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PRODUCTIVITY MEASUREMENT METHODS: CLASSIFICATION, CRITIQUE, AND IMPLICATIONS FOR THE AIR FORCE

By

Thomas C. Tuttle
Maryland Center for Productivity
and Quality of Working Life
University of Maryland
College Park, Maryland 20742

MANPOWER AND PERSONNEL DIVISION
Brooks Air Force Base, Texas 78235

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The objectives are (a) to clarify the meaning of organizational productivity as it applies to Air Force organizations, (b) to describe and critique productivity measurement methods, (c) to describe a procedure for generating measures of productivity in Air Force organizations, and (d) to summarize research which evaluates productivity enhancement methods.

The report has seven chapters and an appendix. Chapter I is an introduction. Chapter II reviews various definitions of productivity and contrasts them with two related concepts—quality of working life and organizational effectiveness. Chapter III reviews the definition of productivity as it relates specifically to the Air

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Force. Chapter IV provides a taxonomy and critique of measures of efficiency, effectiveness, and combined methods that integrate efficiency and effectiveness measures into a comprehensive measurement strategy. Chapter V draws conclusions from the review and implications for Air Force productivity measurement methods. Chapter VI describes a method for generating productivity criteria for Air Force organizations and Chapter VII describes a field demonstration of the methodology. Since the ultimate purpose of measuring productivity is to make improvements, the Appendix highlights the major findings of the literature on productivity enhancement.

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SUMMARY

Objective

The objectives are (a) to clarify the meaning of organizational productivity as it applies to Air Force organizations, (b) to describe and critique productivity measurement methods, (c) to describe a procedure for generating measures of productivity in Air Force organizations, and (d) to summarize research which evaluates productivity enhancement methods.

Background

During recent years, concern about organizational productivity has increased in the Department of Defense (DoD) and in the Air Force. One of the primary reasons for this concern is the continual pressure on the military services to justify budget requests in terms of outputs. In response to initiatives from the White House to improve Federal government productivity, as well as from the DoD, the Air Force finalized its productivity improvement plan on 15 November 1979. This plan directs all major commands and operating agencies to develop their own productivity plan, to appoint a "productivity principal" as the contact person for all productivity matters, and to report productivity results annually to Air Force headquarters.

To fulfill their responsibilities under this plan, productivity principals and operating managers must understand the meaning of productivity in an Air Force environment and be aware of alternative approaches to productivity enhancement.

Approach

Information was obtained from a comprehensive literature review and from field visits to more than 50 Air Force, Army, Navy, and civilian organizations engaged in productivity improvement efforts. Results were analyzed and used to develop a methodology for generating criteria for measuring organizational productivity. Additional information was obtained from a simulated field test of the proposed productivity measurement methodology conducted at an Air Force Avionics Maintenance Squadron.

Specifics

The report has seven chapters and an appendix. Chapter I is an introduction. Chapter II reviews various definitions of productivity and contrasts them with two related concepts—quality of working life and organizational effectiveness. Chapter III reviews the definition of productivity as it relates specifically to the Air Force. Chapter IV provides a taxonomy and critique of measures of efficiency, effectiveness, and combined methods that integrate efficiency and effectiveness measures into a comprehensive measurement strategy. Chapter V draws conclusions from the review and implications for Air Force productivity measurement methods. Chapter VI describes a method for generating productivity criteria for Air Force organizations and Chapter VII describes a field demonstration of the methodology. Since the ultimate purpose of measuring productivity is to make improvements, the Appendix highlights the major findings of the literature on productivity enhancement.

Organizational productivity in the Air Force has recently emerged as an important but not yet well-defined area of concern. Based on Air Force requirements, a procedure was described for generating measures of productivity in Air Force organizations. Based on a simulated field test, it appeared that the methodology offers sufficient promise to justify the recommendation that it be further tested in a number of functional Air Force organizations.

PREFACE

This report is a third interim technical report for Contract No. F-33615-79-C-0019, Taxonomy and Codification of Productivity Criteria. This 18-month effort has focused on reviewing and critiquing existing approaches to defining and measuring productivity and drawing implications from existing methods for use in measuring productivity. This research was completed under Work Unit 7734-08-10. Two previous interim reports were produced under this contract: Manager's Guide to Productivity Improvement Resources and Programs, TP 81-12, and Measuring and Enhancing Organizational Productivity: An Annotated Bibliography, TR-81-6.

This research is part of a larger effort to develop methodologies for assessing and improving productivity and performance in Air Force organizations. In the current environment where a renewed awareness of the need for effective military organizations is coupled with strong fiscal pressures, the level of concern for productivity has increased at all levels. This research area not only addresses an important area of research, but also an urgent national need.

The author wishes to thank Ms. Elizabeth C. Clark for her able administrative, editorial and clerical assistance, Mr. Robert E. Wilkinson who provided valuable input to the development of the productivity measurement method, and Ms. Myra Palla who typed the final manuscript. Appreciation is also expressed to the AFHRL project monitor, Dr. Charles N. Weaver, for his valuable comments and suggestions. Finally the author wishes to thank the previous AFHRL project monitors who provided significant assistance in earlier phases of the research: Major John O. Edwards, Jr., Dr. William E. Alley, Dr. Joe T. Hazel, and Mr. William L. Titsworth.

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I. INTRODUCTION

Productivity in the United States, as measured and reported by the Bureau of Labor Statistics, is declining at an alarming rate. If present trends continue, the United States will fall behind our trading partners Japan, West Germany, Canada, and France in terms of total productivity before the end of the 1980s (American Productivity Center, 1979). While output per labor hour is declining, over one third of U.S. workers recently surveyed claim that their skills and abilities are not being adequately utilized by their jobs (Quinn & Staines, 1979). The contrast between declining productivity and the unused human potential raises questions about the ways in which organizations are structured and managed.

This report is intended to be of assistance to researchers and managers who are working to improve the productivity of Air Force organizations. Before it is possible to make major improvements, the concept of productivity must be understood, and methods must be developed for measuring it. This report has four objectives. First, it seeks to clarify the meaning of productivity as it applies to Air Force organizations. Secondly, it seeks to highlight promising measurement techniques by assessing the strengths and weaknesses of existing approaches to organizational productivity measurement. Third, as an aid to productivity enhancement, the report summarizes the results of research on those variables which are assumed to have a positive impact on organizational productivity. Finally, the report integrates some of the promising measurement approaches into a methodology that is appropriate for generating productivity criteria in Air Force organizations.

The report has seven chapters and an Appendix. Chapter II reviews definitions of productivity and contrasts them with definitions of two related concepts--organizational effectiveness and quality of working life. Chapter III addresses the meaning of productivity in a military environment--such as the U.S. Air Force. In Chapter IV, various approaches to measuring productivity are described and evaluated. Chapter V draws conclusions from the review and implications for Air Force productivity measurement methods. Chapter VI describes a method for generating productivity criteria for Air Force organizations and Chapter VII describes a field demonstration of the methodology. Since the ultimate purpose of measuring productivity is to make improvements, the Appendix highlights the major findings of the literature on productivity enhancement.

II. WHAT IS PRODUCTIVITY?

Before measuring any construct, it first must be defined. Defining productivity is particularly challenging because the term has been used in many different ways. This chapter will discuss some of the most common definitions of productivity and help clarify the concept by contrasting it with two related concepts--organizational effectiveness and quality of working life.

Productivity - The Economist's View

According to a leading productivity economist, productivity is the relationship between output and its associated inputs when the output and inputs are expressed in real (physical volume) terms (Kendrick, 1977). This definition can be depicted as a ratio expressed as:

$$\text{Productivity} = \frac{\text{Output}}{\text{Inputs}}$$

This definition of productivity is developed from production theory which attempts to explain the process by which inputs to a firm are transformed into products to be sold in the marketplace. The basic production function states that the volume of output (Q) is a function (F) of the volume of the basic factors of production. These are labor (L), capital (K), intermediate products purchased from other firms (X) and the level of productive efficiency which changes over time (T). This production function is expressed as:

$$Q = F(L, K, X, T).$$

From this function are derived various productivity indices. For example, labor productivity = $\frac{Q}{L}$ relates the volume of output to the quantity of labor input normally expressed as numbers of hours worked. Capital productivity would be $\frac{Q}{K}$, or output per unit of capital input. Both capital productivity and labor productivity are referred to as "partial" productivity ratios by the economist, since they relate output to only one type of input. If all inputs, labor, capital, materials, energy, etc., are included in the denominator of the ratio we have what is called a "multi factor" or "total factor" productivity ratio.

While economists typically define productivity as a ratio of outputs to inputs stated in real or physical terms, they sometimes substitute prices or costs for physical volumes. Siegel (1980) points out that productivity defined as a "family of ratios of (a) input price to (b) output price" (p. 24) is equivalent to the definition expresssed in physical quantities.

When price or cost formulations are used in the numerator in place of physical quantities, gross output values can be misleading. For instance, the sales value of output includes not only the "value added" by the processing firm but also the profits of firms which supplied raw materials, supplies, or services that were inputs to the production process. Therefore, the economist's definition of productivity is often modified to correct for this problem. An example of a value added definition of productivity is:

$$\text{Net output per employee} = \frac{\text{Value added per year}}{\text{Total number of employees}}$$

Here value added represents the value added to materials in the process of production (Norman & Bahiri, 1972).

In the past, economists have been concerned primarily with macro indicators of productivity. That is, the indicators deal with whole economies or with whole industries rather than with single plants or organizations within an economy or industry. As a result of this focus, economists are concerned with collecting data that can be aggregated from the "bottom up," i.e., from plant level to industry level to the level of the whole economy. The need to aggregate data and the measurement difficulties associated with aggregation have led economists to focus on labor productivity indices to the virtual exclusion of other "partials" such as capital productivity or total productivity. There is evidence that, in the future, economists will begin to focus more on multifactor productivity indices and plant level data that will permit inter-firm comparisons (Panel to Review Productivity Statistics, 1979).

Productivity - The Engineer's View

While accepting the basic notion of productivity as the ratio of output produced per unit of input, the engineer's definition of productivity differs from that of the economist. Conceptually, the engineering approach to productivity grows out of the "normal engineering expression for the efficiency of a machine" (Norman & Bahiri, 1972, p. 27).

$$\text{Efficiency} = \frac{\text{Useful work}}{\text{Energy}} = 1$$

Thus, since output (useful work) is a result of input (energy supplied) in the physical sense, the engineer's ratio cannot be greater than unity. The extent to which the "actual" output approaches the "potential" output is a measure of the efficiency of the process. While unity is the upper limit of efficiency in the physical sense, in financial ratios the value can exceed 1 and, in fact, must if the organization is to be profitable.

Considering productivity as basically synonymous with efficiency, the engineering approach leads to three definitions of productivity (Norman & Bahiri, 1972):

1. Generation of useful output from input $\left(\frac{\text{Useful output}}{\text{Input}}\right)$
2. Efficiency of input utilization $\left(\frac{\text{Effective input}}{\text{Actual input}}\right)$
3. Output efficiency $\left(\frac{\text{Actual output}}{\text{Potential output}}\right)$

Productivity (efficiency) is improved when more useful output is produced with respect to the level of input to the process. The second statement covers the efficient utilization of resources in the production process or the degree to which energy, materials, capital, or hours of labor are "useful." The third definition considers the extent to which obtained outputs correspond to some standard of the potential output.

The third definition has stimulated considerable activity in the field of industrial engineering. Much of this work concentrates on the development of procedures for estimating potential output standards. The practice of work measurement and methods-time-measurement attempts to answer two basic questions (Norman & Bahiri, 1972):

1. What is the "best" method to do a particular job?
2. When this best method is used, what is the standard level of output to be expected, given the production environment, materials, labor force, etc.?

Considerable progress has been made over the years in applying work measurement techniques to a variety of workplaces. Even when "engineered" standards are not feasible, other methods have been developed to define potential outputs. Such methods include use of past performance history or technical estimates made by knowledgeable individuals (Bryant, Shallman, & Brewer, 1973), or work sampling (Udler, 1978).

Another point should be made concerning the engineer's definition of productivity as the generation of useful output by input in statement number 1 above. The numerator of this expression, useful output, recognizes that not all output from a production process is useful. This may be due to any number of reasons. The output may not meet quality specifications, it may have been produced after the need for the product has passed, or it may not be consistent with the goals of the organization. In any event, the definition implies that there are standards of useful output which are external to the production process itself. Thus, productivity is not defined as the ratio of <u>total</u> output to input, but as the ratio of <u>useful</u> output to input. This is an important distinction.

In contrast to the economist's definition of productivity, the engineering approach differs in purpose. Industrial and manufacturing engineers typically work at the firm level, designing and implementing work processes. As a result, the engineer's conception of productivity and his techniques typically reflect this micro perspective. Unlike the economist who typically focuses on an industry or whole economy, engineers are usually concerned with the efficiency of an individual, a work group, or a manufacturing process. The economist's approach to defining productivity is reflected in statistics developed for total industries which are reported by trade associations, government agencies, banks and other institutions. In contrast, the analysis and measurement of individual production operations within an organization are the usual focus of the engineer's approach to productivity (A.T. Kearney, Inc., 1978).

<u>Productivity - The Accountant's View</u>

Accountants concern themselves with the financial performance of organizations. The "tools" for monitoring financial performance in organizations are financial ratios. Theoretically, there are no limits to the number of financial ratios that could be derived. In practice, however, only those that are useful to management should be computed (Norman & Bahiri, 1972). Productivity per se has not been of central concern to most accountants although this may be changing (Carr, 1973; Price Waterhouse & Co., 1980). However, the use of financial ratios has been of concern to accountants since the early 1920s (Bliss, 1924).

While they vary considerably, most financial ratios are broadly concerned with the ratio of "sales return on capital employed" or on a ratio of "profit to assets." Such measures are sometimes termed "business efficiency" (Norman & Bahiri, 1972). Many of these ratios resemble output/input productivity ratios. Consider the following seven ratios for financial control in a decentralized firm (Norman & Bahiri, 1977):

1. Profit/Capital Employed
2. Profit/Sales
3. Sales/Capital Employed
4. Sales/Fixed Assets
5. Sales/Stocks
6. Sales/Employee
7. Profit/Employee

Since these are sales-based ratios they have less to do with production efficiency and more to do with factors in the marketplace. Therefore, they may be misleading if interpreted as productivity measures. Unfortunately, for many decision makers, financial data provide the primary source of input on which decisions are based. This reliance on financial data points out the need to more fully integrate "productivity" concepts into cost accounting systems. This, in fact, is happening through improvements in cost accounting and the development of productivity costing procedures (Norman & Bahiri, 1972).

Productivity -- The Manager's View

American managers have a broad view of the meaning of productivity (Katzell, Yankelovitch, Fein, Ornati, & Nash, 1975). These authors surveyed two groups of managers--Chief Executive Officers (CEOs) and Industrial Relations Officers (IROs). Approximately 2,450 questionnaires were mailed to CEOs and 950 to IROs. The 563 completed questionnaires that were returned were approximately equally spread between the two groups. With only a 16% return, there is no assurance that the sample was representative of the total population of managers. However, there was considerable diversity among respondents in terms of age, size of firm, and geographical location. Roughly half of the respondents came from manufacturing organizations.

In the survey, managers were asked to indicate their agreement or disagreement with a number of possible statements concerning the meaning of productivity. The results are summarized in Table 1.

Table 1

Manager's Definition of Productivity [a]

Productivity definition includes:	% Agreeing
1. Quality as well as quantity	95
2. Output per manhour in one company or organization	90
3. Overall efficiency and effectiveness of the operation	88
4. Disruptions, "shrinkage," sabotage and other troubles even if they are difficult to measure	73
5. Rate of absenteeism and turnover as well as output	70
6. Customer or client satisfaction	64
7. Employee loyalty, morale, or job satisfaction	55
8. Ratio of output to input by industry or sector of the economy, but not by individual organization	22

[a] Adapted from Katzell and Yankelovitch, 1975

Based on these responses, it appears that most of the managers would find either the economist's or engineer's definition of productivity to be too narrow. Virtually 9 out of 10 managers would include quality, effectiveness and efficiency in their definition; 7 out of 10 would add the ideas of work stoppages, waste, "shrinkage," sabotage, absenteeism and turnover; and 6 out of 10 managers would include measures of customer or client satisfaction. Such results cannot be considered conclusive evidence of the meaning of productivity to managers. However, the data illustrate that a large group of management policy makers consider productivity to be a very broad concept.

Productivity - The Industrial/Organizational Psychclogist's View

The concern of industrial/organizational psychologists is with investigating human behavior in organizations. Productivity, defined as output/input, is a "results" oriented variable that is partially a function of behavior, but is also affected by other extraneous (to the psychologist) aspects of the work environment. Thus, as a criterion against which to judge the impact of various attempts to modify human behavior in organizations, productivity has not proven as useful as criteria which are defined in terms of worker behavior. Measures of production quantity are useful criteria only if the worker has a direct influence over the amount produced (Zedeck & Blood, 1974).

Although one often finds the term productivity appearing in the literature of industrial/organizational psychology, its meaning is usually vague. For example, a classic theoretical treatment of work motivation contains the following paragraph which erroneously equates productivity and performance.

> It is typically assumed by most people connected with the human relations movement that job satisfaction was positively related to job performance. In fact, human relations might be described as an attempt to increase productivity by satisfying the needs of employees (Vroom, 1964, p. 181).

Katz and Kahn in their classic description of a systems view of organizations define productivity as "a measure of role performance" (1966, p. 374). These authors viewed productivity as a measure of the output of an individual in his or her work role. While it was frequently broadened to include work quality as well as quantity, individual performance has generally been the psychologist's focus.

Psychologists and other organizational researchers have typically given more attention to "organizational effectiveness" and more recently "quality of work life" than to productivity. While these concepts are related to productivity, the nature of this relationship is often implicit and confused. The next two sections will discuss the concepts of organizational effectiveness and quality of working life and will attempt to clarify their presumed relationships to productivity.

Organizational Effectiveness

In discussing the concept of organizational effectiveness, Mahoney and Weitzel (1969) point out the similarities between the problem of defining effectiveness and the "criterion problem" that has plagued personnel psychologists for many years. Thorndike (1949) differentiated three sets of criteria for research on employee selection: ultimate, intermediate, and immediate. The ultimate criterion is a final goal stated in general terms and is not susceptible to assessment by outside observers. The final criterion rests on the judgements of officials best qualified to determine if stated organizational goals have been achieved. In practice, various mid-range criteria (immediate or intermediate) are used as surrogates to assess the effectiveness of organizational units. Rational processes are used to determine the relevance of immediate and intermediate criteria to ultimate criteria since measures of ultimate criteria are usually not available.

As various models of effectiveness are proposed, the number of mid-range criteria begins to mushroom. This, in fact, is what has happened in the organizational effectiveness research literature. A number of researchers have attempted to describe various models of organizational effectiveness (Mahoney & Weitzel, 1969; Campbell, Bownas, Peterson, & Dunnett, 1974; Engel, 1977; Goodman & Pennings, 1976; Steers, Porter, Mowday, & Stone, 1975; Price, 1968; Coulter, 1979; Mahoney & Frost, 1974). The dimensions of effectiveness growing out of several dozen models were cataloged by Campbell et al., 1974. The dimensions are:

Overall Effectiveness	Conflict/Cohesion
Productivity	Flexibility/Adaptation
Efficiency	Goal Consensus
Profit	Role and Norm Congruence
Quality	Managerial Task Skills
Accidents	Managerial Interpersonal Skills
Growth	Information Management and Communications
Absenteeism	Readiness
Turnover	Utilization of Environment
Satisfaction	Evaluation of External Entities
Motivation	Stability
Morale	Internalization of Organizational Goals
Control	Value of Human Resources

In thinking about organizational effectiveness, individuals (e.g., managers, researchers) usually have their own individual models which may include one or more of the listed dimensions. Rather than attempt to define effectiveness, Campbell et al. state:

> Perhaps a better way to think of organizational effectiveness is as an underlying construct which has no direct operational definition, but which constitutes a model or theory of what organizational effectiveness is (1974, p.5).

Following this approach, Campbell, et al. (1974) describe two basic types of models of effectiveness which they label goal centered and natural systems. In a separate paper, Coulter (1979) defines three types of effectiveness models: behavioral-attitudinal, process and goal attainment. Coulter illustrates the models with examples of the types of dimensions used to assess effectiveness. Advocates of the behavioral-attitudinal model claim that certain behavioral and attitudinal characteristics of individuals and groups of individuals offer the most percise measures of the effectiveness of organizations. Included among these are absence of tension and conflict, employee satisfaction, psychological commitment, turnover and absenteeism, inter-personal relations, and morale. The process models involve one or more variables which deal with the internal operation of the organization (e.g., flexibility, adaptability, creativity, open communications, personnel acquisition, retention, and utilization) or the linkage between the organization and its environment (e.g., control over the environment, ability to acquire valued and scarce resources). The goal attainment model defines effectiveness as the extent to which an organization achieves its goals. While this definition seems straightforward enough, there is usually considerable disagreement among researchers over how to define goals and how to measure goal achievement. This argument follows the lines of whether the goals are those prescribed by decision makers, those derived from some theory of organizations, or the informal goals which "actually" guide the behavior of organizational members. Questions also arise as to whether goal attainment is to be measured through employee ratings, supervisory ratings, customer ratings, or through the use of archival data. This discussion recognizes that effectiveness can be viewed from the perspective of at least three different groups, owner/manager, employees, and the society at large.

