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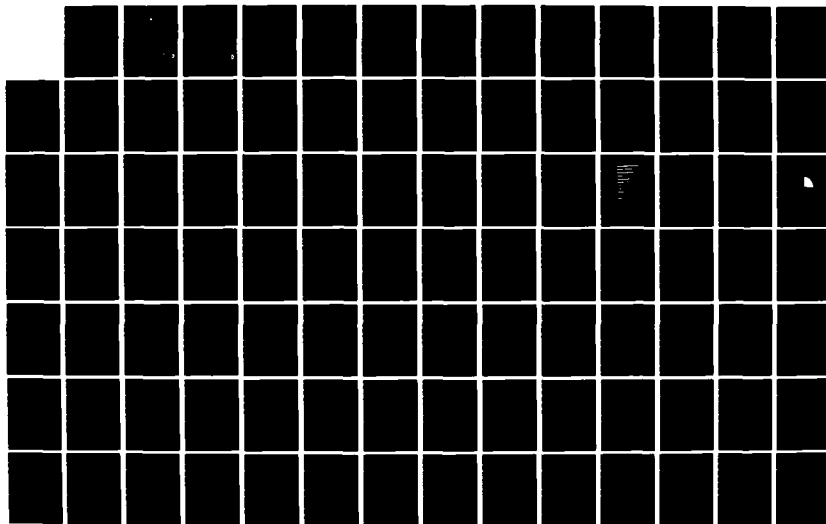
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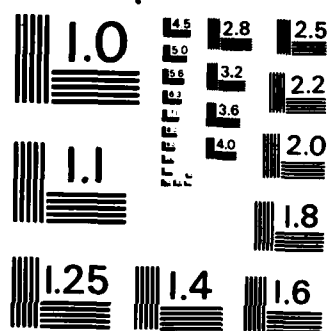
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INDUSTRIAL MODERNIZATION INCENTIVES
PROGRAM (IMIP)
THESIS
Stephen R. Cooper Charles E. Houck
Captain, USAF GS-12, DAFC
AFIT/GLM/LSP/85S-36

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MEASURING THE EFFECTIVENESS OF THE
INDUSTRIAL MODERNIZATION INCENTIVES PROGRAM (IMIP)

THESIS

Presented to the Faculty of the School of Systems and Logistics
of the Air Force Institute of Technology
Air University
In Partial Fulfillment of the
Requirements for the Degree of
Master of Science in Logistics Management

Stephen R. Cooper, B.A.
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September 1985

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The completion of a thesis at the Air Force Institute of Technology not only marks the fulfillment of a major requirement for the award of a master's degree in logistics management, but it also marks a very significant milestone in the professional development of all AFIT graduate students. It is doubtful that any AFIT graduate would disagree that, until a thesis is complete, it is a never-ending source of apprehension, frustration and bewilderment. Once finished, however, hatred and loathing give way to an understanding that, in retrospect, a certain degree of professional discipline and a great deal of knowledge were acquired in the process of completing all required research. Only two names appear on the cover of this thesis; however, our "thesis team" was comprised of numerous individuals whose contributions and support played a significant role in the successful completion of this project. In that light, we want to thank everyone who assisted us in this effort.

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Stephen R. Cooper

Charles E. Houck

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Abstract

The Industrial Modernization Incentives Program (IMIP), cited by Secretary of Defense Weinberger as "the number one DOD initiative" upon which "the future of a strong industrial base largely rests," will soon be evaluated to determine its ability to restore positive productivity growth rates and improved surge/mobilization capabilities within the U.S. defense industrial base. The ultimate validity of this review has been questioned, however, due to a lack of standard measurement criteria. As the first stage of a two-stage effort to test the hypothesis that the IMIP will reduce major weapon system costs; will maintain free and open competition; and, will revitalize the U.S. defense industrial base, government and industry IMIP managers were interviewed to identify valid measures of effectiveness. Nine criteria were recommended as valid, quantifiable measures of IMIP effectiveness upon which accurate measurement of IMIP project benefits should be completed during follow-on Stage II research.

MEASURING THE EFFECTIVENESS OF THE
INDUSTRIAL MODERNIZATION INCENTIVES PROGRAM (IMIP)

I. Introduction

General Issue

The chronic demise of the United States' defense industrial base since World War II has been repeatedly documented in the reports of numerous public, corporate, military and legislative research projects and investigative hearings. Historically, in almost every case, the reluctance of defense contractors to make the capital investments needed to modernize defense plants with state-of-the-art manufacturing technology has been cited as a major contributor to the weakening of the United States' defense industrial base. Specifically, many studies conclude that this failure to modernize defense plants with advanced technology has caused or contributed to the following:

- a. The productivity growth rate of the United States has consistently declined to the point where this country is "dead last in productivity improvements among all industrialized nations of the world" (41:16).
- b. The ability of the defense industrial base to respond to and sustain peacetime "surge" production rates and/or full wartime "mobilization" has been virtually destroyed (41:12). (One report, The

Ailing Defense Industrial Base: Unready for Crisis, concluded that this erosion of "surge" and "mobilization" capacities is so extensive that it is now doubtful that the defense industrial base can even meet basic Five Year Defense Plan requirements (41:22).)

- c. The continued use of increasingly obsolete industrial tools and equipment has contributed to significant increases in the cost of major weapon systems.

Although findings similar to these have been repeatedly emphasized for the last 25 years, only in the last ten years has the Department of Defense, in conjunction with major defense contractors, made a significant, orchestrated attempt to revitalize the sagging strength of the defense industrial base through widespread technical modernization of prime and subcontractor plants.

The cornerstone of this restoration effort is the Department of Defense Industrial Modernization Incentives Program (IMIP) (23:17). The IMIP was originally authorized as a test program by the Deputy Secretary of Defense in November 1982, in response to Initiative #5, Capital Investment, of the DOD Acquisition Improvement Program established in 1980 by then-Deputy Secretary of Defense Frank Carlucci. The objective of Initiative #5 was to "encourage, through a variety of mechanisms, capital investment by DOD contractors to increase their productivity" (32:A-8). To meet this objective, the IMIP was designed as

...a joint venture between government and industry to reduce weapon systems, weapon subsystems or equivalent acquisition costs. Also this venture is designed to accelerate the implementation of modern equipment and management techniques in the industrial base.... This joint venture is formalized through a contractual agreement providing incentives for contractor capital investment beyond that required to meet contractual requirements (2:5).

The importance of the Industrial Modernization Incentives Program to the successful restoration of the defense industrial base and the reduction of weapon system cost has been clearly defined by current government and military leaders.

IMIP has become a high visibility program. Secretary of Defense Weinberger has designated the IMIP as the number one DOD initiative to the White House Conference on Productivity. The Joint Logistics Commanders have signed a joint agreement on support of IMIP. President Reagan's Private Sector Survey on Cost Control has stated 'the future of a strong industrial base largely rests on the success of the IMIP' (16:26). (Emphasis added)

After approximately two years of operation as a test program, the IMIP is tentatively scheduled to be evaluated in late 1985 to determine if the program has been successful and if it should be implemented on a permanent basis (27:36). Essentially, the management question which must be answered at that time will be: "Can the Industrial Modernization Incentives Program (IMIP) and its component programs such as the Air Force's Technology Modernization Program (TECHMOD) reduce major weapon system cost and help revitalize the United States' defense industrial base?"

Specific Problem Statement

When given cursory examination, the answer to this management question might appear to be a relatively simple "yes" or "no" response which could be quickly quantified in terms of total dollar savings in weapon systems acquisition costs, total dollar expenditures for defense plant modernization or simple return on investment (ROI). However, the specific problem posed by the management question requires that the analysis of the Industrial Modernization Incentives Program (IMIP) extend beyond basic cost analysis. In addition, the effect of the IMIP upon crucial components of the acquisition process such as free and open competition, degree of benefit to both prime and subcontractor levels, and defense industrial "surge" and "mobilization" capabilities must also be considered when determining the overall success of the IMIP in meeting its objectives. Yet, formal studies of defense plants modernized under TECHMOD/IMIP or its companion program, Manufacturing Technology (MANTECH), have not been able to accurately measure the overall effect of plant modernization upon major facets of the weapon system acquisition process or upon the defense industrial base with any degree of reliability and validity.

The cause of this situation is two-fold. First, many of the primary objectives of defense plant modernization are abstract concepts which do not lend themselves to quantitative measurement or analysis. Second, comprehensive,

standard measures of program effectiveness have not been developed and adopted by the DOD and its components. Concepts such as defense industrial base surge/mobilization capability, levels or degrees of competition, and degree of benefit to prime and subcontractors are intangible characteristics which are too complex to be measured through direct application of a single, fixed standard. This problem is compounded by the failure of all DOD components to establish standard program evaluation criteria, uniform review intervals and requirements, and standard report formats.

The lack of a uniformly applied DOD industrial modernization evaluation program has long been a subject of concern. For example, a 1979 General Accounting Office (GAO) report expressed concern about the lack of evaluation of the Manufacturing Technology Program (forerunner of TECHMOD/IMIP) by DOD, and about the fact that many completed Manufacturing Technology projects had not benefited the production of defense items (13:2). Similarly in September 1983, a follow-up GAO report expressed concern that

...many MT [Manufacturing Technology] projects have not achieved the primary program goal of improving productivity and reducing Defense acquisition costs. However, there are differing views in DOD and elsewhere on an appropriate approach to evaluating MT program effectiveness (13:1). (Emphasis added)

Finally, in November 1984, the GAO concluded

[The Department of] Defense's planning and monitoring of the program has improved since 1979.... Defense officials and defense contractors believe this program is achieving useful results--reductions in defense acquisition costs, and in other

ways, such as improved maintainability of defense equipment. However, there is neither a Defense wide system to collect information on program results, nor a consensus on what criteria to apply to judge overall program effectiveness. Accordingly individual judgements vary as to how successful the program is (39:cover). (Emphasis added.)

Research Objective

The final objective of this research is to determine if, in fact, the IMIP/TECHMOD is reducing acquisition costs of major weapon systems while maintaining free and open competition and assuring defense industrial base surge/mobilization capability. Two stages of research will be required to achieve this final objective. This thesis will complete Stage I. The objective of Stage I is to identify those evaluation criteria which would provide a reliable and valid measurement of Industrial Modernization Incentives Program (IMIP) effectiveness. Once identified, those criteria would be used to develop a survey instrument which could accurately measure the effectiveness of the IMIP. Stage II should be completed by a separate, follow-up research effort. The objective of Stage II should be to apply the survey to selected IMIP projects and develop conclusions regarding the success of the IMIP in meeting its objective.

Research Questions

To meet the research objective of Stage I, the hypothesis that IMIP and TECHMOD will reduce major weapon systems costs, will maintain free and open competition, and will revitalize the United States' defense industrial base will

be tested. The following investigative questions will act as guidelines for the collection of information.

- a. Has system acquisition cost actually been reduced as a direct result of prime or subcontractor plant modernization?
- b. Has competition been restricted in any way?
- c. Has the adverse, declining productivity growth rate of the defense industrial base been reversed?

Summary

The chronic deterioration of the United States' defense industrial base has been well documented over the last quarter century. Within the past ten years, the Department of Defense has joined with defense contractors in a unified effort to revitalize the defense industrial base through an orchestrated program of plant modernization and productivity enhancement. The keystone of this effort is the Industrial Modernization Incentives Program (IMIP). Technology modernization managers from both the public and private sectors believe that the IMIP is achieving its major objectives of improving productivity while reducing weapon systems acquisition costs. However, citing a lack of standardized evaluation criteria and specified evaluation periods, agencies such as the General Accounting Office have raised concerns regarding the validity of reported IMIP achievements.

The purpose of this research project is twofold. The objective of Stage I is to identify those criteria which would be valid, reliable measures of IMIP effectiveness.

The objective of Stage II should be to use these criteria to develop a standard evaluation instrument for all Department of Defense IMIP projects.

This thesis documents the execution and results of Stage I--the identification of valid, reliable measures of IMIP effectiveness. Chapter II, Problem Background/Literature Review, provides the foundation for this research. An indepth discussion of the components of the defense industrial base is provided. A historical review of the erosion of the defense industrial base along with the actions taken to stop/reverse this decline is presented to highlight the widening scope and seriousness of this problem. The structure and objectives of the Industrial Modernization Incentives Program (IMIP) and other related programs are then discussed to clarify the role and relationships of each program to this effort to restore the productive strength of the defense industrial base. Chapter III, Research Methodology, explains and justifies the techniques used to determine the target universe and sample population; develop a data collection methodology and interview schedule; identify proposed IMIP effectiveness criteria; and analyze the raw sample data. Chapter IV, Analysis of Findings, documents and analyzes interview responses regarding the relative utility and validity of each proposed IMIP effectiveness measure. Finally, Chapter V, Conclusions/Recommendations, summarizes the findings for each criterion; identifies

those criteria found to be useful measures of IMIP effectiveness; and, makes recommendations regarding the scope and direction of future research related to evaluation of the Industrial Modernization Incentives Program.

II. Problem Background/Literature Review

Defense Industrial Base Definition/Composition

The United States' defense industrial base is such a complex, dynamic, multi-level system that, as Antonia Handler Chayes, former Under Secretary of the Air Force, once stated, "An agreed-upon definition of what constitutes a vital defense industrial base, capable of flexible and rapid response to a national emergency, is not readily at hand..."(5:41). However, some description of the defense industrial base is necessary to fully understand and appreciate the need for the DOD Industrial Modernization Incentives Program (IMIP). The Air University Compendium of Authenticated Systems and Logistics Terms, Definitions, and Acronyms provides this basic description of the defense industrial base.

That part of the total privately-owned and Government-owned industrial production and maintenance capacity of the United States, its territories and possessions, as well as capacity located in Canada, expected to be available during emergencies to manufacture and repair items required by the military services (10:343).

The basic component of this industrial base is the individual defense industry. A defense industry is

important to the national defense for the production of material or equipment, and which normally is largely or wholly owned or leased by the U.S. Government; or, which has considerable Government-owned buildings or equipment on the site; or which, in some circumstances and particularly under full mobilization, has total production capacity under contract over an extended period for Defense production or for items essential to the national defense (10:203).

These general and, quite frankly, overly verbose descriptions are best summarized by Ms Chayes as she describes the defense industrial base as

the industrial base from which, in a national emergency, we will require the capability to rapidly produce large numbers of technologically sophisticated weapon systems and spare parts (5:41).

This base upon which we depend for military production is not a unique industrial network, separate from civilian industries, which is committed solely to defense-related manufacturing. On the contrary, "there is no substantive distinction between the military production base and the national industrial complex on which it rests" (20:81).

Two closely monitored indicators of the relative health of the US defense industrial base are its "surge" and "mobilization" capabilities. "Surge" refers to the "expansion of military production within a peacetime environment--without declaration of a national emergency" (4:40-41). As defined by the Air Force's "Blueprint for Tomorrow" Production Base Analysis study group, a surge of the defense industrial base is typically represented by a 50 percent increase in production within 12 months for select mixes of aircraft, missiles, engines, etc. (4:40-41).

"Mobilization," on the other hand, is

the transformation of industry from its peacetime activity to the fulfillment of the military program necessary to support the national military objectives. It includes the mobilization of materials, labor, capital, productive facilities, and contributory items and services essential to the military programs (10:344).

In short, mobilization is "the expansion of military production to meet the demands of a wartime situation" (4:40-41). Unlike a surge which is short-term in length and limited in scope, a mobilization of the defense industrial base represents a long-term, comprehensive industrial expansion. A mobilization of the defense industrial base would typically represent a 200 percent increase in production rates for all mixes of aircraft, missiles, engines, etc., over a 36-month period (4:40-41).

These "textbook" definitions provide a basic working definition of the defense industrial base as it should be-- a responsive, flexible industrial base capable of satisfying short-term, relatively limited peacetime "surge" requirements and long-range, comprehensive, wartime "mobilization" demands. However, they do not address the primary role which the U.S. defense industrial base plays in the maintenance of an effective, flexible, military capability in light of varying degrees of budgetary constraint.

The need for imaginative and effective ways to improve the responsiveness of our defense industrial base cannot be overstated. We must insure the nation of a modern, capable military force which is prepared to respond to a variety of contingencies. Furthermore, the weapon systems deployed by this force must be obtainable at a price the nation can afford (2:3).

Leon Koradbil is more direct in his assessment of the role of the defense industrial base. "The national defense cannot be ensured in the absence of an industrial production base that can meet modern defense requirements" (20:87).

Given that the U.S. defense industrial base is so vital to U.S. military capabilities, why has this critical industrial network deteriorated to the point that

Few would dispute that we are discussing an industry with considerable inefficiency and obsolescence in plants and equipment and one with a shrinking base of reliable subcontractors, a fluctuating work force, and stretched-out production lines...(5:41).

U.S. Defense Industrial Base Deterioration

The facts that "the U.S. has been losing production ground since the end of World War II" and that "capital productivity, i.e., output per unit of tangible capital, has been declining" (19:101) have been well-documented by numerous researchers and analysts over the past 25 years. Many authors believe that, historically, American military and political leaders have "paid little or no attention to the problem of greatly accelerated emergency production by industry..."(24:54). As a result,

Modernization of the U.S. industrial plant rarely [took] place in other than periods of crisis; war (or the threat of war) and the ensuing placement of large production orders seem to be the only general stimuli (20:88).

Consequently, industry saw "little incentive to modernize during periods of normal demand, perhaps because wartime modernization was frequent enough" (20:88).

Events during the period from World War I to the Vietnam War demonstrate the damaging effects of this phenomenon. As Colonel Jesse G. Mulkey illustrated in his article, "Defense Acquisition and Improved Responsiveness of the

U.S. Industrial Base," the relatively rapid succession of World War I, World War II, and the Korean War stimulated the development and expansion of the U.S. defense industrial base. Although the United States entered the First World War "almost totally unprepared," military and political leaders did learn a valuable (and costly) lesson prior to World War II which drove them to mobilize the industrial base long before actual war was declared.

Mobilization...was an evolutionary development of organization and control...technology and events of the period allowed the U.S. sufficient time to accomplish mobilization...never again will we have such time for getting ready (24:54).

This evolutionary process of mobilizing the defense industrial base was not, however, free of problems. As Koradbil points out, "it was not until 1943 that sufficient productive capacity was installed to meet the military requirements" (20:86). Nevertheless, James Huston concluded that, while these efforts to prepare for World War II could, in hindsight, be considered sporadic, ill-managed, and politically motivated, they were significant contributions to the eventual Allied victory.

It is possible that as much was done during the defense period toward...total mobilization... as could have been done if the U.S. actually had been involved in the war eighteen months earlier. Certainly if the contributions of the U.S. during the critical years of 1942-1945 had been delayed another eighteen months, the cost would have been much higher, for by then there might have been no strong allies left to share the burden (17:412-413).

After World War II, defense planners protected this massive defense industrial base in spite of the general

shifting of the U.S. economy from military production to commercial manufacturing. Generally speaking, acts such as the Industrial Management Plan of 1947 and The Defense Production Act of 1950 did maintain the integrity of the World War II industrial base. Proof of this success lies in the fact that, at the outbreak of the Korean conflict, the defense industrial base was effectively mobilized in the extraordinary period of four months--a considerable feat in light of the fact that "a similar effort took over two years ...at the start of World War II" (24:55). However, at the same time that the U.S. was reactivating its wartime industrial base, a very serious and eventually debilitating "disease" was beginning to weaken the foundations of the U.S. defense industrial base.

As can be seen in Figure 1, the "disease" of machine tool obsolescence began to spread throughout the defense industrial base (20:84). Even the newer technologies such as aircraft engines, propellers and aircraft spares exhibited symptoms of equipment obsolescence as early as 1950. Approximately 20 percent of all aircraft engine, propeller and component machine tools were already at least 10 years old. Koradbil infers that this percentage may have been considerably higher had it not been for the fact that

...newly constructed plants are generally newly equipped. Modernization of an old plant seems to be a more difficult decision for management to make. Consequently, unless substantial new building is undertaken by industry, the preponderance of old equipment tends to keep the average up (20:84).

PERCENT
AT LEAST
10 YEARS
OLD

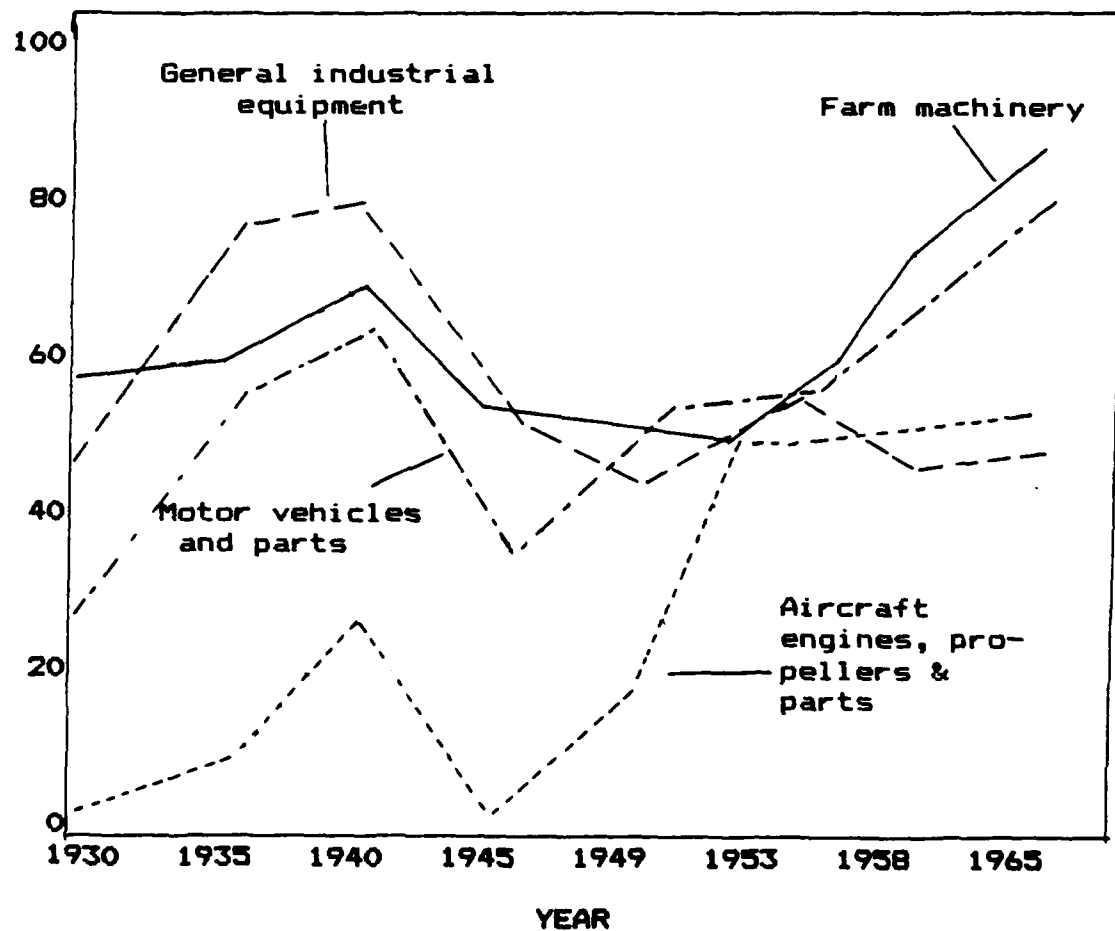


Figure 1. Over-Age Metal-Cutting Machine Tools, Selected Industries, Projected in 1965 (20:84)

It is important to note that this chart, which was published in 1960, predicted that, by 1965, the percentage of machine tools which are at least ten years old would exceed 50 percent. As will be seen, the reduced emphasis on defense industrial readiness, during the period between the Korean War and the Vietnam War contributed to making this prediction a reality. As Mulkey relates,

the national policy of mobilization readiness ...was set aside for other goals such as environmental quality and social change, to the point that the nation no longer had a timely mobilization capability (24:55).

