF CHANGE
(KEY PROGRAM CHANGES: JAN. 80 FYDP — NOV. 80 BES)

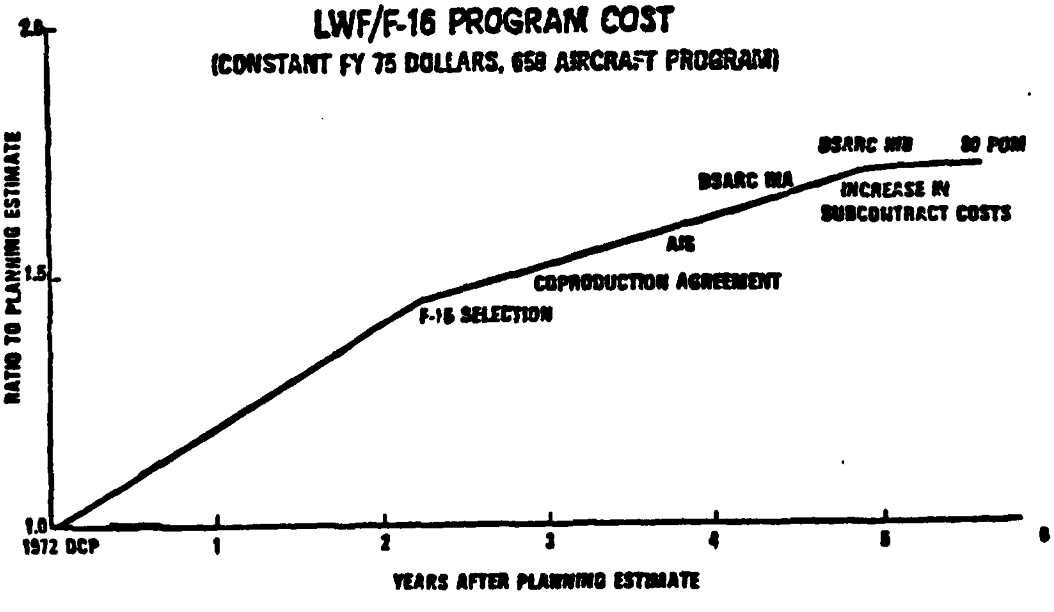


Slide 67

V The Growth in Complexity and Perceived Capability

Our perceptions of uncertain future threats are factors shaping our forces over time. However, these perceptions are not determined solely by the threats facing us; our perceptions are also influenced, in part, by the generally held beliefs of our institutions. Since the end of World War II, the dominant influence shaping growth and change in the US military has been the view that our military superiority should be based upon technological superiority. We have seen that our strategy for technological supremacy has resulted in a force that continuously increases in complexity and cost over the long-term. Our genuinely superior technology has been directed towards increasing a quality known as "capability"--a quality that seems to embody the continual need to increase complexity.

(Slide 68) The F-16 is a good example of how a weapon system can grow in complexity and cost over time. From the viewpoint of cost management, the F-16 has a relatively good record; there are no horror stories associated with its cost history. Nevertheless, the constant dollar cost of the F-16 has grown substantially over the initial developmental estimate made in 1972. In this case, most of the cost growth is attributable to increasing complexity--such as the addition of complex air-to-ground avionics and the AIS to support the avionics--and furthermore, these increases are likely to continue with the planned addition of the AMRAAM and Lantirn. What started off as an austere high performance within visual range air-to-air fighter will be transformed by the late 1980s into a lower performance radar missile air-to-air fighter with avionics intended to attack ground targets in night or adverse weather. These increases in the complexity of the F-16 imply downstream cost and supportability consequences that were not imagined when the decision was made to develop the F-16 in 1972--consequences that, although still imperfectly understood, we will have to live with in the year 2000.



Slide 68

Looking at general trends of growth in the complexity and cost of fighter technology over the last thirty years; we find that in constant dollars, avionics costs have grown by a factor of about 40-50, engine costs have grown by a factor of about 15-20, and airframe cost by about a factor of 5. In avionics, most of the cost growth has been associated with trying to obtain the ability to shoot down enemy fighters at very long ranges and in all weather conditions, and associated with trying to obtain a night/all-weather air-to-ground capability. Often engine technology appears directed towards purely technical goals such as higher pressure, temperature and by-pass ratios. Airframe cost growth has resulted from the complex installation requirements of the increased avionics and the expensive materials and complex inlets associated with speed requirements beyond Mach 2.

Up to this point, we have viewed increases in complexity in terms of the accumulating cost to readiness, force structure, and modernization. However, we also have to ask what this increased cost is buying in terms of increased military capability. At best, combat experience is ambiguous on this point.

For example, in the case of air-to-air combat, it is not clear that increasing avionics complexity has yielded combat dividends that warrant the cost growth. F-86's using machine guns in Korea got about a 10 to 1 exchange ratio over Korean Mig-15s. In contrast, 15 years later, the F-4 in Viet-Nam, with its complex all-weather beyond visual range (BVR) radar missile capability only achieved about a 2 to 1 exchange ratio against the clear weather, within visual range Mig-21. The lethality of the Sparrow missile, .08 to .13, turned out to be at least a factor of 5 lower than predicted. In the 1967 and 1973 Arab-Israeli wars, Israeli Mirage III's (a mid-1950's technology day-visual fighter) achieved better than a 20 to 1 exchange ratio against Arab Mig-21s. In the 1971 Indo-Pakistani War, Pakistani F-86 MK VI aircraft got better than a 6 to 1 exchange ratio against Indian Mig-21, SU-7, and Hawker Hunter aircraft.

Many argue that the visual rules of engagement in Viet Nam precluded the F-4 from maximizing its BVR capability, and that Viet Nam results are not indicative of BVR performance in a European war because the rules of engagement will be different. Even if this argument were true--and the evidence is not clear on this point--we now find that the benefits of the complex BVR capability are contingent upon precise rules of engagement in an uncertain future war--namely the authorization to fire at a target before it has been positively identified.

The picture is also ambiguous with regard to the benefits of increasing complexity in propulsion technology. The chart depicting the variable cost per flying hour (in the discussion of AF tac air) suggests that the afterburning turbofan of the F-15 uses less fuel per flying hour than the turbojet in the F-4; however, the complexity of the F-15 s engine makes it much more expensive to support logistically--a cost difference that in all probability will swamp any fuel savings. Although many of today's fighters have a top speed of Mach 2, we can not expect to use this performance in the vest majority of plausible combat scenarios because most of the fuel is consumed while accelerating to Mach 2.

Thus we see that the benefits of increasing complexity are not self-evident or clear-cut. There is no argument about whether or not we want increased capability. The relevant questions are: How should we perceive capability? Does increasing complexity increase capability or decrease capability? This section discusses these questions by examining the impact of three generally accepted preconceived notions that shape our perceptions of capability. For the sake of brevity, we will refer to these preconceived notions as: (a) the faith that emerging technology will revolutionize capability and cost; (b) the mechanistic attrition mind-set, and (c) the idea of war being a manipulatable deterministic process that can be centrally controlled. These notions will be explained as they are introduced.

NOTION #1 TECH WILL CHANGE CAPABILITY

We can not answer questions about capability by analyzing an individual weapon's effectiveness in isolation. Capability, like complexity, is a quality of the "whole" and it can never be described by a single number. Recall from Gen Clarke's and Napoleon's statements that the synthesis of men and machines into a military capability involves very important intangible considerations--e.g., moral strength, esprit de corps, skill, etc. Any evaluation that ignores these intangibles is at best a very partial and, by necessity, an ambiguous view.

The acid test of war is ultimately the only unambiguous indicator of capability. Moreover, the lessons of combat continue to be difficult to interpret. All other indicators or measures are ambiguous because they are based upon speculation about a future interaction between forces whose self-interest and survival dictate that they act and react unpredictably. (Note: if you are predictable, you are vulnerable.) Now we can reduce part of this uncertainty through testing and training, but we can never remove its dominant aspects. Perceptions of capability will always be shrouded by a veil of speculation and ambiguity. For example, how does one compute the effectiveness of esprit de corps?

Our definition of complexity and our discussion of material readiness revealed that increasing complexity increased the uncertainty in our support structure. This ambiguity combines with the inherent ambiguity surrounding any discussion of capability to soften resistance to the seductive promise that advancing technology will simultaneously provide revolutionary increases in capability and revolutionary improvements in supportability. We know that on rare occasions, technology has revolutionized war. How can one prove ahead of time that a new, imperfectly understood technology will not revolutionize the ambiguous conditions of a future war?