Mahoney and Frost (1974) raise the issue that the choice of a model of effectiveness to apply to a given organization may be a function of the nature of its technology. These authors studied 386 organizational units. With respect to the dominant technology employed by the organizational unit, units were classified as either "long-linked" (59%), "mediating" (24%), or "intensive" (17%). These were defined as follows:

1. long-linked -- Organizations in which there is a belief of complete cause/effect knowledge, high predictability of both input and outputs, and crystallized norms.
2. mediating -- When cause/effect knowledge and predictability of outputs are conditional, where some discretion must be used to match input with available programs for processing.
3. intensive -- Belief in incomplete cause/effect knowledge, ambiguous standards of desirability, low predictability of outcome of actions and a high degree of discretion required.

Managers one organizational level above these units were asked to rate each of the organizational units in terms of the following 14 dimensions of organizational effectiveness as well as overall effectiveness.

1. Performance. Efficient performance, mutual support by supervisors and subordinates, utilization of personnel skills and abilities.
2. Planning. Avoiding disruption and lost time through scheduling and coordination.
3. Supervisory control. Extent of supervisory control over work progress.
4. Results emphasis. The organization emphasizes results not procedures.
5. Cooperation. The extent to which scheduled commitments to other units are met.

6. Flexibility. The ability of the group to adapt to change and new ideas.
7. Initiation. Takes action to initiate improvements in work methods and operations, makes suggestions.
8. Coordination. Coordinates and relates activities with other units in advance.
9. Conflict. Avoidance of conflict with other units regarding responsibilities and authority.
10. Reliability. Meets objectives without constant need for monitoring and followup.
11. Development. The extent of involvement in training and development activities.
12. Staffing. Ability and willingness of staff to move among assignments, and the extent of promotion from within.
13. Delegation. Degree to which supervisors effectively delegate work to subordinates.
14. Cohesion. Lack of complaints, grievances, and conflict within unit.
15. Overall organizational effectiveness. (Adapted from Mahoney and Frost, 1974, p. 129).

Regression analyses used to capture the policies of managers revealed differences in the "models of effectiveness" held by managers as a function of the type of technology employed by the organizational unit. These differences were not always consistent. In general, however, for long-linked technologies, the criteria of effectiveness were smoothness of operation (planning), output performance (results emphasis), and reliability of performance (reliability). For mediating technologies, the predominant criteria appear to be adaptation to change (flexibility), smoothness of operation (planning), output performance (results emphasis), and supervisory control. In the case of intensive technologies still other dimensions emerged. The predominant criteria of intensive technologies were performance, meeting work commitments to other units (cooperation), and quality of staff (development and staffing).

This research is quite significant in pointing out that definitions of organizational effectiveness and the criteria for measuring organizational effectiveness appear to be conditional. At least from the point of view of managers who must judge the effectiveness of organizational units, the criteria on which these judgements are made vary depending on the type of work performed by the organization.

Effectiveness and Productivity

The distinction between effectiveness and productivity remains confused. In attempting to clarify this relationship there appear to be three viewpoints expressed in the literature: (a) productivity is a dimension of the broader concept of effectiveness, (b) productivity is a broad concept which encompasses both efficiency and effectiveness, (c) productivity and effectiveness are separate but related concepts.

In their review, Campbell et al. (1974) distinguished between productivity and efficiency and considered both to be dimensions of organizational effectiveness. Productivity was defined in terms of "the quantity or volume of the major product or service that the organization provides..." (Campbell et al., 1974, p. 50). This definition of productivity might be more accurately termed "production" since it takes no account of the resources required to produce the product or service. This is not to fault these authors since they are simply reflecting the confusion between productivity and production that is rampant in the literature. "Efficiency is usually thought of in terms of a ratio that reflects a comparison of some aspect of unit performance to the costs incurred for that performance" (Campbell et al., 1974, p. 56). As defined, efficiency seems synonymous with the economist's definition of productivity.

A second view of the relationship between productivity and effectiveness is expressed by Coulter (1979). Most simply stated, this view is that "productivity takes into account the efficiency with which an organization achieves its level of effectiveness" (Coulter, 1979, p. 80). In this view, productivity is the integrating concept that links effectiveness and efficiency. A similar position has been taken by Balk (1975), who discusses productivity as a systems concept. He distinguishes between efficiency (the ratio of output to input) and effectiveness (the ratio of output to a standard; e.g., quality, timeliness). Balk then defines productivity as follows (1975, p. 130):

Productivity = efficiency and effectiveness

or

$$\text{Productivity} = O/I + O/S$$

where O = output
I = input
S = "Standard" for measuring output.

A similar view of productivity as a composite of efficiency and effectiveness is presented in a handbook on Total Performance Management (TPM) (National Center for Productivity and Quality of Working Life, 1978, p. 11):

> Productivity in the private sector is usually defined as a ratio--output per unit of input. This definition is deceptively simple, however. Disagreements still occur over many basic questions: Is it really possible to measure productivity? How do you take into account the variety of tasks within one job? How can you separate the contributions of staff hours from other inputs, such as capital investment?
>
> In the public sector, the definition of productivity encompasses two components, efficiency and effectiveness. Efficiency measurements assess the cost per unit of output. Usually quantitative in nature, efficiency measures typically

use staff hours as the basis for input measures and quantity produced as output measures. A more sophisticated, but more difficult, input measurement is total resource expenditures, which may include energy use, capital, investment, depreciation, overhead, and other contributing inputs.

As this discussion points out, productivity, viewed as output/input, is the predominant view in the private sector. Such a notion grew out of manufacturing operations employing "long-linked" technologies. However, in the public sector (as well as in private sector service and administration units) this model is not adequate to account for productivity. Models of productivity incorporating both effectiveness as well as efficiency are needed in the public sector and also in non-manufacturing private sector organizations.

A third view of the relationship between effectiveness and productivity has been proposed by Price (1977). In his discussion, Price equates productivity and efficiency. He says that productivity (efficiency) is separate from, but related to effectiveness. Effectiveness is defined by Price as the degree to which an organization achieves its goals (Price, 1977). To illustrate the meaning of effectiveness, Price cites several examples. A mental hospital with a therapeutic goal that successfully releases a high proportion of its patients into the community would be an effective hospital. However, as Price points out, effectiveness and productivity (efficiency) can vary independently. For example, a business firm whose goal is profits may be very productive but, due to a declining market for its output, suffer from low profits. Despite this firm's high level of productivity (efficiency), it is not effective (Price, 1977, pp. 110-111).

Price (1977) takes a narrow view of productivity compared to Coulter's (1979) broader view. Price would not accept Coulter's notion that productivity encompasses both efficiency and effectiveness. This is the crux of the definitional problem. There are two questions that must be answered to resolve this issue. First, should productivity be synonymous with efficiency or is it a broader concept which includes both efficiency and effectiveness? Secondly, if it is narrowly defined, is productivity a dimension of effectiveness, or are productivity and effectiveness totally separate, but related concepts?

Quality of Working Life

The preceding discussion points out the difficulties in distinguishing between the concepts of effectiveness and productivity. A related problem exists with another "concept" freqently appearing in current organizational literature--quality of working life. Quality of working life is a concept which has almost as many definitions as organizational effectiveness. For present purposes, "quality of work," "quality of work life," and "quality of working life" are considered synonymous.

A leading proponent of quality of working life, Ted Mills, defines the concept as an attempt:

> to provide people at work (manager, supervisors, rank and file workers) with structured opportunities to become actively involved in a new interpersonal process of problem solving toward both a better way of working and a more effective work organization, the payoff from which includes the best interests of employees and employers in equal measure (Mills, 1978, p. 23).

In their extensive literature review, Katzell et al. (1975) define quality of working life as the combination of a worker's job satisfaction, motivation, and balance of work life with other aspects of the worker's life.

> A worker can be said to enjoy a high quality of working life when he (a) has positive feelings towards his job and its future prospects, (b) is motivated to stay on the job and perform well, and (c) feels his working life fits well with his private life to afford him a balance between the two in terms of his personal values (Katzell et al. 1975, pp. 69-70).

Katzell et al. (1975) view quality of working life somewhat more broadly than Mills (1978). Furthermore, the Mills definition views quality of working life as a process while Katzell et al. (1975) view it as the individual's evaluation of the outcomes of the work relationship.

A third perspective, and one which lends itself to measurement, is proposed by Herrick and MacCoby (1972). This approach defines "quality of work" as comprised of four dimensions: security, equity, individuation, and democracy. These are defined as follows:

1. Security -- Freedom from fear and anxiety concerning physical health and safety, income, and future employment.
2. Equity -- The extent to which compensation received is commensurate to the worker's contribution to the value of a service or product.
3. Individuation (craftsmanship, autonomy and learning) -- The extent to which work stimulates the development of unique abilities, and capacity for craftsmanship, and continued learning rather than boredom and stagnation.
4. Democracy -- The extent to which workers' views are listened to and taken into account in decision making, and/or structures are created in which workers' power and responsibility are institutionalized. "Wherever technically possible, workers should manage themselves..." (Herrick & MacCoby, 1972. In Herrick, 1975, p. 4).

Herrick (1975) assumes that organizations can be assessed and profiled on each of these four dimensions. In this framework, changes in "quality of work" are hypothesized to relate to changes in organizational outcomes including labor productivity, absenteeism, turnover, scrap, etc.

A fourth view of the concept of quality of working life is provided by the report of a task force established to develop methods for measuring quality of work life (Davis & Cherns, 1975). The goal of the task force was to review the various approaches to defining and measuring quality of working life and to recommend a definition and a set of measures that would have utility for assessment and policy making. After acknowledging lack of agreement among researchers and practitioners, the group proposed a number of dimensions which should be included in any conceptualization of quality of working life (Davis & Cherns, 1975):

1. Employment conditions (safety, health, physical environment)
2. Employment security (future of the job)
3. Income adequacy (present and future)
4. Equity of pay and other rewards
5. Worker autonomy
6. Social interaction
7. Self Esteem
8. Democracy (participation in decision making)
9. Worker satisfaction

These four views of quality of working life share the basic ingredient of workers having input into decisions that affect them at work. The Mills (1978) definition emphasizes process issues while the others, Katzell et al. (1975), Herrick, (1975) and Davis and Cherns (1975) emphasize the individual's subjective reaction to conditions in the work place. Katzell et al. (1975) offer a broad definition that allows for variation in employee values while Herrick favors a definition which is normative and prescriptive with respect to "good" quality of working life. Davis and Cherns add a future orientation to the definition. They view quality of working life not only to include worker reactions to present conditions but also their reaction to anticipated future developments.

<u>Quality of Working Life and Productivity</u>

Either implicitly or explicitly, all of these approaches view quality of working life as conceptually separate from objective outcomes of the workplace such as productivity. However, all would admit that there is some relationship between "good" quality of working life and labor productivity. For instance, Herrick (1975) states this in clear terms:

> The concept, however, rests primarily on the belief that the actions which can reasonably be expected to insure labor productivity are the same actions which should be taken in any event to increase human fulfillment through work: that is, improving the conditions of security and equity and the opportunities for individuation and participation (p. 18).

The conclusion emerging from this review is that quality of working life and productivity are conceptually distinct, but compatible concepts. Most authors would agree that productivity improvements frequently accompany improvements in quality of working life. Furthermore, as stated by Herrick (1975), procedures taken by organizations to improve quality of working life may be very similar, or identical, to the procedures required to improve labor productivity. The philosophical difference appears to be that quality of working life advocates have concentrated more on outcomes to employees while productivity advocates have focused more on benefits to the organizations.

Summary

This chapter has surveyed various definitions of productivity. Definitions were classified, for discussion purposes, as representative of several viewpoints: economists, engineers, accountants, managers, and industrial/organizational psychologists. The chapter concluded with a discussion of two related concepts, organizational effectiveness and quality of working life. These were described and their assumed relationships to productivity were presented.

III. PRODUCTIVITY - AN AIR FORCE VIEW

This chapter will describe the "official" Air Force view of productivity proposed by Air Force Headquarters and selected Major Commands. Next, it will present some "unofficial" views derived from interviews with Air Force managers and researchers in a wide variety of field organizations. The interviews were conducted during the period April 1979 - June 1980, and involved over 50 organizations and over 100 interviewees. Finally, this chapter will present an approach to conceptualizing productivity in Air Force organizations that recognizes the unique mission of a military organization.

Productivity - The Official Air Force View

On 15 November 1979, the Air Force issued its Productivity Plan. This plan was issued in compliance with DoD Instruction 5010.34 (August 4, 1975) and DoD Directive 5010.31 (April 27, 1979) which directs each DoD Component to establish its own productivity improvement goals and planned approaches to productivity enhancement. In these documents the DoD provides three different definitions of productivity:

1. Organizations must be (a) effective--accomplish the right things, in the right quantities, at the right times, and (b) efficient--accomplish the right things with the lowest possible expenditure of resources. The efficiency with which organizations utilize all types of fund resources (operating and investment) to accomplish their mission represents total resource productivity. The efficiency with which organizations utilize labor resources to accomplish their missions represents labor productivity (DoD I-5010.34, August 4, 1975).

2. The productivity of an organization may be broadly defined as the efficiency with which its resources are utilized to produce final outputs (DoD I-5010.34, August 4, 1975, Encl. 3 p.a.).

3. Productivity. The ratio of goods produced or services rendered (output) to resources expended (input) (DoD D-5010.31, April 27, 1979).

The first example defines productivity in terms of both efficiency and effectiveness. However, the second and third define productivity as roughly comparable to efficiency. Thus, the DoD definition of productivity is unclear.

In its plan, the Air Force adopted the narrow, efficiency definition. Productivity is defined as "the ratio of goods produced or services rendered (output) to resources expended (input)" (Air Force Productivity Plan, 15 November 1979). While the plan acknowledges the concept of effectiveness and effectiveness measurement as a way to determine if a particular goal or objective is achieved, the focus of the plan is clearly on efficiency.

The efficiency view of productivity is also reflected in the definition of productivity contained in AFR 25-5, the regulation describing the Air Force Management Engineering Program. In the regulation's glossary of standard terms, productivity is defined as:

> The efficiency in using resources to carry out a given mission. Measured in terms of the ratio of output to input. Also, the ratio of actual performance to standard performance, or level of performance, in a previous period--applicable to either an individual worker or a group of workers (AFR 25-5, Vol. 1, 7 November 1977, p. A2-3).

While this definition addresses mission accomplishment, an effectiveness concept, it emphasizes efficiency as the way to operationalize the concept, e.g., output/input, or actual output compared to a standard.

Another "official" view of productivity comes from AFM 25-1, The USAF Management Process, 15 October 1964.

> The effectiveness of the Air Force is its capability, on an ever-ready basis, to meet the threat of any combination of potential enemies. This capability is the end-result of the overall operational system of the Air Force; the numerous components of the system are the achievements of specific objectives. The need to maintain our capabilities on a continuing basis is nearly always a paramount factor in our managerial efforts to increase the quantity and quality of the end-product. Except in emergencies, managers should increase effectiveness only to the level at which it *can be maintained*. Managerial action which increases productivity but hurts morale, for example, is likely to be so destructive to long-term effectiveness that it cancels any short-term gain. An improvement which undermines our capabilities to sustain effectiveness is no improvement at all (p. 7).

The precise meaning of productivity in the quoted passage is not clear. What is interesting, however, is the assertion that "productivity" and effectiveness levels need to be kept in balance. Attempts to maximize productivity in the short-term may lead to a long-run decrease in organizational effectiveness. Throughout AFM 25-5 there are references cautioning against the tendency toward "piece-meal management" or attempts to substitute "technical efficiency" for overall operational effectiveness (pp. 36-37, p. 40).

As Major Commands (MAJCOMs) and Operating Agencies are asked to comply with the provisions of the Air Force Productivity Plan they must address the question of how to define productivity. As previously discussed, there is some room for interpretation with respect to the official Air Force definition of productivity, although the efficiency definition appears to be the predominant one. Some of the definitions proposed by the MAJCOMs in their own plans include:[1]

> Productivity is the well-documented, more efficient use of all resources to accomplish a stated mission.
>
> Productivity. The relationship between the volume of goods and services produced and the physical input used in their production over a specified period of time.
>
> Productivity. The efficiency with which resources are used to accomplish a given mission.
>
> ...doing more with less and insuring mission accomplishment with minimum resources.

Based on this sample of definitions, there appears to be a tendency for the MAJCOMs to include explicit reference to "mission accomplishment" rather than "goods and services produced" in their definitions of productivity. However, in operationalizing productivity and reporting to higher headquarters, MAJCOMs are under pressure to measure and report efficiency defined as output of final goods and services per unit of labor input. There is no corresponding requirement in the Air Force Plan to measure or report the impact of this production of goods and services on mission accomplishment. While unlikely, it is conceivable that the "more productive" organization could be the least effective in terms of overall mission accomplishment and vice versa. Because MAJCOMs seem principally concerned with mission accomplishment, the pressure to measure and report efficiency separate from mission accomplishment places them in a difficult position. In order to provide a better understanding of this situation, the next section provides some reactions to Air Force productivity initiatives obtained from Air Force managers during the series of field visits.

Air Force Productivity - A View From the Field

In interpreting the reactions of Air Force managers to the concept of productivity, one should keep in mind that during recent years the Air Force has been shrinking in terms of active duty personnel. "Doing more with less" has become the slogan associated with these cutbacks and also the target of many managers' wrath. Unfortunately, the productivity program, perhaps partly due to its organizational identity with the manpower community which is perceived as responsible for manpower cuts, has become identified with budget and management cuts.

During the course of this project, field visits were made to MAJCOMs and operating agencies. More than 50 organizations were visited and interviews were conducted with over twice that many people. One of the questions asked was, "What does the term productivity mean to you?" A variety of responses were obtained.

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[1]These definitions were included in drafts of Command Plans provided the author on the condition that their exact source not be disclosed.

From the Air Force Logistics Command (AFLC), a representative sampling of the definitions obtained is as shown:

> Productivity is the ratio of output to input. Input should include labor and other quantifiable variables (e.g., energy, raw materials, equipment, etc.). Quantifying output is a horrendous problem. Operationally defining effectiveness is a challenge that is unmet.
>
> Productivity is the most effective and efficient use of time and resources.
>
> Productivity in distribution (supply) can be defined as the number of line items issued or received per man hour worked.

These definitions reflect the relatively concrete, measurable types of work performed in AFLC. While there are still difficulties associated with output measurement, this command comes closest to being an industrial operation employing "manufacturing like" technology. In addition, compared to other MAJCOMS, AFLC has had the most experience in applying productivity concepts to its operations.

When other MAJCOMs are considered, a somewhat different situation is discovered. Consider the following definition of productivity from a manager in Air Training Command (ATC).

> The big area in ATC is cost per graduate. However, we don't know if this is productive. It fails to address quality. The real measure of productivity in training is not whether a person graduates or how much it costs, but what that person does 3-5 years from now after he gets out into the field.

Another ATC manager describes his frustrations with productivity measurement as now practiced in the Air Force:

> ...if we're going to talk about productivity and how we go about it, we need to have some kind of conceptual model of how we approach it. At the top of the list is an interpretation of the mission in terms of objectives. At the tail end, we need to measure how well these objectives are acheived and what kinds of measures are necessary to achieve those objectives. ...Since we don't have to make some sort of "sales bogey," it's difficult to translate the total mission statement into specific objectives that not only can be measured but are worth measuring. We measure the things we can measure but the greatest part of a mission is constituted by things that are not easy to measure...[we] measure those things that are easy to measure--and we measure them just great--but whether we achieve our mission will depend on these other objectives that we've avoided because we're not sure how to measure them. Until we come to grips with this sort

> of thing, we're not sure we're assessing the right thing. And if you don't assess the right thing you'll never know if you've been productive.

Concern with mission was also reflected in the productivity definitions offered by managers from Strategic Air Command (SAC).

> It seems that organizations have to determine effectiveness first then define objectives and then determine how efficiently these objectives are being carried out.
>
> Maybe one of our problems is that our mission is not defined specifically enough. I've looked at a lot of mission statements down to the squadron level and they're all very vague and general in nature.

Another SAC commander addressed the issue of the level of the organization as a variable affecting the definition of productivity.

> In order to define productivity one must first specify the level we are defining productivity for. In other words, the measure of productivity for a squadron is different from that for a numbered Air Force.

The dilemma facing one who attempts to define productivity for an operational organization is reflected in this statement from a SAC manager.

> For input we have 117,000 people in SAC, we put billions of dollars into deterrence (equipment), we have buildings and facilities at 76 bases spread all over the world. But what is our output? The fact that we didn't go to war last night? The fact that our missiles are all on alert and all the bombers are ready to go? What is output for SAC?

Air Force Productivity - A Researcher's View

Air Force researchers and those doing research in other military services shed a slightly different perspective on the problem of defining productivity. Reflecting more of a theoretical orientation than most managers, but generally a more pragmatic view than their civilian academic counterparts, military researchers provide an important source of ideas for any attempt to define, measure and improve Air Force productivity. Researchers reflect the disciplines they represent and, therefore, do not speak with one voice. This section will consider a range of views on the meaning of productivity suggested by members of the military research community.

In a recent paper which reviewed the meanings of productivity and effectiveness, Engel (1979) draws the following conclusion.

> Therefore, productivity is one of the objectives of an organization but must be compromised for the overall optimal organizational effectiveness. The other objectives with which productivity competes differ from organization to organization along with the relative

> weights assigned to these individual objectives. There have been many models for measuring organizational effectiveness but there has been little consistency in the objectives considered important to overall effectiveness.
>
> In the military establishment's continuing struggle to do more with less, extreme care must be taken not to develop measures of "success" and then to apply them to all organizations. Since maximization of all goals is seldom if ever possible, a trade-off proposition is frequently required. When the attainment of one objective increases, there is usually a decrease in some other area. Better management will result from a better understanding of these concepts (p. 19).