Figure 2 illustrates the degree of defense preparedness deterioration which had occurred by 1958. One critical point which is not clearly addressed by this graph is the actual degree of machine tool obsolescence in terms of years above the normal obsolescence cycle. In 1960, Korabel stated, "the obsolescence cycle is now approaching five years.... The average age of U.S. cutting machine tools is about 14 years, and this is growing older" (20:38). (Emphasis added.)

Recalling the earlier discussion which linked the incentive to strengthen and modernize the industrial base to periods of national emergency/conflict, it would seem logical to expect the Vietnam War to stimulate modernization of the defense industrial base after such a long period of neglect. However, as Mulkey points out,

War production for the Vietnam conflict was so intertwined with continued emphasis on the civilian economy, that mobilization in the traditional sense was not instituted or seriously considered (24:55).

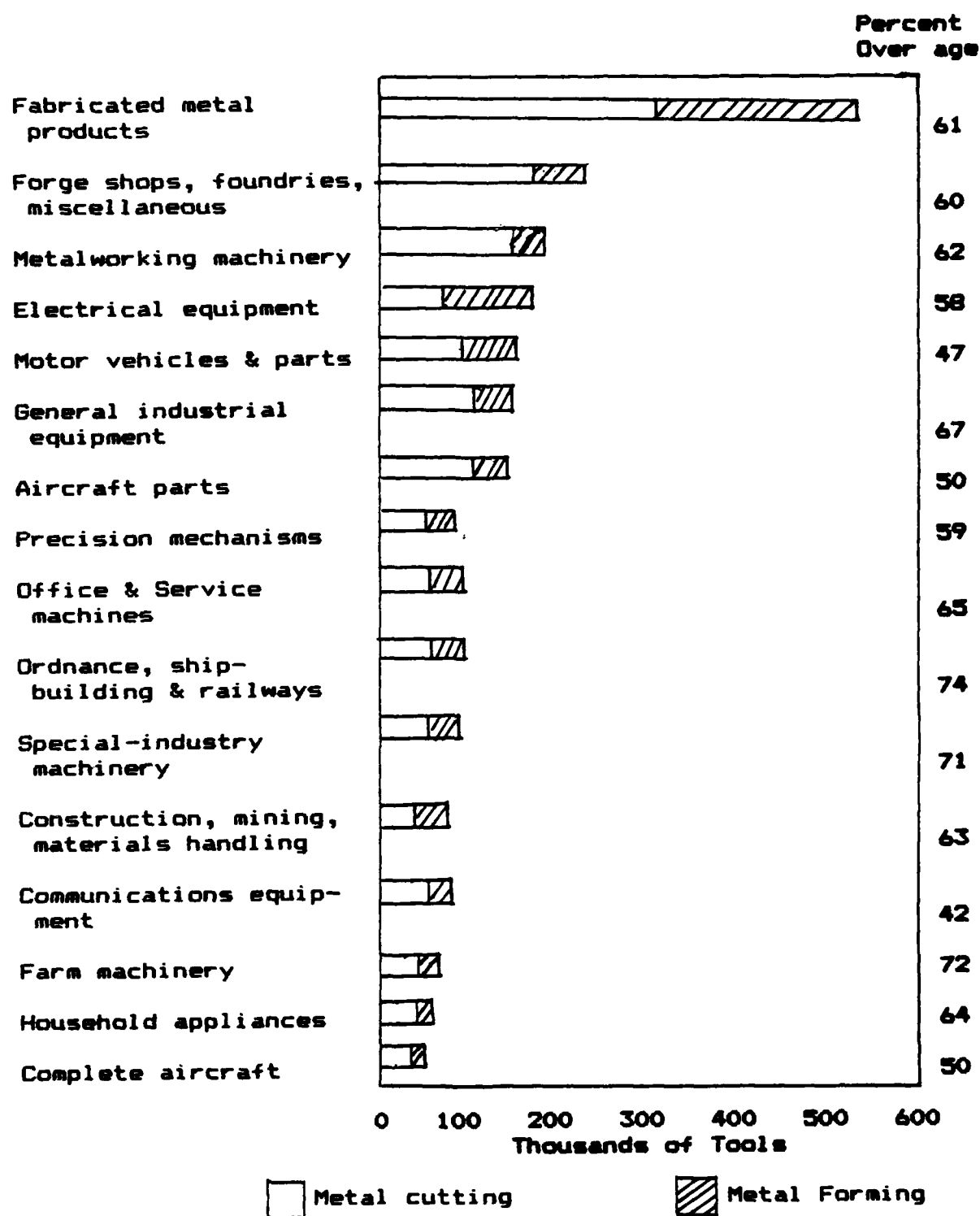


Figure 2. 1958 Machine Tool Inventory in Major Machine-Tool-Using Industries (20:85)

As a result, in spite of the fact that the U.S. was involved in a protracted war, "the U.S. ability to mobilize the industrial base...continued to deteriorate" (24:55).

Many industrial base analysts mark 1973 as the year in which the U.S. actually lost its ability to mobilize its defense industrial base (24:55). This decline was further aggravated by the 1975 oil embargo and the declining defense budgets of the late 70s/early 80s. This deterioration of the defense industrial base led to the publishing of the "Ichord Report"--The Ailing Defense Industrial Base: Unready for Crisis--which chronicled the effects of this long-term neglect.

Causes of Industrial Base Deterioration. Richard H. Ichord, Chairman of the Defense Industrial Base Panel, echoed the beliefs of many defense analysts when he identified one of the major causes of the industrial base deterioration as "...the apparent lack of a long-range strategic plan for industrial preparedness at the Department of Defense" (41:20). Antonia Handler Chayes attributed the erosion of the defense industrial base to inadequate planning caused by inconsistent, contradictory policy-making. "We have that commitment in the Department of Defense but lack an overall approach that meshes policies, ensuring that they complement one another..." (5:46). Mr Tom Murrin, President, Westinghouse Public Systems Company suggests that there is, indeed, a lack of commitment and that it is not restricted to only the Department of Defense.

We still have the technology, the people and other resources to meet the economic challenge of...emerging industrial powers. What we lack is a national commitment--and a well-synchronized strategy (25:50). (Author's emphasis)

Ronald F. Lehman, staff member for the Senate Committee on Armed Services, places the strategic planning responsibility squarely within the Executive Branch.

For Congress to fund major specific steps toward expanding our defense mobilization capacity...the Reagan administration itself will have to establish a clear industrial mobilization policy and program... (21:13).

Mulkey points out that this lack of industrial preparedness planning may not be easy to correct since "the United States has traditionally been lacking in planning for...an industrial base...dedicated to defense preparedness" (24:53). The specific cause of the defense industrial base deterioration, according to Mulkey, was best described by the 1971 Industry Advisory Council to the Secretary of Defense as

the DOD not being able to adequately define and specify its mobilization requirements in a timely, realistic manner.... Requirements...are the foundation for industry decisions about plant maintenance or expansion and capital investment (24:56).

The Ichord panel concluded that the probable cause of this failure to adequately define mobilization requirements was the tendency of the DOD to respond to a weakened force structure by "rationalizing the problem out of existence" (41:20). Essentially, the Ichord panel believed that, as the defense industrial preparedness declined, the DOD responded by revising their "order of battle" to minimize the effect of the reduced mobilization capacity upon military force

strength. Thus, as the industrial base deteriorated, the concept of war shifted from a "long" war, which would be heavily dependent upon the successful mobilization of the defense industrial base, to a "short" war which would be over before the industrial base could be mobilized. The key to this approach is the concept of a "come-as-you-are" war-- a war which "will have to be fought with equipment that is on hand when the war starts because it is assumed that the time to activate the production base could exceed the term of the 'short' war" (41:20). Ichord's complaint was not with the concept of a "short" war itself but, with the use of the "short" war concept to justify a lack of defense industrial preparedness (41:21).

Koradbil proposes a second major cause for the demise of the U.S. defense industrial base. According to Koradbil, military and political leaders have attempted to treat weapon systems and the industrial base which produces them as two separate, unrelated entities. In fact, they are actually two symbiotic subsystems of the overall defense preparedness system.

The government and services have generally exhibited a proper concern with weapons but, for the most part, have taken for granted the sources from which these weapons must come.... The presumption of a choice between weapons and production means is an illusion.... Added cost or compromised readiness is assured if modernization is postponed (20:87).

The condition of the defense industrial base, then, determines the degree of technological sophistication which can

be achieved within weapon systems. "If production facilities are outmoded, product design will be inhibited; face lifting and marginal change will be the rule" (20:6). In their haste to develop, build, and procure more sophisticated weapon systems, the U.S. planners and leaders failed to balance their emphasis between both the defense industrial base and weapon systems to ensure that production technology was progressing "at roughly the same rate as product development" to avoid "serious production restraints" (20:29).

Recent Developments. Twenty-five years ago, Leon Korb warned that any delay in the restoration of the U.S. Defense Industrial Base could have very costly consequences.

If the true costs of modernization were not so cheap and the risk were not so great, the issue might be one for prolonged consideration and delay. However these contrasts are conspicuously apparent. Time may now be cheap--it will be priceless later. The situation is one of great urgency" (20:104).

Twenty years later, the Ichord panel, in effect, accused the Department of Defense of failing to heed this warning to take immediate, positive action to restore the U.S. defense industrial base.

The Department of Defense has done little to improve the capability of the industrial base..., the problem continues to worsen, and new studies are initiated when, in fact, action, not analysis, is what is needed to improve the responsiveness of the base (41:19).

In light of these warnings and accusations, what has been actually accomplished in recent years to revitalize the defense industrial base? The answer, it seems, should be approached from two different perspectives--the government

viewpoint and the viewpoint of the defense contractor--in order to accurately assess recent modernization accomplishments.

From the government viewpoint, the last five years have been a highly productive period in which important industrial preparedness planning policy changes and capital improvements of defense plants have been made. For example, in March 1982, Dr Richard DeLauer, then Under Secretary of Defense, Research and Engineering (OSDR&E) established the Department of Defense Joint Task Force to Improve Industrial Responsiveness. Under his direction, this task force proposed the following major changes to defense acquisition policies to ensure government/contractor awareness of industrial preparedness planning.

- a. Ensure that industrial base planning/preparedness be specifically addressed in DOD Directive 5000.1 and the DSARC/acquisition cycle.
- b. Change the Defense Acquisition Regulations to ensure: (1) the use of contract option clauses to satisfy surge requirements; (2) integration of surge/mobilization planning requirements into procurement planning regulations; (3) definition of the terms "surge" and "mobilization."
- c. Designate a single officer within OSDRE as the single manager for "...all matters relating to the capability of the industrial base to meet peacetime, surge, and mobilization production requirements of the DOD."

- d. Require that "surge and mobilization planning during the systems acquisition cycle...become, in most cases, a contract item" (24:57-58).

Further, in February 1984, a joint Air Force/defense industry study group, chaired by Major General John T. Buck, Vice Commander, Aeronautical Systems Division, Air Force Systems Command, conducted the first DOD-directed Production Base Analysis and published its findings and recommendations in a three-volume report titled Blueprint for Tomorrow (4:38-39). Major among the 34 conclusions reached by the study group were the findings that

- a. ...the government has discouraged productivity growth by providing plant equipment.... Among government-owned equipment, 93 percent was over 15 years old versus only 39 percent in a similar age group for contractor-owned.
- b. ...we found the present industrial base cannot surge and sustain... One panel noted that its ability to surge was 'more coincidence than the result of purposeful direction'...to the best of our knowledge, no effective surge plan exists.
- c. ...there is not a detailed industrial mobilization plan, and without one our mobilization capability faces severe limitation.
- d. ...our efforts through TECHMOD and similar industrial base initiatives have gained industry's attention and have resulted in considerable investment on their part (4:39-42).

From the defense contractor's viewpoint, however, it appears that these findings did not tell them anything that was not already known (Note the similarities between the Blueprint for Tomorrow findings and those of the Koradbil and Ichord reports) nor did the findings elicit much contractor

confidence about their eventual resolution. Some contractors wondered if corrective actions could survive political influence and the inevitable changeover of executive administrations and congressional leadership. "We've seen Administrations and Congress's with all kinds of initiatives. Are they willing to continue to support defense? That's the crux: will they be consistent"? (44:32). Others questioned whether positive actions such as the TECHMOD/IMIP would be initiated quickly enough to make contractor participation worthwhile.

The good news is on the objective. The bad news is that they're taking so long to get implemented The effort required to seed such manufacturing technologies initially, and then get Government assistance in developing and implementing them, may be more than many defense contractors would be willing to undertake (44:32).

A third group cited the continued inconsistency within DOD policies as a significant cause of contractor scepticism.

Defense urging industry to boost its "surge" capability is frustrated by past Pentagon decisions to cut back on the numbers of a system it would buy per month... after industry had geared up to an optimum production rate at the outset (33:40).

In general, it appears that defense contractors understood and appreciated the Government's attempt to stimulate plant modernization. However, their optimism is still tempered by a lack of confidence in the Government's, as well as their own, long-range commitment to industrial modernization initiatives.

...we have the essential resources to meet the economic, political, and military challenges we are facing. But, we badly need a strategy and commitment by both Government and industry; particularly by the Department of Defense... (25:50).

Industrial Productivity. Productivity measures the relationship between outputs (amounts of goods and services produced) and inputs (the quantities of labor, capital, and material resources used to produce the outputs). If the same amount of input produces larger quantities of goods than before, or if the same amount of output is produced with lesser quantities of inputs, productivity has increased (6:9).

Since the end of the 1960s, the U.S. industrial sector has experienced a decline in productivity growth. The U.S. is falling rapidly behind other industrial nations, especially Japan and West Germany. Figure 3 (9:62) illustrates the severity of this decline. In 1980, the Defense Industrial Base Panel found that the productivity growth rates for the manufacturing sector of the U.S. economy were lowest among all free world industrialized nations, and that the productivity growth rate of the defense sector was lower than the overall manufacturing sector (41:11). This does not imply that U.S. industry in general or particularly the defense industry is ineffective. It does imply, however, that U.S. industrial effectiveness is decreasing because the investments in plant modernization of the fifties and sixties are not being enhanced with renewed capital investments in eighties (40:17).

Decreased productivity is particularly disturbing to the DOD. First, the cost of typical new weapon systems has

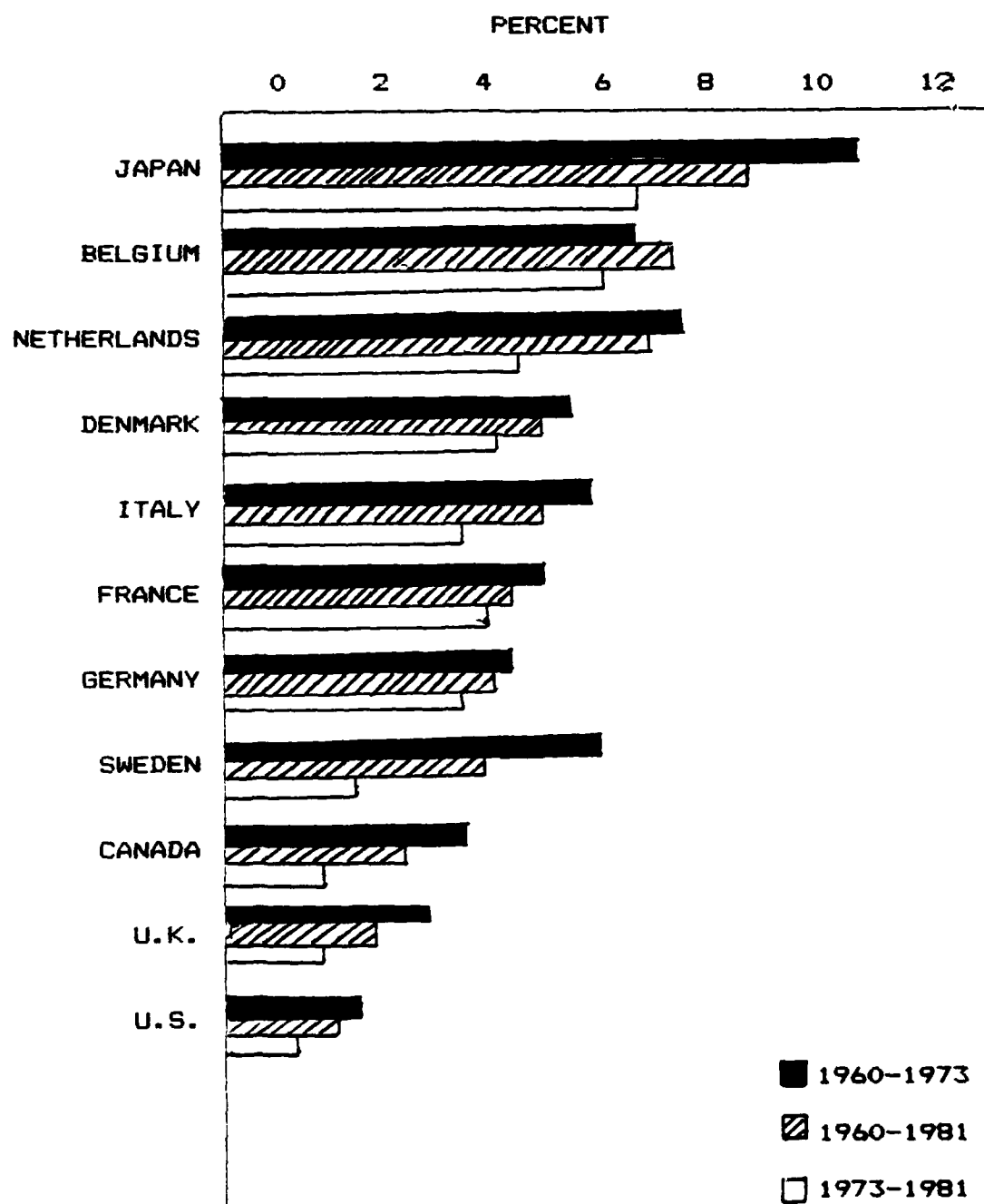


Figure 3. Productivity Growth in Manufacturing Industries Selected Nations 1960-1973, 1960-1981, 1973-1981

Source: U.S. Department of Labor, Bureau of Labor Statistics, "International Comparisons of Manufacturing Productivity and Labor Cost Trends, Preliminary Measures for 1981," June 2, 1982, Table 1.

(9:62)

been increasing at an exponential rate since the end of World War II (see Figure 4) (16:1).

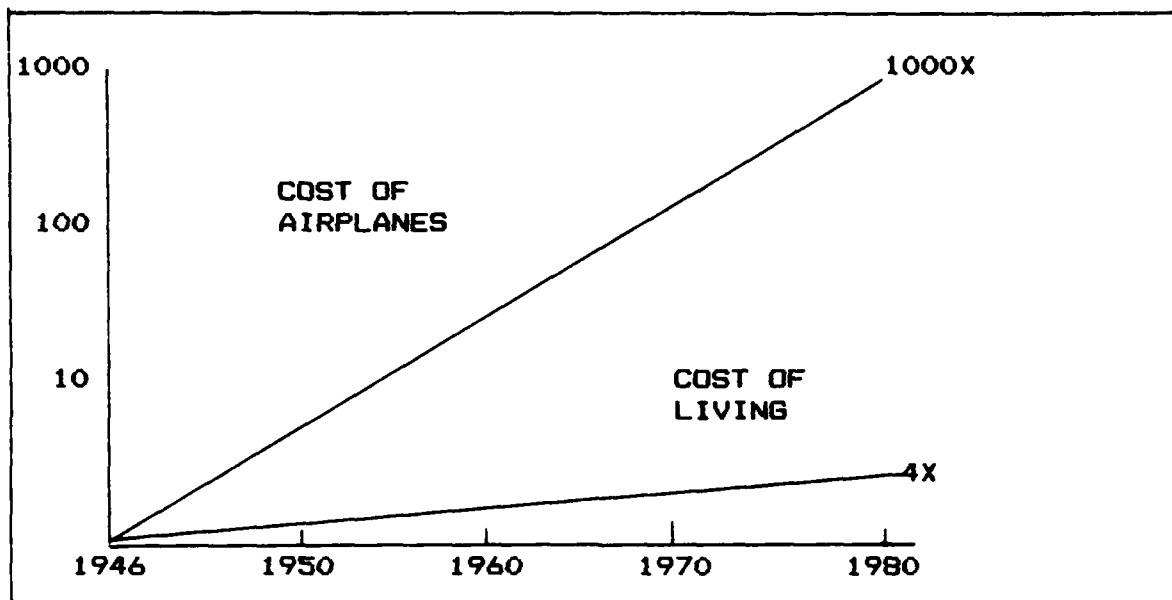


Figure 4. Cost of Living vs. Airplanes

(19:9)

Second, the low rate of productivity growth has perpetuated reduced industrial surge capabilities and has increased acquisition lead times.

The implications of a second-rate U.S. industrial capability are not good. The DOD relies on a strong and viable industrial capability and cannot remain a first-rate military power without this capability (19:2). There are many statistical studies of the productivity slow down and its causes. They generally agree on the magnitude of the slow down and seem to agree on possible causes. The possible causes include:

- a. low expenditures in research and development, which provide the basis for innovation and technological progress;

relatively low rate, as compared to other industrialized countries, of capital formation in the form of plants and equipment;
shift in the composition of output--the distribution of GNP between goods and services whose productivity typically grows rapidly and those whose productivity growth is relatively slow;
changing role and composition of the labor force in terms of age, race, sex, education, and work experience;
decreasing availability and increasing cost of natural resources, especially those related to energy; and,
increase in government activities, particularly in the form of regulation (6:30-31).

International studies have indicated that productivity is primarily influenced by technology and capital. Productivity varies in almost direct proportion to the amount of technology and capital. Approximately half of the rate of productivity growth can be attributed to capital and technology (19:2) (See Fig 5). Those nations displaying the highest ratios of capital to Gross National Product (GNP) achieved the highest rates of productivity increase. Unfortunately, the United States is not the leader of all industrialized nations in terms of capital to GNP (37:6).