The preconceived notion that advancing technology will provide revolutionary changes in cost and capability plays upon these uncertainties. It increases our toleration of the mismatch between the short-term and long-term budget behavior because it suggests that the future will be different from the past. Let us examine how this argument works. First, we will consider two cases (i.e., the F-111D and the F-15) where it was predicted that increased complexity would be accompanied by improvements in supportability, then we will examine a current case (i.e., PGM's) where more capability is being promised for less money.

The first case concerns the F-111D and the Mark II avionics. In the late 1960's, advocates of the Mark II avionics system predicted that highly sophisiticated all-digital technology would provide a revolutionary increase in systems reliability. At that time, it was argued that despite its complexity the mean time between failure (MTBF) would be in excess of 60 hours. On October 8, 1968 the Secretary of the Air Force (in a letter to the Deputy Secretary of Defense) predicted that the Mark II avionics would require less maintenance manhours per sortie than the less complex avionics in the A-7D--i.e., 1.42 MMH/S for the Mark II versus 2.79 MMH/S for the A-7D's avionics. Despite the complexity of the Mark II system, it was argued that emerging technology would significantly improve maintainability-i.e., the future burden of the F-111D would be quite low.

In actual fact, quite the opposite has happened. For example, during FY 80, the Mark II's MTBF was well under three hours and the MMH/S averaged 33.6--i.e., over twenty-three times as large as the predicted MMH/S.

On April 1, 1974, Aviation Week and Space Technology published an article entitled "Simplicity Is Stressed In F-15 Operations and Maintenance" (pp. 50-53). The article indicated that the F15 would require less maintenance and fewer maintenance personnel than any other high speed fighter in the USAF inventory. The F-15 was guaranteed to require no more than 11.3 MMH/FH (compared to 24 MMH/FH for the F-4E), that the MTBF would be a factor of 4.3 greater than the F-4 (i.e., 5.6 versus 1.3 hours), that the F-15 would require no new skills beyond those already found on fighter bases, and that the F-15 would require 15% less manpower than the F-4E. During the last two fiscal years the F-15 required 26.7 MMH/FH and the F-4E required 29.9 MMH/FH. These numbers do not include depot labor. In FY 79, our table on material readiness indicators suggests that the F-15 MTBF is much closer to the F-4s--the ratio of MFHBFs is 1.25 to 1 (.5 versus .4), our discussion of the AIS indicated there is an enormous increase in skill requirements, and the F-15's maintenance manpower requirement is virtually identical to the F-4. Taking depot costs and replenishment spares costs into account, current AF budget data indicates that the F-15 costs about twice as much as the F-4 per flying hour to support.

(Slide 69) Our third case concerns the revolutionary promise of precision guided munitions or PGMs. These weapons are currently very expensive and over time their cost and complexity have steadily increased. This slide depicts this evolution for five families of these weapons: the AIM-9 is the heat seeking Sidewinder air-to-air missile; the AIM-7 is the semi-active radar guided Sparrow air-to-air missile--AMRAAM is its fully active follow-on; AGM-65 is the Maverick anti-tank missile--its guidance has evolved from TV (A/B) to laser (C) to imaging infrared (D); GBU-8 and 15 are TV guided bombs; AGM-45 and 88 are the Shrike and HARM anti-radiation missiles-missiles that home on air defense radars.

On August 11, 1980, Business Week published an article, entitled "The New Defense Posture: Missiles, Missiles, and Missiles," suggesting that the next generation of "missiles so smart they will change the face of warfare" (p. 76) will be in the hands of our military forces by 1985 or so. Historically, the general pattern of evolution has been that once a particular smart weapon is fielded, some unpredicted limitations or problems crop up and a more complex or "capable" follow-on version is developed, presumably to overcome these unforeseen limitations. In the case of air-to-air missiles this evolution has been going on for almost 30 years. The following exerpt taken from the Business Week article (pp. 77-78) describes this pattern for the case of the Maverick missile:

> "Maverick went into development 10 years ago as an electro-optically guided missile that carried a tiny television camera in its nose. The theory was that its camera would photograph a potential target, and the missile would then lock onto it. But the camera did not work well in clouds or at night. So, three years ago, the Air Force turned instead to the development of an infrared guidance system for Maverick.
>
> The infrared device helped make Maverick an all-weather missile, but it also left a lot to be desired. Its sensors spotted targets imprecisely, and its signal-processing computers were too often uncertain about where to steer it. Sometimes the hot spots it saw turned out to be flares fired as decoys. Because it did not see full shapes or images, Maverick still could not distinguish among real and spurious targets well enough to make a truly one-shot weapon.
>
> Evolutionary developments in infrared and radar guidance systems have made the latest models of Maverick, as well as missiles known as Sidewinder and Sparrow, better than their predecessors. But the air-to-ground Wasp and a new missile called AMRAAM (for advanced medium-range air-to-air missile), now in development, should be vastly better systems." (emphasis added)

Now our slide indicates that the imaging infrared Maverick (AGM-65D) will not be operational for some time, yet the Wasp is already being advocated on the basis of the AGM-65D's deficiencies. Later on in the article (p. 78) one advocate predicted "that by the end of the decade, the computers in missiles will come very close to comparing with the human brain. 'Our missile' he says 'will be not just smart but brilliant. The article goes on to predict that although Wasp is vastly "smarter" than Maverick, it should only cost about $25,000 (p. 80) or about one-third the price of the infrared Maverick. The case of the Wasp illustrates the two-sided seduction of promising more for less. We tolerate an imperfect present because we perceive a bright future.

It is also important to understand that the revolutionary capability of smart weapons (and high complexity weapons in general) is very narrowly defined. We are willing to pay the high cost per trigger squeeze because the predicted weapons lethality, coupled with the predicted increase in the survivability of the launching vehicle, promises to make these weapons cost-effective--i.e., under these assumptions, smart weapons are justified as the cheapest way to kill targets. Quoting again from the Business Week article (p. 76):

> "Fired from air, sea, or land, the new missiles should be able to spot and distinguish among targets with near-human perception, tracking them with speed and maneuverability from which there will be no escape, and destroying them with deadly, one-shot accuracy." (emphasis added)

THE INCREASING COST OF AIR-DELIVERED ORDNANCE (1000TH UNIT IN FY 80 $)

WPN	IOC	$K	WPN	IOC	$K
AGM-65A/B	1973	27	AIM-9B	1956	24
AGM-65C	1982	59	AIM-9J	1971	30
AGM-65D	?	77	AIM-9H	1973	44
AGM-65X	?	?	AIM-9L	1978	52
			AIM-9M	1981	83
GBU-8	1968	24			
GBU-15	1980	142	AIM-7E	1968	54
			AIM-7F	1976	118
AGM-45	1963	53	AIM-7M	1982	130
AGM-88	?	148	AMRAAM	?	154

1968 B

Slide 69

NOTION #2
ATTRITION MIND-SET

This brings us to the second preconceived notion (i.e., the attrition mind-set) that shapes our view of capability. The attrition mind-set shapes our perceptions by assuming that meaningful differences in capability can be entirely distinguished through calculable differences in attrition. It encourages the view that war is a quantifiable interaction. We view capability through the perspective of mechanistic attrition models that require precise predictions of lethality, survivability, and patterns of combat interactions such as rules of encounter and shooting to compute outcomes that are measured by casualties or some derivative thereof. This deterministic perspective does not view "capability" as a quality of the "whole" because it does not consider the unpredictable human aspect of interaction.

The attrition mind-set views war as an inanimate interaction between two mechanical forces that act and react predictably. Even if one were willing to accept this severe limitation, it turns out that attrition is often a misleading indicator of capability. The following examples illustrate this point.

- In the Civil War, WWI, and WWII, the winners had more casualties than the losers. At the level of a war outcome, attrition measures would indicate the winners lost and the losers won.

- In WWII, the Germans considered the allied tactical fighter-bomber to be the best anti-tank weapon employed on the western front. The aircraft in question had very low lethality against tanks. However, the allies had presence--in the last eight months of WWII (including the famous European winter), the allies flew over 700,000 fight sorties against targets in France, Benelux, and Germany--over 250,000 sorties were air-to-ground. In contrast, during the same period the Germans flew less than 30,000 fighter sorties. The allied domination of the skies virtually guaranteed that the German panzer forces would be attacked if they tried to move during flyable weather. The fighters' effectiveness was not so much their lethality as their presence--their constant pressure destroyed and disrupted the German's mobility, and mobility is an essential element of armored warfare. There was not enough bad weather or night to make up for this German disadvantage in the air. High complexity aircraft and weapons give up presence (because high cost reduces numbers and supportability problems reduce sortie rates--i.e., numbers in the air) in an attempt to get lethality--a quality whose value is maximized in an attrition model.