Engel's conclusion is similar to that drawn in the excerpt from AFM 25-1 quoted previously, namely that attempts to maximize productivity (efficiency) will likely damage overall organizational effectiveness. Therefore, organizations should seek to "optimize" both productivity and effectiveness. In the long run this is the only way to sustain either efficiency or effectiveness.

In a research report investigating the impact of the Program Planning and Budgeting (PPB) System on the Air Force operating manager, Letzkus (1973) observed:

> A comparison of actual and planned results is undimensional in that it addresses only the effectiveness of mission operations. Missing from such an evaluation is the test of operating efficiency. Although actual operating results may exceed planned results, at what cost was this increased effectiveness achieved? Conversely, the fact that actual operating results are less than planned results may be counterbalanced by increased operating efficiency. Even granting the preeminence of mission effectiveness, the fact remains that performance measurement must be two dimensional: i.e., it must encompass the criteria of both mission effectiveness and mission efficiency (pp. 187-189).

In effect, Letzkus is arguing the other side of the issue. He states that while existing systems are forcing managers to concentrate on effectiveness, they are ignoring efficiency. Although starting with a different premise, his conclusion agrees with Engel. In addition, Letzkus (1973) proposes the following model of Air Force performance:

Organizational performance = Mission efficiency + Mission effectiveness.

Writing from the comptroller's viewpoint, Letzkus (1973) uses the terms costs and benefits rather than input and output. Nevertheless, his discussion of benefit determination provides insight into the definition of output in an Air Force environment, a key issue in defining and measuring productivity. Letzkus (1973, p. 25) discusses three levels of output measures:

1. Operations Indicators - Operations indicators are measures associated with the outputs of activities which indicate in raw financial terms what is produced for money and effort expended. Largely workload and performance statistics, these measures provide little insight into how well needs or objectives are being met. Operations indicators are often selected on the basis of simplicity of understanding and data availability rather than on the basis of relevance and include the kind of data commonly used for the determination of unit costs.

   With reference to Air Force activities, operations indicators would include such measures as hours or sorties flown, work orders processed, the number of engines repaired, students graduated, hours or weeks of training, meals served, etc. These measures indicate work performed. They do not, however, indicate the quality of performance or the results achieved.

2. Program Impact Indicators - Program impact indicators are directly related to a public need or policy and (theoretically) are expressed in or implied by stated program objectives. Outputs of programs should be described in terms that provide a basis for evaluating actual against planned accomplishments. These indicators generally are relevant to levels above the operating level. In the context of this definition of program impact indicators, a relevant Air Force example would be aircraft accidents averted. .... adequacy and quality of repaired engines received by operating activities, the tactical assistance resulting from ordance delivered, etc.

3. Social Indicators - Social indicators reflect changes in social conditions resulting from a combination of programs, but not solely attributable to any one of them. National defense is a public good which influences the "quality of life." The problem is to find a social indicator(s) which measures national defense.

These three levels of indicators represent a spectrum. As one moves from operations indicators to social indicators, the measures become more relevant but correspondingly more difficult to measure. Most efficiency-based approaches to productivity are only concerned with the lowest level of this spectrum, operations indicators.

A similar view of the limitations of efficiency based measures was expressed by a faculty member in an Air Force school.

> Productivity (as traditionally defined) does not indicate whether an organization is doing its job. It does not reflect whether the organization is keeping current, adapting to new procedures, technology or new situations. Therefore, a definition of productivity must include effectiveness as well as workload. However, since goals are not ususally defined we can't measure effectiveness therefore we fall back to a dependence on workload. We don't focus on quality. Productivity should be defined as workload and goal accomplishment.

Another military researcher's disenchantment with the efficiency definition of productivity was expressed as follows:

> Work group effectiveness is a better term than productivity defined as a ratio of output to input because there are some organizations which have restricted outputs or their output product is readiness. In that case a difference in the inputs would change the ratio. ... I'm not sure we can measure the effectiveness of "being there." This is the organizational level. But we can get specific inputs and outputs down at the sub-unit level. We often fail to see this. Down at the work group level they are producing and they produce measureable quantities of output.

Still another researcher stated the issue in this way:

> Productivity must use or include both efficiency and effectiveness. In peacetime the focus is on efficiency - in wartime effectiveness is all that matters.

Summary of Field View of Productivity

The prevailing viewpoint from field managers and researchers interviewed is that the "official" Air Force definition of productivity, the ratio of goods produced or services rendered to the resources expended, is too narrow. Managers and researchers interviewed agree that it is not enough to consider only the efficiency with which work is performed. Assessment of an organization's performance must also take into account the extent to which an organization is achieving its mission. Ironically, the Department of Labor, which fosters the efficiency measurement system used to generate National productivity statistics, sums up the problem as follows:

> The main difference between the concepts of productivity and efficiency is that the former includes no evaluation in relation to some overall goal. A measure of productivity does not indicate anything about the appropriateness of the activity itself. The program or activity and, consequently, the output is taken as given. Thus interest only in questions of productivity can result in efficiently carrying out the wrong functions (U.S. Department of Labor, 1972, p. 6).

Productivity in Air Force Organizations: A Proposed Conceptualization

An article by Balk (1975) provides a useful conceptual framework for viewing productivity in Air Force organizations. Using a very simple model (Figure 1) Balk (1975) explains that the production process involves

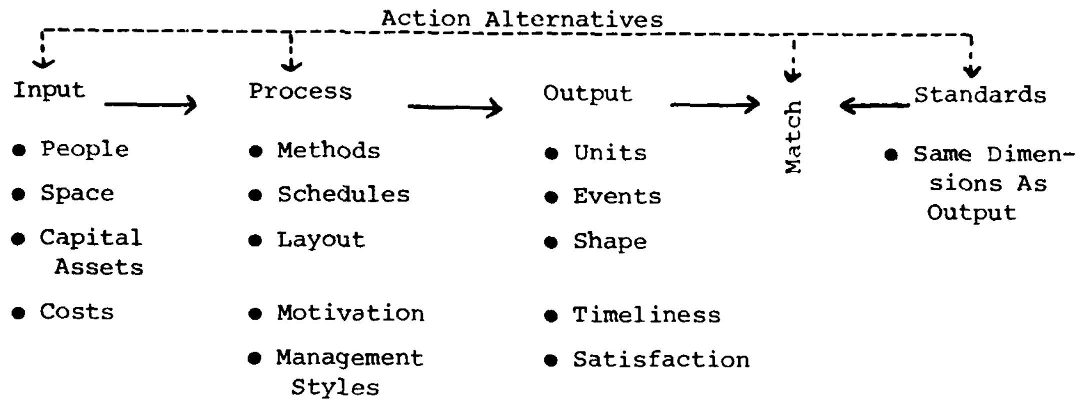

Figure 1. Elements of the Production Process (Adapted from Balk, 1975)

converting inputs into outputs and comparing these outputs to standards to determine if the process should continue or be modified. If outputs fail to meet standards, one can revise inputs, change the processing procedures, or revise the standards. Ratios are computed to analyze and control this process. Comparisons of output to input are known as efficiency ratios. Comparisons of output to standards are known as effectiveness ratios. As Balk (1975) points out, productivity has been synonomous with efficiency.

> Industry and classical economics have used the simple output to input ratio because quality is a step in the manufacturing process. In service industries, customers are assumed to buy only "satisfactory" outputs. These market mechanisms do not operate in most of the public sectors. Thus a productive process in one which optimizes efficiency and effectiveness ratios (1975, p. 130).

This leads Balk (1975, p. 130) to define productivity as follows:

$$\text{Productivity} = \text{efficiency} + \text{effectiveness}$$

or

$$\text{Productivity} = \frac{\text{Output}}{\text{Input}} + \frac{\text{Output}}{\text{Standard}}$$

This definition of productivity suggests that efficiency and effectiveness must strike a balance in order to optimize productivity. They are not independent and Balk (1975) acknowledges that the notion of "quality fights quantity" is included in his conception of productivity. He goes on to argue that the key to understanding productivity is understanding outputs. We have traditionally focused on the physical characteristics of output. We have measured quantity, form, shape, adjerence to schedule, etc. But, writing about the public sector, Balk, (1975) maintains that there are also intangible characteristics of output such as client satisfaction, value to the community, and other "feelings" about the results of government services. This "impact" of the outputs on the environment is an important productivity dimension. However, according to Balk (1975), these less tangible aspects of output make us uncomfortable because we don't know how or when to apply them.

As a way out of this dilemma, Balk (1975) postulates the concept of "task ambiguity". This concept builds on the common sense notion that more routine work is easier to measure than is less routine work. So the amount of "routine" in work may determine how we measure aspects of work and how we use the numbers. Task ambiguity relates to factors of work such as variety, control over input, dependence on others, and skill requirements. As variety increases, and as control over input decreases, and as dependence on others and skill requirements increase, then task ambiguity increases. Balk argues that task ambiguity is related to styles of measurement. He hypothesizes that as task ambiguity increases:

1. Measurement reliability and validity decreases
2. The utility of efficiency ratios decreases
3. The importance of effectiveness ratios increases
4. The possibility of a single measure to define a productivity situation decreases (Balk, 1975, p. 131).

Balk's assertion that the characteristics of tasks have an impact on the type of measurement is similar to the previously discussed idea that the dominant technology in an organization (e.g., long-linked, mediating, intensive) has an effect on definition of organizational effectiveness (Mahoney and Frost, 1974).

The conceptual scheme and line of reasoning proposed by Balk leads to conclusions that are consistent with the views on productivity expressed by Air Force managers. Balk's model would support the manager's comments that efficiency-based definitions and measures are too narrow to adequately assess productivity in Air Force organizations. This reasoning suggests that a broader definition of productivity in Air Force organizations be adopted which embraces the concepts of both efficiency and effectiveness. Such a definition is:

> Productivity in Air Force organizations refers to the volume of resources used to produce products and services (efficiency) and the extent to which these products and services conform to acceptable standards of mission performance (effectiveness).

This definition implies that productivity should be measured in Air Force organizations by using a family of efficiency and effectiveness ratios.

IV. PRODUCTIVITY MEASUREMENT METHODS: DISCUSSION AND CRITIQUE

This chapter considers various approaches to measuring organizational productivity. It includes an introductory section which describes a number of basic considerations in organizational measurement and concludes with a discussion of the criteria that should be used in analyzing productivity measurement approaches. Following a description of the desirable features of productivity measures, individual methods are described and critiqued. Categories of measurement methods reviewed are efficiency measurement, effectiveness measurement, and integrated approaches. The chapter concludes with a discussion of the impact of productivity measures on the phenomenon of productivity itself.

General Measurement Issues

Measurement - A Definition

Measurement is a process which involves assigning numbers to objects, events or attributes according to specified rules or procedures. More precisely, a measurement operation "is a standardized rule that maps each of a set of objects into one, and only one, of a set of categories or numbers" (Hays, 1967, p. 5). The concept of standardization is critical to the measurement process and, in practice, means that different people who apply the rule to particular events and situations obtain very similar results. Thus, an organizatonal productivity measurement process is standardized if two different analysts assign the same values to the same organizations at a given point in time (Nunnally, 1967).

In the definition of measurement, it is important to note that numbers are assigned to attributes of objects or events. "Strictly speaking, one does not measure objects - one measures their attributes" (Nunnally, 1967, p.3). The implicaton of this point for organizational measurement is that one or a few measurements of an organization (e.g., size, productivity, etc.) should not be used to characterize or "evaluate" the (total) organization. Many attributes must be measured if one is to adequately describe in quantitative terms an entity as complex as an organization.

Benefits of Measurement

Use of standardized organizational measurement procedures offers many benefits to both researchers and managers (Nunnally, 1967). One benefit is objectivity. Use of standardized measurement procedures takes much of the guesswork out of observations, and allow independent verification of organizational attributes. Secondly, numerical indicies provided by measurement procedures allow reporting of results in finer detail and more precisely than would be possible with subjective descriptions. These numerical indices also permit use of mathmatical and statistical analysis procedures. Without such analytical tools, organizational research and practice would be seriously impaired. Finally measurement results facilitate communication between researchers, managers, members of the organization, and others who influence or are affected by the organization's activities. Unless standardized measurement procedures exist, it is virtually impossible to evaluate an organizaton's performance and to communicate to an interested audience that progress has been made.

Levels of Measurement

The type of measurement operation selected or developed depends on the attribute to be measured and the purpose of measurement. Four levels of measurement are typically identified by statisticians: Nominal, ordinal, interval and ratio (Hays, 1976).

Nominal. In nominal level measurement, numbers are used either as labels (e.g., classrooms in a building are numbered 1, 2, 3, etc.) or as a means of assigning people, objects, or events to categories (e.g., male = 1, female = 2).

The use of numbers in this way does not imply any quantitative meaning in terms of the amount of an attribute (Nunnally, 1967).

Ordinal. In ordinal measurement, (1) objects of measurement are ordered from most to least with respect to some attribute, (2) there is no indication of how much of the attribute the measurement object posesses, and (3) there is no indication of how far apart the objects are on the attribute being measured (Nunnally, 1967). For example, if military organizations are assigned ranks depending on their level of readiness (category 1, category 2, etc.) this would be an example of ordinal measurement. The only conclusion that can be drawn from this classification scheme is that category 1 organizations are higher on the attribute (readiness) than category 2 organizations, and that category 2 organizations are higher than category 3 organizations, and so on.

Interval. Interval measurement procedures lead to a rank ordering of objects of measurement with respect to an attribute when the distances between objects are known. However, ordinal procedures do not provide any information about the absolute magnitude of the attribute for any object of measurement (Nunnally, 1967). The use of a productivity index is an example of interval measurement. For example, if the measured productivity in 1980 is selected as the arbitrary zero-point or base year, productivity in successive years is expressed in relation to the 1980 value. For example, productivity values were obtained:

Year	Output	Input	Productivity
1980	4	10	.40
1981	6	12	.50
1982	8	14	.57

When converted to an index, values for the three years might be expressed as: 1980 = 100, 1981 = 125, and 1982 = 143. The numbers 100, 125 and 143 form an interval scale.

Ratio. Ratio measurement includes all the characteristics of interval measurement, and the quantities are expressed in relation to an absolute zero. Measures of production constitute ratio measurement when physical units are counted. For example, if the number of aircraft refueled on five consecutive days were 20, 8, 12, 7, and 10, these numbers form a ratio scale. Since zero aircraft refueled means an absence of the attribute (number of aircraft refueled), this scale has a meaningful zero point.

Importance of Level of Measurement

In developing and interpreting measures of productivity, the level of measurement produced by a particular measurement operation is significant. If a given measurement operation produces only ordinal measurement and ratio interpretations are attempted, they will lead to inaccurate conclusions. In addition, the application of statistical procedures to productivity indicators must be done in accordance with the level of measurement represented by the indicator. For example, attempting to compute an average (arithmetic mean) for ordinal data is not justified.

Characteristics of Good Productivity Measures

In addition to level of measurement, there are also important attributes of productivity measures. Hurst (1980, pp. 43-49) described nine characteristics which he lists as desirable for measures of organizational performance.

1. Controllable. The person or group being measured should have control over the aspects of performance measured by the indicator. In other words, groups should not be held accountable for results that are outside of their control. For example, percentage of on-time takeoffs may not accurately measure productivity of an Air Force operations section since inputs from maintenance and supply are also involved.

2. Congruent. The performance measure for a sub-system should be compatible with the overall mission and objectives of the larger organizational system of which it is a part. For example, areas of performance measured for a branch should be relevant to the overall mission of the squadron.

3. Measurable. The characteristic should be quantifiable through procedures that are feasible. In addition, a measurable characteristic should be:

a. Unequivocal. Not subject to misinterpretation, and sensitive to actual changes in performance that occur;

b. Reproducible. Similar performance changes will produce similar measures repeatedly;

c. Accurate. Not subject to random or systematic basis that will introduce measurement error; and

d. Objective. Multiple observers of the characteristics should agree on what is good performance and what is bad.

4. Understandable. The extent to which the relationship between level of performance and the measure will be understood by the individual being measured. For example, complex schemes used to weight labor input would be less understandable than simple unweighted schemes.

5. Choosable. The extent to which the people being measured have a say in the measures by which their organization will be judged. For example, workload factors imposed by regulation are less choosable than factors generated at the local level.

Hurst (1980, p. 46) acknowledges that not all of these attributes of good measures can be achieved at the same time. An example of the type of trade-offs often encountered is a trade-off between accuracy and understandability. For example, a productivity indicator in a vehicle maintenance organization may be:

$$\frac{\text{number of engines tuned}}{\text{number of hours worked}}$$

Since all engines are not equivalent, it may be necessary to develop a "standard output unit." For example, if the shop repairs 1/4 ton vehicles, 3/4 ton vehicles, and 2-1/2 ton vehicles, the output unit may be the number of 3/4 ton engine equivalents repaired. While this would more accurately reflect output, it would be less understandable to members of the organization whose performance is being measured than simply counting the number of engines repaired.

Other common tradeoffs discussed by Hurst (1980) include: Congruence versus Measurability, Aggregation to higher organizational levels versus Congruence, and Motivation versus Interference. This last issue, the impact of measurement on the phenomenon being measured, will be discussed later in this chapter.

A recent study (A.T. Kearney, Inc., 1978) of productivity in physical distribution outlined a somewhat different list of desirable characteristics of productivity measures. A.T. Kearney, Inc. (1978, pp. 11-13) identified seven criteria for judging productivity measures:

1. Validity. A valid measure is one that accurately reflects changes in real productivity. In a receiving operation that involves moving palletized goods from a receiving dock to the warehouse, the number of pallet loads per hour would be a valid measure. Cases per hour or pounds per hour would be a less valid measure due to the fact that cargo density may vary.

2. Coverage. The more completely the output accounts for all uses of an input resource, the more accurately that input can be tracked. In the example above, if the operator puts cargo on shelves and loads and unloads cargo with a handtruck as well as operates the fork lift, then it may be necessary to have three output measures in order to account for the individual's work time.

3. Comparability. In order for measures to be compared across time they must be reduced to a common denominator. One way to do this is to multiply the number of units produced by the standard times allowed for the task. If standards do not exist then "equivalent units" can be defined and used to aggregate outputs.

4. Completeness. All significant inputs should be included in the measure. In the warehouse example, potential inputs would be labor, energy, equipment depreciation, floorspace, etc.

5. Usefulness. To be useful to a manager, a productivity measure should guide that manager toward some effective action.

6. Compatibility. Whenever possible, data for the measure should be available from existing sources of data and management information systems.

7. Cost Effectiveness. The benefits gained from a measure must exceed the costs associated with collecting the data.

Some of the attributes proposed by A.T. Kearney, Inc., (1978) are basically the same as those proposed by Hurst (1980), although the Kearney list emphasizes feasibility and cost to a greater degree. Nevertheless, these two lists provide a comprehensive set of criteria against which to judge the adequacy of productivity measures.

Review and Critique of Productivity Measures

A scheme for organizing productivity measurement approaches is presented in Figure 2. This simple taxonomy forms the organizational scheme used in the following discussion .

PRODUCTIVITY MEASUREMENT METHODS

Efficiency Measurement

1. Output/Input Measures
   a. Form I -- Micro
   b. Form I - - Macro
   c. Form II
   d. Form III
   e. Form IV
2. Performance Efficiency Measures
   a. Engineered Standards
   b. Statistical Standards
   c. Historical or Technical Audit Standards
3. Utilization Measures

Effectiveness Measurement

1. Goals Achieved
2. Quality
   a. Process Quality Ratio
   b. Prevention Quality Ratio
   c. Conformance to Quality Standards
3. Impact (External)
   a. Impact on Another Organization's Performance
   b. Responsiveness to Customers/Users
   c. Customer Attitudes
4. Impact (Internal)

Integrated Approaches

1. Total Performance Management
2. Behavioral Economic Measurement
3. Production Foreman Performance Appraisal

Figure 2. Taxonomy of Productivity Measurement Methods

Efficiency Measurement

Output/Input Measures. The first category of efficiency measures presented in Figure 2 includes measures which define efficiency as a ratio of outputs to inputs. Both outputs and inputs can be expressed in terms of physical units (e.g., pounds, hours, miles, gallons, number of items etc.) or in terms of cost or value expressed in dollars. Using these dimensions, the four resulting types of output/input efficiency ratios are depicted in Figure 3.

		Outputs: Physical Quantity	Outputs: Price
Inputs	Physical Quantity	Form I	Form II
	Price	Form III	Form IV

Figure 3. Types of Efficiency Ratios

These four types are:

1. $\frac{\text{Output in Physical Quantity}}{\text{Input in Physical Quantity}}$ (Form I)

2. $\frac{\text{Output in Price Form}}{\text{Input in Physical Quantity}}$ (Form II)

3. $\frac{\text{Output in Physical Quantity}}{\text{Input in Price Form}}$ (Form III)

4. $\frac{\text{Output in Price Form}}{\text{Input in Price Form}}$ (Form IV)

Two additional dimensions for classifying efficiency measures are level (micro versus macro) and type (partial versus total factor). In this discussion, micro level efficiency indicators are used to measure efficiency at the work group, work center, branch, or squadron levels. Measures applied to organizations larger than squadron level are termed "macro". Measurement type refers to whether or not the denominator of the ratio includes a single input (partial) or multiple inputs (total factor). Using all factors to classify efficiency measures would lead to the taxonomy shown in Figure 4.