(COMPOSITE FINDINGS OF KENDRICK, DENISON & JORGENSON)

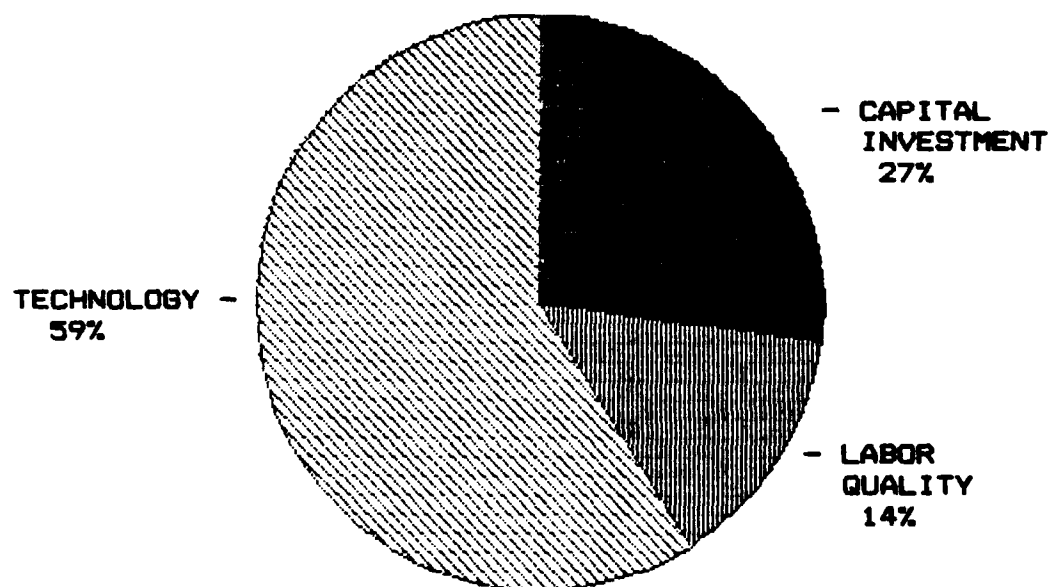


Figure 5. Factors Affecting Productivity

(19:21)

U.S. manufacturing plants and equipment are appreciably older than those of other industrialized nations, and U.S. defense industry equipment is significantly older than the average American manufacturing equipment. Not only is modernization taking place at a slower rate throughout U.S. industry, but investments made in modernization of defense industry plants and equipment are approximately 50 percent less than those of the private sector (12:57-58). For example, during the 1970s, the U.S. aerospace industry invested only two percent of sales in new capital equipment, while the average rate of investment for all U.S. industry was approximately eight percent, and the average rate for all U.S. manufacturing was four percent of sales (41:17).

Several reasons have been cited for industry's unwillingness to increase capital investments. One explanation centers on private industries' management emphasis on short-term profits and maximized return on investment (ROI). Management is reluctant to invest large sums of capital on investments which do not show short-term profits. Also the uncertainty associated with most defense sales is an impediment to developing a sound capital investment program. Double-digit inflation, the high cost of borrowing, tax policies, government over-regulation, and low profits relative to commercial markets are also primary reasons for declining defense industry capital investments.

Technology, the other primary contributor to productivity, is directly related to capital. Capital is required

not only for research and development of new technologies but also for the implementation of new or existing technologies into a contractor's facility (19:3). Government technology funding has existed in industry for many years. The types of technology funded have been varied but have generally involved key technologies needed to design state-of-the-art aerospace weapon systems. Very little government technology funding has been directed to the actual methods of manufacturing these sophisticated systems, so this area was largely left to the private sector. Unfortunately, the private sector also places its primary emphasis on designing new systems instead of efficiently producing new systems (14:16).

Technology Modernization

The DOD commitment to improve industrial productivity began with the "Profit 76" study. This study examined the erosion of the U.S. defense industrial base and found that industry's high return on investment was accompanied by a relatively low return on sales. The high return on investment was "traceable to a markedly low level of investment by defense contractors" (22:4). A similar study, "Payoff 80," focused on defense industry productivity and identified four major areas, one of which was Technology Modernization, as a potential means for improving productivity. However, the "Payoff 80" study recommendations only addressed improved policy guidance, better communication of TECHMOD concepts to contractors, and more emphasis on TECHMOD as it applied to

subcontractors (37:6-7). The recommendation failed to address specific means for implementing DOD TECHMOD programs.

The U.S. Air Force Systems Command (AFSC) has successfully implemented two programs which have resulted in increased contractor capital investments and thereby productivity through two fundamental approaches, "contracting for productivity" and "technology modernization" of defense contractor facilities. Productivity contracting uses contractual arrangements such as multiyear contracts, capital investment incentives, contractual award fees and special contractual provisions to "incentivize and sustain contractors in increasing productivity" (2:1). The mainstays of the AFSC technology improvement effort consist of two separate programs: Manufacturing Technology (MANTECH) and Technology Modernization (TECHMOD).

Manufacturing Technology. The Air Force MANTECH program had its genesis in the 1950s. Originally concerned with U.S. post-World War II basic industrial capacity, MANTECH has evolved into an Air Force tool for enhancing manufacturing technologies and contractor productivity in the aerospace industry (30:15). The Army started a similar program in 1964, with particular emphasis on ammunition. The Navy has been performing work related to MANTECH since the late 1960s. Air Force and Navy MANTECH projects are primarily performed in defense contractor plants, while a substantial portion of the Army projects are performed in plants owned by the DOD (33:1).

As a DOD program, MANTECH provides money, primarily to defense contractors, to demonstrate a first case factory floor application of new or improved technology in producing defense items. The program's overall goals (as defined by the DOD) are to improve productivity and reduce weapon system acquisition costs. Its objective is to develop and improve manufacturing processes, techniques, and equipment to provide timely, reliable and economical production of defense items. Thus, the program encourages defense contractors and the DOD itself to develop and implement or use new or improved manufacturing technology. The MANTECH program's goal is to "bridge the gap" between research and development (R&D) innovation and full-scale production applications (33:1).

The MANTECH program provides funds for new or improved manufacturing technology efforts which are beyond the normal risk of industry and which are directed toward production of current anticipated defense requirements. The MANTECH planning process, completion of the project demonstration, and implementation (if any) of the new or improved manufacturing technology typically takes several years (33:1).

The program is managed primarily by the military services through centralized MANTECH program offices and engineering support staffs. The Air Force Wright Aeronautical Laboratory Materials Manufacturing Technology Division is currently responsible for the development of new manufacturing technologies for specific Air Force needs and is

responsible for the overall management of the Air Force MANTECH Program.

The MANTECH Program has long been recognized for its significant potential for productivity improvement and reduced acquisition costs of defense items. It is viewed as a long-term investment targeted at reducing future procurement and life-cycle costs. After the Air Force funds an initial demonstration of the new or improved technology, it expects industry to apply the technology in producing defense weapon systems (33:2-3). However, this is not always the case. MANTECH does not always directly link the technologies with production applications (2:11). The MANTECH Program has had numerous successes in establishing and implementing manufacturing technology advances, but these successes have consisted primarily of individual discrete projects (30:15). In 1979, the Technology Modernization (TECHMOD) concept was initiated by the Aeronautical Systems Division of AFSC. It facilitates the extension of the MANTECH effort across many programs.

Technology Modernization. The TECHMOD Program is a broad-based program by which the Air Force has attempted to improve the overall health of the defense industry by combining new and existing technologies with the elements of "contracting for productivity" to achieve optimum results in a total factory setting (2:11). TECHMOD is a separate agreement with a contractor which couples potential investment (seed money) with the contractor's investment in

productivity-enhancing capital equipment. TECHMOD is designed to collectively implement specific MANTECH/Technology Modernization applications to develop a broad-based approach for the most productive and efficient long-term capability. A TECHMOD project is accomplished, generally speaking, by a three-phased effort, which is often preceded by a period of planning (Phase 0) involving both the Air Force and the contractor (see Figure 6) (3:3).

A Phase I analysis is required for each TECHMOD project. Phase I is a "top down in-depth factory analysis" which both evaluates the needs of the overall facility and identifies candidate manufacturing technology opportunities which are applicable to the types of systems produced in the facility. This evaluation is usually accomplished by using any one of the numerous computer-aided evaluation programs which are available. Phase I culminates in a negotiated "business arrangement" between the Air Force and the particular contractor. This business arrangement establishes the ground rules for succeeding Phases II and III. The business arrangement is the heart of the TECHMOD contractual agreement. It may be composed of a master TECHMOD contract, enabling technology contracts, clauses in system production contracts, advance agreements or any combination of these. Considerations include general program scope, incentives, benefit-sharing arrangements, information transfer requirements, termination liabilities, applicable technologies, ROI hurdles, etc. These allow the Air Force and the

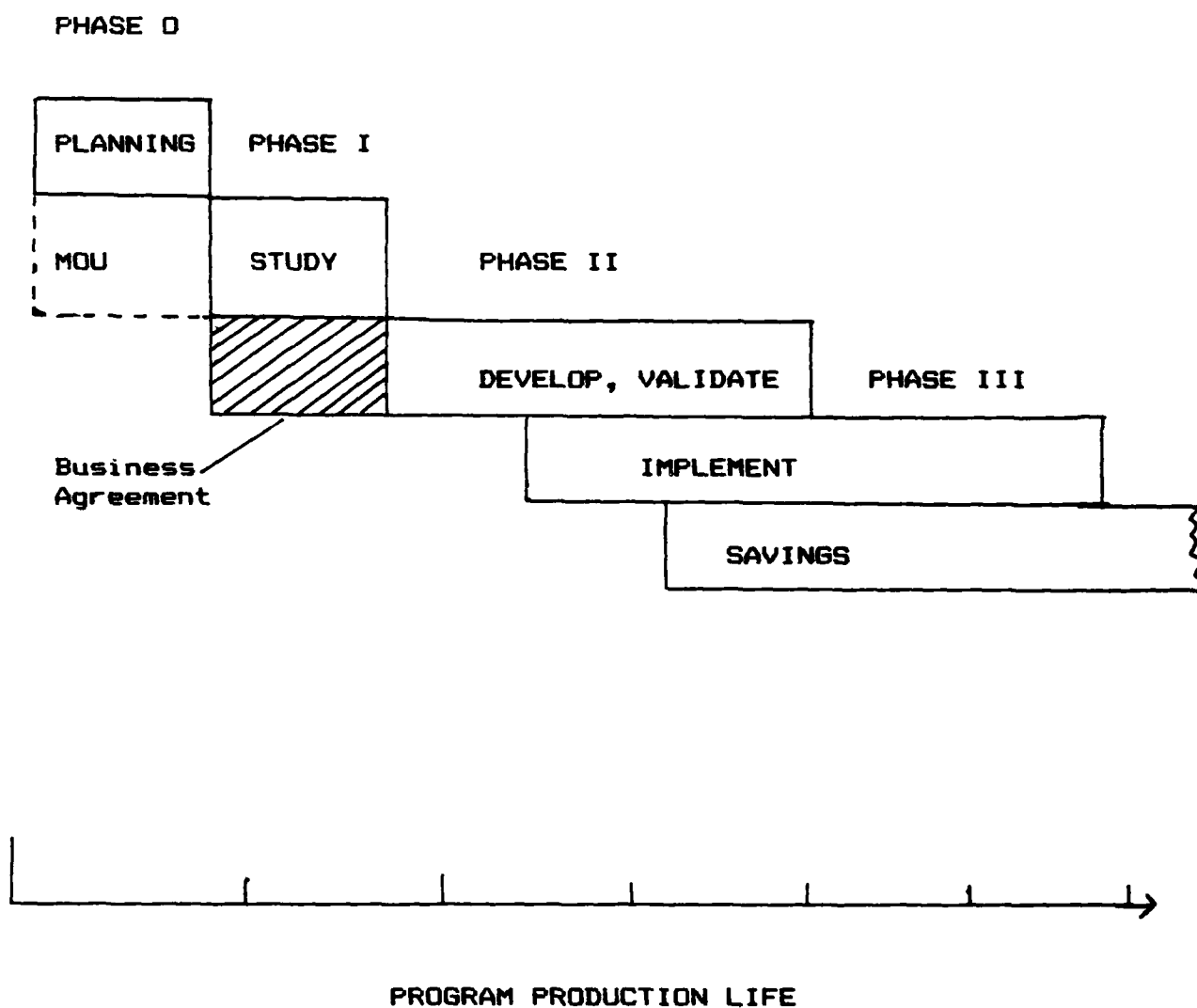


Figure 6. TECH MOD Phasing

(3:3)

contractor to clearly link TECHMOD program benefits with system acquisitions. Phase I funding can be provided by the contractor or from Air Force "seed money" or a combination of the two financing methods; although contractor funding is preferable (3:2).

Phase II is the development of the enabling technologies and design and fabrication of the factory modernization enhancements. TECHMOD enabling technology projects generally are of lower risk and shorter duration than those of MANTECH to ensure implementation into ongoing production. Phase II also identifies implementation plans, specifies hardware/software operational requirements and validates specific applications through method demonstration (3:2).

Phase III is the implementation of the TECHMOD into the contractor's facility. It includes the purchase and installation of the necessary capital equipment required for implementation of those Phase II candidates that demonstrate the highest potential payback and other "off-the-shelf" equipment to be used in the overall plant modernization (3:2).

Industrial Modernization Incentives Program. In the spring of 1981 then-Secretary of Defense Frank C. Carlucci, perceiving a need for economy and efficiency in DOD weapon system acquisitions, took action by chartering five working groups composed of representatives from the Office of the Secretary of Defense (OSD) and the Services. These working groups conducted a comprehensive internal review of the DOD acquisition process and by means of a report recommended 31

initiatives to improve the acquisition process. This report was presented to the Deputy Secretary of Defense on 31 March 1981 (1:83).

After reviewing the report at great length, Mr Carlucci, with the concurrence of the Secretary of Defense, decided to make major changes in both acquisition policy and the acquisition process itself. On 27 July of the same year he added the 32d initiative. These 32 initiatives were aimed at significantly improving the DOD acquisition process by reducing costs, making the process more efficient, increasing program stability and decreasing the time it takes to acquire military hardware. These initiatives were collectively known as the DOD Acquisition Improvement Plan (AIP). The AIP was the boldest, most ambitious contemporary management reform effort to be taken toward reshaping the way DOD conducts its business of weapon system acquisition.

Of the 32 initiatives, Initiative Five was intended to encourage capital investment by DOD contractors to increase their productivity. Initiative Five contained more than a half-dozen specific items designed to stimulate capital investment and ease contractor cash flow problems. One of these items was the Industrial Modernization Incentives Program (IMIP).

On 2 November 1982, the Deputy Secretary of Defense authorized a test of the IMIP with the stated objective of supporting AIP Initiative Five, "Encourage Capital Investment to Enhance Productivity." This test evolved from

successes that the Air Force achieved in its TECHMOD program and from tri-services support of the concept. The experimental program provides a common framework for service efforts such as Technology Modernization and Industrial Productivity Improvement (IPI) and is aimed at more widespread implementation. In order to clearly signify the objective of modernizing and improving the productivity of the defense industrial base, and to satisfy the requirement of a unified DOD policy, the title "DOD Industrial Modernization Incentives Program" was chosen (13:23).

Initial IMIP policy was developed by a Tri-Service Committee, under Navy lead, chaired by Rear Admiral J.S. Sansone, Jr. Subsequently, the Deputy Secretary of Defense established an executive-level Steering Committee composed of representatives from all DOD components and the Office of the Secretary of Defense to monitor and to assess the results of the IMIP test. Rear Admiral Sansone was also designated to serve as the initial chairman of this Steering Committee to ensure continuity (13:23).

IMIP Definition. The IMIP test unifies all existing Service efforts into a single modernization thrust. To clarify terminology, IMIP unification includes the Air Force TECHMOD Program. Once the IMIP effort matures and the IMIP test is completed, the Air Force TECHMOD Program will become part of the Air Force IMIP. For those projects placed on contract or initiated under TECHMOD, the term TECHMOD will continue to be used. Also the term TECHMOD will be continued

where it has already been incorporated into the Planning, Programming, and Budgeting System (PPBS) cycle. When the PPBS process can be influenced, the term TECHMOD/IMIP will be used. On joint service projects, the term IMIP will be used (31:1). For purposes of this thesis, the terms IMIP and TECHMOD/IMIP can be used interchangeably.

The IMIP is applied through a formal agreement between industry and the DOD which contains incentives for modernizing and improving the productivity of the defense industrial base, based on structured analysis and implemented through the increased use of manufacturing technology, plant modernization, and engineering management applications. Emphasis is on improving the productivity of subcontractors and vendors, not only prime contractors. Subcontractors are reached through their primes or directly through separate agreements. Additionally, while the application of the IMIP is for weapon systems, equipment, and materials, it is not limited to only major weapon systems.

Nor is the IMIP strictly a capital investment incentive program. It also emphasizes making productivity improvements to all facets of the manufacturing process including major cost driving areas such as management systems, plant layout, materials handling systems, and other processes, as well as new and existing technology. In short, any business aspect which contributes to lower cost through the application of modern technology can be considered as a basis for the application of IMIP (13:23).

Any defense contractor who performs work for Air Force programs is eligible to participate in the IMIP. The decision to pursue an IMIP project is based upon the level of Air Force business at a given facility, the amount of projected Air Force business, and mutual Air Force/contractor payback that will result from the IMIP project.

IMIP can be initiated in any one of four ways: (1) it may be contained in a program's Request for Proposal (RFP); (2) it can be achieved through mutual Air Force/contractor agreement during performance of an Air Force contract; (3) it can be proposed by a contractor; (4) it can be initiated through a Sources Sought Synopsis, RFP, or competitive process (3:5-6).

IMIP Objective. The IMIP is intended to develop and refine contractual incentives to encourage defense contractors to make productivity enhancing capital investments to improve the overall health of the defense industrial base. The resulting improvements in productivity generate numerous benefits for both the Air Force and the private sector, including the following: technology transfer; reduced acquisition costs; improved quality; shorter lead times; reduced critical/strategic materials consumption; and greater competitiveness in the marketplace. The IMIP should be used to motivate industry investment beyond those efforts required to meet normal contractual obligations (3:4).

IMIP Incentives. IMIP incentives being tested include shared-savings rewards and contractor investment protection.

These incentives are primarily aimed at motivating contractors to invest their own funds. The test program is directed at two primary problems most frequently cited as inhibiting modernization in defense industry: program uncertainty that hinders investment amortization and inhibits long-term planning, and a profit policy which is based on cost (19:17).

For instance, an industrial concern operating in the commercial marketplace environment typically sees either of two related forces: (1) improved productivity which reduces costs and permits realization of a greater profit, market share, or both; or (2) competitive pressures which necessitate productivity improvement. Costs of many DOD weapon system acquisitions, on the other hand, are negotiated so that profits are based on costs. The same incentives to reduce costs that exist in the commercial sector are not present to the same degree in many DOD procurements. Consequently a contractor who takes the initiative and acts to reduce costs may benefit on the instant contract but, may have many of the long-term benefits negotiated away as his cost base decreases. Hence the profit is correspondingly reduced (19:15). A key feature of the IMIP is that it provides three key contracting incentives:

a. Productivity Shared Savings Awards permit industry to share in the Air Force's savings through the use of a sharing arrangement on a percentage basis; through a return on investment (ROI) approach; or, through other appropriate approaches. The IMIP, therefore, removes any industry

motivation to inflate costs in order to maintain or increase profits.

b. Contract termination protection, through an unfunded, contingent liability guarantee, allows for Air Force compensation of the undepreciated balance of the capital assets in the event of premature termination.

c. Contractor investment protection was expanded to include all assets and real property. Since the current policy in Defense Acquisition Regulation (DAR) paragraph 3-815 only allows investment protection on several assets, a blanket waiver was approved so that real property could be considered in the investment analysis (13:24).

IMIP Test Charter. The charter for the test of the IMIP formalizes the following management guidelines/objectives:

a. The charter decentralizes management, allowing each of the DOD components to pursue incentives which they feel will best encourage productivity enhancing contractor investments. Oversight is provided by the executive level steering committee.

b. For the duration of the program, the DOD components have been authorized reasonable deviation from the DAR to encourage innovation and experimentation to obtain desired results.

c. Incentives are primarily targeted toward motivating contractors to invest their own funds. Contractors are

encouraged to provide all funding for the IMIP effort; however, when it is in the best interest of the government, DOD funding can be provided. This funding may be provided from the individual program or acquisition involved, and/or from broader functionally-oriented funding sources. Additionally, DOD funding may be shared on an equitable basis among benefiting programs within and among DOD components (34:6).

d. The charter restricts the application of incentives to investments over and above those which are normally made to satisfy a contract.

IMIP Funding. There are generally two kinds of DOD funds which support the IMIP. They are Program Element (PE) 78011F money and System Program Office (SPO) money. Program Element 78011F money is labeled "Industrial Preparedness;" its funds are specifically earmarked for efforts intended to benefit the industrial base. In addition to IMIP, PE 78011F encompasses MANTECH, industrial base program planning and industrial facilities. The IMIP budget is kept separate and distinct from these other segments of the program element and is represented in the newly formed category known as "Industrial Productivity and Responsiveness Improvement." SPO dollars are those provided by the program manager of a system to support program-related IMIP projects (39:7-8).

Presently, AFSC has over 70 IMIP projects in various phases of completion. Test data and information on the effectiveness of these programs is expected to provide a solid base for future policy development. Defense officials

and contractors believe the IMIP can and is achieving useful results. However, "there is no DOD-wide system for collecting information on project results, nor...a consensus among involved parties on how to measure effectiveness..." (39:i).

The objective of the first stage of this research effort is to identify those criteria which would be valid, reliable measures of IMIP effectiveness. The next chapter, Research Methodology, describes the research guidelines and the underlying justification for each, used to determine key research parameters such as target population and sample size/composition and data collection methodology. Additionally, it describes how the interview schedule was developed and tested; how potential IMIP effectiveness criteria were selected; and, how individual interviews were scheduled and conducted. Finally, it describes data analysis guidelines.

III. Research Methodology

Introduction

As outlined in the first two chapters of this thesis, the capability of the U.S. Defense Industrial Base to respond to peacetime surge and full wartime mobilization weapons production requirements has been seriously eroded. From a historical perspective, this erosion is primarily due to the reluctance of defense contractors to make the capital investments necessary for continuing, large-scale plant modernization. The Department of Defense has attempted to encourage productivity-enhancing investments and restore the productive capability of the defense industrial base through various programs such as the Manufacturing Technology (MANTECH) Program. However, the Industrial Modernization Incentives Program (IMIP), authorized in 1982, represents the first major DOD/defense contractor attempt to attack this problem of declining productivity with a centrally-managed, unified front of coordinated modernization programs.

Generally speaking, IMIP managers believe that the IMIP is reducing acquisition costs and production leadtimes; is stimulating productivity and competition; and, is restoring the overall responsiveness of the defense industrial base. A review of the IMIP to determine if it should be permanently institutionalized by the DOD is scheduled for late 1985. Yet, it appears that the validity of this review may be reduced based upon the GAO conclusion that "there is neither

a Defense-wide system to collect information on program results, nor a consensus on what criteria to apply to judge overall program effectiveness" (39:cover).

The goal of Stage I of this research effort is to develop a consensus regarding those criteria which could/should be used to develop a measurement instrument to accurately gauge IMIP effectiveness. This chapter describes how a consensus of opinion regarding valid measures of IMIP effectiveness was developed through a series of structured interviews with government and defense contractor IMIP program managers. Figure 7 depicts the general research methodology used in the conduct of this project. Specifically, this chapter defines the:

- a. data collection methodology,
- b. the universe and target population from which the research sample was selected,
- c. sampling methodology used to select interviewees,
- d. interview schedule development/validation methodology,
- e. interview techniques, and
- f. data analysis techniques.