- In 1939 and 1940, the German blitz through Poland and the West left the Germans with between 200,000 and 250,000 casualties--virtually all killed or wounded. In contrast, the allies suffered between 3,300,000 and 3,500,000 casualties--of which about 3,000,000 were prisoners. An attrition model would give no idea of the enormity of the German victory. The allies were utterly defeated and the huge prisoner of war bag was more of an indicator of this collapse than the dead bodies. Attrition models cannot calculate the "probability of capture"--the decision to surrender is a distinctly human intangible that no sane analyst would dare try to compute or predict. Even Clausewitz, who is often regarded as the leading theoretical exponent of attrition warfare, has written that prisoners and captured material are much better indicators of success than dead bodies. Captured live bodies are generally indicators of the enemy's declining moral strength.

- In the 1973 Arab-Israeli War, the Israelis decisively defeated the Egyptians (a victory that was not exploited for political reasons) when they captured the entire Egyptian 3rd Army and held them hostage. Again, live bodies were a more important indicator of success than dead bodies.

- Then there is Viet-Nam, we "managed" the Viet-Nam war according to the attrition model. Measures of effectiveness were the body count, truck kill, etc. The fact that we often thought we were winning indicates that these measures can be misleading. Viet-Nam started off as a guerrilla war and Mao has written that in the early stages of a guerrilla war, the guerrillas should avoid fixed battles. Only when the war is reaching victorious culmination does Mao advocate participation in conventional battles. When the guerrillas are willing to stand and fight, their body count is likely to increase; however, their overall strategy suggests the disturbing thought that this body count may be measuring their success, not their failure.

Although the deterministic attrition mind-set shapes our perceptions of revolutionary capability, we see that attrition is not the only indicator of a weapons quality. Attrition is at best a partial description, at worst it can be misleading.

Even if one were willing to accept the attrition view of effectiveness, attrition models are generally based upon unconfirmed assumptions concerning the combat interaction (e.g., rules of encounter and shooting) and weapons performance. The following subparagraphs consider these limitations.

First, we will consider assumptions concerning the form of interaction. For example, air-to-air models generally assume that visual identification is <u>not</u> required either because theater wide rules of engagement permit shooting at unidentified targets, or because of the existence of a high reliability/noncooperative identification friend or foe (IFF) system--a system that has defied development for years and is still only projected to exist.

In general, attrition models do <u>not</u> account for human elements that can shape the form of the encounter--e.g., surprise, confusion, fear, etc. We will discuss the impact of this limitation in more detail during our discussion of force multipliers.

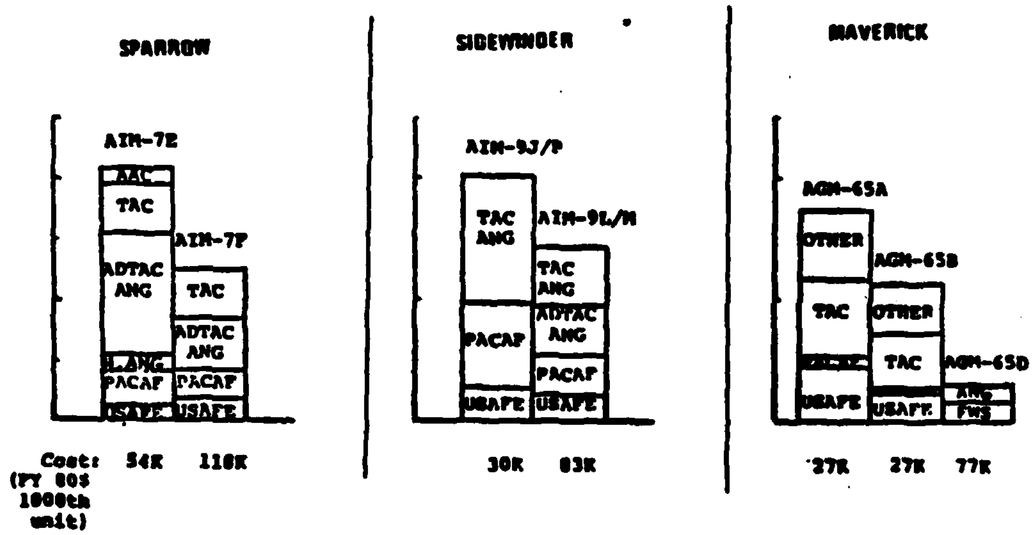
(Slide 70) Second, we will consider assumptions concerning weapon performance. By necessity, one of the most important weapon performance assumptions in the attrition model is weapon lethality--a quality that often is dependent upon the specific form of encounter and shooting as well as technical performance. A critical factor affecting performance and firing tactics is the assumed reliability of the missile. A 10% change in reliability changes the probability of kill by 10%. Recall from our definition of complexity and from our discussion of spares reliability (in the tac air material readiness section) that reliability is more difficult to predict for complex systems than for simple systems because increasing complexity increases uncertainty surrounding the interactions between components. Consequently, the best way to estimate reliability is through a live firing program conducted under realistic combat conditions. Moreover, as the complexity of a weapon increases, its number of failure modes increases. Therefore, a sound reliability verification program should increase the number of firings to maintain the same level of confidence in the reliability estimate.

However, if we look at the missile firing program shown in this slide (note: the projected program for FY 86 was selected to illustrate intentions when large inventories are available), we see that as cost and complexity increase, less missiles are projected to be fired--an observation implying cost is a major factor in shaping this program. This conclusion suggests that although the increased costs are justified in the attrition view by promised increases in lethality; the increased costs lead to <u>less</u> confidence in predicted lethality because our plans do not absorb the increased total cost of the missile firing program. This is one more example of the short term tendency to hold down readiness costs.

This is a defense wide phenomena--as weapons get more expensive, we tend to fire them <u>less</u>--and <u>less realistically</u>--in training and testing. For example, the current front-line air-to-air missile that is fired <u>the least</u> is the AIM-54 Phoenix missile--i.e., the most complex and expensive air-to-air missile in our inventory. Although this missile and its parent aircraft were designed to have a multiple firing capability against a mass air attack with electronic jamming, it has never been tested this way against numerous targets.

MISSILE FIRING PROGRAM

(FY 86)



SOURCE: PT82, USAF Program
Tactical Air Missiles
30 September 1980

Slide 70

(Slide 71) Summarizing the deterministic attrition mind-set, we see that it shapes a perception of capability that: (1) does not consider human elements; (2) is based upon an ambiguous or misleading measure of merit, and (3) embodies speculative or uncertain rules of engagement and performance. Quantitative attrition analyses suppress the visibility of these limitations. Precise, yet in reality uncertain and speculative assumptions are buried deep in the calculation. In addition, the appearance of scientific method combined with computational complexity discourages critical review. Consequently, debate and decisions tend to consider outputs only, and these outputs are what often underly perceptions of revolutionary increases in capability. The case of the AIM-82 missile illustrates this point. This slide was used in an Air Force briefing to describe the results of a quantitative attrition analysis predicting the effectiveness of the AIM-82 missile when fired from an F-15 fighter. At the time of this chart's construction, the AIM-82 was a paper missile and the purpose of the analysis was to determine whether or not to proceed with the program. The analysis "predicted" an exchange ratio of 955 to 1 in favor of the F-15. In other words, for every F-15 lost, this analysis predicted that we would shoot down 955 enemy fighters. Now recall that the F-4 achieved 2 to 1 in Viet Nam, so 955 to 1 represents a rather revolutionary improvement. What is significant about this result is that it reached the "four star" level of the Air Force before it was seriously questioned. The central point of this example is that speculative "evidence" of capability revealed through such attrition analyses can be intimidating and thus "persuasive," even to the initiated. What might normally be put into the category of pure hyperbole acquires the aura of scientific reasoning; "brilliant weapons" do seem plausible. As a footnote, the Air Force subsequently cancelled the AIM-82 on its own initiative.

AIM-82A PROGRAM

AIR COMBAT EFFECTIVENESS ANALYSIS (Cont'd)

EXCHANGE RATIOS

		THREAT MIG-21F, AIM-9J	THREAT MIG-21F, AIM-82/30°	THREAT MIG-21F, AIM-82/50°
F-15	AIM-9J	18/1	1/2.3	1/8
	AIM-9E (X)	22/1	1/1.6	1/6
	AIM-9K/50°	245/1	1.7/1	1/2
	AIM-82/50°	955/1	6/1	1.4/1
F-4	AIM-9J	1/6	1/41	1/159
	AIM-9E (X)	1/4.7	1/20	1/39
	AIM-9K/50°	1.2/1	1/2.3	1/5
	AIM-82/50°	5/1	1.8/1	1/1.4

Slide 71

NOTION #3 WAR IS MANIPULATABLE

(Slide 72) The mechanistic attrition mind-set encourages the third preconceived notion--i.e., the idea of war being a manipulatable deterministic process that can be centrally controlled. The focus is on lethality, and the enemy is treated as an inventory of inanimate targets to be processed at least cost. (Note: in Pentagonese this is known as "target servicing.") Complex attrition calculations amplify this view by lending respectability to speculations about the "capability" of increasingly complex weapons. Since, in this view, the only way to defeat the uncertain threats facing us is by fielding weapons having the increasing "capability" to service targets, long term growth in weapons complexity and cost is unavoidable and therefore low numbers must be accepted.