Level	Macro		Micro	
Type	Total	Partial	Total	Partial
I				
II				
III				
IV				

Figure 4. Taxonomy of Efficiency Measures

The discussion of efficiency measures will not treat all the possible measures corresponding to the cells of Figure 4. The discussion will focus on the four types of output/input measures defined in Figure 3. Only Type 1 will be broken down into macro and micro levels. However, before discussing each of the four ratio forms, several overall considerations in evaluating efficiency measures should be discussed. With respect to level of measurement, macro and micro indicators have different purposes. Macro measures (e.g., Command-wide or Air Force-wide) are useful at the policy level and are useful for budget formulation but have little value for the operating level. Even though the data for macro level measures are normally aggregated up from lower levels, the "gross" measures of output used are not meaningful to managers who want to analyze the sources of productivity problems in their organizations. Many of the output indicators used in the productivity reporting system are workload measures (e.g., number of active duty pay accounts serviced, authorized base population served, weighted population supported, etc.). Managers who input data normally do not receive feedback about their organization's productivity. Line managers do not know productivity levels because the output data are combined with input (usually only labor) data at organizational levels above the work center or branch.

In general, total factor measures are preferable to partial measures because they provide a more accurate accounting of an organization's "true" efficiency. This is particularly true for higher level organizations. A rule of the thumb for determining the inputs for efficiency ratios is that the efficiency measure for a unit should include in the denominator only those inputs over which the organization has some control (Thor, 1979).

One of the difficulties in using efficiency ratios in the Air Force is that managers have very little control over the inputs to the process. They cannot, at least over the shortrun, adjust input levels of labor to the workload. Organizations are authorized and assigned personnel in relation to their workload. Therefore, there are a given number of "hours" of input available to a unit commander. While these hours can be allocated to tasks in different ways, the total labor input is, for all practical purposes, fixed. Thus, the only variable is workload. Organizations vary in terms of the amount of control they have over their workload. Where there are slack periods and labor input is fixed, the labor efficiency is poor. Where workload is heavy, labor efficiency increases. Neither high nor low efficiency value is a valid measure of the efficiency of such organizations. The efficiency ratio simply measures fluctuations in workload which are outside the organization's control.

A final issue with efficiency measures concerns the desirable characteristics of output indicators. In its guide to implementing productivity programs in the Federal Government, the Joint Financial Management Improvement Program (1977) described some "tests" that may be applied in selecting or defining outputs:

1. Mutually exclusive. Can the input required to produce the output be readily identified?

2. Process definable. Are the same steps required to complete the operation each time?

3. Countable. Can the number of units produced or services provided be quantified?

4. Uniform over time. Will the nature of the product or service remain relatively stable over a reasonable period of time?

5. Mission oriented. Does the product or service represent all or a significant part of the mission of the activity being measured?

6. Quality definable. Is quality of the product relatively stable, or at least definable? Quality becomes a problem only when it changes, but definition is needed to determine if a change has occured. If changes have occurred, these can usually be factored in to adjust the productivity equation.

7. Data readily available. To what extent is data available from existing systems?

8. Directness of the measure. Are the measures direct or, if proxy (indirect) measures are necessary, is there a rational relationship between the output and the measure (JFMIP, 1977, p.13-14).

With these general considerations in mind, this section will discuss each of the four forms of efficiency ratios.

1. Form I - Physical Quantity Input and Output - Micro Level

a. Description. There are many examples of efficiency indices that involve physical quantities. Two examples are presented below:

$$\text{Labor partial} = \frac{\text{Number of line items issued by supply branch}}{\text{Total hours worked}}$$

$$\text{Energy partial} = \frac{\text{Number of passenger-miles driven}}{\text{Number of gallons of fuel used}}$$

b. Critique. Physical quantity measures offer many advantages for efficiency measurement. Since they are not affected by inflation, they can be compared directly with data from previous periods. Other advantages include relative ease of computation, ease of understanding, and generally high acceptability. Disadvantages of the measure in an Air Force organization are that the index may fluctuate as a result of factors that are not controllable by the organization. When managers have little control over the number of personnel assigned, as is the case in the Air Force, labor partials, such as the first example above are misleading. In addition, aggregating outputs, such as line items, can be misleading if there are large differences in the time to process them. Because of this problem, the Air Force productivity program makes use of weighted line items processed as an output of supply organizations. In high volume organizations, it is a reasonable assumption that these differences in unweighted line items will average out, but in low volume operations outputs should be standardized or weighted before they can be meaningfully aggregated. Unless this is done, the indicator will have low validity and low acceptability to managers. It will also have low relevance as a criterion for evaluating organizational change efforts. Furthermore, if the organization has a fluctuating workload with idle periods, this will distort the labor partial indicator. A further disadvantage of partial efficiency indicators is that they are distorted by factor substitutions (e.g., capital for labor). Labor productivity may show a spurious improvement when the source of improvement is really a new piece of equipment.

2. Form I - Physical Quantity Input and Output - Macro Level

a. Description. Form I indicators are the types of measures typically reported by Air Force Headquarters, DoD and the Bureau of Labor Statistics. Generally these measures are reported in index terms. Table 2 provides an example of how such an index is calculated. The data presented are illustrative only.

Table 2

Computation of Labor Partial Index

	(a) Month 1 (Base)	(b) Month 2	(c) Index (b÷a)x100
1. Output (Meals served in DoD dining halls)	1,000,000	1,200,000	120
2. Input (Hours worked by dining personnel)	250,000	250,000	100
3. Efficiency (1÷2)	4	4.8	120

b. Critique. Such macro index measures provide top-level policy makers with information that is useful for budgeting and planning purposes. The measures also provide an indication, if interpreted with caution, of the extent to which labor resources are efficiently utilized in relation to a previous period. There are many disadvantages of the macro measures. Aggregating outputs at this level produces a number which has dubious meaning unless the outputs are extremely homogeneous, are standardized, or are weighted before combining. Because of the degree of aggregation required, the measure is insensitive to small or moderate productivity changes in a given organization. While the macro measures may have broad policy meaning, they have little, if any, benefit for the operating manager at the micro level. Such macro measures are difficult to interpret and have little value in evaluating organizational change programs.

3. Form II - Price Outputs and Physical Quantity Inputs

a. Description. Form II measures present outputs in terms of dollar values. Such measures are widely used in the private sector where sales in dollars is a frequently used output. Government organizations, including the Air Force, have difficulty establishing dollar values for their outputs. As a result, this form is not widely used in the Air Force.

An example of a Form II index is:

$$\text{Shipping value per hours worked} = \frac{\text{Dollar value of items shipped}}{\text{Labor hours}}$$

or

$$\text{Utilization of space} = \frac{\text{Sales in dollars}}{\text{Square feet of retail space}}$$

An indicator used in military commissaries is:

$$\text{Commissary efficiency} = \frac{\text{Deflated dollar value of sales}}{\text{Commissary labor hours}}$$

b. Critique. Form II indices are understandable and acceptable to managers and are easy to compute since most organizations maintain the necessary data. In their "raw" form, however, these indices can be misleading. In general, physical measures of output are preferable to output stated in dollars because dollar measures are affected by inflation. Selling prices are affected by wholesale prices, selling expenses, fixed asset costs, markups, etc. Dollar values, even when adjusted for inflation, do not provide an accurate way to aggregate different types of outputs. For example, in the previous shipping example, unless items were priced according to the required handling time, the output measure would have low validity. If separate indices were computed for each product and these were adjusted for inflation, then the Form II indices would be valid measures that would be useful for evaluation purposes.

In a manufacturing context, the confounding effects of other costs are often removed by subtracting the cost of materials from the value of the output. This adjustment produces an output value called "value added by manufacturing." The most accurate approach to adjustment is the double inflation approach (Greenberg, 1973) in which the deflated cost of materials is subtracted from deflated value of output. This produces an index:

$$\text{Value added per manufacturing hour} = \frac{\text{Value added}}{\text{Labor Hours}}$$

In the military environment, except for industrially funded activities, there are relatively few situations in which sales or value added are appropriate output measures. Furthermore, when aggregated output measures are used they are relatively insensitive to changes in organizational efficiency which may be less than the fluctuations in the dollar values because of factors unrelated to organizational efficiency. Because of the need to correct for inflation and other cost factors, this measurement form requires considerable computation. This difficulty, coupled with its low validity, reduces its acceptability to managers. As a result, it is of little use in guiding managerial decisions. The Form II measure is also of little value in evaluating the impact of organizational change programs.

4. Form III - Physical Quantity Outputs and Price Inputs

a. Description. Form III measures report outputs in physical forms and inputs in price or value terms usually expressed in dollars. Felsinger (1976) provides an example of such a measure:

$$\text{Materials efficiency} = \frac{\text{Number of planned maintenance actions accomplished}}{\text{Dollar value of materials consumed for repair parts}}$$

This index has been proposed for use on Navy ships to measure the number of planned maintenance actions per OPTAR dollar spent (Felsinger 1976). OPTAR costs are expenditures approved by the ship's commanding officer for day-to-day equippage, repair parts, and other operating expenses. Fuel, utilities, shipyard repairs, and personnel costs are excluded. An Air Force example from the supply area is:

$$\text{Total factor efficiency} = \frac{\text{Number of weighted line items processed}}{\text{Deflated costs of labor, material, and energy}}$$

This example makes use of a weighting procedure for outputs. While one might consider line items processed to be homogeneous, in fact, some line items take longer to process than others. There are various procedures for establishing output weights (estimation, work measurement, etc.). Regardless of the procedure used, each line item is given its appropriate weight prior to summing. For example, assume that it takes a supply clerk 10 minutes to issue a uniform, 5 minutes to issue a weapon and 1 minute to issue a tool kit. If weapon issues are taken as the standard, then uniform issues would receive a weight of 2, weapons would receive weight of 1, and tool kits would receive a weight of .2. Total output would be obtained as follows:

$$\text{Output} = 2\ (\text{Number of uniforms}) + \text{Number of weapons} + (.2)\ \text{Number of tool kits}$$

With respect to inputs, the supply index includes all the relevant cost factors involved in processing line items. Total labor cost includes direct labor, indirect labor and non-available labor.

b. Critique. Particularly for the military, where outputs can be more easily expressed in physical quantity terms than in price terms, this Form III index is very useful. Since outputs are expressed in physical terms, this measure is easy to interpret and meaningful to managers. Its inverse can be interpreted as the cost per unit of output. With the denominator (inputs) expressed in terms of deflated costs, it is usually possible to obtain the necessary input data directly from existing cost accounting systems. The outputs expressed in physical quantities are most useful if they meet the criteria for defining outputs presented earlier. Form III measures are amenable to total factor productivity measurement as previously illustrated in the supply example. Disadvantages of Form III measures are few, except for organizations having a large number of outputs. Combining all outputs into a single index may be difficult from the standpoint of developing an acceptable weighting scheme. It may also be undesirable because, as the complexity increases, its acceptance and utility to managers decreases. In such an organization, multiple indices covering the significant outputs and their associated costs are recommended.

5. Form IV - Outputs and Inputs in Price Terms

a. Description. Form IV measures are in essence financial ratios. Examples of Form IV efficiency measures include:

$$\text{Labor efficiency} = \frac{\text{Sales or value added}}{\text{Dollars of payroll}}$$

$$\text{Capital efficiency} = \frac{\text{Sales or value added}}{\text{Dollars of capital invested}}$$

b. Critique. Form IV ratios probably represent the most common ratios used by managers; thus, they must have high acceptability. However, these ratios are seriously flawed from the standpoint of providing useful information to managers about the "true" efficiency of the organization. As has been previously pointed out, price forms are less useful than physical quantity formulations. In the military context, this is even more true. Even when corrected for the effects of inflation and expressed in index terms, price or economic value is not a good basis for aggregating outputs in forming efficiency ratios unless prices are proportional to units of work (labor energy, etc.) used to produce them. This rationale is based on Bureau of Labor Statistics practice. When forced to use unit price weights instead of unit labor weights in aggregating output, the Bureau of Labor Statistics makes the assumption that unit value weights are proportional to number of unit employee hours required to produce the outputs (Bureau of Labor Statistics, 1978).

At the micro level, Form IV indices can be used in evaluation as an overall summary measure for the branch, squadron, or plant. However, to be useful in guiding management practice, they should be supplemented by more specific Form I or Form III product or service oriented indices. Form IV indices have little benefit for purposes of evaluating organizational change programs.

Performance Efficiency Measures. Performance efficiency measures are measures that deal with the relationship between an actual or obtained level of performance and a standard or expected level.

1. Performance efficiency based on engineered standards

   a. Description. Two types of engineered standard are in use in the Air Force and in other organizations. One is the end-item standard that provides precise estimates of "should take" times for an average qualified worker to perform a task (e.g., repairing a carburetor on a vehicle or processing a travel claim). A second type of standard is the manpower standard used for determining staffing lines and provides a basis for computing the number of personnel required to handle a given volume of work. While both types of standards can be used to generate measures of performance efficiency, end item standards are most useful for efficiency indices at the micro or work center level. This discussion will not focus on the techniques of developing standards as this is a highly complex and technical subject. Instead, the present discussion will focus on the use of standards in computing efficiency ratios.

   The Air Force activity which makes the most use of end-item standards for work is Air Force maintenance. Standards have been developed for most maintenance actions. For a specified repair, inspection, or other maintenance action, there is an average time that is required for the average qualified technician to make a given repair. If the actual time for the repair is compared with the standard, this leads to a measure of performance efficiency. The general form of a performance efficiency index is:

$$\text{Performance efficiency} = \frac{\text{Standard time}}{\text{Actual time}}$$

   The index shown above can be used for assessing the efficiency of an individual on one task or it can be averaged to assess the efficiency of an organization. A more common way of summarizing such data is in terms of earned hours. Consider the example in Figure 5.

   b. Critique. The advantages of performance efficiency measures include quantifiability, understandability, and utility to managers as a guide to management practice. Assuming that the standard is accurate, the process is objective and requires relatively simple bookkeeping and computa-

Task: Processing adjustments to travel claims in a finance and accounting office

Output measure: number of adjustments processed

Standard: 1.619877 hours to process 1 adjustment

Number of work units completed: 494

Actual hours expended: 1207

Performance efficiency: $\frac{\text{Work units completed x Standard}}{\text{Actual hours}}$

$$= \frac{\text{Earned hours}}{\text{Actual hours}} = \frac{494 \times 1.619877}{1207} = 66\%$$

Figure 5. Illustration of Performance Efficiency Computation

tional procedures. As an evaluation tool, the efficiency index provides an acceptable criterion assuming both the input (labor hours) and the workload are under the control of the organization. For example, if an organization has a fluctuating workload generated by an outside organization and it cannot adjust input accordingly, its rate of efficiency will not be a useful gauge of the organization's actual efficiency.

A disadvantage of the approach is that development of engineered standards is expensive. Standards which are not updated as work and work processes change lose their applicability over time. There is usually some resistance by workers to this procedure unless they are consulted and have an input into the standards development process. This and other efficiency-based approaches can be criticized if they make no provision for changes in quality of the output. The approach assumes that quality is constant for the units of work counted. In high volume operations, where work is quite standardized and other quality monitoring procedures are in effect, this assumption may be reasonable. However, in less routine work centers, where there are some decisions to be made by workers and some discretion in processing is required, this approach is expensive to apply and maintain and probably not cost-effective. Performance efficiency indices using engineered standards are useful in situations that fit the constraints underlying the method. Most of the problems with the method result from poor implementation and failure to keep standards current rather than from flaws of the methodology itself.

2. Performance efficiency based on statistical standards.

   a. Description. The illustration presented in Figure 5 deals with a single workload factor. In the development and application of manpower standards across work centers or across time periods for a given work center, multiple workload factors are typically utilized. This enables the procedure to comprehensively cover the organization's workload. For example, the work outputs for an office of administrative services within a Federal Agency is measured on four outputs: number of pieces of correspondence routed, number of pieces of cash mail handled, number of transactions in an internal fund, and number of travel inquiries answered. Inputs are the number of hours worked. Using historical data from a period of 52 weeks, a multiple regression analysis is conducted relating outputs to input. This process produces an equation that can be used to predict hours worked on the basis of variations in the level of output.

An example of such an equation is:

$$\begin{aligned} \text{Total hours} = {} & 39.92 \quad \text{(constant)} \\ & + .0076 \times \text{No. pcs. correspondence} \\ & + .1245 \times \text{No. pcs. cash mail} \\ & + .1958 \times \text{No. fund transactions} \\ & + .0449 \times \text{No. travel transactions} \end{aligned}$$

Applying the equation to actual data for a week yielded the following results (U. S. Department of Commerce, undated):

$$\begin{aligned} \text{Total Standard Hours earned} = {} & 39.9271 + 8868 \times .0076 \\ & + 354 \times .1245 \\ & + 153 \times .1958 \\ & + 425 \times .0449 \\ = {} & 191.9368 \end{aligned}$$

$$\text{Productivity Index} = \frac{\text{Total std. hours earned}}{\text{Hours worked}} \times 100$$

$$= \frac{191.9368}{128} \times 100$$

$$= 1.50 \times 100 = 150$$

Thus, the productivity for the week was 150% compared to the base period, the average for the 52 previous weeks.

b. Critique. This procedure offers a useful way to track an organization's labor efficiency over time. It requires some statistical knowledge to understand and apply the process. The output measure is relatively straightforward, and the procedure is attractive because it provides a mechanism for aggregating different outputs at the work center level.

A disadvantage of the approach is that it is useful only for assessing labor productivity. However, the approach can be used to generate standard labor costs for outputs that might be combined with other input cost data in developing total factor measures for different output classes. Acceptance of the approach by managers may be complicated by its statistical foundation. Finally, the process loses its effectiveness quickly if the work performed by the organization changes in significant ways. It appears to be best suited to bureaucratic organizations where there is high task specialization and where work roles and the actual work performed are relatively consistent over time.

As an evaluation tool, the methodology offers a very effective and objective way to evaluate the impact of organizational change programs. If an organizational change program leads o improved efficiency, this will be reflected in an increase in the number of earned hours, assuming that the volume of work is elastic and can expand with the increase in organizational capacity. In addition, improved efficiency will be reflected in changes in the regression weights when the equation is reapplied. This could produce a statistical test for assessing the impact of organizational change.

3. Performance Efficiency Based on Historical or Technical Audit Standards.

a. Description. Situations in which the work load is relatively low volume, non-standard in nature, and requires considerable judgement to process do not lend themselves to either engineered or statistical standards of the type previously discussed. The approach required to establish standards in such a work center may make use of either historical standards or what is known as technical estimation. To illustrate the methodology, an example will be drawn from an Air Force procurement organization.

Procurement personnel process a number of different types of procurement actions. Each of these actions varies in terms of the length of time for processing and each is subject to various complexity factors which may or may not occur but which have time demands. This situation can be depicted in the form of a matrix as shown in Table 3. Times within the cells were established by technical estimation using knowledgeable procurement specialists. For each type of procurement item, standard times for processing can be determined simply by adding the time across the complexity elements that apply. The time estimates are based on a combination of operational audits, historical records and technical judgement. Self-reporting by the procurement officer provides the input for hours worked as well as a categorization of the type of procurement action and its complexity factors. The procurement file represents a clear audit trail and can be reviewed as a quality check to determine if individuals accurately report time to complete procurement actions and work performed.

Table 3

Procurement Actions, Complexity Factors and Time Estimates

	Complexity Factors					
Types of Procurement Actions	Award In Simplest Form	Sole Source	Small Bus.[a] Coordination	Mistake In Bid	EEO[b] Comp.	etc.
Purchase Order	3.47	.40	.41	-	-	-
Blanket Purchase Agreement Order	3.63	.40	.41	-	-	-
Basic Ordering Agreement	18.94	-	-	-	2.79	-
Restricted, Advertised 100% Set Aside	4.51	-	-	15.32	2.79	-
Change Order Issuance	14.95	-	.41	-	2.79	-
etc.	-	-	-	-	-	-

[a] Business
[b] Equal Employment Opportunity

On a monthly basis, effiency measures are computed by establishing a ratio of the standard time (earned hours) obtained from the chart and actual hours.

b. Critique. The primary advantage of this approach is that it can be applied to work situations not suited for use of statistical or engineered standards. The logic of the approach is clear and straightforward, thereby increasing its acceptance to management. A by-product of the approach is that it provides careful analysis of the type of work performed in the work center. The approach can be easily modified by adding or deleting complexity elements or by revising the time estimates as requirements change. The approach produces indices that are directly compatible with the mission of the organization and its outputs can be defined in such a way that the total mission of the unit can be captured. Finally, in its implementation it is almost inevitable that individuals in the organization become involved in development of the procedure. A final advantage of the procedure is that there should be high agreement among observers as to whether a particular complexity element is performed which would lead to high reliability.

Use of historical or technical audit standards has some disadvantages. First, it requires a considerable investment of time to develop the complexity and time estimates. Second, in operation, the procedure relies on self-reports of incumbents. Individuals must be willing to take the time to accurately report time spent and work performed. To achieve valid reporting, employees must be made to feel that it is in their best interests to do so. If employees feel that their efforts to participate in a measurement system will be rewarded by getting additional staff or in other ways, the quality of the data is likely to improve. The quality of the output data can be assessed through periodic quality control checks since there is a clear audit trail.

Utilization Measures.

1. Description. In its simplest form, a measure of utilization is the ratio of actual utilization to the potential utilization of labor, space, equipment, or other aspect of organizational capacity. Some utilization ratios drawn from physical distribution/logistics include:

$$\text{Equipment Utilization} = \frac{\text{Equipment hours used in put-away}}{\text{Total equipment hours available}}$$

$$\text{Facility Utilization} = \frac{\text{Sq. feet of storage used}}{\text{Sq. feet of storage available}}$$

$$\text{Labor Utilization} = \frac{\text{Labor hours spent in replenishing stock}}{\text{Labor hours worked by replenishment workers}}$$

$$\text{Overall Receiving Utilization} = \frac{\text{Total volume received per day}}{\text{Total receiving capacity per day}}$$

2. Critique. In general, the more of an organization's capacity being utilized the better. Certainly this is true for civilian organizations. However, for many military organizations, particularly those which have wartime missions, utilization ratios during peacetime may not be meaningful. Units which are authorized equipment for wartime use would probably not find high rates of utilization during peacetime. Low utilization would not mean that the units were inefficient but rather that the mission workload which called for the utilization of the equipment was not present. However, utilization rates for personnel and equipment required for peacetime missions can and should be tracked.