Data Collection Methodology

The selection of personal/telephone interviews instead of a mail survey/questionnaire as the data collection technique for this research project was based essentially upon the principle that "the only way to find out how people feel and what their opinions are is to ask them directly" (35:2).

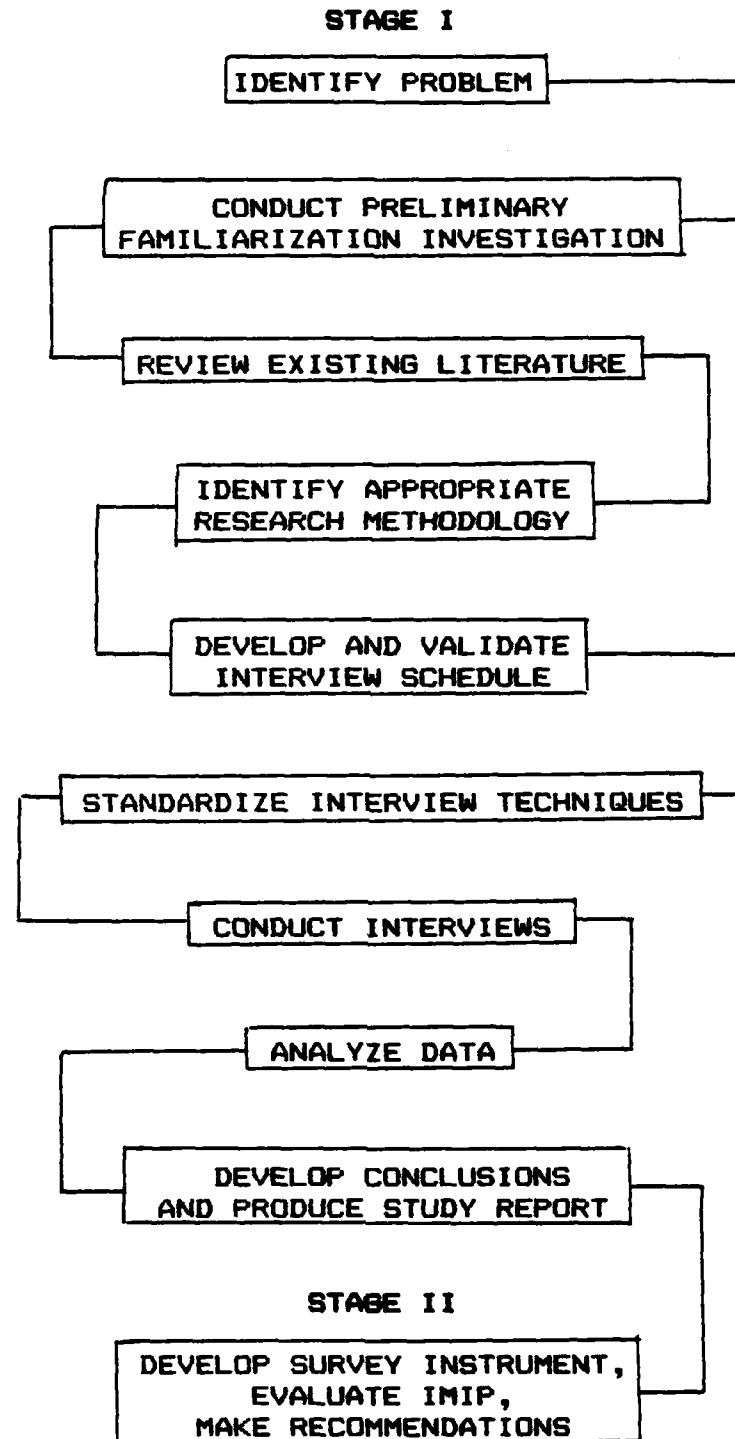


Figure 7. Research Methodology

Adapted from Application of Technology Modernization to the Subcontractor Tier: An Analysis of Contracting Approaches—by Michael Szczepanek and William M. Thompson—LSSR 53-82, AFIT, Air University, September 1982.

Because of the nature of this study--attempting to categorize and quantify concepts with varying levels of abstraction--it was believed that the use of personal and telephone interviews would enhance the probability of collecting clear, accurate responses. Further, the low investment costs in terms of postage, travel and time, as well as the ability to control interview bias were found to be equally attractive.

C. William Emory, in Business Research Methods, states that the primary advantage of personal interviews "is the depth and detail of information that can be secured" (11:294). However, interviewers must be fully aware of and control inherent problems of bias and cost. As Emory points out, bias usually occurs in the form of response error--the failure of the interviewee to respond fully and accurately; non-response error--the failure of the interviewee to respond at all; and interviewer bias--cheating, inappropriate suggestions, word emphasis, tone of voice, question rephrasing (11:299-302). The problem of cost is primarily manifested in potential travel costs since the target population and sample for this study included interviewees located in nearly every state in the continental United States.

To minimize the effects of these inherent disadvantages of the interview technique, the following research guidelines were established. Response error was to be controlled by providing each participant with written guidelines which

explained the exact purpose, scope and sequence of the interview and which defined key terms and concepts. The guidelines were provided at least one week in advance of the scheduled interview date. Nonresponse error was to be controlled by careful probing of each interviewee to ensure clear, complete responses without introducing interviewer bias through improper "leading" questions. Interviewer bias was to be avoided through "standardization" interviews to ensure that both interviewers had an identical understanding of interview goals and technique. Costs, primarily travel costs, were to be minimized through the use of telephone interviews when personal interviews were not economically feasible.

Adoption of telephone interviews as a means of data collection presented some special concerns/limitations which had to be addressed to ensure that all responses were unbiased and valid. First, as Emory points out, limitations on the length of a telephone interview are a major disadvantage of this data collection technique. While stating that ten minutes is usually considered "a practical maximum", Emory has found that "interviews of 20 minutes or more are common" and that, in some extreme cases, "interviews ran as long as 1.5 hours..." (11:307). The key to determining the proper length of a telephone interview is the degree of respondent interest in the interview topic (11:307). The second major disadvantage of a telephone interview is the fact that "it is not possible to use budgets, maps, illustrations, or complex scales." Further, it limits "the

complexity of the questioning and the use of sorting techniques" (11:307).

Recognizing these limitations, the telephone interviews were structured to minimize the effects of these negative influences. First, the interview schedule was designed in such a way that it could be completed, under normal circumstances, within 30 minutes. Second, each interviewee was provided a full set of interview guidelines which defined exactly how the interview was to be conducted; how each question would be worded; the full range of correct/acceptable response categories; each topic to be addressed during the interview; and key terms and concepts critical to clear communication (See Appendix A). Each interviewee was requested to have this interview guide available for reference at the time of the interview. Further, the number of acceptable responses was limited to four to ensure that an excessive number of response options did not confuse the interviewee or cause a loss of participant interest. Finally, the relative reliability of each interview mode was addressed. That is, given the inherent differences, strengths and weaknesses, of each mode of data collection, could the same results be attained from telephone interviews as would be attained using personal interviews. According to Howard Schuman and Stanley Presser, the answer is "Yes."

We do not have a sense that differences...correspond in any consistent way to whether telephone or face to face interviewing was used. This...leads to our belief that the mode of administration has no systematic effects on...experiments" (28:331).

Universe and Target Population

For this research study, the universe consisted of all U.S. defense contractors. Both the Air Force Logistics Command (AFLC) and the Air Force Systems Command (AFSC) had current on-going IMIP projects, in various phases, at the time this research was conducted. As the research and development (R&D) command of the Air Force, AFSC was managing the lion's share (both in fiscal outlays and total number of participating defense contractors) of the IMIP efforts. Conversely, AFLC had only two IMIP projects in progress at the time of this research and neither one had been developed beyond initial Phase I analysis. For that reason, those defense contractors participating in the AFSC programs were chosen as the target population and and sampled at random.

Sampling Methodology

A list of active AFSC IMIP/TECHMOD contracts/projects was obtained from the Aerospace Industrial Modernization (AIM) Office, AFSC/PMI, Wright-Patterson Air Force Base, Ohio (See Appendix B). Current as of 28 March 1985, this list contained 29 primary Air Force TECHMOD contracts as well as 42 programs/individual projects listed under the primary TECHMOD contracts. Approximately 39 defense contractors (prime and sub-) were listed as TECHMOD participants. All four AFSC product divisions were represented: Space Division, Armament Division, Aeronautical Systems Division, and Electronic Systems Division.

Each contract or project was assigned a number between 01 and 71. To ensure that each element of the sample was randomly selected, a basic uniform (0, 1) pseudo-random number generator, GGUBS, from the International Mathematical and Statistical Library (IMSL) was used to generate random numbers. The FORTRAN program used to generate the random number list is at Appendix C. The random number table is at Appendix D.

Random numbers were selected from the random number table by choosing the first two digits to the right of the decimal point which fell in the range between 01 and 71. For example, the first random number on the list, .79683, was discarded since 79, the first two digits to the right of the decimal point did not fall between 01 and 71. Each random number was considered by column until 20 random numbers which met our stated criteria were chosen. The numbers which were selected are underlined (See Appendix D).

Interview Schedule Development/Validation Methodology

The design of the interview schedule (See Appendix E) was influenced primarily by the inherent constraints of telephone interviews--interview length limitations and restricted use of visual aids and support material. As a result, the primary concerns during the development of the interview schedule were the

- a. determination of which measurement criteria to include in the interview and how to state each criterion,

b. determination of the proper mix of open and closed questions, and

c. determination of the proper number of response alternatives and definition of each option.

Generally, the intent was to design an interview schedule which could be completed within 30 minutes, regardless of mode, given reasonable interviewee preparation and without extensive support material or visual aids.

Determination of the IMIP effectiveness measures to be included in the interview schedule and how each was to be stated actually began during the preliminary familiarization investigation and literature review phases of the research plan (See Figure 7). Throughout these early phases, all criteria which were cited as possible/suggested measures of IMIP effectiveness, as well as those criteria which were cited as actual measures of IMIP effectiveness currently in use by the Department of Defense were collected. In addition to those criteria gathered during the initial review of literature, all IMIP effectiveness criteria which were gathered during preliminary, investigative interviews and "brainstorming" sessions involving both researchers and the research advisor for this project were included. This initial list of IMIP effectiveness criteria was sorted by listing similar criteria--both in wording or intent--into like groupings for further refinement. Each group was then addressed separately and reduced to one key concept/term through an iterative process of discussion and elimination.

Key to the selection of any one IMIP effectiveness criterion for inclusion in the final interview schedule was the ability of that criterion to provide a valid, reliable measure of IMIP effectiveness when applied to the full spectrum of IMIP projects. In short, the intent was to develop a set of "generic" measures which would not require revision/readjustment to fit individual IMIP projects.

Seventeen measures of IMIP effectiveness were selected for inclusion in the final interview schedule. Each of these criteria was subjected to a final researcher review to determine how each was to be specifically stated and to determine if any support material--definitions, clarifications, etc.--was required to ensure full understanding by the interviewee. If additional explanation was required, that information was included in the list of key terms, interview guidelines, and definitions which was provided to each interviewee at least one week in advance of the scheduled interview date. Once the proposed interview schedule and list of key terms and definitions was completed, they were submitted to the Aerospace Industrial Modernization (AIM) Office, AFSC/PMI, for a final "panel of experts" review and coordination. Once all comments/recommendations were satisfactorily resolved, the interview schedule was considered complete.

To reduce the possibility of induced bias caused by response and interviewer error and to minimize the length of the interview, the closed question format was used for

each of the 17 IMIP effectiveness criteria. As defined by the University of Michigan Institute for Social Research, "in the closed question, the response categories are part of the question and the interviewer checks the box containing the respondent's choice" (35:19). Each closed question was worded in exactly the same manner for each IMIP effectiveness criterion--"_____ is a valid measure of IMIP effectiveness." For each question, the respondent was given four possible alternatives from which to choose. The respondent could:

- a. strongly disagree--The proposed criterion is not, in any way, a usable, valid measure of IMIP effectiveness.
- b. disagree--The proposed criterion, as stated, would not be a valid measure of IMIP effectiveness unless redefined.
- c. agree -- The proposed criterion, as stated, could be an accurate measure of IMIP effectiveness while recognizing that there are better measurement criteria of effectiveness in terms of validity and reliability.
- d. strongly agree -- The proposed criterion, as stated, would provide a reliable, valid measure of IMIP effectiveness which could be quantified and uniformly applied to all DOD technology modernization programs.

The decision to provide four response alternatives was the result of a tradeoff between increased measurement sensitivity and ease of interviewee response. It was believed that interviewees would find a greater number of choices very confusing during telephone interviews due to the increased level of "splitting hairs" that would be required if more response alternatives were available. As a result, it was concluded that the appropriate level of measurement sensitivity could be attained by using the four response criteria listed above. Emory supports this view.

There is little conclusive support for any particular scale length...however, the most widely used scales range from three to seven points and it does not seem to make much difference which number is used (11:261).

Emory further points out that bias can be induced when using rating scales through three primary types of response error--"leniency," the phenomenon of "easy" or "hard" raters; "central tendency," fear of expressing extreme options; and "halo effect," the carrying over of a general impression from one rating to the next (11:263-264). Of these three, "central tendency" errors seemed to pose the greatest threat to the validity of this research. The success of this effort to reach some conclusion regarding valid IMIP measures of effectiveness relied totally upon the researcher's ability to motivate each respondent to clearly differentiate between usable/unusable criteria. Therefore, to ensure that respondents indicated strong agreement or strong disagreement when appropriate, the "disagree" and

"agree" responses included caveats which were designed to reduce the effects of any bias induced by "central tendency." To ensure that respondents clearly differentiated between "disagree" and "strongly disagree," the "disagree" option carried a follow-up requirement of redefining the proposed effectiveness criterion in order to make it a usable measure of IMIP effectiveness. This process of redefinition allowed the respondents to self-test the validity of their response without influence from the interviewer--if the proposed criterion could be redefined then "disagree" was probably the correct response; if not, then the proposed criterion, as stated, would probably not serve as a valid measure of IMIP effectiveness and the proper response should be "strongly disagree." A similar self-test was applied to the "agree" and "strongly agree" response options. "Strong" agreement clearly required that the proposed effectiveness criterion be applicable to the entire spectrum of IMIP projects and that it could be quantified and compared against a generally accepted standard. If either of these conditions could not be met in the respondent's mind, then "agree," which recognized that some criteria were better measures of IMIP effectiveness than others, would become the appropriate response.

Interview Techniques

The first five interviews were jointly conducted by both interviewers to ensure that subsequent interviews were completed in an identical, consistent manner--same

voice inflection, order of questioning, uniform data entry, etc.--for maximum measurement reliability.

All interview sessions were conducted either in person or by telephone in the following manner:

- a. Each prospective interviewee was initially contacted by telephone to determine availability/willingness to participate in the research project.
- b. Interview appointments were scheduled with each government or contractor TECHMOD manager who expressed a willingness to participate. A preliminary letter of introduction was forwarded to each participant at least one week in advance of their respective interview date. (See Appendix A). This letter introduced the participants to the specific focus of the research and afforded each the opportunity to prepare fully for the actual interview. This letter of introduction also provided a definitive list of key terms (See Appendix A) appearing on the interview schedule. All interviewees were given the opportunity to review and ask questions in regard to the definitions prior to their interview in order to ensure that critical terms/concepts were completely understood by the respondents.
- c. The researchers conducting the interview introduced themselves, the purpose of the interview, and the focus of their research project.

- d. All interviewees were guaranteed anonymity of their responses and were reminded that the respondent's answers should reflect personal opinions/judgements based upon their technology modernization experience.
- e. The researchers proceeded into the interview and recorded the interviewee's response.
- f. The researchers concluded the interview by providing the respondent with the opportunity to reemphasize any previous statement which the respondent considered germane to the measurement IMIP effectiveness.

Data Analysis

For purposes of the study, the percentage of the "strongly agree" and "agree" responses for each particular question of the interview schedule, out of the total number of responses of all interviewees for the particular question, was used as the benchmark in ranking the results on an ordinal scale in descending order of relative importance for each of the potential measures of IMIP effectiveness (See Appendix F for tabular summation of raw data). This enabled the researchers to reduce data into a standard form, with a base 100, for comparisons of study results. Further, interviewee comments which explained the rationale for a particular response or which suggested a particular method for quantifying a criterion were grouped and analyzed to highlight overall trends.

Both the ordinal ranking of and significant opinion trends regarding each proposed criterion were considered in the final identification of valid measures of IMIP effectiveness. The next chapter synthesizes the numerical results and significant comments for each proposed IMIP effectiveness criterion.

IV. Analysis of Findings

Introduction

A total of 19 interviews were completed during the period from 18 April 1985 to 9 June 1985. Twenty-two government and contractor IMIP/TECHMOD program managers representing the 20 randomly selected IMIP projects had been originally targeted as potential participants. However, three individuals could not be contacted by researchers to schedule an interview appointment. It must be strongly emphasized that, without exception, each individual contacted responded enthusiastically to the request for an interview. Further, the high quality of individual responses reflected the sincere interest of and in-depth preparation by each person during their participation in this research effort. Interview durations ranged from approximately 30 minutes to in excess of two hours. The longest interviews occurred during the "learning curve" period in which the researchers were standardizing their interview techniques. Once this "learning curve" effect was overcome, a normal interview lasted between 30-40 minutes depending on the number of comments by the interviewee.

During this series of interviews, a set of rudimentary demographic data was collected to illustrate how long the typical government or contractor TECHMOD program manager had been involved with technology modernization programs. The typical government TECHMOD program manager had been

involved with technology modernization efforts for approximately 1.25 years. None of the government managers had more than two years of experience. The modal level of experience was one year. The typical military manager was a captain or major with a 6524/6516/2716 Air Force Specialty Code (AFSC). The typical contractor TECHMOD program manager possessed about 3.5 years of technology modernization experience. The most experienced contractor program managers had five years of experience. The modal level of experience for contractors was four years.

The analysis of responses to each of the 17 proposed criteria for the measurement of IMIP effectiveness is summarized in this chapter. Each criterion has been analyzed to highlight ordinal ranking according to the total number of agree/strongly agree responses as well as to note underlying causes for the overall response. Further, proposed methods for quantifying each criterion are discussed. Finally, causes for dissent are also presented and analyzed. See Appendix F for a tabular presentation of the results.

Percentage of IMIP Projects Directly Applied to DOD Weapon System Production

As stated on page 35, previous technology modernization programs, such as MANTECH, have achieved significant productivity improvements through application of new or improved technology in the production of DOD weapon systems. There has not been, however, a one-to-one linking of manufacturing technology advances with production applications in all

instances. Often technology advances are accomplished and for some reason are put "on the shelf" and forgotten. For this reason, the contractor and government TECHMOD program managers were asked whether or not the percentage of IMIP projects which are directly applied to DOD weapon system production offered a viable means of measuring the effectiveness of the IMIP.

"Percentage of IMIP projects directly applied to DOD weapon system production" was tied at twelfth place with "percentage of IMIP projects completed," "degree of improved readiness," and "increased competitiveness" when ranked according to the percentages of "agree" and "strongly agree" responses to the statement, "Percentage of IMIP projects directly applied to DOD weapon system production is a valid measure of IMIP effectiveness." Eleven respondents--57.9 percent of the total sample--indicated agreement or strong agreement. Of these 11 responses, 9 were "agree" (81.8%) and 2 were "strongly agree" (18.2%). The remaining eight responses (42.1%) included five "strongly disagree" and three "disagree" responses.

The results indicate that "percentage of IMIP projects directly applied to DOD weapon system production" would be a valid measure of IMIP effectiveness. However, the large number of "agree" responses (9) relative to the "strongly agree" responses (2) reflects the general consensus that one key qualification must be included with this criterion to ensure its validity and reliability. The responses of both

government and contractor managers strongly indicated a belief that a 100 percent success ratio was both unrealistic and unattainable. The government should be willing to accept some percentage of projects which ultimately may not be applied to DOD weapon system production or, at least, not immediately applied. With the vast number of enabling technologies being developed, most of which are pushing the state-of-the-art, there will be some which fail or produce less than desirable results. Almost without exception, both government and contractor TECHMOD program managers feared that if a 100 percent application rate was mandated by the DOD or by the individual Services, only those programs with very little risk would be selected for implementation, thereby creating even greater technology voids than those which might exist today.

Suggested methods for quantifying "percentage of IMIP projects directly applied to DOD weapon system production" were mainly simple mathematical ratios. For example, the mathematical measures included:

- a. Measure success against a standard of 100 percent. Examine each project to see if it has been applied to DOD weapon system production and then compare that percentage with a minimal acceptable standard percentage to judge if the IMIP is achieving desired results. Of equal importance to the development of the minimal acceptable standard would be the establishment of the period of time during which the assessment would be conducted.

b. Measure success against a standard of 100 percent. Calculate the total dollar value of all IMIP projects which are directly applied to DOD weapon system production and divide this figure by the total dollar value of all IMIP projects. Again, a minimal acceptable percentage as well as a time period for the assessment would have to be established.

c. As a secondary measure, it was suggested that products/projects favorably affected by IMIP/TECHMOD applications could be examined.

The primary reasons given for disagreement or strong disagreement with this criterion as a measure of IMIP effectiveness included:

a. This measure would be too hard to accurately quantify.

b. A strict percentage would not be a good indicator. Although some projects are completed, the real cost savings to the DOD would also have to be taken into consideration. In effect, it was suggested that this potential measure could not "stand alone."

c. For those projects which are not applied to production, there may be extenuating circumstances. For example, enabling technologies could be developed for use in the future. Or a change in the direction of the state-of-the-art could render the technology prematurely obsolete. If IMIP effectiveness was judged according to the ratio of projects applied to production to the total number of projects,

one would have to account for the reason why the projects were not applied to DOD weapon systems production.

Percentage of IMIP Projects Completed

This criterion is concerned with whether or not IMIP projects which are completed (proceeding up through Phase III-implementation into a contractor's facility) could be used as a benchmark for assessing IMIP effectiveness.

Along with the previous criterion, this criterion was tied at twelfth when ranked according to the percentages of "agree" and "strongly agree" responses to the statement, "Percentage of IMIP projects completed is a valid measure of IMIP effectiveness." Again 11 respondents--57.9 percent of the total sample--indicated that this criterion could be used as a measure of IMIP effectiveness. Of these 11, seven indicated agreement and four indicated strong agreement. Among the remaining eight respondents, six indicated disagreement and two indicated strong disagreement. These responses indicate that the majority of government and contractor managers believe that this could be a useful measure of IMIP effectiveness.

Of those program managers responding favorably, the proposed methods of quantifying this criterion include:

- a. Use a mathematical ratio of the projects completed to those started. Compare this percentage to a predetermined percentage to determine whether or not results are at an acceptable level.

b. As a secondary measure, evaluate each and every project at certain stages of completion (e.g., 40 percent and 70 percent) and assess the cost effectiveness of each project relative to alternative production methods. If the cost-savings of the project do not meet expectations, cancel the project.

c. In addition to a mathematically-determined ratio, each project would be weighted to reflect the benefits derived from the project--production cost reduction, lead-time reduction, quality improvements, transferability of the project, projected reduction in costs of future programs, etc.