The princip~~le~~al physical dimension shaping our perception of the Soviet threat is its size. In the attrition perspective, this perception is magnified because it translates into a requirement to "service" a large number of targets. Moreover, this "servicing requirement" is perceived as all the more awesome because, as we have seen, rising cost (perceived as a necessary consequence of the increased capability to service targets) has led to force structure reductions. Consequently, we perceive a growing need to "optimally manage" our scarce attack assets when servicing this superior number of targets. To do this, it is argued, we need "force multipliers."

IMPACT

LONG TERM WEAPONS COST GROWTH PRECLUDES MAJOR INCREASES IN FORCE STRUCTURE:

——RESULT——

WE PERCEIVE INCREASING PRESSURE TO DEVELOP A MECHANISM TO "EFFICIENTLY ALLOCATE SCARCE ATTACK ASSETS" AGAINST A NUMERICALLY SUPERIOR ENEMY--

I.E., WE NEED FORCE MULTIPLIERS

Slide 72

(Slide 73) Force multiplication, involves first identifying our enemies "critical nodes"--i.e., targets--and then concentrating attacks on these critical nodes. To do this, it is necessary to collect vast quantities of sensor data, analyse it, uncover an enemy activity pattern, and synthesize that pattern into an appreciation of enemy intentions that can be quickly digested by the human mind. Speed dictates that this process be mechanized as much as possible. The appreciation would then quickly be communicated to the centralized manager for high-speed target servicing decisions and these decisions would be quickly implemented through a detailed command, control, and communication system. A fundamental requirement is a survivable communications system with the qualities indicated in this slide. Such a system currently does not exist.

FORCE MULTIPLICATION

- **NEED A THEATER SURVEILLANCE SYSTEM TO SEE BIG PICTURE**
  - **-- MUST ACQUIRE, PROCESS, AND INTERPRET VAST QUANTITIES OF SENSOR DATA**
- **NEED A BATTLE MANAGEMENT SYSTEM TO CENTRALIZE DECISION-MAKING**
- **NEED A DETAILED WEAPON ASSIGNMENT AND ENGAGEMENT SYSTEM**

NECESSARY CONDITION:

SECURE, RELIABLE, JAM-RESISTANT, HIGH-CAPACITY COMMUNICATIONS SYSTEM

Slide 73

(Slide 74) Force multiplicaton in combat must be "well-oiled"--the complex interaction of sensors, data links, processing and fusion centers, geo-positioning systems, command guided weapons, etc.--and people--must work smoothly in the chaotic stresses of combat. This slide shows a very partial list of the types of systems used in force multiplication. Many of these systems are exceedingly complex and have virtually unknown downstream supportability implications. Military maintenance concepts have not even been specified for some systems. Force multipliers intend to solve a problem caused by complexity--i.e., low numbers--by pumping in more complexity, not only at the "bits and pieces" level; but more importantly, by pumping in complexity at the organizational level. Our emerging communication linkages illustrate this crucial point.

FORCE MULTIPLIERS - (Continued)

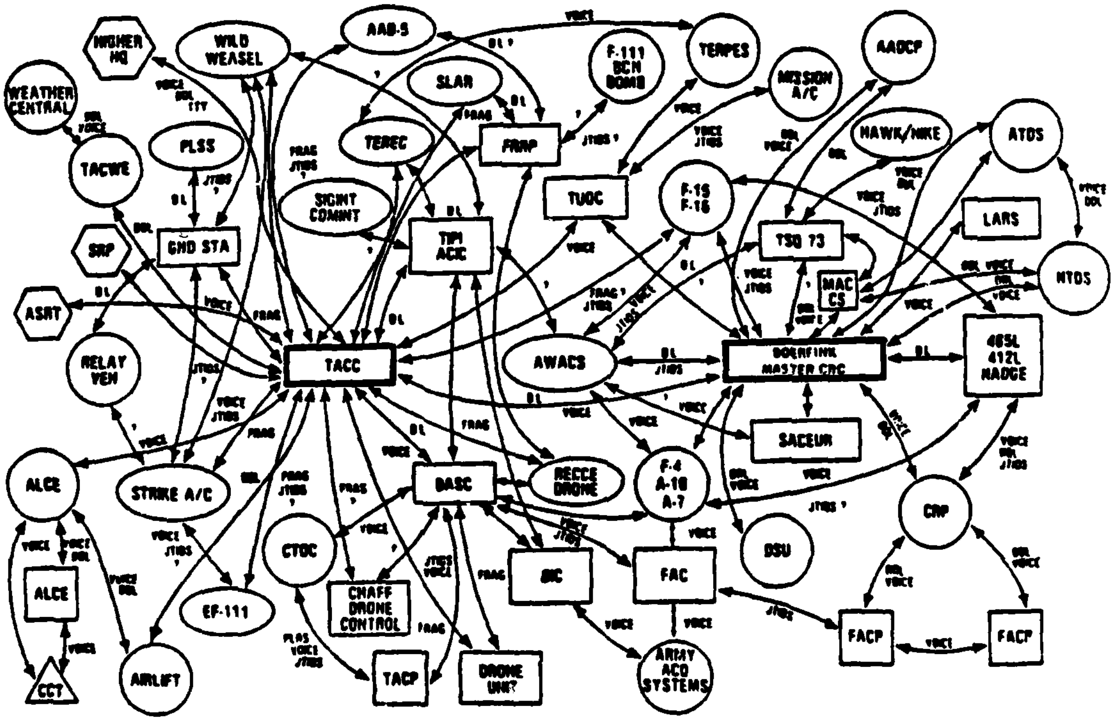
TO FORCE MULTIPLY IN COMBAT, WE WILL NEED A WELL-OILED TECHNOLOGICALLY SOPHISTICATED COMPLEX INCLUDING --INTER ALIA--SENSORS, DATA LINKS, COMPUTERIZED PROCESSING AND FUSION CENTERS, PRECISE GEO-POSITIONING SYSTEMS, STAND-OFF COMMAND GUIDED WEAPONS.

SYSTEMS REQUIRED: PLSS, AWACS, QSR, JTIDS, PAVE MOVER, GPS, LORAN, BETA, TR-1, GBU-15 . . . .

SOLUTION: MORE COMPLEXITY

Slide 74

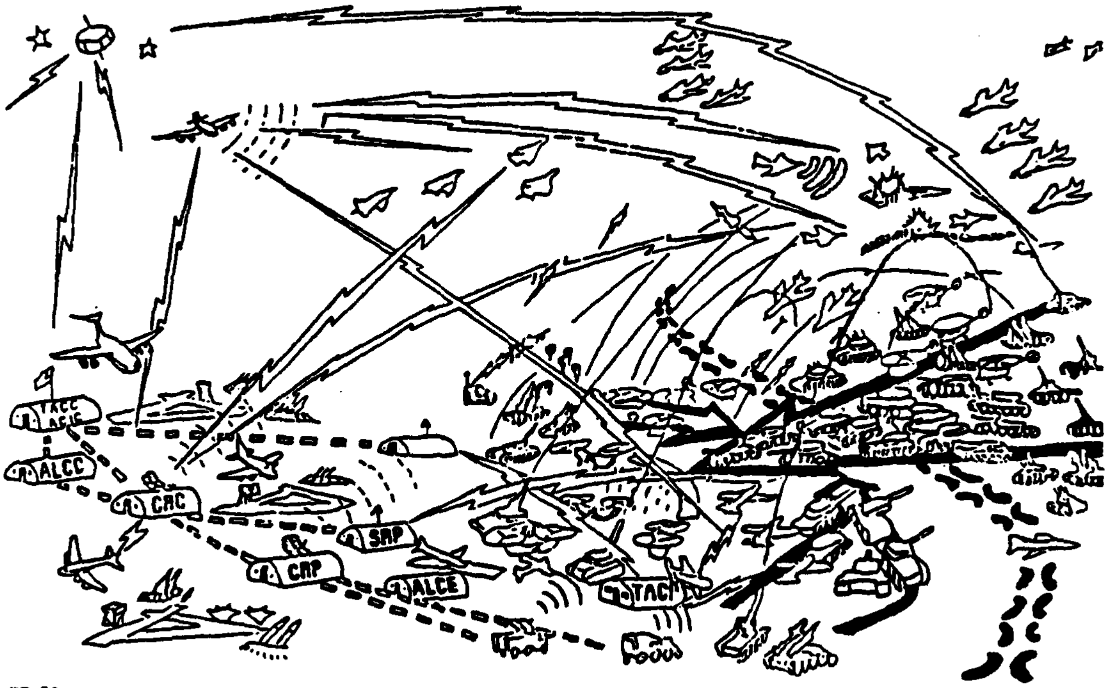
(Slide 75) This slide, taken from an official briefing, lays out the communications linkages perceived necessary in a modern force multiplication scheme. It is important to appreciate that this slide is the result of a serious analysis of the NATO Command, Control and Communications, and Intelligence (i.e., C^3I) system. Note the JTIDS (Joint Tactical Information Distribution System) links--often they are followed by an ambiguous "?" indicating a possible linkage. Lets look at the linkage capability of JTIDS a bit more closely.