   In general, utilization rates are meaningful indices for managers of the extent to which valuable assets are being utilized. However, it is important that consistent definitions be developed in order to have accurate recording of "capacity." For example, in determining equipment availability, is the time spent conducting preventive maintenance on a piece of equipment counted as time when the equipment is utilized, is it counted as unavailable time to be subtracted from total time available, or is it actually counted as utilization time? Clear and unambiguous recording procedures must be established in order to have meaningful utilization measures. Such measures are useful in assessing the effects of organization change programs.

Effectiveness Measurement

Effectiveness has been defined previously as the extent to which an organization achieves its goals. The definition can be broadened to include not only the dimension of goal achievement, but also other dimensions such as quality of the output, impact on the external environment, and impact on the organization itself. Usilaner and Soniat (1980) list the following as effectiveness dimensions relevant to the services of state and local government: responsiveness, timeliness, accessibility, availability, participation, safety, reliability, and citizen participation and/or satisfaction. Chapter 2 reviewed the concept of effectiveness and the many dimensions that researchers have proposed and measured. This section will focus principally on objective measures of effectiveness dimensions.

Goal or mission oriented criteria are the most frequently mentioned measures of effectiveness by managers. This was illustrated in a study of 68 Navy Managers (Bowser, 1976). In addition to the criterion of meeting operational commitments, which was by far the most important dimension of concern, Navy managers also mentioned efficiency, training, operational readiness, having sufficient resources, operational time factors, safety, communications, adequate maintenance, and quality of equipment as important criteria.

Interviews with 23 Naval Officers attending the Naval Postgraduate School yielded the following list of measures of component effectiveness (Campbell, et al., 1974):

Reenlistment rate

Non-judicial punishment rate

Ratio of rated to non-rated personnel

Ratio of qualified to non-qualified personnel

Unauthorized absence rate

First tour reenlistment rate

Long-term stability of personnel

Court martial rate

Manning level ratio

Percentage taking exams who pass

Percentage of persons eligible for promotion who are recommended

Rate of correspondence course participation

Rate of participation in group activities

Number of times per person per ship per month sick call rates

Percent time sleeping while off duty

Rating of morale by top officers

Overall rating of personnel capability by top officers

Perceived leadership effectiveness by crew members

Food and personal services evaluation

Reported drug usage

Overall ADMAT inspection grade

Discharges other than honorable

Grievances directed to others outside of command (letters to Congress, etc.)

Percentage of maintenance actions deferred due to insufficient manning or expertise

Percentage of required training completed by officers

Requests for transfer/per man/per unit of time.

Satisfaction with present assignment

Satisfaction with shipmates

As this list suggests, there is a virtually unlimited number of possible criteria of effectiveness. In defining and measuring effectiveness, it is helpful to have some structure or categories of effectiveness measures. In discussing effectiveness measurement, Balk (1975) points out that the essence of effectiveness is a comparison between an output and some standard. The Urban Institute and the International City Management Association (1974) point out that the measurement of effectiveness of municipal services includes:

1. the degree to which the intended purposes of the service are being met

2. the degree to which unintended adverse impacts of the service on the community occur

3. the adequacy of the quantity of the service provided relative to the community's needs, desires, and willingness to pay

4. the speed and courtesy displayed in responding to citizen complaints

5. citizen perceptions of the satisfactoriness of the service

Goals achieved.

1. Description. The first category of effectiveness measurement to be discussed is the category of goal achievement. This measurement approach assumes that quantifiable goals have been established and performance is assessed relative to those goals and standards. This approach is in common use in the Air Force. For example, with respect to aircraft availability:

$$\text{Aircraft Availability} = \frac{\text{percentage fully mission capable}}{\text{standard percentage for Command}}$$

This measure assesses the extent to which the number of aircraft available to fly missions is, on the average, consistent with the percentage expected by the Major Command. With respect to aircraft departure reliability from the originating station, one command has a standard of 98%. Thus, 98% of the flights originating from the home station should take off on time. A measure of effectiveness for this goal is:

$$\text{Departure Effectiveness} = \frac{\text{departure reliability percentage}}{\text{standard percentage for Command}}$$

In addition to ratios, goal achievement may also be measured in terms of adherence to schedules, planned achievements versus actual achievements, etc.

2. Critique. Measuring effectiveness in terms of performance against goals or standards is a straightforward, understandable approach as long as an organization has established measurable goals and objectives that are consistent with the mission of the unit. In establishing effectiveness measurement procedures, it is important that the measurement operations be explicitly defined. For example, in the first illustration (Aircraft Availability), whether an aircraft is fully mission capable, or partially mission capable can involve judgement. To the extent that a unit is under extreme pressure to report to a higher headquarters a number that is in compliance with the Command standard, there would be a tendency to make the percentage look as good as possible. However, having explicity defined criteria for mission capable aircraft will help reduce this measurement bias. In addition, when measurements are used as the basis for rewards and punishments to organizations rather than for diagnosis, then they become increasingly susceptible to bias.

Generally measures of effectiveness which refer to the achievement of goals are measures that are useful to managers and are understandable. If managers participate in establishing goals, and if they are considered fair and attainable by actions under the control of the organization, then these goal oriented measures are acceptable to managers. The cost effectiveness of goal attainment measures is high if organizations have delineated and prioritized goals and are measuring those things which are really important. Frequently, it is better to measure well a few objectives that are critical to an organization's mission, rather than try to measure everything the organization does, but measure it poorly.

From the point of view of evaluation, measures of goal attainment often have less utility than might appear because there frequently is little variation in the measures. For example, in a squadron flying C-9 aircraft over a 12 month period, the departure reliability rate fell below 100% (the standard is 97%) only for four months. In those months the rate was 99.4%, 97.9%, 99.0%, and 99.5%. As a research criterion, this would not be very useful since there is little room for improvement in this measure. This is frequently the case in goal areas that are closely monitored by higher headquarters.

Quality. Definitions of quality are almost as elusive as definitions of productivity. However, considerable progress has been made recently in defining and measuring quality. Adam, Hershauer and Ruch (1978) have recently defined quality as:

> ...the degree to which a product or service conforms to a set of predetermined standards related to the characteristics that determine its value in the marketplace and its performance of the function for which it was designed (p. 7).

While this definition shifts the discussion of quality from a consideration of quality to a consideration of the "standards", it does help focus the issue.

Following the approach of Adam, et al. (1978), quality is measured by defining key quality deviations from the standards of acceptable performance. In a later paper, Adam, Herschauer and Ruch (1981), propose two general forms of quality indices: process quality and prevention quality.

1. Process Quality Ratios.

   a. Description. The process quality productivity ratio has following general form:

   $$\text{Process Quality} = \frac{A}{pU + cE}$$

   where: A = No. of units acceptable and free of errors

   U = No. of units processed

   E = No. of units subjected to correction procedures

   p = Processing cost per unit

   c = Cost per unit for correction processing

   b. Critique. This is, in effect, a total factor productivity measure that considers quality. It has the same advantages as the total factor measure discussed previously In addition, this measure has the advantage that costs of reprocessing caused by errors can be isolated as a separate item. In organizations which have error detection mechanisms. this measure can be applied with minimal additional cost. In organizations that do not have such mechanisms, additional cost will be required to institute error detection systems. Many Air Force organizations have quality control procedures and could make use of this measure. Examples are maintenance organizations, administrative organizations which process "cases" such as personnel, finance, etc. Organizations whose output is an input to an automated system can make use of computer-generated error reports. A process quality measure is useful to managers as a source of feedback and it is a very useful criterion for evaluating organizational performance. One frequently occurring outcome of organizational change is an improvement in product or service quality.

2. Prevention Quality Ratio.

   a. Description. The prevention quality productivity ratio is an index of the cost per unit of prevention service. The general form of this index is:

   $$\text{Prevention Quality} = \frac{S}{D + M + Z}$$

where: S = Percent of "units" satisfactorily serviced during the period

D = Development cost allocated for this prevention system

M = Maintenance cost per period to execute the prevention system

Z = Special costs required by the prevention system

This general form can be used to assess the productivity of any error prevention subsystem. Examples of such subsystems include quality control, consumer protection, safety, and affirmative action.

b. Critique. This index represents one way to assess the effectiveness of efforts to prevent errors. In effect it provides a means for tracking the cost of preventing problems. The unit chosen can be people serviced, products inspected, community members protected, etc. Making such a measure operational will usually require additional effort to gather cost data in the denominator and to define the population satisfactorily serviced. Developing an adequate measure of the number of units successfully serviced is a difficult problem. For example, does the absence of a complaint mean that a person was serviced adequately? Does the absence of an accident mean that the safety program is effective? How does one assess the number of accidents that might have occurred with no investment in a safety program? These are some of the questions which must be answered in operationalizing this index. Despite these concerns, the index can provide valuable cost visibility for programs of prevention.

Schaenman and Swartz (1974) suggest the use of a variation of the prevention quality index in evaluating the effectiveness of fire prevention services:

$$\text{Fire Prevention Effectiveness} = \frac{\text{Fire incidence rate per 1,000 population}}{\text{Fire prevention expenditures per 1,000 population}}$$

These authors suggest that this index be viewed over time in order to make it meaningful. The fire prevention index focuses on the number of "errors" as opposed to the number "properly serviced." Since organizations are more likely to keep data on mistakes, complaints, rejects, accidents, etc. than on the "number of buildings that do not burn" or the "number of training flights without an accident," it would seem that the error measurement approach would be less costly and more acceptable to most organizations. Unfortunately, interpretation of the index is not as straightforward as the prevention quality index. With respect to their relevance for evaluating organizational change programs, neither the prevention quality nor the prevention effectiveness index is likely to be very useful except in organizations where "errors" are rather frequent events. Most criteria of this sort (e.g., accidents, fires, injuries) are, fortunately, rare events; therefore, the measures have relatively little variance. As a result, this form of quality index would not likely be sensitive to improvements in organizational effectiveness resulting from change programs.

3. Conformance to Quality Standards.

   a. Description. The most common way of assessing quality is in relation to established standards. The mechanism for determining conformity in the Air Force is typically through inspections, although other measurement approaches are also used. For example, response time to a call may be a quality indicator for the base taxi service. If the standard response time is 4 minutes with an allowable deviation of 5%, it is possible to determine through dispatcher records whether the average response time lies within the acceptable range.

   In another area such as base housing, the maintenance may be performed either by a contractor or by government personnel. A quality indicator for the required "change of occupancy maintenance" (that maintenance required to prepare a residence unit for the next occupant) is the percentage of units turned over that require rework. With a standard set at 4% rework as acceptable, conformance to the standard is monitored by 100% inspection of units by the Family Housing Management Office.

   In the area of procurement, processing time is a quality index. Procurement managers monitor the average cycle time for various types of procurement actions. In one MAJCOM, data is regularly maintained for the number of days required to process small purchases under $10,000. The MAJCOM has set a standard of 50 days, and monitors the the average number of days required on a monthly basis. This average is reported and graphed monthly in relation to the standard.

   b. Critique. Conformance to standards of quality is the essence of quality measurement. The advantages of this approach are that it forces an organization to make relevant quality dimensions and standards explicit. When applied to important organizational outputs, quality measures are valuable, have high management acceptance, and are potentially useful indicators for evaluation. However, if they are to have these positive attributes, the indicators must be realistic, and the dimension must be controllable through actions taken by the organization's members. For example, in aircraft maintenance, maintenance induced delays in departures are a quality indicator. However, if maintenance fails to complete a repair operation because it has to wait for supply to get a needed part to the flight line, then this quality measure will not be viewed as "fair" by maintenance personnel. Nevertheless, conformance to quality standards can be a very useful management and evaluation criterion. With respect to evaluation, however, such criteria sometimes suffer from the problem mentioned previously of having insufficient variation to be sensitive to changes. This is particularly the case in areas where the consequences of an error are very serious.

Impact --External. In addition to whether an organization achieves its goals and produces products and services which conform to specifications, one must consider the impact which an organization's outputs have on its environment. In some cases, impact can be directly assessed; in other cases, it is difficult or impossible to assess. For example, the impact of a flight line refueling operation on a wing's aircraft departure reliability can be directly assessed by counting the number of times flights are delayed due to flight line refueling. However, the impact of a professional military school's educational programs on its graduate's performance in future assignments is much more difficult to assess. This section will consider three approaches to assessing impact of an organization's output: direct or indirect impact on another organizations's performance, responsiveness to customers/users, and impact on customer attitudes.

1. Assessing Impact On Another Organization's Performance

a. Description. One type of impact measure is the extent to which the output of an organization has an effect on the performance of another organization which depends on the first organization's product or service. To illustrate this type of measure, consider the impact of an avionics maintenance squadron on the departure reliability index for a wing. Delayed departures due to avionics components are an example of the squadron's impact on the performance of the wing as measured by departure reliability. For example:

$$\text{Impact} = \frac{\text{Number of takeoffs delayed or aborted due to avionics}}{\text{Number of avionics maintenance actions completed}}$$

Another example would be the number of times organization A's output is rejected by organization B. For example, an aircraft maintenance shop may subcontract fabrication work to a machine shop. The machine shop's impact could be assessed in terms of the percentage of components produced which were rejected by the receiving maintenance organization's quality inspection.

b. Critique. Measurement of the impact of an organizaion's outputs on the performance of the consuming organizations is an "ultimate criterion of effectiveness." When the impact is direct, such as in the maintenance rejects example above, this is a very useful measure to managers. When the assessment is indirect, its usefulness and acceptability are dependent on the plausibility of the cause-effect relationship between the organization's performance and the measure. When this is contaminated by other influences, many managers find such indicies to be necessary but not as helpful to them in guiding management practice as other more direct measures of efficiency and effectiveness. In essence, some managers might say that "if you do the job right, impact will take care of itself."

The same factors that cause managers to play down the importance and utility of indirect measures of impact also restrict their utility as evaluation criteria. For example, in the previous avionics example, the avionics squadron could perform its job accurately and efficiently but still be "charged" with a delayed departure due to factors beyond its control, such as the performance of some other unit (e.g., supply not being able to get a part on time). Such criterion contamination reduces the utility of impact criteria for evaluation purposes.

2. Responsiveness to Customers/Users.

a. Description. Responsiveness can be assessed in a variety of ways. Many organizations use objective indicators of responsiveness, timeliness of response, and measures of customer behavior. A private air freight firm records and monitors indices of responsiveness such as (Bryant, Brewer, Beasley, Wagner, and Adlfinger, 1972):

Percentage of incoming calls answered in 30 seconds

Percentage of customers called back in 90 minutes

A data processing work center monitors indicators such as (Kirkbride, 1977):

Percentage of bills paid per month without user complaint

Average time job received versus desired completion time

Number refunds requested

Percentage of repeat complaints

b. Critique. Responsiveness indicators, when measured over time, have the advantages of objectivity and sensitivity to performance change. Measures such as "Percent of calls answered in 30 seconds" are preferable to those depending on customer behavior because they measure performance that is controllable by the organization. Responsiveness measures that are linked closely to the behavior of organizational members are extremely useful to managers, are acceptable, and make good evaluation criteria. The only disadvantage is that some effort and cost is required to develop behavior recording procedures. In most cases, the advantages of measuring such key responsiveness behaviors outweigh the costs of data collection. Customer behavior measures are difficult to interpret unless the organization maintains longitudinal data which allows trends to be detected.

Impact -- Internal. The criteria discussed to this point have focused on goal-centered measures of efficiency and effectiveness. It is also important to consider process criteria--the extent to which the organization's capability for future production is enhanced or impaired. There are no direct measures of this future productive capacity. However, the "health" of the organization can be inferred from assessment of indices of absenteeism, requests for transfer, non-judicial punishment rates, accidents, stress related health problems, etc. Other internal impact measures include perceptions and attitudes of organizational members on topics such as reactions to job characteristics, working conditions, adequacy of supervision, interpersonal relationships, participation in decision making, adequacy of planning, goal setting and performance feedback and recognition for accomplishments. At the same time organizational results are monitored, it is important to measure these process indicators to ensure that the organization's "productive capacity" is being maintained. In the Air Force environment, useful measures of such process criteria have been previously developed (Hendrix & Halverson, 1979; Gould, 1978; Tuttle, Gould, & Hazel, 1975).

Integrated Approaches

The previous section emphasized the need to measure not only goal-centered criteria, but also process criteria. The goal-centered criteria provide indicators of what the organization has accomplished in the past. Process criteria provide information on the "health of the organization." The organization's health is an indicator of what the organization can be expected to accomplish in the future (Likert, 1977).

Measurement approaches which recognize this distinction and the importance of integrating measures of both types are Total Performance Management (National Center for Productivity and Quality of Working Life, (NCPQWL) 1978), Behavioral-Economic Measurement (Herrick, 1975; Macy and Mirvis, 1976), and a Navy system for evaluating the performance of production foremen. These three approaches will be discussed in this section.

Total Performance Management (TPM).

1. Description. Formerly called Total Performance Measurement, this process integrates procedures from industrial engineering

and behavioral sciences into a comprehensive management process. TPM has five basic components (NCPQWL, 1978):

1. The employee survey
2. The customer or user survey
3. Measurement of efficiency, effectiveness
4. Information feedback to managers and employees
5. Planning of action to correct deficiences

TPM differs from traditional performance measurement in at least three ways. First, it is based on the assumption that workers are the best source of information of their performance and work situation and on how these can be improved. Secondly, performance data are collected at regular intervals in order to spot emerging problems before they become crises. Third TPM provides a means for viewing specific problems in relation to the total organization. Fourth, TPM data is made available to everyone in the organization.

Proponents of TPM suggest that there are four questions that should be asked in order to determine an organization's readiness for TPM (NCPQWL, 1978):

1. Are valid productivity data routinely available? If not this is the place to start. Trying to implement TPM at the same time basic productivity measurement is introduced may be too much for the organization at one time.

2. What resources are available to implement TPM? Experience with the process suggests that there must be a full-time coordinator who has assistance from individuals with expertise in industrial engineering and behavioral science. Money must be allocated for the coordinator, consultants, or advisors, and for other direct costs such as printing surveys, clerical, and computer assistance in administering surveys and analyzing results.

3. Are there time limits on the project? Managers looking for a "quick fix" of their productivity problems should not use TPM. Usually, 5 to 6 months are required to plan, collect, and analyze survey data. The full process, including feedback and development of solutions, takes longer. Including assessment of results, 2 years is a realistic time frame for a TPM project.

4. Will the organization support the process? Top management must support the process from start to finish. The process can be threatening in that it will shift communication patterns from "top-down" to "bottom-up" approaches. Managers must expect to hear criticism and must be prepared to deal with it constructively. A

frequent comment from organizations involved in TPM was stated by one site coordinator. (NCPQWL, 1978, p. 5)

> As more people get more involved, we really picked up momentumm.....but we really didn't know what we were getting into when we began.

The remainder of this discussion will focus on the measurement approach which underlies TPM. The measurement philosophy is summarized in the following paragraph from the TPM manual (NCPQWL, 1978, p.2) which says that:

> Total Performance Management emerged from the realization that both approaches, industrial engineering and behavioral science, provide useful information when combined in a systematic way. By using productivity measures and data on employee attitudes in combination, as well as data about customer satisfaction, managers can obtain a more realistic picture of their organization's performance problems and potentials. By providing this information to employees, and seeking their recommendations, managers can open avenues to plan for change.

a. Measures of efficiency. The primary measures of efficiency in TPM have been measures of output per hour of labor input. Efficiency trends are normally assessed by converting efficiency ratios to index form for comparison across time periods. Table 4 illustrates hypothetical efficiency data from a TPM project.

In computing efficiency measures, use of total resource input in the denominator rather than partial resource inputs is recommended. Using total resources can give a more accurate view of efficiency than reliance on partial input data. Table 5 illustrates this point. Results from the administration department demonstrate the optimal result. Output per hour worked has gone up while total cost per unit of output (the total resource measure) has declined. The library, on the other hand, has increased labor efficiency, but the cost per unit of output has gone up at an even faster rate. This is an undesirable situation that would not have been obvious from measures of labor efficiency alone.

Table 4

Labor Efficiency Indices for Three Years[a]

	Base Year	Year 2	Year 3
Weighted Output	3600	4400	4650
Output Index	100	122	129
Input	4200	4200	4325
Input Index	100	100	102
Efficiency Rate	.857	1.047	1.075
Efficiency Index	100	122	126

[a] Adapted from National Center for Productivity and Quality of Working Life, 1978, p.15.