The primary reasons given for disagreement or strong disagreement with this criterion as a valid measure of IMIP effectiveness center on two exceptions. First, accurate assessment of the IMIP requires objectivity. If an opportunity exists for technology advancement, the DOD should take the initiative. Even though there may be a high level of opportunity, a promising program may turn out to be infeasible. The DOD must be willing to accept some losses and should not just implement programs in which a 100 percent completion rate is assured. Second, to accurately determine the success/failure of a program, overall cost savings would also have to be quantified in addition to the simple completion ratio to assess whether or not the implemented projects met their long and short-term goals. Given

these considerations, a weighting factor would have to be applied to assess overall program effectiveness.

Degree of Improved Readiness

This criterion was also tied at twelfth place on the ordinal ranking scale. Again, 57.9 percent of the total sample indicated agreement or strong agreement with the use of this criterion as a measure of IMIP effectiveness. All favorable responses indicated that measurements of productivity or production capacity could be used to quantify this measure. Specifically, it was suggested that measurement of plant productivity before and after implementation of an IMIP project would be a good indicator of improved readiness. However, adjustments for "normalization"--improvements which could/would have taken place without implementation an IMIP project--would have to be taken into account.

The second most frequently suggested method of quantifying this criterion was the assessment of improved readiness by measuring increased production capacity of the plant (a before and after comparison) or by examining reduction in manufacturing cycle time (through-put rate increases as a result of IMIP implementation).

Unequivocally, the primary reason cited for disagreement or strong disagreement with this criterion as a measure of IMIP effectiveness was that all respondents felt that "degree" and "readiness" were too hard to define or quantify. In fact, most felt that "degree of improved readiness" might be a qualitative rather than a quantitative measure.

As a result, it is not quantifiable standing alone. To quantify readiness, it was felt that the factors which impact readiness would have to be first defined and then methods of measuring/quantifying changes ("deltas") in those factors would have to be developed. Presently, it appears to be too nebulous to accurately measure. It is of interest to note that if "degree of improved readiness" could be defined and quantified, 100 percent of the respondents felt that this criterion would be a valid measure of IMIP effectiveness.

Reduced Acquisition Cost

One-hundred percent of the respondents concurred that this criterion should be used as a measure of IMIP effectiveness. Eight respondents (42%) agreed and eleven respondents (58%) strongly agreed about the utility of this criterion. This criterion ranked first among the seventeen proposed criteria for the measurement of IMIP effectiveness. To quote one of the IMIP program managers, "This is what the IMIP is all about; this is the thrust of the IMIP and, currently, this is the only--be it good or bad--criterion applied in making a go, no-go decision in regard to an IMIP project or to assess the overall effectiveness of the IMIP itself."

Even though this was the highest-ranking criterion, there were several methods suggested for quantifying the measure. They included:

a. Examine savings which occur over the life of the business deal, as well as unit cost reductions of the particular system or item being produced. (Include overhead as well as direct rates.)

b. Compare dollar savings against some baseline cost and examine cost reductions in such a way as to eliminate the variability of the economic climate.

c. Measure the reduction in total acquisition cost--total life cycle cost--of the system as well as initial cost savings.

d. Determine cost savings of the total program, to include reduced quantities, which are a result of improving readiness, reliability, quality, productivity, etc.

Only one caveat was mentioned in regard to this criterion as a measure of IMIP effectiveness. If cost reductions are evaluated in terms of an "old" cost versus a "new cost," care must be exercised when developing an enabling technology that doesn't exist presently. Assessment of cost savings to be realized some time in the future could be difficult.

Improved Productivity

Only two respondents disagreed and only one respondent strongly disagreed with the statement, "Improved productivity is a valid measure of IMIP effectiveness." Overall, 16 respondents--84.2 percent of the total sample, indicated either agreement or strong agreement with this statement. As a result "improved productivity" was the fourth most

recommended criterion for measuring IMIP effectiveness. The ten "agree" responses and six "strongly agree" responses reflect the high regard of all IMIP managers for this particular criterion as a useful measure of IMIP effectiveness.

The proposed methods for quantifying "improved productivity" included:

- a. Using a common base for measurement, examine production in terms of increased quantities produced with a constant amount of input. The net result should be a lower per unit cost.
- b. Measure increases in output relative to a constant input (e.g., raw materials, machinery, labor, capital).
- c. Compare reduction in acquisition costs before and after IMIP implementation to determine if a cost reduction has occurred.

Of those program managers responding unfavorably, the main reason cited for not including this criterion as a measure of IMIP effectiveness was the problem of how to isolate and measure productivity gains associated with particular IMIP projects. They felt that a common DOD standard which could be used as a basis of measurement (e.g., MIL STD 1567) would have to be invoked on each project. It was felt that such a standard may be too expensive to implement contractually on all IMIP projects. Further, it was also suggested that other variables would have to be considered in assessing improved productivity and that, perhaps, productivity gains alone would not "stand alone as an effective

measurement criterion. For instance, if item quality has suffered or scrap/rework rates have increased as a result in a gain of productivity, these factors would have to be taken into consideration.

Improved Item Quality

"Improved item quality" was tied with "reduction in production leadtime" as the second most recommended criterion for measuring IMIP effectiveness. Of the 19 total responses, 17 (89.5%) indicated either agreement or strong agreement with the statement "Improved item quality is a valid measure of IMIP effectiveness." There was an almost even split of "agree" and "strongly agree" responses--nine and eight respectively. This reflects the strong regard of all IMIP managers for the usefulness of this criterion as a measure of IMIP effectiveness. Quantification methods were similar and all included isolating cost savings resulting from improved quality. The most frequently cited methods of measuring improved quality were:

- a. Compare scrap and rework levels before and after implementation of the particular IMIP project and assess cost savings relative to improved quality (rework yields).
- b. Assess cost savings associated with smaller reject rates which are the result of IMIP implementation.
- c. Examine reductions in manufacturing costs, to include scrap and rework rate reductions (manufacturing loss reduction), as well as inspection costs. Combine this cost reduction with field failure rates (reliability over the

total life cycle of the particular system) to assess total dollar savings of the IMIP program.

d. Determine cost savings relative to reduced inspection times.

e. Examine cost savings associated with reduced labor hours in quality control.

If these suggested methods were combined, a comprehensive accounting of cost savings relative to improved item quality could be captured.

No one respondent strongly disagreed that this criterion could be measure of IMIP effectiveness. However, one respondent expressed concern about the application of this criterion to all IMIP projects. This respondent believed that unless an IMIP project is specifically implemented to increase item quality, this measure may not be relevant. Each IMIP project does not ensure improve item quality; therefore, this criterion should only be used to assess "quality projects"--those intended to improved inspection and testing techniques.

The only other respondent disagreeing with this criterion as a measure of IMIP effectiveness stated "To truly assess the effectiveness of item quality, one has to look at the total life cycle cost reduction. This is impractical; would take too long; be too costly; and, it may simply be too hard to isolate those costs associated with improved quality."

Improved Reliability

This criterion was ranked seventh, along with "advances in the state-of-the-art," in terms of overall respondent agreement. Of all respondents, 68.4 percent were in agreement or strong agreement that this criterion should be accepted as a valid measure of IMIP effectiveness. However, all respondents, regardless of agreement or disagreement with the validity of using reliability improvements as a measure of effectiveness, expressed concern with the ability of the DOD and industry as a whole to quantify reliability and to measure reliability accurately. This concern weakens the support for this criterion as a means of measuring IMIP effectiveness.

Of those managers responding favorably to using improved reliability as a measure of effectiveness, only two methods of quantification were suggested. In fact, of the nine "agree" responses and four "strongly agree" responses, very few managers even suggested a method of quantification. One method was intended to assess long-term reductions in the life cycle cost of a system due to reduced maintenance costs and reduced field failure rates. Key measurement parameters included reduced spares costs and the reduced number and skill level of maintenance technicians required as a result of improved reliability. However, the belief that life cycle costs would be very hard to capture and attribute to the improved reliability was emphasized.

The other suggested method for the quantification of improved reliability was designed to assess reliability growth impacts and ownership cost reductions as a result of implementing an IMIP project. Once again, it was recognized that these costs would be difficult to capture.

The managers who disagreed or strongly disagreed provided a strong argument for not using "improved reliability" as a measure of IMIP effectiveness. The reasons cited for not including this criterion as a measure of effectiveness included:

a. It would take too long and would be too hard to isolate life cycle cost reductions due strictly to increased reliability. It would also be too costly.

b. This criterion is more a result of design, as opposed to manufacturing, and probably should not be considered.

c. Reliability is too hard to quantify. The use of this criterion would have to be limited to IMIP projects or processes designed specifically to improve reliability.

d. This measure may not be related to IMIP effectiveness unless a project was structured to increase reliability. Improved reliability is not usually the stated goal of an IMIP project, however, this does not discount the fact that it may be a "side" benefit. It is questionable, even taking into account the agree/strongly agree responses, whether this criterion would be a valid, reliable measure of IMIP effectiveness.

Advances in the State-of-the-Art

This criterion was ranked seventh in terms of overall respondent agreement. Again, of all the respondents, 68.4 percent agreed or strongly agreed that this criterion should be used as a measure of IMIP effectiveness. Of those managers responding favorably, there was no consensus of opinion as to how to quantify this measure. Responses were diversified and included:

a. A method to determine how much the advances are the a result of an IMIP project would have to be developed. A before/after measure would be required. The measure would be situational at best and would have to relate the technology in question to its originating IMIP project.

b. cost-benefit analysis

c. Specific achievements of each project in regard to advances in the state-of-the-art could be itemized and then related to cost savings that result from each advance. In effect, the objective would be to measure the effect of a technology that didn't exist previously or one which was previously less developed.

d. Attributes could be developed about the state-of-the-art results and effects could be stated in words. For example, set up a scale ranging from -2 to +2 with -2 = state-of-the-art advance detrimental, -1 = state-of-the-art advance mildly detrimental, 0 = neutral, 1 = state-of-the-art had positive influence, +2 = state-of-the-art extremely

positive. Rankings could then be assigned on a project-by-project basis after review by a team of "technical experts."

Of the six IMIP program managers responding unfavorably to the use of this criterion as a measure of IMIP effectiveness, all stated that, as a measure, state-of-the-art was "unquantifiable" and that it would be too hard to assign a dollar value to this criterion. Standing alone, this measure would not be usable. It must be associated with some improvement which is measured in dollars. Additionally, the degree of risk associated with each project would have to be examined to determine if advances actually had been made.

Increased Competitiveness

Competition among defense contractors is widely advocated at all levels of the DOD. It is viewed as the single most effective way to reduce the acquisition costs of DOD weapon systems. But how valid would this criterion be for assessing the effectiveness of the IMIP? "Increased competitiveness" was tied for twelfth with three other criteria when ranked according to the percentages of "agree" and "strongly agree" responses to the statement, "Increased competitiveness is a valid measure of IMIP effectiveness."

The results indicate that this criterion would have marginal utility as a measure of IMIP effectiveness. Although 57.9 percent of the total sample (11 of the 19 respondents) indicated either agreement or strong agreement, there was no consensus and, in fact, some skepticism as to how this

measure could be quantified. One respondent suggested comparing the win ratios of competitive contracts for defense contractors before and after implementation of IMIP projects. Another suggested a comparison of prices for systems affected by an IMIP project with prices of the same weapon system under a non-IMIP program to determine if a positive correlation existed between a contractor's ability to compete and the implementation of an IMIP project. Many believed that none of the methods mentioned would provide conclusive results. In fact, these beliefs paralleled those of respondents responding unfavorably--competitiveness is too hard to quantify, therefore it would not be a valid measure. Of those respondents providing "strongly disagree" responses, several stated that increased competitiveness will not result from the IMIP; rather, the IMIP is actually destroying competitiveness. "One should be trying to assess this negative impact on the defense industrial base which is sure to take place in the long run!"

Degree of Technology Transfer

"Degree of technology transfer" was tied at fifth place with "increased surge/mobilization capability (responsiveness)" when ranked according to the percentages of "agree" and "strongly agree" responses to the statement, "Degree of technology transfer is a valid measure of IMIP effectiveness." Fourteen respondents--73.7 percent of the total sample--indicated agreement or strong agreement. Of these 14 responses, 10 were "agree" (71.4%) and 4 were

"strongly agree" (28.6%). The remaining five responses (35.7%) included three "disagree" and two "strongly disagree" responses.

The results indicate that the criterion "degree of technology transfer" would be a valid measure of IMIP effectiveness. However, the large number of "agree" responses (10) relative to "strongly agree" (4) reflects the general consensus that two key qualifications must be attached to this criterion to ensure its validity and reliability. First, this criterion should only be used to evaluate those IMIP projects which included technology transfer as an original objective. Most respondents expressed concern that evaluation of an IMIP project which produced new technology which was not intended to be or could not economically be adopted by other companies would bias the evaluation results and could jeopardize the operation of an otherwise successful project. Second, this criterion must reflect equally the willingness of an "originating" company to "leave" technology as well as measure the willingness of other companies to adopt new technology. The responses generally indicated a belief that responsibility for technology transfer is equally divided between the originator and the potential recipients in terms of open and free dissemination and exchange of information.

Suggested methods for quantifying "degree of technology transfer" ranged from simple mathematical ratios to extensive information data base files. For example, the mathematical measures included:

a. the number or percentage of new IMIP-related technologies adopted/applied by companies other than the originator;

b. the number of individual company programs affected by the transfer of IMIP-related technology (could be used both for originator and other companies);

c. the percentage of technology adopted by a company before/after establishment of an IMIP project; and,

d. a weighted overall measure of effectiveness--number of contractors wanting to use/adopt new technology without solicitation by government using contractor funding. Other methods were designed to measure both the willingness of the originating company to encourage the transfer of technology and the responsiveness of other companies to these efforts. One respondent suggested that indicators such as the number of meetings, seminars, articles, and marketing actions sponsored by an originator of new technology be used to measure the level of participation in technology transfer. Similarly, levels of participation in these exchange mediums by potential users could be used as an indicator of recipient interest. For instance, a typical "who shows interest?" measure could be the level of capital investment based upon IMIP-related technology over a specified period of time for potential users. Similar measures could be based upon such indicators as total savings realized as a result of technology transfer. Another

suggested method would establish a master list of all transferable technology developed through IMIP and a list of companies which have adopted technology on that list.

The primary reasons given for disagreement or strong disagreement with this criterion as a measure of IMIP effectiveness are based upon questions regarding the relative importance of and incentives to participate in transfer of technology. Most notable were the beliefs that the transfer of technology was not a high-priority objective and that other goals such as cost reduction were, in fact, receiving more emphasis. As a result, among those who disagreed/strongly disagreed, most indicated that this criterion should not be used as a sole measure of IMIP effectiveness due to the differing levels of interest in/applicability of technology transfer among individual IMIP projects.

Increased Surge/Mobilization Capability (Responsiveness)

Identical to "degree of technology transfer," 14 respondents (73.7 percent of the total sample) indicated agreement/strong agreement with the statement, "Increased surge/mobilization capability is a valid measure of IMIP effectiveness." Of these 14, 11 indicated agreement and 3 indicated strong agreement. Among the remaining five respondents, three indicated disagreement and two indicated strong disagreement. Generally, these statistics indicate that the majority of government and contractor IMIP managers believe that this criterion could be a valid measure of IMIP effectiveness. However, a review of comments and suggested

methods of quantifying this criteria reveals a striking, though not surprising, difference in contractor/government perspectives regarding the use of increased surge/mobilization capability as a measure of IMIP effectiveness.

Based upon the responses from defense industry IMIP managers, increased surge/mobilization capability is a straightforward matter of mathematical ratios. Almost without exception, suggested indicators of increased surge/mobilization capabilities were based primarily upon levels of through-put or reductions in manufacturing cycle times. Composite examples from all contractor responses include:

- a. product leadtime before/after implementation of an IMIP project (measured in products per unit time);
- b. production capacity before/after implementation of an IMIP project (measured in terms of quality, direct labor, lead time, etc.); and,
- c. system acquisition time before/after implementation of an IMIP project (an all-inclusive measure composed of engineering development, prototyping, and manufacturing phases).

These measures clearly reflect a dominant concern of defense contractors with the impact of individual IMIP projects upon production levels as well as in-use/potential manufacturing capacity.

Government IMIP managers, on the other hand, viewed the question of measuring increased surge/mobilization capability from a wider-ranging "What if?" attitude. For example,

one proposed method to quantify increases in surge/mobilization capability was based upon the use of contractor-defined surge/mobilization production scenarios to test the ability of all levels of production to respond to valid surge/mobilization requirements. Actual quantities of components/end items produced during regular production and surge/mobilization periods would be compared to assess the ability of all levels of production to respond to a particular scenario. "Percent increase" would not be used as a measure to prevent statistical camouflage of a production shortfall or to prevent inflation of production figures.

Comparison of these two perspectives is not meant to infer that the proposed measures of one are necessarily more comprehensive, valid, or reliable than the measures of the other. Rather, this comparison is offered as one possible explanation for the large number of "agree" responses when compared to "strongly agree" responses. That is, both groups seemed to have a definite perspective of the meaning of "increased surge/mobilization capability" yet, both groups indicated that further definition would be required before this criterion could be used to measure IMIP effectiveness. It seems that this dichotomy of views suggests the use of a composite measure which is composed of components from each viewpoint.

The five "disagree/strongly disagree" responses also provided some indirect support for a consolidation of the two perspectives of measuring increased surge/mobilization

capability. All five responses, regardless of whether from government or private industry, seemed to recognize that a "composite" measure which combined measurement of "production floor" capacity with "what if" scenarios reflecting true surge/mobilization requirements was required to make this a valid measurement criterion. Typical responses which led to this conclusion included, "Only applies to production floor application--IMIP goes beyond this" and "Too many what ifs."

Reduction of Production Leadtime

Only two respondents disagreed with the statement, "Reduction of production leadtime is a valid measure of IMIP effectiveness." Overall, 17 respondents--89.5 percent of the sample, indicated agreement or strong agreement with that statement. As a result, "reduction in production leadtime" was tied with "improved item quality" as the second most recommended criterion for measuring IMIP effectiveness. The almost even split of "agree" and "strongly agree" responses--nine and eight respectively--as well as the consistent trend of agreement regarding quantification methods reflects the strong regard of all IMIP managers for the usefulness of this criterion as a measure of IMIP effectiveness. Without exception, every proposed method of quantifying this criterion was based upon one basic calculation--change in production leadtime equals production leadtime before IMIP implementation minus production leadtime after IMIP implementation.

MEASURING THE EFFECTIVENESS OF THE INDUSTRIAL
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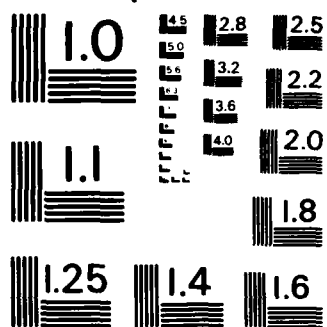
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MICROCOPY RESOLUTION TEST CHART
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Differences among the proposed methods of quantification consisted primarily of definitions of individual terms and parameters as well as related factors which might improve the measurement validity of this criterion. For example, respondents suggested that factors such as changes in finished product, raw material, and work in-process inventory costs should be measured in conjunction with reductions in production leadtime to analyze the overall impact of an IMIP project upon a manufacturing process. Other suggestions emphasized the importance of defining the level of study--prime and/or subcontractor--and the importance of measuring the impact of IMIP-induced leadtime reductions upon total acquisition costs.

No one strongly disagreed with this statement. However, one respondent expressed concern about the ability of this criterion, as stated, to "catch" the full impact of an IMIP project since production leadtime was related primarily to the production process and direct labor. Essentially, the respondent believed that this criterion would not adequately measure the significant impact which IMIP has upon indirect labor/activities. Another respondent indicated that the emphasis should be moved from a reduction in time by redefining this criterion as "reduction in item cost."

Number of Commercial Spinoffs

As opposed to the popularity of the previous criteria, only two (10.5 percent) of the nineteen respondents indicated agreement with the statement, "The number of commercial

spinoffs is a valid measure of IMIP effectiveness." Equally significant is the fact that 13 of the remaining 17 negative responses were "strongly disagree" reflecting the unqualified belief of the majority of respondents that the number of commercial spinoffs generated by a particular IMIP project is not a valid measure of relative efficiency or effectiveness. As a result, this criterion was ranked seventeenth of the 17 proposed criteria.

Most interviewees simply did not see any correlation between the number of commercial spinoffs and the success of an IMIP project in terms of benefit to the DOD. Typical comments included: "Not a DOD concern; No impact upon IMIP effectiveness; Questionable worth to the DOD; Nice to have; What different does it make?" Further, some responses indicated that use of this criterion to measure IMIP effectiveness may, in fact, cause contractors to slant IMIP efforts toward the development of technology conducive to commercial applications rather than DOD uses. Finally, many respondents believed that quantification would be difficult at best because, as one person said, "Contractors would be reluctant to publicize the number of commercial spinoffs" realized from an IMIP project.

Comments from those who agreed with the survey statement also admit that quantifying this measure would be extremely difficult and costly. Both respondents indicated that this criterion could be useful only if all commercial spinoffs from technology developed through the IMIP were

reported and tracked. The purpose of this tracking system would be to capture the percentage of new commercial products developed through application of IMIP-generated technology.

Plant Modernization

The initial breakdown of all responses to the statement, "Plant modernization is a valid measure of IMIP effectiveness," does not lead to any immediate conclusions about the potential usefulness of this criterion. Twelve respondents, 63.2 percent of the total sample, did agree or strongly agree with the above statement. Only three, however, were convinced that plant modernization was so useful as a measure of IMIP effectiveness that they indicated strong agreement—accepted the criterion, as stated, without any qualifications. Further, the ranking of plant modernization, as an effective measure of IMIP effectiveness, at ninth place (tied with "increased productivity growth rate" and "reduced critical material usage") also reinforces these apparently inconclusive results. If one were to rely upon these three indicators alone, it might be difficult to determine the true beliefs of those interviewed. Analysis of comments recorded during the interview, however, reveals that all respondents, even those who disagreed or strongly disagreed seemed to believe that this criterion could be a valid measure if certain qualifications were established.

Regardless of their respective responses—agree or disagree, IMIP managers from both government and private

industry seemed to concur that one essential qualification must be integrated into this criterion to ensure its measurement validity and reliability. In short, "modernization for modernization's sake" must not be encouraged by this criterion. To prevent this phenomenon from happening, respondents generally believed that any measure of plant modernization must move its focus from a simple "bean count" of robots and computers to a larger systems-oriented approach of "What is the impact of modernization upon the capacity of this plant and what is significant about the IMIP project's role in this modernization effort?" Combining the views of two respondents (who, incidentally, disagreed with the survey statement), the "intent of IMIP is to develop enabling technologies; not subsidize modernization." Therefore, one "must know the connection between modernization and its underlying reasons." The question, then, is no longer, "Has the implementation of an IMIP project resulted in plant modernization?" It is, rather "How have the enabling technologies developed through IMIP-sponsored modernization improved product quality, plant capacity, throughput, etc.?"