XP 17

SLIDE 75

CONTROL AND COMMUNICATIONS



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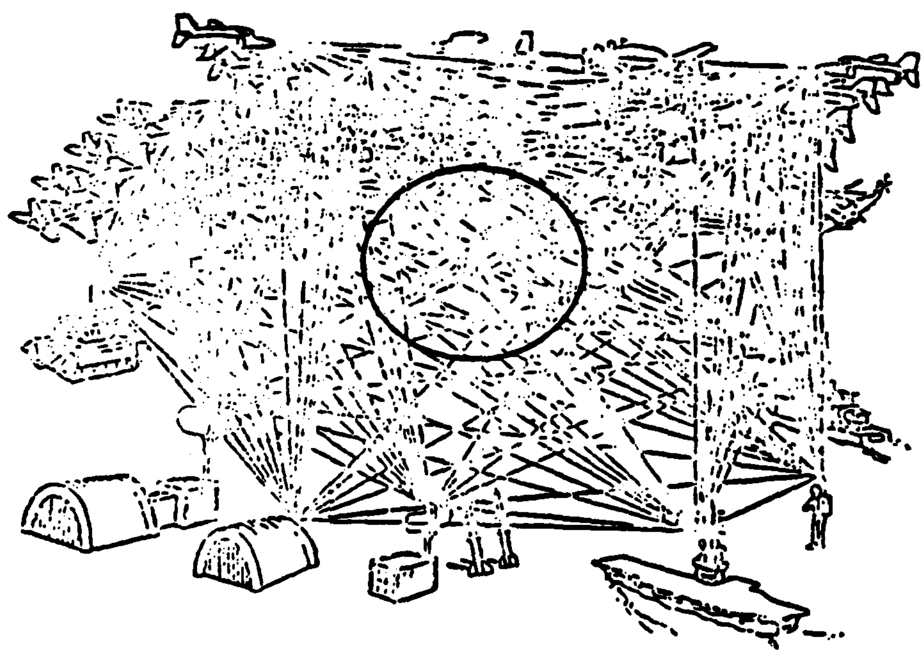
SLIDE 75A

(Slide 76) On paper, JTIDS has a phenomenal capability to transmit data. Whether such data can be turned into information and absorbed by the human brain during conditions of combat is another matter. This slide was taken from an analysis having the purpose of defining JTIDS' operational concept. The analysis was intended to support DSARC deliberations over the future course of the program so it also represents the results of a serious effort. Proliferating data communications such as JTIDS raise a question concerning our ability to absorb the information being communicated.

Thus, we see that in addition to increasing weapons complexity, the mechanistic attrition mind-set and the idea that war is a manipulatable deterministic process lead to increasing hardware and organizational complexity in command, control, and communications. However, we have also seen that the attrition perspective abstracts out unpredictable human actions. Since command and communications are meaningless concepts without people, we are forced to squarely face the intangible issue concerning the impact of this increasing technological complexity on soldiers in combat.

INFORMED PILOTS KILL MORE AND LIVE LONGER



CONTRACT SPONSOR ESD
CONTRACT NO. [illegible]
PROJECT NO. [illegible]
DEPT. D61

Slide 76

(Slide 77) One of Clausewtiz's enduring contributions is his study of human behavior in war. We can use his concept of friction to help crystalize this issue. This slide displays one of his most famous statements.

> EVERYTHING IN WAR IS VERY SIMPLE, BUT THE SIMPLEST THING IS DIFFICULT. THE DIFFICULTIES ACCUMULATE AND END BY PRODUCING A KIND OF FRICTION THAT IS INCONCEIVABLE UNLESS ONE HAS EXPERIENCED WAR.

CARL VON CLAUSEWITZ

Slide 77

(Slide 78) Clausewitz's concept of friction describes why things naturally go wrong in war. Friction includes some of the factors underlying the material readiness patterns discussed earlier. Friction is bad weather during the Battle of the Bulge, contagious panic in France in 1940, an empty prison at Son Tay, and the dominant characteristic of the Iranian rescue mission. A famous response to friction is the WWII phrase: "Keep it simple, stupid." Clausewitz considered friction to be the central factor that distinguished real war from theoretical analyses. The existence of friction means that war is not a deterministic process. The clarifying question concerning the impact of complexity on the man-machine relationship in combat is: Does increasing complexity increase or reduce friction?

By necessity, we need to look at real war so this question can only be answered through historical research. Col John Boyd, USAF Ret., significantly enriches Clausewitz's concept of friction in his thought provoking briefing "Patterns of Conflict." This briefing summarizes Boyd's research on conflict from 400BC to the present. According to Boyd, Clausewitz had a limited one-sided view of friction. Clausewitz was concerned about reducing his own friction (a valid concern) but he failed to see the opportunities for increasing his enemy's friction. Boyd observes that the writings of the Chinese military theorist, Sun Tzu, stress these opportunities and that the extraordinarily successful operations of Genghis Khan and Tamerlane exploited these opportunities. Boyd then

CLAUSEWITZ ON FRICTION IN WAR

- FRICTION IMPEDES THE SMOOTH FUNCTIONING OF THE MILITARY MACHINE
- FRICTION IN WAR INCLUDES:
  - FOG OF WAR: DECISIONS MUST BE BASED ON IMPERFECT INFORMATION
  - PSYCHOLOGICAL PRESSURE
  - PHYSICAL STRESS ON MEN AND MACHINES
  - THE UNEXPECTED

FRICTION DISTINGUISHES REAL WAR FROM WAR ON PAPER

ONLY ONE LUBRICANT REDUCES FRICTION:

COMBAT EXPERIENCE

- QUESTION: DOES INCREASING COMPLEXITY INCREASE OR REDUCE FRICTION?

Slide 78

synthesizes these two views with the operations of Genghis Khan, Napoleon, the successful German blitzkrieg commanders, and successful guerrilla commanders into a general theory of conflict--a theory that he supports with historical analysis and observations from real war. In sharp contrast to the deterministic view of the attrition mind-set, the central consideration in Boyd's theory is human behavior in conflict. In this context, he suggests that increasing complexity works on our mind and makes mental operations more difficult. It causes commanders and subordinates alike to be captured by their own internal dynamics--i.e., they must devote increasing mental and physical energy to maintain internal harmony--and hence they have less energy to shape, or adapt to, rapidly changing external conditions. In Boyd's perspective, the idea of decreasing complexity to diminish our friction and free up our operations gives us the opportunity to magnify our enemy's friction and impede his operations.

Force multipliers use emerging technology to centralize decision-making and control. There is precedent for a centrally directed war of attrition. Basically, WWI was a "big logistics" war of attrition requiring detailed coordination of large masses that moved over a limited transportation system. Centralization was perceived as desirable and communications technology--i.e., telephone--enabled the centralization of command and control in what quickly became a static war of attrition. All major beligerents evolved centrally directed forces.

Late in the war, the Germans began to appreciate that this centralization was a major source of weakness. The allies had exploited their communications and the centralized system had increased their rigidity. For reasons that are not relevent to our example, the Germans failed to break the stranglehold of centralization during the war. However, after the war a former signals (i.e., communications) officer named Heinz Guderian had a brilliant innovative conception to restore mobility and to get away from the effects of debilitating attrition.