Table 5

Comparison of Labor Efficiency and Total Cost Per Unit of Output[a]

	Annual Percent Change, 1974-1976	
Department	Labor Efficiency	Total Cost Per Unit of Output
Administration	+ 7.4	- 6.9
Finance	+ 6.2	+ 1.0
Library	+ 4.8	+ 6.1
Recreation	- 0.1	- 2.3
Public Works	+ 2.9	+ 1.1

[a] Adapted from National Center for Productivity and Quality of Working Life, 1978, p. 20.

b. Measures of effectiveness. Effectiveness measures take into account the extent to which an organization fulfills its mission, the extent to which it delivers high quality products and services, and the organization's impact on other organizations, customers, and its own employees. The previous discussion of effectiveness measures provides some illustrations of their use and some considerations in developing valid measures. In TPM, the focus is on objective measures of effectiveness, e.g., goals accomplished, response time, percent rejects, scrap produced.

c. Employee survey. The employee survey obtains information from workers and managers regarding the functioning of the organization and their reactions to working in the organization. There are many previously developed surveys that address such issues. Two which have been developed specifically for Air Force organizations are the Occupational Atittude Inventory (Gould, 1978; Tuttle, Gould, & Hazel, 1975) and the Organizational Assessment Package (Hendrix & Halverson, 1979).

d. Customer survey. In TPM the rationale underlying the customer survey is that users of products or services are in the best position to judge their value. Questions in the survey should address aspects of the organization's effectiveness that are important to consumers and are under the organization's control, such as timeliness, accuracy, completeness, and courtesy. The survey also gathers background information on the respondent to assess the individual's knowledge of the organization, degree of contact with products and services, and other demographic data that would help identify the respondent's point of view (e.g., income status and education level).

e. Combining data sources. Once the data are gathered, there must be a plan of analysis in order to make sense out of the data. One way to organize the information is in terms of "End Results" and "Targets of Opportunity." End results focus on the accomplishments of the organization and targets of opportunity represent areas of needed improvement.

Comparisons provide a useful way to analyze and organize the TPM data. Specifically, it may be helpful to compare:

1. results for individual units with overall organization averages

2. employee attitudes with customer attitudes

3. employee attitudes in efficient and effective units with attitudes of employees in less efficient and effective units

4. managers and hourly workers (or officer and enlisted) perceptions

5. all groups over time

2. Critique. TPM provides a means for integrating performance measurement data into an overall productivity improvement effort. Using any one of the types of measurement alone runs the risk of providing an incomplete picture of the organization's performance. This approach provides data that are highly useful for managers in guiding their management practices to improve productivity. Since organization effectiveness can be viewed from at least three perspectives, management, employees, and the society at large, TPM provides a means of reflecting these multiple viewpoints. Having multiple data sources tends to improve the validity of the data for diagnostic purposes. Another major advantage is that the process encourages employee input to the measurement process which will not only lead to better measures, but will also make the results more acceptable to all members of the organization. This is a prerequisite for meaningful change.

   For TPM to be successful within an organization, the organization must be ready to commit the resources and to open itself up to in-depth scrutiny. The process is likely to stimulate resistance from managers who are uncomfortable with criticism. The process could require a considerable investment of resources. For example, the costs incurred by one TPM project implemented in a city totaled almost $80,000 (NCPQWL, 1978). Over half of these costs ($47,000) were in-kind costs. Furthermore, costs assume the existence of productivity data, and include not only measurement but also feedback and improvement planning.

   In many ways, TPM provides a "blueprint" for evaluating the impact of an organizational change effort. A comprehensive evaluation design should include the types of measurement data suggested by this procedure. When carefully developed and collected over time, the multiple measures can provide a valid and meaningful set of evaluation criteria.

Behavioral Economic Measurement

1. Description. While TPM represents a blending of behavioral science procedures and industrial engineering approaches, the behavioral economic measurement process is, as the name implies,

a blend of behavioral and cost accounting procedures. The approach involves developing a set of behavioral measures that can be converted to dollar values. Since Brogden and Taylor (1950) first proposed the "dollar criterion," behavioral scientists have been slow to adopt this approach. A more recent attempt which stimulated this behavioral-economic approach to evaluating quality of working life programs was described by Herrick (1975). Herrick identified ten aspects of counter productive labor activity that could be measured. These counter productive activites (CPAs) were as follows:

(a) absenteeism,

(b) accidents,

(c) tardiness,

(d) turnover,

(e) strike days lost,

(f) grievances,

(g) inventory shrinkage,

(h) machine repair,

(i) quality below standard, and

(j) production below standard.

In addition, Herrick proposed computational formulas and provided detailed examples of procedures to convert these CPA measures to dollar values.

Following Herrick's lead, Macy and Mirvis refined this list and developed a set of operational criteria that were applied to the evaluation of a quality of working life program (Macy and Mirvis, in press; Mirvis and Macy, 1976). These authors defined a standard set of behaviors that conform to three criteria:

(a) definable so that incidents that could be significantly affected by the work environment are distinguished from those unaffected.

(b) measurable and convertible to significant costs to the organization.

(c) categories of measures and costs of the behaviors are mutually exclusive.

Table 6 lists the behavioral definitions and the computational formulas for these indices. Each of the indices can be converted to dollar values by calculating from the organization's cost accounting system the cost per incident and multiplying this cost by the total number of incidents.

Table 6

Behavioral Definitions and Computational Formulas[a]

Behavioral Definitions	Computational Formulas
Absenteeism: Each absence or illness over 4 hours.	Absenteeism Rate: Number of Absence Days / Average Work-Force Size x Working Days
Tardiness: Each absence or illness under 4 hours	Tardiness Rate: Number of Tardiness Incidents / Average Work-Force Size x Working Days
Turnover: Each movement beyond organizational boundaries.	Turnover Rate: Number of Turnover Incidents / Average Work-Force Size
Internal Employment Stability: Each movement within organizational boundary.	Internal Stability Rate: Number of Internal Movement Incidents / Average Work-Force Size
Strikes and Work Stoppages: Each day lost due to strike or work stoppage.	Strike Rate: Number of Striking Workers x Number of Striking Days / Average Work-Force Size x Working Days
Accidents and Work Related Illness: Each recordable injury, illness or death from a work related accident or from exposure to the work environment.	Accident Rate: Number of Accidents and Illinesses x 200,000[b] / Total Yearly Hours Worked
Grievance: Written grievance in accordance with labor-management contract.	Grievance Rate: Plant: Number of Grievance Incidents / Average Work-Force Size. Individual: Number of Aggrieved Individuals / Average Work-Force Size

Table 6 (Con't)

Behavioral Definitions and Computational Formulas[a]

Behavioral Definitions	Computational Formulas[a]
Productivity:	Productivity:
Resources used in production of acceptable outputs (comparison of inputs with outputs).	Total:
	$\frac{\text{Output of Goods or Services (Units or \$)}}{\text{Direct and/or Indirect Labor (Units or \$)}}$
	Below Standard: Actual versus Engineered Standard
	Below Budget; Actual versus Budgeted Standard
	Variance: Actual versus Budgeted Variance
	Per Employee: Output/Average Work-Force Size
Production Quality:	Quality:
Resources used in production of unacceptable output.	Total:
	Scrap + Customer Returns + Rework - Recoveries ($, Units, or Hours)
	Below Standard: Actual versus Engineered Standard
	Below Budget: Actual versus Budgeted Standard
	Variance: Actual versus Budgeted Variance
	Per Employee: Total/Average Work-Force Size
Downtime:	Downtime:
Unscheduled breakdown of machinery.	Labor ($) + Repair Costs or Dollar Value of Replaced Equipment ($)
Inventory:	Inventory, Supply, and Material Usage:
Material and supply variance; Unscheduled resource utilization	Variance (Actual versus Standard Utilization [$])

[a]Adapted from Macy and Mirvis (1976)

[b]Base for 100 full-time equivalent workers (40 hours x 50 weeks).

2. <u>Critique</u>. Advantages of the behavioral economic approach are that it provides a standard set of criteria that are carefully defined, applicable across organizational settings, meaningful, and acceptable to managers. The approach yields measures that are expressed both in physical quantity terms and in dollar terms. For evaluation purposes, physical quantity measures are likely to be more useful. However, if organizational change occurs, dollar terms will help communicate the significance of the change to managers. Thus, the behavioral economic approach represents a major advance in techniques for assessing the impact of organizational change efforts.

The behavioral categories defined by Macy and Mirvis include indices that could be classified as both efficiency and effectiveness according to the definitions used in this review.

<u>Efficiency Indices</u>

productivity

inventory, supply, and material utilization

<u>Effectiveness Indices</u>

absenteeism

tardiness

turnover

internal stability rate

strike rate

accident rate

grievance rate

quality

downtime

From an evaluation point of view, the criteria have content validity in that they cover major behaviorally related dimensions of organizational performance.

The approach has some disadvantages. It does not include assessment of performance in relation to overall organizational goals in areas covered by the measures. This criticism is a bit unfair, in that the authors attempted to define general categories that were applicable to a wide range of organizations. For research purposes this is necessary. However, from the point of view of a manager who wishes to measure the performance of his or her organization, additional measures would be required. One example of an organizational specific criterion that is missing is an assessment of the impact of the organization on its external environment. Except for the turnover index, these indices look at the organization as separate from its environment.

There are also some disadvantages associated with converting behavioral indices to dollar values. Many of these have been discussed previously. The two main problems are correcting for the effects of inflation and establishing valid and meaningful costs per incident. This later problem is less a concern for productivity (efficiency) measures than for measures such as grievances, absenteeism and tardiness. Costing the effects of such behavioral variables requires use of human resource accounting principles. New recordkeeping systems may have to be developed to provide necessary cost data for such computations. Macy and Mirvis (in press) acknowledge these problems and provide a very detailed analysis of the procedures required to generate meaningful data. Nevertheless, establishment of the required accounting systems will entail additional costs to organizations. However, the costs should not be exorbitant or out of line with the benefits to be obtained.

While very appropriate for private sector organizations, some of the proposed criteria are not applicable to the Air Force environment, e.g., strikes and grievances, except in mostly civilian unionized settings. Other categories would have to be redefined for use in the military environment, for example, turnover could be redefined as reenlistment rate. Nevertheless, the philosophy underlying the behavioral economic approach is very applicable to military organizations. Appropriately modified, such an approach would be very useful for the evaluation of organizational change programs in Air Force organizations.

Production Foreman Performance Appraisal.

1. Description. In one of the Navy's major maintenance facilities employing civilian workers, a system was developed for appraising the performance of shop foremen. In effect, it is a system for measuring efficiency and effectiveness at the work group level.

The system design effort had three goals (Morgan, 1979):

(a) increase the objectivity of performance appraisals by utilizing the same automated management information system used for production planning and budgeting,

(b) include a range of factors specifically geared to cover the critical elements of a shop foreman's job, and

(c) encourage meaningful feedback and communication between foremen and their supervisors.

The system is comprised of 10 performance elements. Each element can be worth as much as 10 points; therefore, the highest score attainable is 100. Elements 1 to 5 are objective factors and the performance factor (worth 5 of the 10 points) comes directly from the automated maintenance data system. Thus, this portion of the rating is not subject to rater bias (leniency, halo, etc.). The rater, however, can modify the objective performance score by allocating up to 5 more points per element. This feature allows the supervisors to give credit to the individual whose objective score does not accurately describe performance due to factors beyond his or her control. Elements 6 to 10 are subjective factors rated by the supervisor on a scale of 1 to 10 points.

The 10 elements incorporated into the appraisal system are as follows:

Objective Measures

1. Direct performance (performance against labor standards)
2. Quality defects (conformance with shop quality goals)
3. Ready for issue index (conformance with standard)
4. Indirect budget performance (actual vs. projected)
5. Sick leave control (conformance with goal)

Subjective Measures

6. Schedules
7. Safety
8. Personnel Management
9. Personal Characteristics and Leadership
10. Equal Employment Opportunity Performance

During each appraisal period, supervisors review the performance of foremen for the previous period and establish specific measurable goals for elements 1 to 5 for the next reporting period.

2. Critique. This system illustrates the successful integration of efficiency and effectiveness measures in an operational measurement system. With respect to a work center, the criteria measured are comprehensive and mission oriented.

The system effectively combines objective measures generated by existing automated maintenance data systems with subjective ratings of important performance dimensions. The use of objective data avoids the problems of self-report measures and helps counteract rater bias, such as "inflation" of performance ratings. The correction factors applied to the objective measures allow evaluators to offset deficiencies in the objective measures. This, coupled with the fact that people being rated participated in its development, will likely cause foremen to view the system as fair and make it acceptable to them. Because it relies on existing data, the system is cost-effective.

Disadvantages of the system as a productivity measurement method are that it lacks measures of organzational impact and it fails to quantify some factors that could be quantified (safety, schedule compliance, aspects of personnel management, etc.). Despite these objections, the approach demonstrates quite well how efficiency and effectiveness can be integrated into an operational measurement system at the work group level. Some compromises are inevitable in such an operational system. This approach represents an excellent example of an integrated measurement method.

For evaluation purposes, the system is very useful. It yields an overall performance score, individual performance dimension scores, and corrected and uncorrected scores on the objective factors. It is not obvious which would provide the most useful criteria; however, this could be determined empirically. The system provides very useful data for evaluative purposes. Application of the method to Air Force organizations could be made where there is an employee-hour reporting system (e.g., maintenance).

Impact of Measurement on Productivity

Productivity measurement is sometimes viewed by managers as a passive process of recording the results produced by the organization. Certainly measurement does fulfill this purpose. Measurement also has a more active impact. What the organizaion measures is often viewed by employees as synonymous with what the organization views as important. Duerr (1974) describes an example of a productivity measurement system which encouraged managers to engage in counter-productive behavior. The company compared each of its 12 bottling plants monthly in terms of their operating efficiency defined as:

$$\text{Operating Efficiency} = \frac{\text{Number of Bottles Produced}}{\text{Minutes of Work Time Available} \times \text{Line Speed in Bottles per minute}}$$

Plant scores were posted monthly on each bottling line. Upon investigating, the researcher discovered that the system provided incentives for managers to keep improvement ideas hidden from managers in other plants, to keep inaccurate records of machine downtime, to "adjust" actual physical inventory values, and to incur costs in unmeasured performance areas to make the operating efficiency look good. Reliance on a single measure which was used as a basis for rank ordering plants clearly had counter productive effects (Duerr, 1974). Measurement in this organization coupled with unfortunate uses of measurement data led to increased costs rather than increased productivity.

Interviews with managers in the Air Force revealed examples similar to that described in the bottling factories. Consider the following illustration of the impact of measurement on the behavior of Air Force personnel which was supplied by a management analyst.

> We track many things. Take dental appointments by the military, for example. If the word gets out that our office is going to present to the commander data concerning missed dental appointments, "no-shows," I can show you on our charts that when we announce we are tracking this there will be a drastic decrease in "no shows." Everybody starts making their dental appointments. So they make their appointments for a while, then that chart will start edging up again. Then we hit the item again and it comes down. We select the items by those that are getting out of tolerance. But if Col. "X" hears we are going to track "no-shows," he lets his squadron commanders know, they let their sergeants know and all of a sudden everyone is showing up for dental appointments.

Frequently, productivity measurement relies on self-report measures. When there are incentives to "look good" on the measure, then self-reporting procedures have serious weaknesses. This was illustrated in the following comments by the manager of an accounting organization.

> When the criterion is the number of audit reports issued, what we get is a lot of short reports. When the criterion is the the number of findings, we get a lot of nit-picky findings. When we combine them and count the number of reports and the number of findings we get a lot of nit-picky reports.

The following quote illustrates how the indicators tracked by a management information system can subvert the purpose it was designed to accomplish.

> The program was carried to such extremes that it prevented the crew evaluation and training process. The objective of crew training was to fly an instrument landing system (ILS) approach. Under the Management Information System (MIS) the objective became that of flying more ILS approaches in a given amount of flying time. So people cut approaches short, used different

> procedures, used external radar to get to the "fix" rather than fly the instruments. They turned immediately after crossing the runway instead of flying the proper procedures for missed approach. People would come out with tremendous numbers of ILSs but were they productive in the sense of improving their ability? The decision that came through is that they were not.

This manager goes on to identify the crux of the issue regarding measurement and how measures are used.

> We quantify the quantifiable and you get what you reward don't you? In the case of the MIS we reward what we measure. You put all these numbers on a sheet and everybody starts focusing on the numbers which only tell part of the story.

The numbers only tell part of the story! This points out one of the most basic criticisms of productivity measurement as currently practiced in the Air Force. Reliance on one or two measures to assess the productivity of an organization leads to the types of unintended consequences reported above. Productivity measurement should be broadened to encompass the types of efficiency and effectiveness criteria discussed in this report. The next chapters describe a proposed methodology for developing such a set of measures for use in Air Force organizations.

V. CONCLUSIONS AND IMPLICATIONS FOR AIR FORCE PRODUCTIVITY MEASUREMENT

As stated in Chapter I, the objectives of this report were to clarify the meaning of productivity as it applies to Air Force organizations, to assess existing productivity measurement methods, and to develop a methodology for generating Air Force productivity criteria. Chapters II through IV focused on the first two objectives. This chapter summarizes the major conclusions emerging from the preceding discussion which have implications for the third project objective, development of a productivity measurement methodology for use in Air Force organizations.

Conclusions From Previous Research

Based on material reviewed in the preceding chapters, six points were found to be important in guiding the development of a productivity measurement methodology for use in Air Force organizations.

1. The definition of productivity for Air Force organizations should incorporate the concepts of both efficiency and effectiveness (Balk, 1975; Coulter, 1979; Engle, 1979; Letzkus, 1973; National Center for Productivity and Quality of Working Life, 1977). Productivity measurement programs that monitor only efficiency may lead to the conclusion that improvements are being made when, in fact, efficiency improvements are being made at the expense of effectiveness as measured by indicators of quality, safety, customer satisfaction, or future performance capability. On the other hand, programs that monitor only effectiveness may fail to consider costs associated with achieving the desired levels of effectiveness, and therefore may contribute to inefficient use of resources.

2. An organizational productivity measurement scheme should include multiple measures of both efficiency and effectiveness (Herrick, 1975; Macy & Mirvis, 1976; National Center for Productivity and Quality of Working Life, 1977). Organizations have multiple goals and mission statements have many facets. Therefore, assessments of organizational efficiency and effectiveness must be multidimensional to assure that these multiple facets are covered.

   Since measurement can affect performance, failure to measure a critical aspect of mission accomplishment may be a signal to organizational members to divert time, attention, and resources to those mission areas that are measured in an effort to "look good."

   As a guide to developing a comprehensive set of measures, the criterion categories listed in Table 7 may provide a useful point of departure .

Table 7

Criterion Categories to Consider in Developing a Set of Productivity Measures for an Air Force Organization

Criterion Category	Potential Measures
Efficiency	Output A (expressed in physical units) / Inputs used to produce Output A (expressed in constant dollars) (Repeat for key outputs B, C, D, etc., and compare with previous period, budget, or goals).
Effectiveness	
Quality of Performance	Number of errors, amount of rework, amount of scrap, number of rejects or returned items, etc., compared to budgets, standards, or goals. (May be done for each product or service.)
Timeliness	Response time, processing time, schedule reliability, etc., compared to standards or goals.
Performance Impact on Customers	Effects (positive or negative) on the user organizations's mission performance, customer complaints, responsiveness to complaints, customer attitudes, etc., compared to previous period or goal.
Performance Impact on the Organization Members	Morale, training quality, safety maintenance and availability of tools and equipment, health status, disciplinary actions, etc.

3. A set of efficiency and effectiveness measures should have as many as possible of the following characteristics (Hurst, 1980; Joint Financial Management Improvement Program, 1977; Kearney, A. T., Inc., 1978):

a. Completeness. The set of measures should comprehensively cover the significant facets of the organization's mission and the resources expended in mission-related activities.

b. Comparability. Measures should be comparable from one time period to another. To make meaningful longitudinal comparisons of productivity for organizational units, the measures should remain applicable through time. In general, it is not cost-effective to include measures of non-recurring workloads or functions in a productivity measurement system that will be used to track an organization's productivity over time.

c. Input coverage. Outputs used in the efficiency measures should comprehensively cover the relevant inputs used by organization. For example, if labor is the primary input, the output measures should comprehensively cover the results obtained from all employee hours worked. To the extent that mission-related transformations of input are not reflected in the output measures, efficiency will be understated. On the other hand, output measures should not reflect transformations of input that are not mission related.

d. Compatability with existing data sources. In general, measures should be generated which make use of existing data sources rather than require collection of new data. This is true because it reduces the cost of measurement and increases the likelihood that measures will be implemented.

e. Cost-effectiveness. The benefits derived from a set of measures must exceed the costs associated with collecting the data and preparing management productivity reports.

f. Consistent across organizations. To be useful for research, measures must be consistent across organizations. While measures may vary across organizations performing different functions, the most useful set would be relatively invariant across organizations performing the same functions.

g. Acceptable to organization members. Managers and members of the organization whose work output is being measured must accept the measures as being fair and useful. Acceptance of the productivity measures is increased if individuals whose work is being measured and managers who will use the measurement data participate in its development.

4. Individual measures in a set of productivity measures are most useful if they possess the following features (Hurst, 1980; Joint Financial Management Improvement Program, 1977; Kearney, A. T., Inc., 1978):

a. Validity. Individual measures should accurately reflect changes in the mission-related aspect of efficiency or effectiveness being measured. Valid measures are relatively free of measurement biases such as omission of pertinent elements of performance (deficiency), including extraneous informaton unrelated to productivity (contamination) or combining non-equivalent elements in constructing input or output values (distortion).

b. Uniqueness. The measure should account for some aspect of productivity that is important to the organization and not measured by any other indicator in the measurement set.

c. Understandability. The relationship between the level of performance and the measure should be understood both by managers who will use the data as well as the organizational members whose work outputs are being measured.

d. Controllability. Members of the organization being measured should be able to influence the organizational output being measured. Individuals should not be assessed and held accountable for results that are outside their control.

e. Reliablity. Repeated reapplication of the indicator to the same level of organization performance should produce the same measurement or score. Measures should also be based on accurate and reliable source data.

5. For most Air Force applications, Form III efficiency measures which employ outputs expressed in physical units and inputs expressed as dollar costs are most useful (Felsinger, 1976). Forms of the efficiency ratio that make use of dollar values of output are generally not applicable to Air Force organizations because of the difficulty of establishing the "market value" of outputs. Dollar costs of inputs however, can usually be obtained and will provide a common denominator for use in aggregating inputs. This facilitates the use of total factor productivity ratios as opposed to less meaningful partial measures.