Two important factors which most respondents found essential to this systems-oriented approach to measurement of plant modernization are the concepts of risk and intent. To maintain the proper perspective when trying to evaluate the significance of IMIP-related plant modernization, respondents generally indicated that the risk associated

with the development, adoption and implementation of a particular project must be considered. Typical research questions might include:

a. How significant is this IMIP project and its related plant modernization in relation to improved total production, quality, capacity, etc.?

b. How significant were the risks accepted by the adopting company during the planning, development and implementation phases of the IMIP project?

Intent is also important to the evaluation of IMIP-related plant modernization in the sense that one must know the degree of modernization forecasted during the Phase I analysis in order to gauge the actual degree of modernization achieved.

In light of these comments/conclusions, it was mildly surprising to note that many of the proposed methods of quantifying this criterion were basic measurements of the average age of capital equipment and levels of capital investment. While these indicators are important contributing factors in the overall analysis of production capabilities, exclusive reliance upon these indicators seems to move away from the more systems-oriented approach which earlier comments seem to support. Typical suggestions included:

- a. average age of equipment,
- b. age of capital equipment,
- c. capital funds expended,
- d. 5-year capital investment levels, and
- e. degree of computerization/use of robotics.

Other measures moved closer to the overall systems view of IMIP and plant modernization--"actual capital dollars incentivized by IMIP" or "degree of continued integration of IMIP into overall plant modernization." However, one proposed method seemed to come closest to the target of measuring the overall impact and significance of IMIP-related plant modernization upon a production process. This method will be called the "systems-oriented" measurement approach for discussion purposes.

The "systems-oriented" measurement approach employs a set of production attributes to measure the impact of IMIP-generated plant modernization upon the overall plant/production process. Typical attributes of modernization might include increased capacity, production through-put, decreased rejection rates, scrap rates, rework rates, etc. The list of potential attributes is limited only by the degree of specificity required by the stated project objectives in the Phase I analysis and the needs of the parent/adopting company. Each attribute would then be weighted according to its importance relative to the other evaluation attributes and the intended project goals. A scaled rating of actual degrees of change for each attribute could be made, weighted, and compared to predetermined standards to measure benefits gained from an IMIP project relative to the degree of plant modernization. The most attractive feature of this method is the degree of evaluation flexibility which it provides IMIP evaluators. A wide range of evaluation factors can be

incorporated into the approach and the individual weights can be adjusted to reflect changing IMIP priorities.

Ability to Increase Productivity Growth Rate

Similar to the discussion of "plant modernization," exclusive reliance upon the breakdown of responses to this statement could provide some very misleading conclusions. For example, similar to the response rate for "plant modernization," 63.2 percent of those interviewed (12 of 19 respondents) indicated agreement or strong agreement with this statement. Further, only three of those twelve respondents strongly agreed that the "ability to increase productivity growth rate" would be a valid measure of IMIP effectiveness without qualification. Finally, as stated earlier, this criterion was ranked ninth, along with "plant modernization" and "reduced critical materials usage," in terms of overall respondent agreement. However, unlike "plant modernization," analysis of the comments recorded during the interviews does not reveal a strong case for accepting this criterion as a valid measure of IMIP effectiveness. It appears that the majority of the respondents, regardless of their degree of agreement or disagreement or their management perspective, believed that a lack of universal measurement standards and uncertainties regarding the appropriate level from which this criterion should be viewed, seriously weaken the validity and reliability of this criterion as a measure of IMIP effectiveness.

Comments indicate that the quantification process to determine increases in productivity growth rate is a rather simple and straightforward process of comparing productivity levels before and after implementation of an IMIP project and expressing the difference as a percentage of increase. Once again, like earlier criteria, this comparison could be made using any combination of numerous production attributes such as those discussed for "plant modernization." The real difficulty, then, is not mathematical quantification; rather, it lies with finding a standard scale of productivity against which individual measurements could be ranked/rated. Some respondents suggested that a universal scale such as those established by the Federal Bureau of Standards be adopted to measure productivity growth rates. However, several other respondents questioned the validity of using a universal standard to evaluate the productivity growth rates of individual IMIP projects which tend to have highly specialized goals and applications. The general feeling appears to be that, if productivity growth rates are to be measured, then specific internal standards should be developed by the parent corporation to measure relative growth rates.

Questions regarding the levels of analysis for this criterion also contribute to the reluctance of respondents to enthusiastically endorse this criterion as a valid measure of IMIP effectiveness. Two basic points were highlighted during the interviews. First, the focus of this criterion should be on a specific weapon system to help preclude

influence by factors external to the individual IMIP project. Second, a few responses indicated that this criterion was too dependent upon other effectiveness measures to be considered as a key, primary measure of IMIP effectiveness.

Follow-on Contracts

This statement evoked such a negative response that the number of "strongly disagree" responses (10) is exceeded only by those recorded for "number of commercial spinoffs" (13). Overall, approximately 79 percent of all responses were "disagree" or "strongly disagree" (15 respondents). Of the remaining four respondents, three indicated agreement and only one indicated strong agreement.

Nearly all respondents considered "follow-on contracts" as a "long-range, fallout criterion" which had little or no influence upon the measurement of IMIP effectiveness. With the exception of one respondent who did not provide any comments, all of those who strongly disagreed with this survey statement indicated that follow-on contracts had "no bearing" upon IMIP effectiveness and, as a result, were "not a concern" when measuring program success. Two major perceptions fueled this consensus. First, most believed that the award of follow-on contracts was influenced by other, more significant, factors which were not related to implementation of an IMIP project. Second, use of "follow-on contracts" as a measure of IMIP effectiveness would introduce a significant "time-lag" factor into the evaluation process since follow-on contracts represent "long-range,

fallout" benefits. As a result, most indicated that this criterion would be of little use in the measurement of IMIP effectiveness.

The perception of the four respondents who agreed/strongly agreed with the survey statement as well as three respondents who "disagreed" was that this criterion would be useful if a specific level of application were defined and a cost factor introduced. To ensure that the scope of this criterion was not too broad, respondents indicated that the scope should be limited to the level of the individual company. Further, this criterion "must be related to competitiveness" in the sense that "it allows a company to perform additional work which they could not do before IMIP implementation." The "common denominator" for this criterion would be the degree to which future prices/bids "reflect the benefits of reduced costs" induced by an IMIP project.

Reduced Critical Material Usage

Once again, the initial response breakdown for this proposed criterion is somewhat inconclusive and does not accurately reflect the intuitive attractiveness of this criterion as a measure of IMIP effectiveness. Although only 63.2 percent of the total sample (12 of 19 respondents) indicated agreement or strong agreement with this statement, further analysis reveals that the responses were primarily colored by individual perspectives of one major qualification rather than definite differences in opinion regarding the overall utility of this criterion. Most respondents who

disagreed with this survey statement stated that this criterion could be a valid measure of IMIP effectiveness if and only if reduced usage of critical materials was a stated goal of the individual IMIP project. Likewise, several respondents who agreed or strongly agreed with the statement based their response upon the same qualification. In short, the majority of the respondents found this criterion intuitively attractive as a possible measure of IMIP effectiveness as long as its application was restricted to those projects which were specifically intended to reduce usage of a particular critical material(s).

Two primary approaches of quantifying this criterion were proposed. The most popular method was the comparison of the quantity of a critical material used before IMIP implementation with the amount consumed after IMIP implementation. Alternative indicators included measurement of reduced costs associated with the reduced usage of critical materials and the degree to which the use of critical materials was replaced by the use of non-critical materials. The second approach places its focus at the national level and measures the overall impact of IMIP upon the national reliance upon critical materials which have foreign sources of origin with a special interest upon unfriendly sources.

Open Question

The purpose of this question was to give each respondent the opportunity to identify any other possible measures

of IMIP effectiveness which had not been previously discussed. Additionally, it gave each respondent the opportunity to review/clarify earlier responses and comments. Rather than trying to summarize the responses to this question, all responses have been listed below to give the reader an idea of the wide range of suggested evaluation criteria and guidelines which were recorded.

a. Government IMIP Project Managers

- Suggested Evaluation Criteria

- Short-term return on investment (ROI) for government
- Environmental/Economic Impact--e.g., displacement of workers
- Impact upon flight safety

- Suggested Evaluation Guidelines

- Assess each project individually. Each/all criteria may not be applicable in all cases.
- Be aware of basic differences between evaluating IMIP effectiveness at prime-and subcontractor levels.
 - Different motivations
 - Lower levels require more subjective evaluation due to the difficulty of tracking IMIP usefulness/ impact as affected outputs rise to the top at prime contractor.

b. Private Industry IMIP Project Managers

- Suggested Evaluation Criteria

- Capital spent per year for factory modernization to measure demonstrated interest in improved factory floor

- Return on investment
- Internal cash flow
- Degree of willingness to participate in IMIP
- Combine selected individual criteria such as advances in the state-of-the-art, increased productivity, and improved surge/mobilization capability.
- Affect of IMIP upon the DOD business base--the number of weapon systems affected by IMIP tied to a dollar value.
- In-process inventory levels and manufacturing flexibility: Increased flexibility to change product lines affects size of required inventory levels.
- Suggested Evaluation Guidelines
 - Consider cost savings, origins of capital for each program
 - Group projects into broad classifications to ensure validity of measures.
 - Emphasize a solid up-front business agreement.

Overall, respondents generally indicated that the list of 17 proposed criteria for measuring IMIP effectiveness was fairly exhaustive. As can be seen, however, the evaluation criteria which were suggested in response to this question are, in most cases, extensions/elaborations of the basic criteria suggested in the first part of the interview.

Summary

The individual responses to each of the 17 proposed measures of IMIP effectiveness were grouped in an ordinal

ranking of relative measurement validity and reliability according to the total number of "agree" or "strongly agree" responses. Additionally, interviewee comments were grouped and analyzed to highlight the key concerns and qualifications which influenced the relative ordinal ranking of each criterion. Overall, the responses of the 19 government and defense industry IMIP program managers who participated in this survey indicate that nine of the proposed criteria would be valid measures of IMIP effectiveness if properly qualified and/or defined. The remaining eight criteria, however, appear to have significant weaknesses or flaws which reduce their measurement validity and reliability to unacceptably low levels. The nine criteria identified as potentially valid measures of IMIP effectiveness were:

- a. reduced acquisition cost,
- b. improved productivity,
- c. improved item quality,
- d. advances in the state-of-the-art,
- e. degree of technology transfer,
- f. increased surge/mobilization capability (responsiveness),
- g. reduction of production leadtime,
- h. plant modernization, and
- i. reduced critical material usage.

The eight criteria considered to be of questionable or marginal value to the measurement of IMIP effectiveness were:

- a. percentage of IMIP projects directly applied to DOD weapon system production,
- b. percent of projects completed,
- c. degree of improved readiness,
- d. improved reliability,
- e. increased competitiveness,
- f. number of commercial spinoffs,
- g. ability to increase productivity growth rate, and
- h. follow-on contracts.

As indicated by the overall responses to the "open" question included in this interview schedule, the respondents considered this list of potential IMIP measurement criteria to be generally exhaustive. Given that the list is exhaustive, the initial task of identifying potentially valid measures of IMIP effectiveness has been completed.

This rudimentary classification of criteria is, however, only the first step toward the development of a comprehensive, standardized IMIP evaluation system. Chapter V, Conclusions/Recommendations, outlines how each valid criterion should be defined/qualified; defines the method of quantification and standard of comparison which should be used for each criterion; summarizes the weaknesses of marginal criteria; and, outlines the level of analysis or perspective from which the evaluation of IMIP effectiveness should be approached. Additionally, specific areas of follow-on research are recommended.

V. Conclusions/Recommendations

When you can measure what you are speaking about and express it in numbers, you know something about it; but when you cannot measure it...your knowledge is of a meager and unsatisfactory kind.

- Lord Kelvin
(7:42)

Research Synopsis

The fact that the United States' defense industrial base has been seriously weakened due to the failure of both the Government and defense industries to systematically modernize defense plants through a coordinated program of capital investments has been well documented. Research reports abound with recommended actions which could reverse this deterioration; however, it seems that, in most cases, the only action which has resulted from these reports has been the generation of additional reports documenting this same decline of the defense industrial base from a different perspective. This seemingly perpetual cycle of inactivity has, in itself, become a problem. As Richard H. Ichord stated, "Action, not additional studies, is what is urgently needed if our national security objectives are to be realized" (41:23).

The Industrial Modernization Incentives Program (IMIP) is the catalyst for the very action which Mr. Ichord deemed crucial to the restoration of the defense industrial base. The IMIP, in operation as a test program for almost three years, is the first major attempt by the DOD and major

defense contractors to revitalize the defense industrial base through a coordinated program of plant modernization/capital investment. Senior government officials have designated the IMIP as the "number one DOD initiative" upon which "the future of a strong industrial base...rests" (16:26). Since its inception in late 1982, the IMIP has rapidly matured into a major influence upon the DOD acquisition process. Within the Air Force, the IMIP has influenced acquisition and production decisions for major systems ranging from the B-1B to the Global Positioning System. Further, the success of IMIP in revitalizing the U.S. defense industrial base will be a major determinant of the United States' future ability to develop the technologies required to support the Strategic Defense Initiative.

The Industrial Modernization Incentives Program will soon be evaluated to determine if it has been effective in halting the deterioration of the U.S. defense industrial base and reducing weapon system acquisition costs. The management question that must be answered at that point, in effect, will be: "Can the IMIP and its component programs such as the Air Force's Technology Modernization Program (TECHMOD) reduce major weapon system cost and help revitalize the United States defense industrial base?" While the answer to this question may, at first, appear to be a relatively simple matter of quantifying acquisition cost reductions or increased levels of capital investments, previous research has shown that accurate evaluation of previous technology

modernization programs was not achieved due to the lack of quantifiable, standardized DOD measures of effectiveness and evaluation periods.

The final objective of this research will be to determine if, in fact, the IMIP/TECHMOD is reducing acquisition costs of major weapon systems while maintaining free and open competition and assuring maximum defense industrial base surge/mobilization capability. Two stages of research will be required to meet this final objective. Both stages of research will test the hypothesis that the IMIP and related programs such as TECHMOD will reduce major weapon system costs, will maintain free and open competition, and will revitalize the United States' defense industrial base. The objective of Stage I is to identify those evaluation criteria which would provide a reliable and valid measurement of IMIP effectiveness. The objective of Stage II should be to use these criteria to develop an evaluation instrument; apply the instrument to selected IMIP projects; and, develop conclusions regarding the effectiveness of the IMIP in restoring the U.S defense industrial base and reducing acquisition costs.

This thesis documents the execution and completion of Stage I--the identification of valid and reliable measures of IMIP effectiveness. Through a series of personal and telephone interviews, 19 government and defense contractor IMIP managers were asked to evaluate the validity of 17 potential measurement criteria and to determine how best to

quantify those criteria found to be useful measures of IMIP effectiveness. The overall percentage of "agree" and "strongly agree" responses to each interview question as well as explanatory comments were evaluated to determine which criteria would best serve as measures of IMIP effectiveness. Nine of the original seventeen proposed measurement criteria were identified as valid measures of effectiveness. They are

- a. reduced acquisition cost,
- b. improved productivity,
- c. improved item quality,
- d. advances in the state-of-the-art,
- e. degree of technology transfer,
- f. increased surge/mobilization capability (responsiveness),
- g. reduction of production leadtime,
- h. plant modernization, and
- i. reduced critical material usage.

The remaining eight criteria found to be of marginal value, when considered individually, include:

- a. percentage of IMIP projects directly applied to DOD weapon system production,
- b. percent of projects completed,
- c. degree of improved readiness,
- d. improved reliability,
- e. increased competitiveness,
- f. number of commercial spinoffs,

- g. ability to increase productivity growth rate, and
- h. follow-on contracts.

This chapter will summarize the findings for each of the 17 proposed criteria. For those found to be useful measures of IMIP effectiveness, key qualifications will be specified and methods of quantification will be defined. For those criteria found to be of marginal or no use, key weaknesses/flaws will be discussed. Finally, related areas of further study and evaluation will be recommended.

Findings

The initial step toward developing a comprehensive, standardized method of evaluating the ability of the DOD Industrial Modernization Incentives Program (IMIP) to reduce weapon system acquisition costs; stimulate competition; and, revitalize the U.S. defense industrial base has been completed. Nine criteria have been identified as valid measures of IMIP effectiveness. Yet, until a complete situational perspective which explains the social and technological forces which shape the character of the U.S. industrial base is established as the basis for IMIP analysis, the intrinsic ability of these criteria to accurately assess IMIP accomplishments is significantly diminished.

As Major General Joseph H. Connolly and Lieutenant Colonel Robert E. Shafer point out, new technology alone will not revitalize the industrial strength of the United States.

New tools and new ways to analyze the evolving changes must be developed to insure that objectives to improve the nation's defense industrial base are realized (8:39). (Emphasis added.)

This "new way to analyze evolving changes," according to Gen Connolly and Lt Col Shafer, must be very sensitive to shifts in management attention between two major factors of productivity--labor and technology. For example, in the past, industry has tended to substitute additional labor for technology to improve productivity since "labor has been in reasonably good supply and capital has been too expensive" (8:33). This will not always be the case, however, since "most studies today show technology followed by capital investment as the key drivers to productivity growth" (8:32). Consequently, "company managers will...make greater use of advanced technology as a substitute for the increasing expense of labor" (8:36).

Any proposed method of evaluation/analysis must, therefore, be sensitive to the resulting decrease in costs which traditionally have been classified as "direct" labor as well as a possible increase in "indirect" labor costs (8:36). The ultimate impact upon industrial modernization evaluation methods will be a shift toward the linking of total cost and productivity measures.

Rethinking of work measurement is...needed to prevent putting all the eggs in the direct labor basket while indirect costs remain unchecked. That suggests a future focus on total costs or price.... What is important now is total or unit cost trends--and whether cost inputs are of a productive character (8:36-37).

The evaluation system to measure the overall effectiveness of the IMIP, then, must be sensitive to this shift in productivity factors from labor to technology and must be able to "catch" the full impact of direct and indirect labor costs upon the total cost or price of a program.

Given the importance of this situational perspective, the following criteria and associated methods of quantification are recommended for use as the basis for a standard method of evaluating the effectiveness of the Industrial Modernization Incentives Program.

a. Reduced acquisition costs should be evaluated by examining indirect and direct cost savings which occur over the life of the business deal as well as unit cost reductions of the particular system or item being produced. This total cost savings figure should reflect the impact of other factors such as increased item quality and productivity and should be applied to all IMIP projects.

b. Improved productivity should be applied to all IMIP projects and should be evaluated using a two-step approach. First, output in terms of units per time period which is the result of IMIP implementation should be compared to the output before IMIP implementation to determine if output has increased/decreased given that inputs have been held constant. Second, this increase/decrease in output should be linked to acquisition cost in order to determine the actual impact of productivity improvements upon total system costs.

c. Improved item quality should be applied to all IMIP projects and should be evaluated in conjunction with improved productivity. Comparison of scrap and rework levels as well as inspection costs before and after the implementation of an IMIP project should be made to assess the cost savings which are the result of improved quality. This cost figure should be related to measured increases/decreases in productivity to determine the correlation between the two measures. Further, as data become available, combine the reductions in manufacturing costs which are due to IMIP implementation with subsequent field failure rates to assess total savings/costs.

d. Advances in the state-of-the-art should be used to evaluate all IMIP projects. Initially, this criterion should be quantified by itemizing advances in the state-of-the-art resulting from an IMIP project and linking these advances to any resulting cost reduction. This method, however, could be, and probably should be, replaced eventually by a more specific means of quantification. It must be reemphasized that, while a majority of those interviewed agreed that this criterion could be a valid measure of IMIP effectiveness, no real consensus regarding the best way to quantify this measure was reached. Thus, the suggested method of quantification is simply the means by which inclusion of this measure in this list is assured.

e. Degree of technology transfer should be used to evaluate only those IMIP projects for which transfer of

technology is feasible. Further, this criterion should equally measure the willingness of an "originating" company to "leave" technology as well as the willingness of other companies to adopt IMIP-generated technology. Two approaches should be used to quantify this measure. First, if an IMIP project is being evaluated at its "originating" company, then all efforts of that company to encourage the transfer of technology--meetings, seminars, publications, marketing actions, etc.--should be reviewed to determine a relative level of participation. Additionally, an attempt should be made to assess the effectiveness of these efforts by determining the number of companies which were influenced to adopt IMIP-generated technology with internal funding. The basic measure in this case would be the number or percentage of new IMIP-related technologies adopted by companies other than the originator. Likewise, if the IMIP-generated technology is being evaluated at a "recipient" company, then the basic measure would be the number of individual company DOD programs affected by the transfer of IMIP-generated technology. In both instances, the impact of participation in the transfer of technology upon total acquisition costs could be quantified by indicators such as cost savings realized as a result of technology transfer or the level of capital investment applied to IMIP-generated technology over a specified time period.

f. Increased surge/mobilization capability (responsiveness) should be used to evaluate all IMIP projects. A composite measure consisting of a basic production ratio and

realistic normal/surge/mobilization scenarios should be used to ensure that an IMIP project has improved and can sustain required manufacturing flexibility. The production ratio could compare factors such as production leadtime or capacity before and after the implementation of an IMIP project. Regardless of the basic ratio, it must be linked with valid production scenarios which simulate expected normal, surge, and mobilization production requirements. Further, the actual quantities of production before and after IMIP implementation should be compared rather than percentages such as "percent increase" to avoid camouflage of shortfalls or statistical inflation.

g. Reduction of production leadtime should be used to evaluate all IMIP projects. As reflected by the interview responses, the basic calculation for quantifying the impact of an IMIP project upon production leadtime should be production leadtime before IMIP minus production leadtime after IMIP implementation. This basic figure should then be juxtaposed with changes in finished product, raw material, and work in-process inventory costs to facilitate analysis of the overall impact of an IMIP project upon a manufacturing process (Connolly's total cost).

h. Plant modernization should be used to evaluate all IMIP projects; however, encouragement of "modernization simply for modernization's sake" must be avoided. To prevent this from happening, simple "bean counting" of machinery or robots must yield to a more "systems-oriented" measure which

reflects the total impact of IMIP-generated technologies upon key factors such as plant capacity, product quality, through-put, etc. To accomplish this, a set of modernization attributes such as increased capacity, production through-put, decreased rejection, scrap and rework rates, etc. should be established according to the original project objectives found in the Phase I analysis. Each attribute should then be weighted according to its importance relative to other evaluation attributes and project goals. A scaled rating of actual degrees of change for each attribute should be made, weighted, and compared to predetermined standards to measure the benefits gained from an IMIP project relative to the degree of plant modernization. This method provides a great deal of evaluation flexibility to IMIP evaluators. A wide range of evaluation factors can be incorporated into the approach and individual weights can be adjusted to reflect changing IMIP priorities. In addition, secondary measures such as average age of capital equipment and capital funds expended per time period should be made to collect basic demographic data which illustrate the condition of the U.S. defense industrial base.

i. Reduced critical materials usage should be used to evaluate only those IMIP projects which were specifically intended to reduce usage of particular critical material(s). The basic method of quantifying this criterion should be the comparison of critical material quantities used before implementation of an IMIP project with the quantities used

after implementation. This figure could then be linked with resulting cost savings to reflect its impact upon total acquisition cost. This measure also provides evaluation flexibility through its ability to focus upon specific areas of concern such as the impact of the IMIP upon national reliance upon critical materials which have either friendly or unfriendly foreign sources of origin.