Guderian's conception resulted in the blitzkrieg, and a central ingredient of his idea was to use emerging communications technology to decentralize command and communications. In this regard, his brilliant innovations were

- Put a radio in every tank

- Set up a division communications net so that the commander could command from any point in the division

- Commanders forward, always be at the decisive point of action. Result: on the spot decision-making is quicker and clearer, orders were radioed back to Chief of Staff who was empowered to over-rule his superior if necessary, and personal leadership set a superb moral example

- Verbal orders only, convey only general intentions, delegate authority to lowest possible level and give subordinants broad lattitude to devise their own means to achieve commander's intent. Subordinants restrict communications to upper echelons to general difficulties and progress. Result: clear, high speed, low volume communications.

These brilliantly simplifying ideas, as embodied in Blitzkrieg, "force multiplied" against the French in 1940--i.e., in addition to the Maginot Line, the French had a larger number of equal or better quality tanks than the Germans. When it was allowed to operate unfettered in the East, the blitzkrieg approach "force multiplied" successfully against Russian numerical superiority. We should not let the fact that the Germans lost WWII (together with excesses and evils of the Nazi regime) blind us to the lessons that can be learned from this impressive performance.

We have seen that attrition can be a misleading indicator of success or failure; we should also realize that the specific form of attrition assumed in force multiplier models--and quantitative attrition analyses in general--is a form that rarely occurs in combat. These models assume that attrition takes the general form described by Lanchester in his famous paper (circa 1917) analysing air-to-air combat during World War I. Actually, Lanchester hypothesized three alternative forms of attrition; however, his "concentration of firepower" or "Square Law" is the most widely used form. The "Square Law" hypothesizes that the attrition rate for a Blue force is a constant (determined by Red's individual weapons effectiveness) multiplied by the surviving strength of the Red force. Red's attrition rate is calculated in an identical fashion.

(Slide 79) Given Lanchester's equations, the starting size of the opposing forces and their weapons lethality estimates determine the probability of battle outcomes. Unfortunately, real world combat data does not support the Square Law's hypothesis. The dashed "S" curve in the left hand chart of this slide plots the Lanchesterian probability of a Blue victory as a function of Blue-to-Red force ratios. The solid curve represents the results of a wide range of historical battle outcomes. Lanchesterian predictions are extremely sensitive to force ratios--hence, since we seem to be outnumbered, the belief in the need for force multipliers. Actual combat outcomes suggest that force ratios are far less influential--numbers are relevant but they are <u>not</u> the magic answer either.

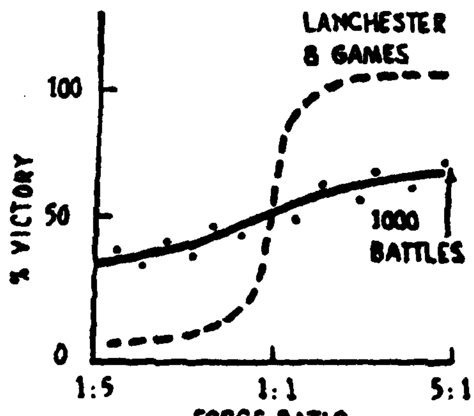
One reason why Lanchesterian predictions fail is that they assume lethality is <u>constant</u>. Even if we ignore the speculative assumptions underlying weapons lethality discussed earlier, it turns out that lethality is determined, in large part, by external combat circumstances. Lethality is <u>not</u> constant in real war, the right hand chart plotting exchange ratios versus force ratios illustrates this point. Lanchester (i.e., the dashed line) predicts that lethality is independent of force ratios. Analysis of real war shows that exchange ratios (the relative lethality of the defenders' weapons to the attackers' weapons) change dramatically (note the logarithmic vertical scale) with the attacker to defender force ratio. In other words, the more the defender is outnumbered by the attacker, the more lethal the defenders weapons are. The defender may still lose but he is going to take a lot of attackers with him. There are many plausible reasons for this pattern when human considerations are added. For example, when greatly outnumbered, the defender is likely to know he is in deep trouble and consequently he may be more willing to take risks, he may be resigned to "die like a man" taking as many of the enemy with him, and he doesn't have much of an IFF problem--he can shoot at just about anything that moves. On the other hand, the attacker may be confident of success--why take chances, and he may face a tougher IFF problem. Evidence and common sense suggest that the Lanchester "concentration of firepower" effect is swamped by other factors.

By assuming that individual weapons lethality is constant, the Lanchesterian perspective abstracts out the unpredictable human element, and tends to become preoccupied with weapons "capability" and force size. This directs attention away from the <u>decisive</u> contribution of human skill. For example, Lanchester ignores the impact of <u>suprise</u> (an effect that is by definition unpredictable). He assumes that if Blue fires the first shot and per chance misses, the probability of kill for the second shot is unchanged--i.e., Red is too stupid to duck behind cover. History is filled with examples of surprise being the major effect shaping outcomes. For example, since WWI, 60%-80% of the air-to-air kills in all wars have been against an enemy who was surprised. Lanchester also ignores the increased friction caused by the distinctly human effect of <u>confusion</u>.

As engagements increase in numbers of participants, they become more difficult to understand and much harder to handle with automated systems. The AIMVAL/ACEVAL tests reveal that exchange ratios changed as complexity of the engagements increased--even when force ratios are held constant. As engagements went from 1V1 to 2V2 to 4V4, exchange ratios changed significantly. On a much grander scale, Boyd has uncovered extensive historical evidence suggesting that ambiguity and fear can be exploited to undermine the enemy's mental operations to the point of bringing about his collapse as a functioning military force.

Example:

FAILURE OF BATTLE OUTCOMES TO CONFIRM MODELS



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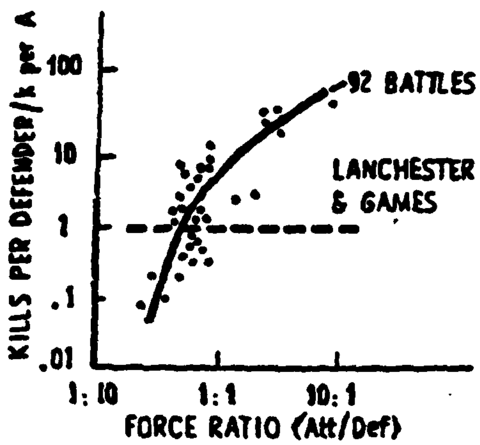


REF: R. HELMBOLD (NATO)

Slide 79

(Slide 80) One final, and perhaps most important comment on the attrition mind-set. If we are going to allow the mechanistic attrition perspective to dominate procurement and operational planning, we should ask whether this is a sensible strategy for the US to use against the USSR. More than any nation in history, the USSR has demonstrated that it can take enormous attrition and win. Although a strategy of attrition plays right to a principle source of Soviet strength, the US has never experienced a level of attrition that even remotely compares to the Soviet experience. Our ability to play the game on the Soviet scale is not demonstrated. This chart depicts the combat deaths of the beligerents in WWII. By our measure of merit, we were minor combatants having less casualties than the Rumanians. The bar at the far right depicts the total number of combat deaths since 1776 including both sides of the War Between the States. It is interesting to note that the Russians were completely defeated in WWI--to the point that society collapsed--yet they suffered less than one-third the casualties suffered in WWII.

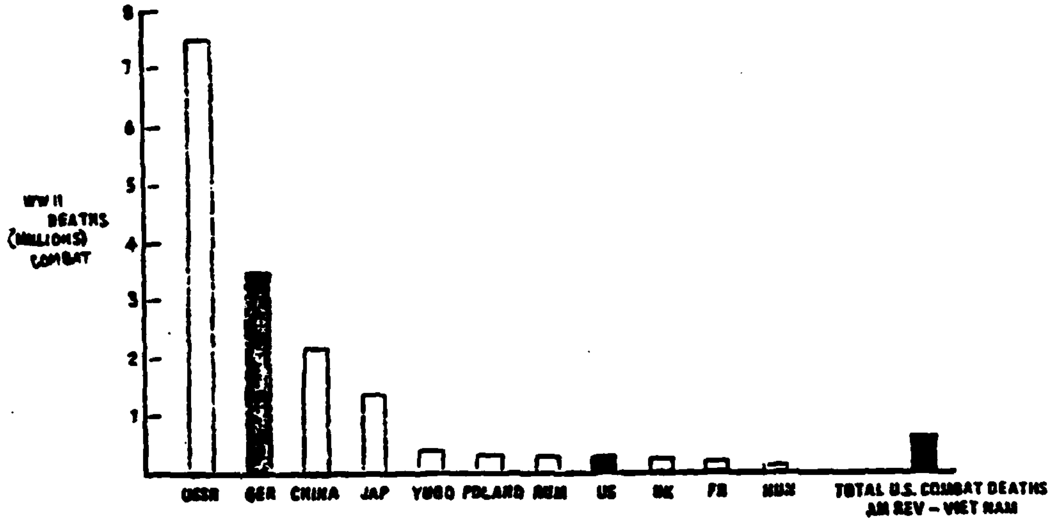
Summarizing this section, we have discussed the excessive influence of three beliefs shaping our perceptions and decisions. ● The first is our faith that advancing technology will make the future different from the past. This faith is reinforced by the ambiguity surrounding perceptions of capability and the future performance of emerging technologies. The result is a subtle permissive influence stimulating the mismatch between our short-term and long-term budget behavior.