6. Efficiency and effectiveness measures should be developed for the key facets of mission performance (Duerr, 1974; Mollenhoff, 1977). For any organization, there is virtually an unlimited number of possible productivity measures, but the number of measures developed should be kept to a manageable number. This requires the establishment of priorities among the various facets of performance and the development of measures only for the areas judged to be key results areas.

7. Measurement activities in Air Force organizations should make use of a measurement coordinator (National Center for Productivity and Quality of Working Life, 1978). Experience

with the Total Performance Management process suggests that the development of a productivity measurement program is most effective when a measurement coordinator is involved. In the Air Force, such an individual may come from a staff or support organization. The role of the coordinator is to organize the process, insure its technical soundness and to be the catalyst who assures that the process is completed. Ideally, the coordinator will have had experience in working as a group facilitator or trainer and have knowledge of measurement procedures in either industrial engineering or behavioral science. Where the coordinator lacks this expertise, access to individuals with these skills and knowledge should be arranged.

Implications for Methodology Development

Implications for developing a productivity measurement methodology for use in Air Force organizations may be derived directly from the conclusions in the previous section. Five implications seem particularly relevant. Figure 6 depicts the relationship between the conclusions presented earlier and the five implications for methodology development.

Item Identification of Conclusions Which Lead to the Implication	Implications
4 c, d	1. Employees should participate in the measurement process
6	2. Management should decide what facets of performance will be measured.
3 d, e	3. Existing data should be used.
1, 2, 3, 4, 5, 6, 7	4. A measurement coordinator is needed.
1, 2, 3, f	5. The methodology must generate criteria which are useful for research purposes.

Figure 6. Process of Deriving Implications from Conclusions

1. Employees should participate in the measurement process. The measurement process may impact efficiency and effectiveness positively or negatively (Duerr, 1974). If measures are perceived by organizational members as being unfair or inaccurate, and if they are used in negative rather than positive ways, then they may adversely affect organizational productivity. However, if measures are viewed as fair and reasonable and are used to provide meaningful feedback to members, then they

will likely have a positive impact on productivity. Therefore, to help insure that the impact of the measurement process on performance will be positive, individuals being measured should have an opportunity to participate in the process of developing the measures. Participation can be expected to improve worker acceptance of the resulting measurement process, take advantage of the worker's detailed knowledge of the work process, and therefore enhance the quality of measures and the productivity of the organization (Adam, Hershauer and Ruch, 1978; Balk, 1975; Taylor, 1979).

2. Management should decide which facets of performance will be measured. There are many possible indicators of efficiency and effectiveness. A methodology to generate productivity criteria should attempt to restrict the set of measures developed to those that are most important for organizational decision making. Management of an Air Force organization is responsible for establishing priorities and for judging the extent to which activities contribute to mission accomplishment (AFM 25-1, 1964). Therefore, the selected methodology should provide management with the opportunity to determine which aspects of organizational efficiency and effectiveness are to be measured.

3. Use existing data if possible. Any effort to measure productivity in an Air Force organization should make use of existing data and information systems rather than require the collection of new data (Air Force Worldwide Productivity Conference, 1978). This implication takes into account the fact that new data collection is expensive and should only be carried out when the value of the data is sufficient to justify the cost. This principle, however, should not be allowed to divert the process away from potentially important key results areas simply because of a lack of data. On the other hand, the measurement process should not allow existing data to lead to the inclusion of trivial or misleading measures.

4. Measurement coordinator needed. The measurement methodology should be designed on the assumption that a measurement coordinator will direct its implementation. The coordinator should "steer" the measurement process sufficiently to insure that the measures defined are consistent with the criteria of technical adequacy discussed previously in conclusions number 3 and 4. As a result of this responsibility, the coordinator should have an understanding of the strengths and weaknesses of the productivity measurement approaches discussed in Chapter IV.

5. Methodology must generate research criteria. The implications have, to this point, focused on the need for developing a methodology which will yield productivity criteria which can be used for a single organization. In addition

to this need, the methodology must generate criteria which are suitable for research in multiple organizations that perform similar work. Generalizable criteria are necessary to assess the effects of organizational change programs on productivity using cross-sectional, as opposed to longitudinal research designs. Developing such criteria is a major goal of the present research and of the methodology described in Chapter VI.

VI. METHODOLOGY FOR GENERATING PRODUCTIVITY INDICATORS

Based on the preceding review of productivity measurement and improvement techniques, this chapter describes a new approach for generating productivity indicators in an Air Force organization. The methodology is intended to be sufficiently general to be applicable to any functional area and to any organizational level, including sections, branches, squadrons, or wings. The proposed procedures represent a synthesis of previous research (e.g., Adam, Hershauer, & Ruch, 1978; Balk, 1975; Mollenhoff, 1977; Ohio State Productivity Research Group, 1977). In tailoring the approach to the Air Force environment, modifications in previously developed methodologies were required. In particular, these modifications involved derivation of key results areas (KRA's) from mission statements, formation of groups, sequencing of group activities to involve commanders at critical stages of the process, and, developing procedures for generalizing indicators across organizations.

Overview of the Measurement Procedure

The methodology has five phases: Background, Definition of Key Results Areas (KRAs), Definition of Indicators and Data Sources, Generalization of Indicators, and Implementation.

1. Background. The background phase involves the initial decision to measure productivity in a particular organization, selection and orientation of measurement coordinators, familiarization of coordinators with the organization to be measured, and development of a description or "model" of the target organization in systems terms.

2. Definition of Key Results Areas (KRAs). In this phase, a group including the top two levels of management of the target organization (Group A) is convened. The process involves a consideration of the mission of the organization and uses structured group procedures to break the mission into categories that describe the organization's principal intended accomplishments. These categories are called key results areas (KRAs).

3. Definition of Indicators and Data Sources. This phase involves convening a group of individuals who are drawn from the second level of management and their immediate subordinates (Group B). Using a structured group process similar to that used in Phase 2, Definition of Key Results Areas, this group is asked to generate and prioritize specific indicators for each of the key results areas developed above. In addition, Group B is asked to suggest additional key results areas if they feel that important areas were omitted by Group A. Indicators will also be generated for any new KRA's recommended by Group B.

Once these indicators are developed, a third group (Group C) is formed by drawing members from both Group A and B. In a discussion mode, Group C reviews the products generated by Groups A and B, and redefines any items needing clarification or additional definition. Once satisfied with the definitions of key results areas and the specific indicators, Group C identifies existing sources of data for each indicator. Indicators for which no data is currently available are identified and procedures are proposed for obtaining the required data. At the end of Phase 3, a set of indicators will have been defined along with the sources of data required to implement the measurement process.

4. Generalization of Indicators (Optional Phase). If the indicators are to be used only within the organization involved in generating them, Phase 4 is not required. However, if the methodology is to be used to develop a common set of productivity indicators for use across organizations within a functional area, then Phase 4 is required. The purpose of this phase is to develop generalizable criteria that can be applied to multiple organizations. This phase would be required in developing research criteria applicable to a number of similar organizations. Stated in the most simple terms, Phase 4 involves repeating abbreviated versions of Phase 1 to 3 with organizations B, C, D, etc., until a recurring set of indicators is obtained which can be consistently applied across the organizations.

5. Implementation. Once the indicators have been developed, Phase 5 involves actual measurement of the productivity of the target organization(s). Implementation strategies will differ considerably from organization to organization and any detailed discussion of a particular implementation is beyond the scope of this report.

Description of the Measurement Procedure

This section will describe each of the major steps in the procedure for generating productivity criteria. The discussion will be organized according to the previously described phases of the methodology. If the purpose of measurement is to develop productivity indicators for a single organization, then the process should begin with Phase 1. However, if the purpose is to develop generalizable indicators for research purposes, then one should start the process with Phase 4.

Phase 1. Background Phase

1.1 Decision to measure productivity. The procedure starts with a decision to measure the productivity of an organization. The initial purpose for measurement has implications for the procedures followed and for the outcome. There are many reasons why productivity measurement may be undertaken. For example a unit commander may be having problems and desires to call in an "outside" consultant (e.g., Base Management Engineering Team or a consulting team from the Leadership and Management Development Center at Maxwell AFB) to help the organization improve its performance. As a part of this process, either the manager or the "consultant" may decide that productivity indicators should be developed prior to the intervention to determine if the organizational change program "works" and has no unintended negative side effects.

The Air Force productivity program also acts as a stimulus to local commanders to initiate productivity improvement efforts. Under this program, organizations are asked to report productivity indicators to higher headquarters. As a part of his or her productivity plan, a commander may decide to develop a comprehensive set of indicators that will have utility for managing the organization, for planning and budgeting and for satisfying the requirements of the plan. Finally, an Air Force laboratory conducting research on productivity enhancement efforts may use the methodology for generating criteria for assessing the impact of organizational change programs on productivity. These are just a few of the reasons for initiating the measurement procedures described.

1.2 Select measurement coordinators. In order for the procedures to be adequately followed, it is necessary to select at least one, (preferably two) measurement coordinators. The use of two coordinators helps guard against the introduction of bias and is most effective for conducting the group process procedures. Coordinators selected should not be members of the target organization or in its regular chain of command. They should have good verbal skills, some experience in group facilitation, and some familiarity with the basic concepts of productivity and productivity measurement. The preceding chapters of this report would provide coordinators a reasonable introduction to the subjects of productivity and productivity measurement.

1.3 Familiarization with the organization. Once selected, the measurement coordinators should familiarize themselves with the organization under study. This familiarization process might begin with a meeting between the coordinators and key members of the target organization and its parent unit. In this initial meeting, coordinators should be introduced to members of the organization, and the purpose of the measurement program should be discussed.

Following this initial meeting, it is helpful for the coordinators to spend some time with the commander of the parent unit of the target organization. This session can shed considerable light on the unit's history, current status, mission, and organizational structure and provide coordinators an overview of the target organization's role in its larger organizational context.

During this visit to the organization, coordinators should obtain relevant documentation describing the mission, organization, manning posture, types of work performed, and the types of management analysis data currently being collected. At this stage of the process coordinators should try to avoid immersion in detail. Instead, they should focus on the organization as a system. In so doing, they should attempt to determine significant inputs and outputs, as well as other significant organizations in the target organization's environment.

1.4 Define organizational boundaries. In the Air Force, boundaries between organizational units are usually quite clear. However, if the specific boundaries of the target organization are unclear, the coordinators should define explicitly what is within the scope of the measurement effort and what is outside that scope. For example, if the target organizaton is a wing-level organization which also operates a base, then decisions have to be made as to whether tenant units on the base that are not part of the wing organization are to be included. Some of the issues to be resolved include the following:

a. What personnel are considered within the organization (e.g., reservists, civilians, uniformed military)?

b. Where do customer interfaces occur?

c. What is the nature of the service demands, timing and location?

d. Are people on detail to be included?

e. What levels of management and what functional groups are to be included?

f. What physical plant and resources are to be included?

g. With what other organizational units does the target organization interface?

1.5 Construct organizational diagram. To conclude Phase 1, and to provide input for the group procedures in Phase 2, the coordinators should construct a systems diagram of the target organization. This diagram should depict major elements pertaining to the organization's structure and manning posture. It should depict the overall flow of work and show major inputs, outputs, and significant interrelationships with other organizations.

Phase 2. Definition of Key Results Areas

2.1 Form management Group A. Phase 2 begins with the coordinators identifying individuals to serve as members of Group A. Since the major function of this group is to identify the key results areas for the target organization, its members should be in a position to make knowledgeable determinations of this sort. Generally, Group A will consist of members of the target organization's management and working supervision and representatives of the parent organization. For a guide to determining membership of Group A, see Figure 7 .

Figure 7 lists the steps in sequential order that should be followed in forming Groups A, B, and C. Steps 1 to 4 place the target organization in the context of its organizational hierarchy. Once Step 4 has been accomplished, forming groups as described in Step 6 is straightforward. As pointed out in Step 7, when dealing with an organization at the bottom of the organizational hierarchy, Groups A and B will be the same group. In organizations that provide services to the public, it may also be helpful to include representatives from customer groups or organizations.

The principal concern in forming Group A should be to include policy and decision makers who have knowledge of all facets of the organization's performance. The optimum group size should be 6 to 12 participants.

2.2 Orient Group A. Once the group members are selected, coordinators should announce a group meeting following the appropriate communication channels. The orientation has several purposes. It should attempt to gain the support of the members for the activity, it should inform members of the benefits of measurement for the organization and for the Air Force, and it should acquaint them with fundamentals of efficiency and effectiveness measurement and the approach to be followed. In effect, this session should attempt to sell participants on the approach in order to obtain their enthusiastic participation, and it should guide them toward the goal of identifying key results areas.

2.3. Generation of Key Results Areas (KRAs) - The concept of "key results areas," or KRA, borrows from Mollenhoff (1977). In his conception, KRAs are the results that individuals in an organization are paid to achieve. This same concept might be called organizatonal objectives by others. In an Air Force organization, KRAs represent a way to break the unit's mission statement into operational parts that are amenable to measurement.

The process of generating KRAs makes use of a structured group process called the nominal group technique (Delbecq, Van de Ven, & Gustafson, 1975). The process has the following steps:

Steps	Example
1. Identify target organization	Squadron
2. Identify next highest level organization	Wing
3. Identify next two levels below target organization. The level below the lowest organizational level with a supervisor would be called "organizational members."	Branch and Section
4. List these in hierarchical order	1. Wing 2. Squadron[a] 3. Branches 4. Sections
5. If the next level below the target organization is "organizational members", go to Step 7	
6. If three organizational levels can be identified then determine groups as follows: a. Group A consists of representatives of levels 1, 2 and 3 b. Group B consists of representatives of levels 3 and 4 c. Group C consists of selected individuals from Groups A and B	<u>Group A</u> 1. Wing 2. Squadron[a] 3. Branches <u>Group B</u> 3. Branches 4. Sections
7. If only three levels can be defined then Groups A and B are the same group.	<u>Groups A & B</u> 1. Branch 2. Section[a] 3. Members

Figure 7. Guide to Determining Group Membership

[a]Denotes target organization for measurement procedure

2.3.1. Silent generation. Members are asked to independently list on a sheet of paper the KRAs for the organization. Coordinators might make this process clearer by asking individuals to write their answers to the question "What results are the members of this organization paid to achieve." Allow 5 to 10 minutes for the listing.

2.3.2. Round-robin listing. Once sufficient time has been allowed and each member is ready to proceed, coordinators will proceed around the group in round-robin fashion asking members to share one of their KRAs. This process is repeated until all members have exhausted their lists. Items suggested by members are listed on flip charts by the coordinators without comment or without discussion by other members of the group.

2.3.3. Clarification. Following the listing, group members are given time to review the list and to ask questions of other members in order to clarify the meaning of particular items. In this discussion phase, it is common for members to suggest combinations of items, groupings of two or more under a single heading, and other revisions. The coordinators' role is to steer the discussion, to keep it focused on the task, and to urge resolution of questions concerning the meaning of items. When group members are satisfied with the meaning of each of the item, and when redundant or overlapping items have been combined or eliminated, the procedure continues to the next step.

2.3.4. Vote 1. Members are then asked to select the items from the list which they feel are the most important KRAs for the unit. The number selected is arbitrary and depends on the number of items listed by the group. Generally, having the group list 5 to 8 items is satisfactory. Members are then provided with index cards. Assuming that they are asked to select the top 5 items, they are asked to write these five on index cards, one to a card. The cards are then sorted in priority order. Weights are assigned to items by members as follows. The most important item is given a "5", next most important a "4", and so on. Each member's set of five cards is then collected by the coordinators.

2.3.5. Tally results of vote 1. At this stage of the process, members are given a break, and coordinators tally the results of the voting. The total number of points received by each item and the voting results for each item is displayed on the flip charts by the coordinators.

2.3.6. Review vote 1 results. Members then return from the break and are asked to review the voting results. Where voting patterns are inconsistent, for example in a 12 member group an item may receive six 5's and six no votes (i.e. the item was not selected as one of the top 5 by 6 members). This indicates either an ambiguous item or a major discrepancy between members regarding the importance of a KRA. Coordinators should question members to determine the reasons for such inconsistent voting and then lead the group to resolve the problem. If the item is unclear and subject to misinterpretation, then it should be revised. If there is a legitimate disagreement among members regarding an item's importance, then some discussion should be allowed. In this case, the role of the coordinators is to insure that this process is one of clarification of the issues and not the exercise of social pressure. Discussion should be allowed to continue until all points of view are heard, although disagreements may remain at this stage.

2.3.7. Vote 2. This step involves a repeat of the voting process in 2.3.4.

2.3.8. Tally results of vote 2. Following voting, the coordinators tally the results and display them on the flip charts in front of the group as feedback. Ideally, members will remain while the votes are being tallied in order to receive immediate feedback. This completes the nominal group process for Group A. Past experience shows that the total time required for this procedure is 3 to 4 hours.

2.4 Develop chart listing and describing Key Results Areas. To conclude the second phase of the methodology, coordinators will summarize the Group A activity on a chart which depicts and defines the KRAs. The chart also lists KRAs in priority order showing the numerical score received by each during the final voting. This chart constitutes input into Phase 3.

Phase 3. Definition of Productivity Indices and Measurement Methods

3.1 Form Group B. Group B is composed of individuals from two organizational levels below the target organization. For example, if the target organization is at the squadron level, Group B will include individuals from the branch level (who were also in Group A) as well as individuals from the section or work center level. See Figure 7 for an illustration of this procedure.

3.2 Orient Group B. As was the case with Group A, Group B should be briefed on the purposes of the measurement effort, the process followed so far, the results of Group A's work, and the importance of input from organizational levels below the level of the target organization level. In addition, the briefing to Group B should provide an introduction to productivity measurement, drawing on some specific examples to illustrate the concepts of efficiency and effectiveness. This productivity measurement briefing is intended to structure the group activity and to steer it toward the goal of defining acceptable indicators for KRAs.

3.3 Generate productivity indices for key results areas - At the beginning of the structured group process, time should be devoted to a discussion of the KRA development process completed by Group A. Since Group B includes some members who were also in Group A, one of these individuals could be asked to present this briefing. The ground rule to follow in the event that Group B does not accept the listing developed by Group A is that Group B can add additional KRAs. However, it cannot delete any KRA's suggested by Group A. Once a set of KRAs has been agreed upon, the procedure moves to the next step.

3.3.1. Silent generation. To begin the nominal group process, the coordinator should select one of the KRAs that will be relatively easy to measure. Members of Group B should then be asked to write on an index card the indicators which they feel best measure the KRA.

3.3.2. Round-robin listing. In round robin fashion, the coordinator asks members to share one of their indicators. This process continues until each member has been asked for input. The process is then repeated until all indicators listed by members have been shared and have been recorded by the coordinators on flip charts.

3.3.3. Clarification. Time is then allowed for questions and clarification. Based on this discussion, indicators may be modified or, with the consent of the original presenter, combined with another item, or deleted. This step ends when the indicators proposed by all group members are understood by the total group.

3.3.4. Vote 1. Members are then asked to vote for the indicators they feel provide the best measure of the KRA. In deciding how to vote, members are asked to select the indicator that should be used if there could be only one indicator for the KRA. Then they select the next best and so on until the appropriate number to be ranked is completed. The coordinator determines how many indicators each participant should be asked to rank order using the following rule of thumb. If there are five or more, then half should be rank ordered. For example, if the group lists seven indicators for a KRA, then each member should be asked to vote for 4. Members vote by listing the indicator on an index card and assigning a weight. The "best" indicator gets a weight equal to the number of items voted on. The next best gets a vote of 1 less and so on.

3.3.5. Voting and tallying. Members are then instructed to go to the next KRA and list indicators. While they are listing indicators, the coordinators are tallying the votes for KRA #1. Once members have listed indicators for a KRA, steps 3.3.2 - 3.3.4 are repeated. This process continues until indicators have been developed for all KRAs. Based on experience with this process, 2 sessions of 2 to 2½ hours each will be required. These sessions should be held on consecutive days if possible to maintain the continuity of the process.

3.4 Develop chart listing Key Results Areas and indicators - Using the results of Group B's activity, coordinators should construct a chart depicting the indicators proposed to measure each KRA.

3.5 Refine indicators and develop data sources. The next stage of the process involves reviewing the indicators and defining the required sources of data. The information is derived from Group C which is comprised of selected members of Groups A and B supplemented by individuals who are familiar with existing data sources. The coordinators will moderate Group C's activities which will follow a discussion mode. The chart prepared in 3.4 is the primary input to the process. The coordinators explain that the purpose of this session is to review the KRA's and indicators, to resolve remaining discrepancies between Groups A and B, to refine the indicators and to identify sources of data for the indicators. While availability of data has not been a significant concern up to this point, questions of cost effectiveness of data gathering are important considerations for Group C. For example, it is expected that if two indicators have been ranked about equal in value, the one which involves the lowest data collection cost will be selected. Tradeoffs between the value of an indicator and its cost for data collection will be weighed carefully as Group C reviews the porposed indicators. In general, Group C will attempt to select the indicators for which data is already being gathered, either by the unit itself or by a parent organization. When new data gathering is necessary, the group will develop a justification in light of the alternatives available (e.g., substituting a less desirable but acceptable measure for which data are available versus keeping logs to generate new data). Only when clearly justified, should new data be gathered. If new data are required, the group will recommend procedures to collect it.

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3.6 Develop chart of KRA's, indicators and data sources. The chart developed in 3.4 will be revised to reflect the discussion by Group C.

3.7 Briefing of recommendations to target and parent unit commanders. Since acceptance of the recommendations by commanders is necessary, briefings of the results are required. The briefings will be conducted by members of Group C and the measurement coordinators. Normally, the target unit commander will be a part of Group C. If so, the briefing need only be scheduled for the parent unit(s) as appropriate.