The following eight criteria were found by the interview respondents to be of little or no value to the measurement of the effectiveness of the Industrial Modernization Incentives Program (IMIP) in the reduction of weapon system acquisition costs and restoration of the U.S. defense industrial base when considered individually. Generally, the interview respondents believed that:

- a. percentage of IMIP projects directly applied to DOD weapon system production would motivate the DOD and defense contractors to avoid implementation of high-risk projects which might not have immediate DOD production applications thereby creating a larger technology gap than that which might already exist;
- b. percent of projects completed would also encourage the DOD and defense contractors to implement only low-risk projects which had a very high probability of success rather than accepting projects with a high risk of failure which could potentially generate equally high benefits;
- c. degree of improved readiness was, in fact, a qualitative measure which could not be economically quantified;

d. improved reliability was essentially unquantifiable due to the joint inability of the DOD and defense industries to quantify and measure reliability;

e. increased competitiveness would not provide conclusive evaluation results because, as a measure, it is too complex to be quantified and, in fact, would not reflect the actual decrease in competitiveness which is likely to result from IMIP implementation;

f. number of commercial spinoffs was not, in any way, related to the measurement of IMIP effectiveness and, if applied as a measure, could motivate defense contractors to implement only those IMIP projects which had future commercial applications;

g. ability to increase productivity growth rate would be a weak measure of IMIP effectiveness due to the lack of valid standards against which improvements could be compared--some respondents supported the use of universal standards and others supported the use of project-specific standards; and that

h. follow-on contracts was a "long-range, fallout" criterion which had not influence upon the measurement of IMIP effectiveness.

The fact that these criteria were found to be of marginal value when considered individually should not be construed to mean that they are not to be considered at all. On the contrary, measures such as "degree of improved readiness" and "increased competitiveness" are complex, qualitative

concepts which constitute a major portion of the basic DOD acquisition/production philosophy from which technology modernization efforts such as the IMIP are derived. As such, subjective conclusions about each criteria for all IMIP projects must be developed based upon the quantitative results recorded for the nine basic criteria described above and the "expert opinion" of the evaluator(s). Although subjective in nature, they nevertheless provide a key indication of the overall contribution which an individual IMIP project is making toward achievement of the stated IMIP objectives of improved productivity, reduced acquisition cost, and a revitalized defense industrial base.

Conclusion

The Industrial Modernization Incentives Program represents a firm commitment by both the United States Government and U.S. defense contractors to restore and sustain defense readiness which has been seriously lacking for approximately 40 years. Impressive strides in the improvement of productivity growth and reduction of acquisition costs have been made; however, the most significant benefits to be derived from the IMIP are yet to come. Careful management and control of the program now, in its early stages, will ensure that maximum benefits will be realized in the future. The key to control is accurate and timely system evaluation and program refinement as necessary.

This research effort has defined nine valid, quantifiable measurement criteria upon which a comprehensive

evaluation system for the Industrial Modernization Incentives Program should be established. The need for such an evaluation system is obvious in light of past demands, such as Mr. Ichord's, for action, not further study, to ensure the restoration of the U.S. defense industrial base and the reduction of weapon system acquisition costs. This need for a comprehensive, reliable IMIP evaluation system is made even more immediate by the growing belief among IMIP managers, participants, and observers that the IMIP may be degrading free and open competition among defense contractors rather than sustaining it. Numerous individual beliefs have been voiced which indicate that participation in the IMIP may, in fact, give contractors an unspoken competitive edge over companies who have not been chosen to participate in the program. In short, this evaluation system is needed to help determine if the IMIP is reinforcing the very barrier to entry, which it is supposed to demolish, by motivating the DOD to award contracts based upon the level of technology modernization.

Recommendations

The primary recommendation to be made is, of course, to evaluate the effectiveness of the IMIP using the individual and composite criteria developed during this research effort as key measurement guidelines. Accomplishment of this task will require the initiation of the second stage of this project--development of an evaluation instrument using the IMIP effectiveness criteria identified in this

report; applying that evaluation instrument to selected IMIP projects; and, determining if, in fact, the IMIP is meeting its stated objectives. Additionally, this recommendation, carries with it an important qualification which is critical to the success of any future evaluation of the IMIP. Every evaluation of an IMIP project should begin with a thorough review of the basic business agreement and the Phase I analysis to ensure that the project objectives are clearly understood. Omission of this action could cause misapplication of irrelevant measurement criteria and, as stated earlier, could result in the termination of an otherwise successful IMIP project.

In addition to the completion of Stage II of this research project, researchers should initiate a separate investigation to determine the validity of concerns that the IMIP will actually reduce competitiveness rather than sustain/improve it. The importance of such a study is obvious in light of the current emphasis upon free and open competition at all levels of the Government and DOD.

The future role of the IMIP in the development and support of the Strategic Defense Initiative (SDI) should be the focus of a third study. Preliminary studies and seminars have already concluded that a number of critical enabling technologies may not be sufficiently advanced to successfully execute the SDI. This study should specifically highlight how key IMIP characteristics such as technology transfer,

reduced critical material usage, and improved productivity could improve the ability of the defense industrial base to meet all technological requirements of the SDI.

Appendix A: Letter of Introduction/Key Terms,
Guidelines, Definitions



DEPARTMENT OF THE AIR FORCE
AIR FORCE INSTITUTE OF TECHNOLOGY (AU)
WRIGHT-PATTERSON AIR FORCE BASE, OH 45433

REPLY TO
ATTN OF LSG

SUBJECT Research Interview--Industrial Modernization Incentives
Program (Ref: telecon with)

TO

1. Thank you for agreeing to participate in our research efforts to measure the effectiveness of the Industrial Modernization Incentives Program (IMIP). As stated earlier, the purpose of this interview is to collect your perceptions about those criteria which would best serve as valid measures of IMIP effectiveness. Your responses will play an important role in the future development of a reliable, valid method of measuring the effectiveness of the DOD Industrial Modernization Incentives Program. We want to re-emphasize that you are guaranteed complete anonymity and your responses will be treated with strict confidentiality.

2. As previously arranged, a personal/telephone interview has been scheduled for 1985 at .

3. The researchers for this project, Mr Charles E. Houck, GS-12, and Capt Stephen R. Cooper, USAF, are candidates for the degree of Master of Science in Logistics Management at the School of Systems and Logistics. Their major area of study is acquisition logistics. Their research is being led by Dr William C. Pursch, Head, Department of Contracting Management. Mr Houck has served in a variety of logistics management positions at both the Air Force Logistics Command and Air Force Systems Command. Captain Cooper is an aircraft maintenance officer who has unit-level flight line and major command staff logistics management experience.

4. A list of key terms, interview guidelines, and definitions is attached. We believe it will help describe the scope of the questions, illustrate how the interview will be conducted, and provide a common understanding of important concepts. We ask that you have this list available during your interview.

5. Again, our sincere thanks for your cooperation. If you have any further questions, please contact us at 513-255-7212/6335 (commercial) or 782-7212/6335 (Autovon).

CHARLES E. HOUCK
GS-12, DAFC

STEPHEN R. COOPER
Captain, USAF

1 Atch

Key Terms, Guidelines, Definitions
AIR FORCE--A GREAT WAY OF LIFE

KEY TERMS, GUIDELINES, DEFINITIONS

BACKGROUND

Investigative research has generally concluded that defense officials and contractors believe that the Industrial Modernization Incentives Program (IMIP) can, and is, achieving favorable results. However, concerns have been raised regarding the lack of a DOD-wide system to collect information on various program results and the lack of a consensus on what criteria to apply to judge overall IMIP effectiveness.

RESEARCH OBJECTIVES

The ultimate objective of this research is to identify those criteria which would provide reliable, valid measures of IMIP effectiveness and use them to develop a survey instrument which would accurately evaluate IMIP effectiveness. The purpose of this interview is to gather the perceptions of military and contractor technology modernization managers regarding the reliability and validity of suggested IMIP evaluation criteria. Further, their ideas about the best way to quantify those criteria identified as valid IMIP effectiveness measures will be collected.

KEY CONCEPTS

The concepts listed below outline the intended scope of the interview and should help you focus your thoughts regarding possible criteria for the evaluation of IMIP.

Atch 1

- Percentage of IMIP projects directly applied to DOD weapon system production
- Percent of projects completed
- Degree of improved readiness
- Reduced acquisition cost
- Improved productivity
- Improved item quality
- Improved reliability
- Advances in the state-of-the-art
- Increased competitiveness
- Degree of technology transfer
- Increased surge/mobilization capability (responsiveness)
- Reduction of production leadtime
- Number of commercial spinoffs
- Plant modernization
- Ability to increase productivity growth rate
- Follow-on contracts
- Reduced critical material usage

INTERVIEW GUIDELINES

For each proposed criterion, you will be asked a question similar to this example.

"_____ is a valid measure of IMIP effectiveness."

For each suggested criterion, we would like you to indicate whether you

a. strongly disagree, (In your opinion, the proposed measurement is not, in any way, a usable, valid measurement of IMIP effectiveness.)

b. disagree, (In your opinion, the proposed criterion, as stated, would not be a valid measure of IMIP effectiveness unless redefined.)

c. agree, (In your opinion, the proposed criterion, as stated, could be an accurate measure of IMIP effectiveness while recognizing that there are better measurement criteria of IMIP effectiveness in terms of validity and reliability.)

d. strongly agree, (In your opinion, the proposed criterion, as stated, would provide a reliable, valid measure of IMIP effectiveness which could be quantified and uniformly applied to all DOD technology modernization programs.)

If you disagree with a statement, please indicate how the proposed criteria should be redefined to make it a usable measure of IMIP effectiveness. If you agree or strongly agree with a statement, please indicate how the particular criterion could best be quantified to measure IMIP effectiveness.

KEY DEFINITIONS

Acquisition Cost

Total cost to the Air Force of acquiring a complete weapon system.

A term used within DOD to denote the aggregation of costs to develop, produce, and deploy a weapon system in its operational environment. It commences with the conceptual phase and is completed when the last unit is delivered to the

using command. It excludes all operational activities associated with the mission application of the acquired weapon system.

The actual or estimated value of an item of material or a service in terms of its original cost to the U.S., exclusive of any cost incurred subsequent to acquisition and without regard to the time at which actual acquisition occurred or the method by which financed.

Defense Industry

Important to the national defense for the production of material or equipment, and which is largely or wholly owned or leased by the U.S. Government; or, which has considerable Government-owned buildings or equipment on the site; or which, in some circumstances and particularly under full mobilization, has total production capacity under contract over an extended period for Defense production or for items essential to the national defense.

Defense Industrial Base

That part of the total privately-owned and Government-owned industrial production and maintenance capacity of the United States, its territories and possessions, as well as capacity located in Canada, expected to be available during emergencies to manufacture and repair items required by the military services.

Lead-Time

The allowance made for the amount of time required to accomplish specific objectives.

Lead-time in the acquisition sense refers to the time interval consisting of the total Government and contractual effort to define, develop, procure and produce, test and evaluate, install and checkout, and turnover to a using agency items for the operational inventory.

Mobilization

The process by which the armed forces or part of them are brought to a state of readiness for war or other national emergency. This includes assembling and organizing personnel, supplies, and material for active military service.

The act of preparing for war or other emergencies through assembling and organizing natural resources.

The transformation of industry from its peacetime activity to the fulfillment of the military program necessary to support the national military objectives. It includes the mobilization of materials, labor, capital, productive facilities, and contributory items and services essential to the military programs.

Surge Capability

Refers to the expansion of military production within a peacetime environment--without declaration of a national emergency. A surge of the defense industrial base is

typically represented by a 50 percent increase in production within 12 months.

Technology Transfer

The mechanism by which the benefit of taxpayer money invested in IMIP can be multiplied many times. Through this mechanism, other manufacturing firms and other DOD programs benefit from the new technologies and concepts that are developed and proven. Future expenditures of development dollars to reinvest existing technology are avoided and the cost savings from productivity investments are potentially multiplied many times.

Validity

Ability of a research instrument to measure what it is purported to measure and the extent to which it provides adequate coverage of the topic under study.

Productivity

Measure of the relationship between outputs (amounts of goods and services produced) and inputs (the quantities of labor, capital, and material resources used to produce the outputs).

Reliability

a. The probability that a system, subsystem, or equipment will perform a required function for a specified time period under a given set of conditions.

b. When applied to a method of measurement, reliability is concerned with estimates of the degree to which a measurement is free of random or unstable error. A measure is reliable to the degree that it supplies consistent results.

Service Life

The total usefulness of the item in respect to the weapon it supports; that is, from first inception of the weapon until final phaseout.

Appendix B: Air Force Systems Command IMIP/TECHMOD
Contracts/Projects

Air Force Systems Command IMIP/TECHMOD

Contracts/Projects

ASSIGNED NUMBER	CONTRACTOR	TITLE
1	MAGNAVOX ADVANCED PRODUCT	GPS USER SEGMENT TECHNOLOGY MODERNIZATION
2	MAGNAVOX ADVANCED PRODUCT	AUTOMATED ASSEMBLY OF MINIA- TURIZED ELECTRONICS
3	MAGNAVOX ADVANCED PRODUCT	THERMOGRAPHIC ANALYSIS FOR FAULT DETECTION
4	MAGNAVOX ADVANCED PRODUCT	OPTICAL SCANNING COMPARATOR AND PATTERN RECOGNITION TECHNIQUES
5	HAC TORRANCE	TWT AMPLIFIER TECH MOD
6	GE-VALLEY FORGE	COMMUNICATION SPACECRAFT PROD (DSCS III) TECH MOD
7	HUGHES AIRCRAFT CO.	AMRAAM TECH MOD
8	HAZELTINE CORP	MICROCIRCUIT AUTOMATED TESTER
9	WESTINGHOUSE	WESTINGHOUSE TECH MOD
10	WESTINGHOUSE	STANDARD ELECTRONICS ASSEMBLY STATION
11	WESTINGHOUSE	ROBOT ENABLED ASSEMBLY OF CABLES AND HARNESES
12	WESTINGHOUSE	MATERIAL ACCOUNTABILITY AND ROBOTIC KITTING
13	HAZELTINE CORP	ADVANCED CCC TECH MOD PROGRAM
14	HAZELTINE CORP	QUALITY TEST INFORMATION SYS- TEM (QTIS)
15	HAZELTINE CORP	MATERIAL STORAGE TRANSFER ENTRY & ROUTING SYSTEM (MASTERS)
16	E-SYSTEMS	E-SYSTEMS TECH MOD PROGRAM

ASSIGNED NUMBER	CONTRACTOR	TITLE
17	ROCKWELL INTL	ROCKWELL COLLINS TECHMOD (COMTECH)
18	ROCKWELL INTL	INTEGRATED CHIP ASSEMBLY SYS- TEM (ICAS)
19	ROCKWELL INTL	ROBOTIC ASSISTED MECHANICAL PREPARATION (RAMP)
20	ROCKWELL INTL	INTEGRATED DATA AND DISTRIBU- TION SYSTEMS (IDDS)
21	ROCKWELL INTL	SUB-ASSEMBLY BURN-IN ASSUR- ANCE SYSTEM (SABAS)
22	SINGER	SINGER-KEARFOTT TECHMOD (COM- TECH)
23	SINGER	INCOMING INSPECTION (II) WORK CENTER
24	SINGER	AUTO MODULE ASSEMBLY (AMA) WORK CENTER
25	SINGER	AUTO MODULE INSPECTION & TEST (AMIT)
26	GENERAL ELECTRIC	GE SYRACUSE TECH MOD PROGRAM
27	TBD	MILSTAR TECH MOD PROGRAM
28	SONICRAFT	SONICRAFT TECH MOD PROGRAM
29	TBD	WWMICS INFORMATION SYSTEM (WIS) TECH MOD
30	MARTIN-MARIETTA	TRI-SERVICE TECH MOD PROGRAM
31	GENERAL DYNAMICS	F-16 TECH MOD PROGRAM
32	GENERAL DYNAMICS	F-16 INDUSTRIAL TECH MOD (ITM) PROGRAM
33	GENERAL DYNAMICS	F-16 INDUSTRIAL TECHMOD (ITM) AIREASEARCH
34	GENERAL DYNAMICS	F-16 INDUSTRIAL TECHMOD (ITM) TRACOR

ASSIGNED NUMBER	CONTRACTOR	TITLE
35	GENERAL DYNAMICS	F-16 INDUSTRIAL TECHMOD (ITM) GOODYEAR
36	GENERAL DYNAMICS	F-16 INDUSTRIAL TECHMOD (ITM) GOODYEAR AEROSPACE
37	GENERAL DYNAMICS	F-16 INDUSTRIAL TECHMOD (ITM) SPERRY
38	GENERAL DYNAMICS	F-16 INDUSTRIAL TECHMOD (ITM) DELCO
39	GENERAL DYNAMICS	F-16 INDUSTRIAL TECHMOD (ITM) SIERRACIN/SYLMAR
40	GENERAL DYNAMICS	F-16 INDUSTRIAL TECHMOD (ITM) ARKWIN
41	GENERAL DYNAMICS	F-16 INDUSTRIAL TECHMOD (ITM) WESTINGHOUSE
42	GENERAL DYNAMICS	F-16 INDUSTRIAL TECHMOD (ITM) SIMMONDS PRECISION
43	GENERAL DYNAMICS	F-16 INDUSTRIAL TECHMOD (ITM) AEROSPACE AVIONICS
44	GENERAL DYNAMICS	F-16 INDUSTRIAL TECHMOD (ITM) SUNDSTRAND
45	ROCKWELL INTL	B-1B TECH MOD
46	LOCKHEED-GEORGIA CO.	GELAC/AVCO TECH MOD PROGRAM
47	LOCKHEED	VOICE DATA ENTRY SYSTEM (GELAC)
48	LOCKHEED	BRUSH DEBURR (GELAC)
49	LOCKHEED	DIRECT NUMERICAL CONTROL (GELAC)
50	LOCKHEED	COMPUTER AIDED SET UP (GELAC)
51	AVCO AERO- STRUCTURES	SEALANT APPLICATION SYSTEM (GELAC)

ASSIGNED NUMBER	CONTRACTOR	TITLE
52	AVCO AERO- STRUCTURES	ELECTROMAGNETIC CLAMP (GELAC)
53	LOCKHEED-GEORGIA CO.	CAPACITANCE HOLE PROBE (GELAC)
54	PRATT & WHITNEY	PRATT & WHITNEY PROPULSION T/M PROGRAM
55	PRECISION CAST- PARTS CORP.	PW PROPULSION T/M PROGRAM (PRECISION CASTPARTS)
56	RMI COMPANY	PW PROPULSION T/M PROGRAM (RMI)
57	UNIVERSAL CYCLOPS CORP.	PW PROPULSION T/M PROGRAM (UNIVERSAL CYCLOPS)
58	MARTIN MARIETTA	LANTIRN TECHMOD (MARTIN MARIETTA)
59	MARTIN MARIETTA	HERMETIC CHIP CARRIER (HCC) & PRINTED WIRING BOARD (PWB) WORKCENTER
60	BOEING (BMAC)	BMAC TECHMOD
61	GENERAL ELECTRIC	GENERAL ELECTRIC PROPULSION T/M PROGRAM
62	LADISH COMPANY	GE PROPULSION T/M PROGRAM (LADISH)
63	TRW, INC.	GE PROPULSION T/M PROGRAM (TRW)
64	BOEING (BMAC)	BMAC TECHMOD PROGRAM
65	BOEING (BMAC)	BMAC ELECTRONIC ASSY MODERNI- ZATION (BEAM)
66	BOEING (BMAC)	BMAC ROBOTICALLY ENABLED ASSY OF CABLES AND HAR- NESSES (REACH)
67	CLEVELAND PNEUMATIC	CLEVELAND PNEUMATIC TECH MOD
68	FAIRCHILD	FAIRCHILD TECH MOD

ASSIGNED NUMBER	CONTRACTOR	TITLE
69	AVCO AERO- STRUCTURES	AVCO WILMINGTON TECH MOD
70	LOCKHEED	LOCKHEED MISSILE TECH MOD
71	TEXAS INSTRU- MENTS	TEXAS INSTRUMENTS TECH MOD

Appendix C: Random Number Generator

```

PROGRAM RAND1
DOUBLE PRECISION DSEED
DIMENSION X(500),R(500)
REAL XBAR,VBAR,SDEV,PARAM
INTEGER NR
DSEED=5439277833.DO
NR=500
PARAM=.50
N=500
CALL GGUBS(DSEED,NR,R)
WRITE(06,3) (R(I),I=1,60)
3  FORMAT(5(1X,F10.5,4X))
DO 10 I=1,500
YY=R(I)
44  X(I)=(=ALOG(YY))/PARAM
10  CONTINUE
WRITE(6,26)
WRITE(6,3) (X(I),I=1,60)
WRITE(6,26)
XBAR=0.0
VBAR=0.0
Y=0.0
DO 20 I=1,500
XBAR=XBAR + X(I)
VBAR=VBAR + (X(I)**2)
20 CONTINUE
XBAR=XBAR/N
VBAR=(VBAR-((XBAR**2)*N)/(N-1.))
SDEV=SQRT(VBAR)
WRITE(06,25) XBAR,VBAR,SDEV
25  FORMAT(/1X,5HXBAR=,F10.2,4X,5HVBAR=,F10.2,4X,
5HSDEV=,F10.2)
26  FORMAT(XXXX1X)
STOP
END
16.51.05.UCLP, CA, N1706H3, 0.183KLNS.

```

Appendix D: Random Number Table

Random Number Table

.79683	.24897	.51227	.67374	.60466
.52519	.13745	.06767	.30366	.55352
.00004	.68651	.10016	.43205	.41362
.74376	.44295	.61260	.97637	.84283
.45675	.65173	.64591	.78726	.56182
.49424	.71186	.21052	.26180	.07064
.20055	.61722	.64201	.26418	.09801
.22113	.61158	.88432	.80962	.21558
.33537	.61229	.72545	.58925	.44475
.89467	.72161	.15726	.05860	.82635
.41218	.50993	.36346	.60237	.11378
.25482	.78759	.10257	.85520	.30015

Appendix E: Interview Schedule

Interview Schedule

Interview Control No. _____
Date of Interview _____
Mode: In-Person: _____
Telephone: _____
Interviewer: Houck _____
Cooper _____
Start Time: _____
Stop Time: _____

PRELIMINARY/DEMOGRAPHIC INFORMATION

I. Defense Contractor

- a. Name _____
- b. Firm _____
- c. Division _____
- d. Job Title _____
- e. At what level of management do you consider yourself? Upper ____ Middle ____ First Line ____
- f. How long have you been directly involved with technology modernization programs with your present employer? _____
- g. How long has your present employer had a technology modernization office/division/program? _____

II. Military/Government Manager

- a. Name _____ Rank/Grade _____
- b. Organization _____ AFSC/Series _____
- c. Duty Title _____
- d. At what level of management do you consider yourself? Upper ____ Middle ____ First Line ____
- e. How long have you served in your present technology modernization position? _____

Investigative research has generally concluded that defense officials and contractors believe that the Industrial Modernization Incentives Program (IMIP) can, and is, achieving favorable results. However, concerns have been raised regarding the lack of a DOD-wide system to collect information on various program results and the lack of a consensus on what criteria to apply to judge overall IMIP effectiveness.