● The second influence shaping our perceptions and decisions is the mechanistic attrition mind-set. The attrition mind-set shapes our perception of capability through its excessive focus on individual weapon lethality. Decisive elements of combat effectiveness are ignored, and its deterministic perspective encourages the belief that war is quantifiable via body count and number of targets destroyed. Weapons of increasing complexity and cost can be easily justified by predicting high lethality. Moreover, our faith that high technology weapons offer revolutionary capabilities (i.e., the first belief) amplifies these perceptions.

● The third belief shaping our behavior is the idea that war is a manipulatable deterministic process that can be centrally controlled. This perception is amplified by our faith in revolutionary implications of emerging technology and by the attrition mind-set. By ignoring human elements and the concept of friction (in Col Boyd's sense), this notion of war leads naturally to the speculative concept of "force multipliers"--a bureaucratic buzzword that subtly implies one is getting something for nothing.

THE STRATEGY OF ATTRITION

QUESTION: CAN THE U.S. ENDURE THE PAIN? 1/



1/ PARTICULARLY – IS THIS STRATEGY REALISTIC AGAINST RUSSIANS?

Slide 80

VI Observations and Conclusions

We have examined the realism of defense decision-making and planning by relating uncertainties and variations in the real world to our decisions and plans. Our discussion revealed the following interconnected impressions:

The bureaucratic mechanism producing our financial plans establishes conditions for a mismatch between plans and reality by assuming certainty in future budgets and costs when in fact the real world is characterized by uncertain budgets and costs. Our country's economic problems suggest that the problem of budget uncertainty is likely to get worse over the coming decade and the increasing complexity of our hardware suggests that the problem of cost uncertainty will get worse. A sound planning system must recognize these uncertainties if a comprehensive strategy addressing the future consequences of current decisions is to be produced. (Note: recently it has become fashionable to argue that the solution to the planning problem is to have eight-year planning instead of five-year planning. This recommendation misses the central issue of uncertainty and in all probability will make matters worse because then we would be saddled with producing eight-year plans one year at a time. Tying up more people by increasing debilitating out-year "square-filling" exercises is not a solution. The central need is for a flexible planning system--you don't increase flexibility by lengthening the straight-jacket.)

I • The historic mismatch between short-term and long-term budget behavior is evidence that we have not been able to convert our short-term desires (which continue to be reflected in our plans) into long-term reality. In the short-term, we try to hold down readiness expenditures and pump up modernization expenditures; however, despite long-term savings from quantity reductions in people and force structure, the rising cost of low readiness has squeezed modernization over the long term.

II • The increasing complexity of our hardware is an inseparable part of this destructive pattern because it is the source of the long-term increases in the magnitude and the uncertainty of both investment and operating costs. The sharply increasing cost of replacement slows modernization and the rising cost of low readiness (i.e., operating costs that must be absorbed) squeezes the overall investment budget, in effect magnifying the process by leaving less money to modernize with more expensive equipment. Growing operating costs have overwhelmed the savings accrued from the significant long-term reductions in personnel and force structure.

III • The case of AF Tac Air suggests that budget constraints are not the source of the problem. The problem is more one of a collective decision and planning process that does not consider the future consequences of its decisions. During the 1970s, Tac Air implemented a budget profile similar to that projected in current plans. The vigorous post-Viet Nam equipment investment in Tac Air was accomplished, in part, by readiness reductions and deferred investment in other areas. However, as we enter the 1980s, we find that Tac Air's investment requirements for the next five years and the rising cost of low readiness has made it, once again, too expensive to plan significant readiness improvements over the next five years. Notwithstanding these plans and the current low state of personnel and material readiness, this budget is justified by a War and Mobilization Plan that projects a near-term readiness for an across-the-board surge to incredibly high sortie rates in a short-warning European war.

IV • In general, our current plans for high peacetime budget growth project the same historical tendency to pump up investment and hold down readiness. Investment plans change dramatically from year to year and the pattern of these changes indicates that these plans embody optimistically low esimates of future investment costs. Moreover, these investment plans are accompanied by unrealistically low projections of operating costs. In general, it appears that our plans do not account for the future consequences of current decisions.

V • The amplification of three questionable beliefs seems to have put us into a mental straight-jacket. No alternative to increasing complexity can be conceived when perceptions are shaped by: (1) the perpetual faith that a technological revolution in cost and "capability" is right around the corner; (2) "capability" as defined by the attrition mind-set; and (3) the idea that war is a manipulatable deterministic process that can be actually controlled. By ignoring decisive human elements and the concept of friction, these perceptions stimulate decisions that accelerate the growth in complexity--i.e., increase our dependence on a strategy that is not working.

These general impressions enable us to make some statements about institutional factors impeding realistic planning.

(Slide 81) The planning process lacks overall discipline. The PPBS directs attention to the "bits and pieces" making up the "whole," and as a result, decision-makers are swamped with detail. The administrative complexity of the PPBS compounds the ambiguity, in effect, softening up the decision process to the excessive influence of narrow interests.

These narrow interests take the form of unbalanced investment advocacy pressures. We have seen that our plans are dominated by these pressures: planned overall investment budget growth is unrealistically high, predicted investment costs are understated, there is the tendency to add new investment programs when budget constraints are eased, and the operating accounts are underfunded.

Investment decision-making focuses attention on individual procurement programs. Since the general problem of the cost-budget squeeze cannot be ignored, it takes the form of arbitrary budget constraints and the sponsors of individual systems bureaucratically compete for limited funds. This competition is intensified by rewarding the program sponsor in accordance with how successfully he moves "his" program through the "bureaucratic wickets." The advocate depends, in part, on the contractor for cost information. The attrition mind-set measures capability in terms of the "capacity-to-kill-per-dollar" so the advocate is under continuous pressure to maximize the decision-maker's perception of this measure. The case of the AIM-82 is only an extreme example. Consequently, we have the ingredients for an incentive structure that is likely to be biased towards being optimistic when predicting future costs and "capability." Increasing complexity magnifies the impact of any bias because the costs are more difficult to predict and the stakes are greater.

OBSERVATION

DECISIONS AND PLANS LACK DISCIPLINE: FOCUS IS ON "BITS AND PIECES", NOT THE "WHOLE"

- **PLANNING IS DOMINATED BY INVESTMENT ADVOCACY**
  - **Resource Expectations Are Optimistic**
  - **Operating Accounts Are Underfunded**
- **NARROW FOCUS IGNORES "REAL WORLD" UNCERTAINTY**
- **FIXED FORCE STRUCTURE PLANNING GENERATES INCENTIVE TO MAXIMIZE PERCEIVED UNIT CAPABILITY**
- **UNBALANCED ADVOCACY PRESSURES IN A HIGHLY VISIBLE – YET WEAK – ADVERSARY PROCESS PROVIDES LITTLE PRESSURE TO REMOVE CONTRADICTIONS PRESENT IN THE "WHOLE"**

RESULT

✔ *Poor Correspondence of Plans with Reality*

✔ *Internal Contradictions*

✔ *Fallacious Belief that Growing Budget Will Solve Problems*

SLIDE 81

A system that is dominated by individual program advocacy cannot cope with these uncertainties. The impact of unplanned cost growth is viewed in terms of an individual weapon's cost rather than in terms of the impact to overall force effectiveness. Since the majority of investment programs exhibit cost growth and since we have a tendency to absorb cost growth in lieu of cancellation, short-term individual decisions to absorb incremental growth accummulate imperceptibly through gradual quantity reductions and readiness reductions. Unplanned budget variations contribute to this pattern, and also provide a convenient source of blame for the problem.

Fixed force structure planning directs attention away from the "whole" (why look at the "whole" since it is fixed?) and provides an arbitrary incentive to increase the complexity of the parts--i.e., to maximize their perceived "capability." The services should at least have the option (and incentive) to consider larger numbers of lower complexity, higher effectiveness systems.

Finally, the PPBS centralizes a highly visible, yet in reality weak, adversary process that provides the illusion of overall control and thus directs attention away from the problem of program discipline. The excessive influence of investment advocacy that is evident in our plans confirms the observation that there is little pressure to remove internal contradictions. For example, we advocate increased budgets because we perceive a growing threat, yet at the same time we project low readiness to meet the same growing threat.