During our research, we found the following criteria were most frequently suggested as possible measures of IMIP effectiveness. We would like your opinion of the potential validity of each criterion as an accurate measure of IMIP effectiveness. Additionally, we would like your opinion regarding how best to quantify those criteria which you identify as the best measures of IMIP effectiveness.

For each suggested criterion, we would like you to indicate whether you

- a. strongly disagree
- b. disagree
- c. agree
- d. strongly agree

that the proposed criterion would be a valid measure of IMIP effectiveness. You should strongly disagree if, in your opinion, the proposed measurement is not, in any way, a usable, valid measurement of IMIP effectiveness. You should disagree if, in your opinion, the proposed criterion, as stated, would not be a valid measure of IMIP effectiveness unless redefined. You should agree if, in your opinion, the proposed criterion, as stated, could be an accurate measure of IMIP effectiveness while recognizing that there are better measurement criteria of IMIP effectiveness in terms of validity and reliability. You should strongly agree if, in your opinion, the proposed criterion, as stated, would provide a reliable, valid measure of IMIP effectiveness which could be quantified and uniformly applied to all DOD technology modernization programs.

If you disagree with a statement, please indicate how the proposed criteria should be redefined to make it a usable measure of IMIP effectiveness. If you agree or strongly agree with a statement, please indicate how the particular criterion could best be quantified to measure IMIP effectiveness.

(1) Percentage of IMIP projects directly applied to DOD weapon system production is a valid measure of IMIP effectiveness.

- (a) SD (go to #2)
- (b) D (go to #1a)
- (c) A (go to #1b)
- (d) SA

(1a) In your opinion, how should this criterion, as stated, be redefined to make it a valid measure of IMIP effectiveness?

(1b) In your opinion, what information or data should be used to accurately quantify this measure of effectiveness?

(2) Percent of projects completed is a valid measure of IMIP effectiveness.

- a. SD (go to #3)
- b. D (go to #2a)
- c. A (go to #2b)
- d. SA

(2a) In your opinion, how should this criterion, as stated, be redefined to make it a valid measure of IMIP effectiveness?

(2b) In your opinion, what information or data should be used to accurately quantify this measure of effectiveness?

(3) Degree of improved readiness is a valid measure of IMIP effectiveness.

- a. SD (go to #4)
- b. D (go to #3a)
- c. A (go to #3b)
- d. SA

(3a) In your opinion, how should this criterion, as stated, be redefined to make it a valid measure of IMIP effectiveness?

(3b) In your opinion, what information or data should be used to accurately quantify this measure of effectiveness?

(4) Reduced acquisition cost is a valid measure of IMIP effectiveness.

- (a) SD (go to #5)
- (b) D (go to #4a)
- (c) A (go to #4b)
- (d) SA

(4a) In your opinion, how should this criterion, as stated, be redefined to make it a valid measure of IMIP effectiveness?

(4b) In your opinion, what information or data should be used to accurately quantify this measure of effectiveness?

(5) Improved productivity is a valid measure of IMIP effectiveness.

- (a) SD (go to #6)
- (b) D (go to #5a)
- (c) A (go to #5b)
- (d) SA

(5a) In your opinion, how should this criterion, as stated, be redefined to make it a valid measure of IMIP effectiveness?

(5b) In your opinion, what information or data should be used to quantify this measure of effectiveness?

(6) Improved item quality is a valid measure of IMIP effectiveness.

- (a) SD (go to #7)
- (b) D (go to #6a)
- (c) A (go to #6b)
- (d) SA

(6a) In your opinion, how should this criterion, as stated, be redefined to make it a valid measure of IMIP effectiveness?

(6b) In your opinion, what information or data should be used to accurately quantify this measure of effectiveness?

(7) Improved reliability is a valid measure of IMIP effectiveness.

- (a) SD (go to #8)
- (b) D (go to #7a)
- (c) A (go to #7b)
- (d) SA

(7a) In your opinion, how should this criterion, as stated, be redefined to make it a valid measure of IMIP effectiveness?

(7b) In your opinion, what information or data should be used to accurately quantify this measure of effectiveness?

(8) Advances in the state-of-the-art is a valid measure of IMIP effectiveness?

- (a) SD (go to #9)
- (b) D (go to #8a)
- (c) A (go to #8b)
- (d) SA

(8a) In your opinion, how should this criterion, as stated, be redefined to make it a valid measure of IMIP effectiveness?

(8b) In your opinion, what information or data should be used to accurately quantify this measure of effectiveness?

(9) Increased competitiveness is a valid measure of IMIP effectiveness.

- (a) SD (go to #10)
- (b) D (go to #9a)
- (c) A (go to #9b)
- (d) SA

(9a) In your opinion, how should this criterion, as stated, be redefined to make it a valid measure of IMIP effectiveness?

(9b) In your opinion, what information or data should be used to accurately quantify this measure of effectiveness?

(10) Degree of technology transfer is a valid measure of IMIP effectiveness.

- (a) SD (go to #11)
- (b) D (go to #10a)
- (c) A (go to #10b)
- (d) SA

(10a) In your opinion, how should this criterion, as stated, be redefined to make it a valid measure of IMIP effectiveness?

(10b) In your opinion, what information or data should be used to accurately quantify this measure of effectiveness?

(11) Increased surge capability/mobilization (responsiveness) is a valid measure of IMIP effectiveness.

- (a) SD (go to #12)
- (b) D (go to #11a)
- (c) A (go to #11b)
- (d) SA

(11a) In your opinion, how should this criterion, as stated, be redefined to make it a valid measure of IMIP effectiveness?

(11b) In your opinion, what information or data should be used to accurately quantify this measure of effectiveness?

(12) A reduction of production leadtime is a valid measure of IMIP effectiveness.

- (a) SD (go to #13)
- (b) D (go to #12a)
- (c) A (go to #12b)
- (d) SA

(12a) In your opinion, how should this criterion, as stated, be redefined to make it a valid measure of IMIP effectiveness?

(12b) In your opinion, what information or data should be used to accurately quantify this measure of effectiveness?

(13) Number of commercial spinoffs is a valid measure of IMIP effectiveness.

- (a) SD (go to #14)
- (b) D (go to #13a)
- (c) A (go to #13b)
- (d) SA

(13a) In your opinion, how should this criterion, as stated, be redefined to make it a valid measure of IMIP effectiveness?

(13b) In your opinion, what information or data should be used to accurately quantify this measure of effectiveness?

(14) Plant modernization is a valid measure of IMIP effectiveness.

- (a) SD (go to #15)
- (b) D (go to #14a)
- (c) A (go to #14b)
- (d) SA

(14a) In your opinion, how should this criterion, as stated, be redefined to make it a valid measure of IMIP effectiveness?

(14b) In your opinion, what information or data should be used to accurately quantify this measure of effectiveness?

(15) Ability to increase productivity growth rate is a valid measure of IMIP effectiveness.

- (a) SD (go to #16)
- (b) D (go to #15a)
- (c) A (go to #15b)
- (d) SA

(15a) In your opinion, how should this criterion, as stated, be redefined to make it a valid measure of IMIP effectiveness?

(15b) In your opinion, what information or data should be used to accurately quantify this measure of effectiveness?

(16) Follow-on contracts are a valid measure of IMIP effectiveness.

- (a) SD (go to #17)
- (b) D (go to #16a)
- (c) A (go to #16b)
- (d) SA

(16a) In your opinion, how should this criterion, as stated, be redefined to make it a valid measure of IMIP effectiveness?

(16b) In your opinion, what information or data should be used to accurately quantify this measure of effectiveness?

(17) Reduced critical materials usage is a valid measure of IMIP effectiveness?

- (a) SD (go to #18)
- (b) D (go to #17a)
- (c) A (go to #17b)
- (d) SA

(17a) In your opinion, how should this criterion, as stated, be redefined to make it a valid measure of IMIP effectiveness?

(17b) In your opinion, what information or data should be used to quantify this measure of effectiveness?

(18) In your opinion, what other criteria, which we have not discussed in this interview, would be valid measures of IMIP effectiveness? How would you quantify this/these criterion/criteria?

Appendix F: Tabular Summation of Raw Data

Relative Overall Ranking

<u>RANK</u>	<u>CRITERIA</u>	<u>RAW SCORE</u> (Agree/ Strongly Agree)	<u>%</u> (A+SA/19)
1	Reduced acq. cost	8/11	100
2 (T)	Improved item quality	9/8	89.5
	Red. prod. leadtime	9/8	
4	Improved productivity	10/6	84.2
5 (T)	Deg. of tech transfer	10/4	73.7
	Improved surge/mob. capability	11/3	
7 (T)	Improved reliability	9/4	68.4
	Advances in state-of-art	8/5	
9 (T)	Plant modernization	9/3	63.2
	Increased prod. growth rate	9/3	
	Reduced critical material usage	9/3	
12 (T)	% of IMIP projects directly applied to DOD weapon system	9/2	57.9
	% of projects of com- pleted	7/4	
	% of improved readiness	7/4	
	Increased competitiveness	8/3	
16	Follow-on contracts	3/1	21.1
17	Number of commercial spinoffs	2/0	10.5

KEY--IMIP MEASURES OF EFFECTIVENESS

1. Percentage of IMIP projects directly applied to DOD weapon system production
2. Percent of projects completed
3. Degree of improved readiness
4. Reduced acquisition cost
5. Improved productivity
6. Improved item quality
7. Improved reliability
8. Advances in the state-of-the-art
9. Increased competitiveness
10. Degree of technology transfer
11. Increased surge/mobilization capability (responsiveness)
12. Reduction of production leadtime
13. Number of commercial spinoffs
14. Plant modernization
15. Ability to increase productivity growth rate
16. Follow-on contracts
17. Reduced critical material usage

OVERALL RESULTS
(19 Total Respondents)

CRITERION #	STRONGLY DISAGREE	DISAGREE	AGREE	STRONGLY AGREE
1.	5	3	9	2
2.	2	6	7	4
3.	3	5	7	4
4.	0	0	8	11
5.	1	2	10	6
6.	0	2	9	8
7.	1	5	9	4
8.	2	4	8	5
9.	3	5	8	3
10.	2	3	10	4
11.	2	3	11	3
12.	0	2	9	8
13.*	13	3	2	0
14.	2	5	9	3
15.*	2	4	9	3
16.	10	5	3	1
17.	2	5	9	3

*A Respondent did not/could not answer

OVERALL-GOVERNMENT IMIP MANAGERS
(8 Respondents)

CRITERION #	STRONGLY DISAGREE	DISAGREE	AGREE	STRONGLY AGREE
1.	2	2	3	1
2.	1	4	3	0
3.	3	1	2	2
4.	0	0	2	6
5.	0	1	2	5
6.	0	0	3	5
7.	1	1	3	3
8.	1	1	2	4
9.	1	1	3	3
10.	0	2	4	2
11.	2	2	2	2
12.	0	1	2	5
13.*	6	0	1	0
14.	1	3	2	2
15.*	0	0	4	3
16.	5	2	1	0
17.	0	2	4	2

*A respondent could not/would not answer.

OVERALL-CONTRACTOR IMIP MANAGERS
(11 Respondents)

CRITERION #	STRONGLY DISAGREE	DISAGREE	AGREE	STRONGLY AGREE
1.	3	1	6	1
2.	1	2	4	4
3.	0	4	5	2
4.	0	0	6	5
5.	1	1	8	1
6.	0	2	6	3
7.	0	4	6	1
8.	1	3	6	1
9.	2	4	5	0
10.	2	1	6	2
11.	0	1	9	1
12.	0	1	7	3
13.	7	3	1	0
14.	1	2	7	1
15.	2	4	5	0
16.	5	3	2	1
17.	2	3	5	1

Bibliography

1. Acker, David D. and George R. McAleer, Jr. "New Opportunities for Innovative Management," Concepts, 5(4): 83-95 (Fall 1982).
2. Aeronautical Systems Division, Air Force Systems Command. A Guide to Technology Modernization and Contracting for Productivity. Wright-Patterson AFB OH, 22 July 1982.
3. Aeronautical Systems Division, Air Force Systems Command. Industrial Modernization Program: A Guide to Technology Modernization and Contracting for Productivity, Wright-Patterson AFB OH, revised May 1984.
4. Buck, Major General John T. "The Health, and Illnesses, of the U.S. Aerospace Industrial Base Pinpointed in Massive Air Force/Industry Study," Government Executive, 16:38-42 (June 1984).
5. Chayes, Antonia Handler. "The Defense Industrial Base: A Policy Approach," Defense Management Journal 18:40-46 (First Quarter 1982).
6. Committee for Economic Development. Research and Policy Committee. Productivity Policy: Key to the Nation's Economic Future. Washington DC: Library of Congress, 1983.
7. Connolly, Major General Joseph H. "Defense Factory Modernization Needs New Contract Cost Accounting and Management Controls," National Contract Management Journal, 18:37-53 (Fall 1984).
8. Connolly, Major General Joseph H. and Lieutenant Colonel Robert E. Shafer II. "Looking Ahead at Productivity and Defense Contract Costs," National Contract Management Journal, 17:31-39 (Summer 1983).
9. DeGrasse, Robert W.J. Military Expansion Economic Decline. New York: M.E. Shapre, Inc., 1983.
10. Department of the Air Force. Compendium of Authenticated Systems and Logistics Terms, Definitions, and Acronyms. AU-AFIT-LS-3-81. Wright-Patterson AFB OH: Air Force Institute of Technology, School of Systems and Logistics, 1 April 1981.
11. Emory, C. William. Business Research Methods. Homewood, Illinois: Richard D. Irwin, Inc., 1980.

12. Gansler, Jacques S. The Defense Industry. Cambridge MA: The Massachusetts Institute of Technology Press, 1980.
13. General Accounting Office. Interim Observations on Effectiveness of DOD's Manufacturing Technology Program. GAO/AFMD-83-105. Washington: General Accounting Office, 28 September 1983.
14. General Accounting Office. Interim Observations on Review of DOD's Manufacturing Technology Program. GAO/AFMD-83-97. Washington: General Accounting Office, 14 September 1983.
15. Heffner, Captain Richard P., USAF and Major John A. Weimer, USAF. Technology Modernization for DOD Sub-contractors: A Study of Market, Business Financial and Capital Investment Factors. MS thesis, LSSR 60-83. School of Systems and Logistics, Air Force Institute of Technology (AU), Wright-Patterson AFB OH, September 1983 (AD-A134 382).
16. Hering, Commander Joe and Dr Linda Brandt. "Summary and Status of the DOD Industrial Modernization Incentives Program (IMIP)," National Defense, 68:23-26 (Jan 84).
17. Huston, James A. The Sinews of War: Army Logistics 1775-1953. Washington DC: Office of the Chief of Military History United States Army, 1966.
18. "Implementing the Carlucci Initiatives: Can the Rabbit Make the Turtle Run?" Government Executive, Vol 14: 18-21 (October 1982).
19. Kluter, Major Eugene E., USAF. Producing More For Less: A Guide For Writing Cost Reduction Contracts. Unpublished research report, Unnumbered, Air Command and Staff College, Maxwell AFB AL, 1979.
20. Koradbil, Leon et. al. The Army Production Base, Vol I, Jan 1960. Operations Research Office, The Johns Hopkins University, Bethesda MD. (LD0822A)
21. Lehman, Ronald F. "Industrial Preparedness: A Congressional Perspective," Defense Management Journal 18:7-13 (First Quarter 82).
22. McPhillips, Major Edward F., USAF. Incentives for Defense Contractor Capital Investment Programs on Negotiated Contracts. Unpublished research report No. 1676, Air Command and Staff College, Maxwell AFB AL, 1982. (AD-B066 359).

23. Mittino, John A. and A. Douglas Reeves. "Productivity Improvement in the Department of Defense Acquisition Environment," Program Manager, 14-23; 28 (Nov-Dec 84).
24. Mulkey, Jesse G. "Defense Acquisition and Improved Responsiveness of the U.S. Industrial Base." Defense Science 2000+, Vol 2:53-59 (June 1983).
25. Murrin, Thomas. "Productivity Improvement: The Defense Customer Should Stimulate, Not Discourage Contractors," Government Executive 14:47-50 (Sep 82).
26. Prince, Daniel E. "Positively Getting Rid of Negative Incentives in Air Force/Industry Programs," Government Executive, 15:35-40 (March 1983).
27. Sargent, Lieutenant Commander William J. and Lieutenant David J. Fager, USN. The Industrial Modernization Incentives Program. MS Thesis. Naval Postgraduate School, Monterey CA 93943, December 1983 (LD 57128A).
28. Schuman, Howard and Stanley Presser. Questions and Answers in Attitude Surveys, Experiments on Question Form, Wording and Context. New York NY: Academic Press, 1981.
29. Slay, General Alton D., USAF. "Rx For An Ailing Industrial Base," National Defense. Vol 65 No. 367, pp 31, 57-58. April 1981.
30. Stansberry, Lieutenant General James W. "Revitalizing Defense Industries: The DOD-Industry Partnership." Defense Management Journal 18:2-6 (First Quarter 1982).
31. Stimson, Richard A. and A. Douglas Reeves. "Improving Defense Contractor Productivity." Defense Management Journal, Third Quarter 1983, pp. 41-44.
32. Thayer, Paul. Deputy Secretary of Defense Memorandum, "Guidance on the Acquisition Program (AIP)." Washington DC, 8 June 1983.
33. "The Carlucci Initiatives: Firing Blanks at the Wrong Targets?" Government Executive, Vol 14:38-40 (September 1982).
34. Under Secretary of Defense for Research and Engineering. DOD Industrial Modernization Incentives Program. (Draft) DODI 5000.xx, 2 November 1982.
35. University of Michigan, Institute for Social Research. Interviewer's Manual. Ann Arbor MI: The University of Michigan, 1976.

36. USAF Aerospace Industrial Modernization Office. Air Force Systems Command Industrial Modernization Initiatives Program Technical Review--1984.
37. U.S. Air Force, Air Force Systems Command. Payoff 80 (Executive Report on Manufacturing Investment Strategy). Andrews AFB MD: HQ AFSC, 1 October 1980.
38. U.S. Air Force Systems Command. Technology Modernization (TECHMOD). AFSCR 800-17. Andrews AFB MD, 1 November 1983.
39. U.S. Comptroller General. DOD Manufacturing Technology Program--Management is Improving But Benefits Hard To Measure. GAO/INSIAD 85-5, General Accounting Office, 30 November 1984.
40. U.S. Comptroller General. Report to the Congress of the U.S. Impediments to Reducing The Costs of Weapon Systems. Washington: General Accounting Office, 9 November 1980.
41. U.S. Congress, House of Representatives, Committee on Armed Services, Panel on Defense Industrial Base. The Ailing Defense Industrial Base: Unready for Crisis. Hearings, 96th Congress, 2nd session, 1980. Washington: Government Printing Office, 1980.
42. U.S. Congress, Senate, Subcommittee of the Select Committee on Small Business. Tax Depreciation Allowances on Capital Equipment. Hearings, 86th Congress, 1st Session, 1959. Statements of Maurice Peloubet and Joel Borlow. Washington: Government Printing Office, 1959.
43. "Why Air Force and Westinghouse Signed A Partnership Pact," Government Executive 15:20+ (April 83).
44. "Why the 'Carlucci Initiatives' Aren't Working," Government Executive 14:30-32 (August 82).

Interview Participants

Andrews, Captain David, Deputy Propulsion TECHMOD Program Manager. Personal interview. ASD/YZD, Wright-Patterson AFB OH, 26 April 1985.

Black, Major Robert, C-135FR Program Manager/Boeing Military Airplane Company TECHMOD Program Manager. Personal interview. ASD/AFYR, Wright-Patterson AFB OH, 18 April 1985.

Burgar, Major John, F-16 TECHMOD Program Manager. Personal interview. ASD/YPMA, Wright-Patterson AFB OH, 25 April 1985.

Ciscel, Captain David, B-1B TECHMOD Program Manager. Personal interview. ASD-BIDA, Wright-Patterson AFB OH, 18 April 1985.

Daugherty, Major Duffy, Industrial Modernization Incentives Program Manager. Telephone interview. AD/YHD, Eglin AFB FL, 13 May 1985.

Gasperetti, Robert L., TECHMOD Program Manager, Electrical Systems Division. Telephone interview. Westinghouse Corp., Lima OH, 7 June 1985.

Geiser, Karen, TECHMOD Program Manager. Telephone interview. ESD/ALM-P, Hanscom AFB MA, 5 June 1985.

Hollingsworth, J.H., Director, Product Development and TECHMOD Program Manager. Telephone interview. North American Aircraft Operations, Rockwell International Corp., Los Angeles CA, 8 May 1985.

Lorei, John, TECHMOD Program Manager. Telephone interview. Rockwell International Corp., Cedar Rapids IA, 31 May 1985.

Olsen Gloria, TECHMOD Program Manager, Intelligence Systems Division. Telephone interview. Texas Instruments Corp., Sherman TX, 10 May 1985.

Rhenberg, Upton, Program Manager for Industrial Technology, Modernization Advanced Technology Group. Telephone interview. Sundstrand Aviation, Rockford IL, 23 May 1985.

Roesler, Harol, Deputy Manager-Technology Modernization, Electronics Assemblies Modernization Division. Telephone interview. Boeing Military Airplane Co., Wichita KS, 8 May 1985.

Semienko, Vladimir, Engineering Support Manager, Electronics Management Section. Telephone interview. ESD/ALM-P, Hanscom AFB MA, 9 June 1985.

Shames, Al, Manager, Manufacturing Technology, Trainer/Transport Division. Telephone interview. Fairchild Republic Corp., Farmingdale NY, 10 May 1985.

Sylvester, William, Manager of Productivity Assurance, Government Products Division. Telephone interview. Hazeltine Corp., Long Island NY, 17 May 1985.

Thompson, Captain Greg, Asst Chief, Manufacturing Quality Assurance Division. Personal interview. ASD/AFDC, Wright-Patterson AFB OH, 18 April 1985.

Tulkoff, Joe, Director of Manufacturing Technology, Lockheed-Georgia/Air Force Plant #6 (GELAC). Telephone interview. Lockheed-Georgia Corp., Marietta GA, 9 May 1985.

Ulrich, Tom, TECHMOD Program Manager, Design and Operations Division. Telephone interview. Westinghouse Corp., Baltimore MD, 6 June 1985.

Yount, Reed, TECHMOD Program Manager, Aircraft Engine Business Group, Evendale Products Division. Telephone interview. General Electric Corp., Cincinnati OH, 9 May 1985.

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The Industrial Modernization Incentives Program (IMIP), cited by Secretary of Defense Weinberger as "the number one DOD initiative" upon which "the future of a strong industrial base largely rests," will soon be evaluated to determine its ability to restore positive productivity growth rates and improved surge/mobilization capabilities within the U.S. defense industrial base. The ultimate validity of this review has been questioned, however, due to a lack of standard measurement criteria. As the first stage of a two-stage effort to test the hypothesis that the IMIP will reduce major weapon system costs; will maintain free and open competition; and, will revitalize the U.S. defense industrial base, government and industry IMIP managers were interviewed to identify valid measures of effectiveness. Nine criteria were recommended as valid, quantifiable measures of IMIP effectiveness upon which accurate measurement of IMIP project benefits should be completed during follow-on Stage II research.

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