Finally, the domination of plans by narrow interest leads to the fallacious belief that a growing budget will solve our problems. The problem of cost growth is erroneously attributed to arbitrary budget constraints. This is why the case of tac air is so important--Tac Air has the same general problems as the rest of the defense categories, the difference is that tac air has not been constrained like the other forces.

We believe the establishment of program discipline is fundamentally a leadership challenge. Management gimmicks have been tried and they do not work. Moreover, management gimmicks (e.g., zero based budgeting, Blue Ribbon Panels, Defense Resources Board, etc.) have the effect of a placebo rather than a cure--in effect they contribute to the problem by conveying the false impression of a solution. What is required is leadership that can make real national defense take precedence over the component interests involved in defense.

(Slide 82) The planning of individual investment programs is dominated by the absolute thinking of the formal requirements process. Uncertain future threats are precisely defined and this becomes the basis for a rigid specification of an operational need. Once these "needs" are bureaucratically blessed, they tend to become cast in concrete, and only rarely are they subsequently questioned. Finally, the implications of resource constraints are not addressed--requirements are viewed to be absolute entities, independent of actual cost and manpower constraints.

Theoretically, requirements are supposed to be independent of solutions; however, this rarely if ever, turns out to be the case. Since the operational requirement is a major factor affecting successful program advocacy, inevitably requirements become tied to and confused with specific systems. In reality, requirements are most often written with specific hardware systems in mind. Absolute requirements tied to specific systems that are competing for limited resources under the pressures of institutionalized program advocacy is a prescription for intolerance. The system is perceived to be absolutely needed, there are no alternatives to the preferred solution, organizational commitment must be mobilized to insure successful competition for limited funds. Result: an atmosphere that discourages critical review naturally evolves. For programs with a high degree of organizational identification, the atmosphere usually evolves to a point where objective criticism gets confused with disloyalty.

The symbiotic effect of the institutionalized program advocacy and formalized requirements process results in enormous resistance to change, particularly program cancellation, and one of continuous pressure to add new programs. Very few programs are cancelled and new programs tend to be added whenever budget constraints are eased. In the presence of rapidly growing unit costs, the net effect is one of across-the-board reductions in procurement rates, even when budget constraints are eased.

OBSERVATION

INVESTMENT PLANNING IS DOMINATED BY A REQUIREMENTS PROCESS THAT:

- CLEARLY DEFINES AN UNCERTAIN FUTURE THREAT
- RIGIDLY SPECIFIES THE OPERATIONAL NEED
- DOES NOT ADDRESS IMPLICATIONS OF RESOURCE CONSTRAINTS

RESULT: ABSOLUTE THINKING LEADS TO INTOLERANCE

- ALTERNATIVES ARE ELIMINATED
- COMMITMENT TO PREFERRED SOLUTION IS STRICTLY ENFORCED
- OBJECTIVITY, CREATIVITY, AND CRITICISM ARE DISCOURAGED

SLIDE 82

(Slide 83) Although we buy technology to support <u>soldiers</u> in war, plans and decisions do <u>not</u> use the criteria of actual combat to evaluate the potential contributions of emerging technology. Technology is evaluated within an artificial framework derived from the faith in technological revolution, the attrition mind-set, and the idea that war is a manipulatable deterministic process subject to central control. We have seen that this framework considers neither the decisive effect of the human elements nor the central characteristic of actual war--i.e., friction.

This pattern of decision-making is made easier by the institutional fact that there is no senior Pentagon staff organization chartered to study war--particularly, how soldiers act in war and how we can use emerging technology make these actions more effective. The criteria of actual combat can only be derived from the study of combat history and the tactics and strategy of real war. A fundamental value of Boyd's research in this area is that it demonstrates what is possible. He constructs and validates a frame of reference that can be used to evaluate the contributions of new technologies to the effectiveness of real soldiers in real wars.

We have seen that program decisions are supported by hypothesized mechanistic attrition models that ignore the friction of combat and are based upon unvalidated,speculative assumptions. Further, it is rarely possible to even define combat data that could be used to test these theoretical models. This is the antithesis of the scientific method.

Although the study of history can be carried too far; history is the <u>only</u> "evidence" of real war, and to ignore it completely leads to a modern form of medieval scholasticism--i.e., the religion of miracle weapons. Hitler provides an ominous precedent for this unrealistic faith in technology--an observation suggesting a disturbing question: Was Hitler's faith in miracle weapons apparent between 1939 and 1941 when he was winning, or was it apparent in 1944 and 1945 when he was losing?

By ignoring the real world, we have evolved a self-reinforcing--yet scientifically unsupportable--faith in the military usefulness of ever increasing technological complexity. We tend to think of military strength in terms of wonder weapons that are in reality mechanistic solutions--the concept of force multiplication being the latest example.

OBSERVATION

REAL WORLD CRITERIA FOR JUDGING THE TECHNOLOGY TO SUPPORT HUMAN ACTIVITY ON WAR IS NOT CONSIDERED IN DECISIONMAKING AND PLANNING

- THERE IS NO ORGANIZATION CHARGED WITH UNCOVERING THE PATTERNS UNDERLYING HUMAN CONFLICT AND HOW THESE CAN BE EXPLOITED BY EMERGING TECHNOLOGIES
- DECISIONS ARE SUPPORTED BY THEORETICAL MODELS, NOT HISTORICAL ANALYSES
- THERE IS A LACK OF COMBAT DATA TO VALIDATE MODELS AND TESTING

RESULT: THE NEW RELIGION

✔ *A Self-Reinforcing – Yet Scientifically Unsupportable – Faith in the Military Usefulness of Ever Increasing Technological Complexity*

✔ *Mechanistic Solutions that Presume Military Utility Can Be Equated to Precise Engineering Specifications*

SLIDE B3

(Slide 84) In the real world of uncertain budgets and rising costs, we have seen that our decisions and plans have resulted in a force having the qualities listed on this slide. These are qualities of complexity---and they take the form of costs. The costs of increasing complexity can be generalized into low readiness, slower modernization, and declining forces. The crucial question is: Are there positive qualities of complexity to outweigh these negative qualities?

INCREASING WEAPONS COMPLEXITY REDUCES COMBAT READINESS

- DEGRADES COMBAT SKILLS BY CAUSING INADEQUATE AND UNREALISTIC TRAINING
- INCREASES REALIABILITY AND MAINTAINABILITY PROBLEMS
- INCREASES COST OF MAINTENANCE
- INCREASES DEPENDENCE ON LARGE VULNERABLE SUPPORT BASE
- INCREASES ECONOMIC INEFFICIENCY OF PLANS
- SLOWS MODERNIZATION BY INCREASING DEVELOPMENT/PROCUREMENT LEAD TIMES
- MULTIPLES MAGNITUDE AND LIKELIHOOD OF DISASTER
- INCREASES VULNERABILITY TO COUNTERMEASURES
- CUTS FORCES, SUPPLIES, AND MUNITIONS TO INADEQUATE NUMBERS

QUESTION

Do the Distinctive Characteristics Generated by Weapons Complexity Compensate for these Negative Qualities?

SLIDE 84

(Slide 85) Our objective has been to determine the realism of our plans, this slide depicts our finding.

FINDING

PLANNING APPEARS TO BE INDEPENDENT OF:

- THREAT
- BUDGET

Slide 85

(Slide 86) Planning does not relate to future decisions; rather it relates to the future consequences of current decisions. In a nutshell, Pentagon economics discount the present and inflate the future.

...OR PUT ANOTHER WAY, THE FUTURE CONSEQUENCES OF TODAY'S DECISIONS ARE:

? ?

ECONOMICALLY UNREALISTIC PLANS THAT REDUCE OUR ABILITY TO MEET THE THREAT IN ORDER TO MAKE ROOM (HOPEFULLY) FOR FUTURE MONEY ADVOCATED TO MEET A HYPOTHETICAL THREAT

? ?

Slide 86

(Slide 87) We do not see how we can avoid this painful realization. The across the board thrust towards ever increasing technological complexity just is not working. We need to change the way we do business, and in particular, we should use our superior technology in a positive way. Technology should and <u>can</u> increase readiness, not draw it down.

THUS WE ARRIVE AT THE PAINFUL REALIZATION:

THE EVIDENCE PRESENTED REVEALS THAT:

OUR STRATEGY OF PURSUING EVER INCREASING TECHNICAL COMPLEXITY AND SOPHISTICATION HAS MADE HIGH TECHNOLOGY SOLUTIONS AND COMBAT READINESS MUTUALLY <u>EXCLUSIVE</u>.

SLIDE 87