Phase 4. Generalization to Other Units (Optional)

For some measurement purposes, it will be necessary to have a set of indicators which can be applied across similar organizations. These kinds of indicators will be useful for research projects. Such measures are also necessary to productivity improvement efforts which generate comparative feedback to commanders regarding where their organization's productivity stands relative to other similar branches, squadrons, etc.

The procedures for developing generalizable indicators are described below.

4.1 Develop measurement plan. Prior to developing indicators as described in Phases 1 to 3, it is necessary to develop a measurement plan. Development of such a plan requires interaction with different headquarters depending on the scope of the effort. The purpose of the contacts is to obtain clearance, cooperation, and information regarding potential target organizations to serve as measurement locations. To facilitate this process Air Force Functional Account Codes for the organizations might be used to identify the population of organizations.

4.2 Select sample measurement locations. From the population of organizations identified by Functional Account Codes, a sample will be chosen to serve as actual measurement locations. Table 8 provides guidelines for determining the size of this sample. If all work centers fall within the same MAJCOM, then simple random sampling can be used to select work centers. If multiple commands are involved, the number of work centers randomly selected from a given MAJCOM should bear the same percentage relationship to the total sample size as the number of work centers in the given MAJCOM bears to the total number of work centers in the Air Force.

Table 8

Guidelines for Selecting Size of Measurement Sample[a]

If the total number of work center locations is:	then the minimum number to be measured will be:
1-3	all
4-7	4
8-13	5
14-20	6
21-30	7
31-44	8
45-65	9
66-100	10
101-more	10% of total

[a]From AFR 25-5 Vol. II, November 4, 1977, Table 3-3.

4.3 Develop plan for field work. Once the sample is developed, a plan should be developed that will outline the approach to obtaining cooperation, the schedule for field visits and the procedures to be followed within each measurement location. The plan should also indicate the necessary support requirements required from participating organizations.

4.4 Obtain clearance from appropriate headquarters. Once the plan has been developed, it should be submitted or briefed to the appropriate headquarters (AF or MAJCOM) for approval.

4.5 Finalize plans for field visits to measurement locations. With approval of the plan, Headquarters will designate a point of contact for each measurement location and the Headquarters. Working jointly with individuals at both contact points, a final schedule of visits should be established.

4.6 Implementation of the methodology.

4.6.1. Measurement location 1. At measurement location 1 the full procedure would be implemented as described for Phases 1 to 3 above. The result would be the chart described in section 3.6.

4.6.2. Measurement location 2. Procedures carried out at measurement location 2 would be designed to confirm or expand the results from measurement location 1. In addition, any KRAs and indicators which should be added for organization 2 but were not generated for location 1 would be added. Generally, this would be accomplished in an abbreviated application of the methodology. Groups A and B would be formed as previously described, however, unless new KRAs or indicators are added, the nominal group procedures would not be utilized.

During the orientation processes for Groups A and B, each would be given the results from the comparable group obtained in organization 1. Each group would be asked to review the list of KRAs (Group A) and indicators (Group B) obtained from location 1 and indicate whether they are relevant for organization 2. Next, if Group A in the second organization adds KRAs, then Group B would be asked to generate indicators for the added KRAs. The nominal group procedures would be used in this case to generate new KRAs and indicators.

Group C would be convened to consider the resulting KRAs and indicators developed from location 2. This discussion would be conducted as discussed in paragraph 3.5.

4.6.3. Remaining measurement locations. The abbreviated methodology would be repeated at all remaining locations. The additional KRAs and indicators as well as variations in data sources, would be carefully noted for each new location.

4.6.4. Develop common set of KRAs. indicators, and data sources. Following visits to all measurement locations in the sample, the measurement coordinators will reconcile the differences and define a set of common KRAs and indicators which are consistent and meaningful across all measurement locations in the sample. This resulting product would be submitted to participating organizations for review and comment.

4.6.5. Develop summary chart. Measurement coordinators will develop a chart summarizing this resulting common set of KRAs and productivity indicators. They will also note the data sources and any variations among measurement locations that must be taken into consideration.

Phase 5. Implementation

Once the final set of KRAs and indicators are established either for a single organization by applying Phases 1 to 3, or for multiple organizations by applying Phases 1 to 4, the next step is to implement the measurement process. The implementation phase consists of collecting the necessary data to compute the productivity indicators within each KRA. The implementation phase will vary as a function of the purposes for which measurement is undertaken and characteristics of the organizations involved. Therefore, a detailed description of a field implementation of the methodology is beyond the scope of the present report.

VII. APPLICATION OF THE METHODOLOGY: AN EXAMPLE

This section describes a field demonstration of the productivity measurement methodology conducted in an Air Force maintenance organization. The purposes were to demonstrate the feasibility of the approach in an Air Force environment and to illustrate the nature of the results which might be obtained by applying the methodology to an Air Force organization. Since only a single organization was involved in the demonstration, Phase 4 of the methodology, which describes how the criteria can be generalized across organizational settings, was not utilized. Description of the example will follow the phases and steps used to describe the methodology in the preceeding section. Because this was a simulation, it did not make use of all steps in the methodology described in the preceeding chapter.

Phase 1. Background

1.1 Decision to measure productivity

For the purpose of the illustration, the reason for measuring productivity was assumed to be the development of baseline measurement indices for the target organization that could be used to assess the impact of a hypothetical organizatonal change program. To obtain access to an organization to serve as the demonstration site, contact was made with the appropriate MAJCOM headquarters through written correspondence with the Command productivity principal. Following this discussion, a squadron level organization was selected with the understanding that the measurement coordinator, in conjunction with the squadron commander, would select a branch to be the target organization.

In an operational situation, the decision to measure productivity would normally be made by the unit commander. This decision might be motivated by a desire to improve the unit's performance or to comply with a directive from higher headquarters (e.g., compliance with MAJCOM or Air Force productivity plan).

1.2. Select Measurement Coordinator

The author served as the measurement coordinator for this field demonstration.

1.3. Familiarization with the Organization

The process of organizational familiarization started with an orientation meeting between the measurement coordinator and the base productivity principal. Next, a meeting was held with the wing maintenance officer, the squadron commander, officers and non-commissioned officers (NCOs) from the squadron headquarters, and representatives of each work center. The target squadron was an avionics maintenance squadron. In This initial meeting, the measurement coordinator explained the purpose of the measurement effort and the general procedures to be followed. Time was allowed for squadron representatives to raise questions about the process.

This introductory meeting was followed with a short meeting with the squadron commander in which the methodology was discussed in more detail. In turn, the squadron commander provided an overview of the squadron organization and mission. Based on criteria established by the measurement coordinator, the Communications/Navigation branch was selected as the target branch. This meeting concluded with the squadron commander conducting a brief tour of the squadron's activities, and helped the measurement coordinator visualize the organization and operation of the squadron. Having the squadron commander introduce the coordinator to squadron members also paved the way for the excellent cooperation received. Finally, the squadron commander provided a document which described the major subfunctions within the squadron.

Background discussions were also held with the squadron maintenance officer who provided copies of the "Maintenance Digest," a monthly report of the deputy chief of staff maintenance. This document lists maintenance indicators that are routinely tracked at the wing level. Also provided was a document summarizing the results of recent quality control inspections which listed the number and type of deficiencies found for each work center.

The final orientation interview was conducted with the branch Officer in Charge (OIC) to obtain information concerning the organization of the branch. This discussion focused on the mission, inputs and outputs and other organizations that the branch must come into contact with.

A similar process would be followed in an operational application of the methodology.

1.4. Define Organizational Boundaries

Since the Communications/Navigation Branch is a clearly defined organizational entity, the boundaries are quite clear. Included in the branch organization are the NCOIC, the OIC, and three work centers. Individuals who were assigned to the branch but who were on detail were not considered, for measurement purposes, to be a part of the branch.

1.5. Construct Organizational Diagram

Based on the information obtained in 1.3 and 1.4, the diagram shown in Figure 8 was prepared.

Phase 2. Definition of Key Results Areas

2.1 Form Management Group - Group A

In this illustration, the Management Group consisted of the following:

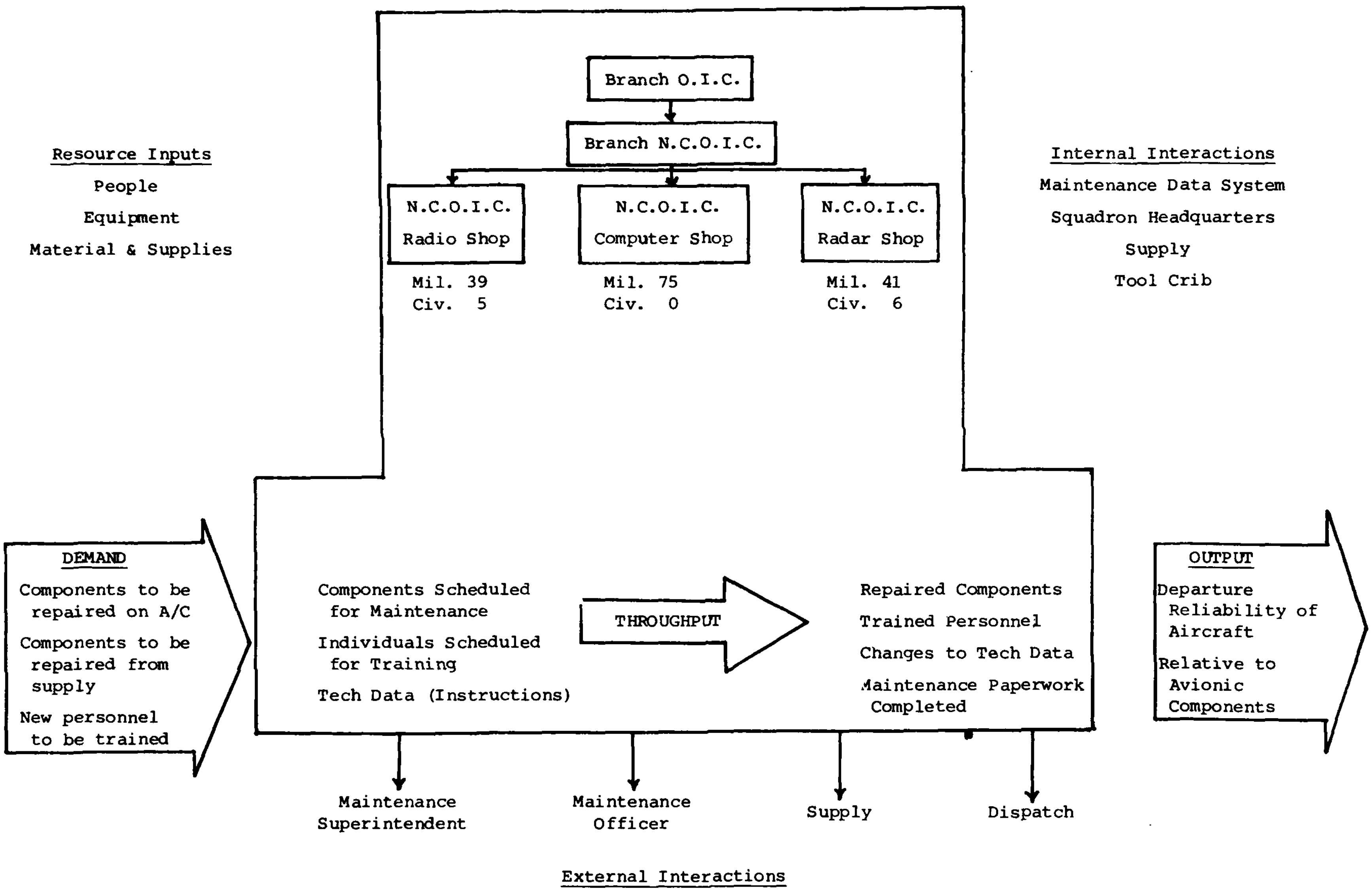

Figure 8. Organizational Diagram -- Communications/Navigation Branch

Squadron Level

Maintenance Officer - Captain
Maintenance Superintendent - Civilian

Branch Level

Branch OIC - 1/Lt.
Branch NCOIC - C/MSGT

Section Level

Radio Shop NCOIC - C/MSGT
Radar Shop NCOIC - S/MSGT
Computer Shop NCOIC - S/MSGT

2.2. Orient Group A

In this illustration, the orientation had begun in Phase 1 (1.3) during the initial meeting with squadron representatives. More specific discussions of the purpose and objectives of the measurement activity were held in individual interviews with members of Group A.

2.3. Generate Key Results Areas

The nominal group process was not carried out in this field demonstration. Instead, individual interviews were held with members of Group A in which each member was asked to go through the same thought processes that would have been required if the nominal group procedures had been used. Generating KRA's in the group setting is probably less demanding on the part of participants than the individual interview process. Therefore, since the interviews produced useful results, it is reasonable to infer that the nominal group procedures used in an operational application of the methodology would have also yielded useful indicators.

2.4 Develop Chart Listing and Describing Key Results Areas

As a result of the individual interviews with group members a number of Key Results Areas were identified. These are listed in Table 9. Because the group activity was not carried out, these were not prioritized.

Phase 3. Definition of Productivity Indices and Data Sources

3.1 Form Group B

In the present example, Group B was comprised of the following:

Radio Shop NCOIC - C/MSGT

Computer Shop NCOIC - S/MSGT

Radar Shop NCOIC - S/MSGT

Radio Shop Technicians (one 5-level and one 7-level military and one 7-level civilian)

Table 9

Key Results Areas from Group A

1. Flight Schedule Reliability - The extent to which scheduled missions are delayed or aborted due to avionics related problems.

2. Component Repair Efficiency - The extent to which work is performed in accordance with estimates and the timeliness in which work is performed.

3. Component Repair Quality - The extent to which repair work is performed without errors or discrepancies and in accordance with specified procedures.

4. Economy of Repair - The extent to which work is performed correctly with a minimum of new parts purchased.

5. Morale of the Unit - The extent to which individuals take pride in themselves and the unit, attempt to improve their physical and social environment, seek opportunities for self-improvement and to participate in group activities.

6. Training - The extent to which individuals are encouraged and assisted to upgrade their technical skills. The extent to which individuals are current on Air Force required training.

7. Demonstrated Management Concern for People - The extent to which management of the unit takes actions to promote the development of individuals in the organization.

8. Safety - The extent to which work is performed in accordance with prescribed safety practices, the proper use and care of safety equipment, and the avoidance of lost time accidents either at work or during off-duty hours.

9. Maintenance of Tools and Test Equipment - The extent to which shop tools and test equipment are properly maintained and secured.

10. Maintenance Data Collection Reliability - The extent to which entries to the maintenance data collection system are made accurately, completely and on-time.

11. Innovation - The extent to which the organization initiates needed changes to the technical data system.

12. Readiness for Mobilization - The extent to which the organization maintains a high degree of readiness for performing its war-time mission.

Table 9 (Con't)

Key Results Areas from Group A

13. Unit Self Sufficiency - The extent to which avionic component repairs can be made at the local level as opposed to submitting them to depot-level maintenance.

14. Adaptability - The extent to which the unit can adapt to new requirements and new missions without sacrificing performance quality.

Computer Shop Technicians (one 5-level and one 7-level military)

Radar Shop Technicians (one 5-level and one 7-level military and one 7-level civilian)

3.2 Orient Group B

This step was simulated in the present illustration with a group interview involving five military technicians, two civilian technicians, and the NCOIC of the Radio Section. The group was given a briefing regarding the purpose of the measurement process. The main concern of the group interview was to determine if individuals from the shop level could provide useful input in the process of generating indicators for key results areas. With a very short introduction and some guidance on the part of the measurement coordinator, useful responses were obtained. Of interest is that the responses reflected an in-depth understanding of the work performed and "fair" methods for evaluating the results of the work. In subsequent discussions with management, it was evident that the technicians provided a different and important perspective from that provided by management. For example, considerable discussion focused on the indicator for the KRA - Flight Schedule Reliability. The technicians felt that it was unfair to include both the number of delays and the number of missions aborted as indicators of the unit's performance. The issue seemed to be that mission delays were often due to the fact that parts needed for a job do not arrive on time from supply. According to the bookkeeping system, maintenance "buys" the delay, however, the technicians point out, correctly, that they are not at fault in approximately 25% of the delays. This point adds validity to the use of non-management personnel in Group B in operational applications of the methodology.

3.3 Develop Chart Listing Key Results Areas and Indicators

The Key Results Areas and indicators resulting from the discussion with Group B are shown in Table 10.

3.4 Review Indicators and Define Data Sources

Group C was simulated by interviews with maintenance management at the squadron level. The interviews involved reviewing the products produced by Group A and B, assessing whether the indicators appeared reasonable and feasible, and determining whether existing data was sufficient for the indicators. In an operational application of the methodology, this process would have also included members from the branch and section level as well as support staff (e.g., data processing). For purposes of this illustration, involvement by these groups was not deemed necessary since there would be no implementation of the results.

The results of the Group C interviews are discussed below.

Table 10

Group B Results

Additions to Key Results Areas

1. Health Status - The extent to which members of the organization exhibit health problems that are diagnosed as job related or the result of job stress.

Indicators

1. Flight Schedule Reliability

   1.1 $\frac{\text{No. aborts due to comm. nav. equipment (current period)}}{\text{No. aborts due to comm. nav. equipment (previous period)}}$

2. Component Repair Efficiency

   2.1 $\frac{\text{Actual time in completion of repair}}{\text{Estimated time in completion of repair}}$

   2.2 No. items overdue to supply

   2.3 Man-hour backlog in the shop

3. Component Repair Quality

   3.1 $\frac{\text{Mean flying time between failures for repaired components (current period)}}{\text{Mean flying time between failures for repaired components (previous period)}}$

   3.2 $\frac{\text{Satisfactory quality control reports}}{\text{Total no. of quality control reports}}$

4. Economy of Repair

   (No indicator proposed)

5. Morale of the Unit

   5.1 $\frac{\text{Percentage of personal appointments met (current period)}}{\text{Percentage of personal appointments met (previous period)}}$

   5.2 $\frac{\text{Retention rate for career fields}}{\text{A.F. average for career field}}$

   5.3 $\frac{\text{No. requests for transfers out of unit}}{\text{Total personnel assigned}}$

Table 10 (Con't)

Group B Results

5.4 $\frac{\text{Percentage of APRs[a] submitted on time (current period)}}{\text{Percentage of APRs submitted on time (previous period)}}$

5.5 $\frac{\text{Percentage of personnel overdue shots for mobility (current period)}}{\text{Percentage of personnel overdue shots for mobility (previous period)}}$

6. Training

6.1 $\frac{\text{No. people current on scheduled training}}{\text{Total No. of personnel due training}}$

6.2 Percentage of jobs performed independently and correctly by OJT trainees following check-out

7. Demonstrated Management Concern for People

7.1 $\frac{\text{Percentage of APRs submitted on time (current period)}}{\text{Percentage of APRs submitted on time (previous period)}}$

8. Safety

8.1 Detected safety violations

8.2 $\frac{\text{No. reportable injuries (current period)}}{\text{No. reportable injuries (previous period)}}$

9. Maintenance of Tools and Test Equipment

9.1 $\frac{\text{No. items overdue calibration}}{\text{Total no. items}}$

9.2 $\frac{\text{No. satisfactory pieces in test equipment inspection}}{\text{No. pieces inspected}}$

9.3 $\frac{\text{Percentage of tool kits with missing or unservicable tools (current period)}}{\text{Percentage of tool kits with missing or unservicable tools (previous period)}}$

10. Maintenance Data Collection Reliability

10.1 $\frac{\text{No. paper work entries to maintenance data system w/o errors}}{\text{Total no. entries to maintenance data system}}$

Table 10 (Con't)

Group B Results

11. Innovation

    11.1 No acceptable tech. data changes/Total no. technicians (7-level)

    11.2 No. accepted suggestions/Total no. eligible personnel

12. Readiness for Mobilization

    (No indicators generated specifically for this key results area since "Readiness was considered a composite of most of the other KRA's.)

13. Unit Self Sufficiency

    (No indicators generated by Group B)

14. Adaptability

    (No indicators generated by Group B)

15. Health Status

    15.1 $\frac{\text{Percentage of dispensary visits for stress related problems (current period)}}{\text{Percentage of dispensary visits for stress related problems (previous period)}}$

[a] APR is Airman Performance Report

3.5 Develop Chart Showing Key Results Areas, Indicators and Data Sources

Table 11 summarizes the final results from the Group C process. A comparison of Table 11 with Tables 9 and 10 illustrates the changes in Key Results Areas and indicators which took place during application of the methodology.

The original list of Key Results Areas generated by Group A (Table 9) was modified during the work with Groups B and C. Group B added a Key Results Area which was labeled "Health Status." Group C deleted two Key Results Areas which were included in the original list (Table 9): Adaptability and Readiness for Mobilization. Adaptability was deleted because no indicators were generated for it. Readiness for Mobilization was deleted because it was viewed by management as a composite of the other areas.

Group C also made some changes in the indicators. Some indicators were deleted and others were added. For example, under the KRA Number 11, Innovation, indicator 11.2 was dropped. Maintenance management felt that submissions to the Air Force Suggestion System were not a useful indicator since previous technical suggestions submitted by the unit were reviewed by individuals who lacked the knowledge to appreciate the suggestion's value to technical organizations.

3.7. Briefing Unit Commander

A final discussion was held with the branch OIC and the Squadron Commander informing them of the results of the procedure. In an operational application of the procedure, a formal briefing would be held for the Unit Commander and higher command levels as appropriate following the Group C activity. The purpose of the briefing would be to inform commanders and to obtain the formal acceptance of the Key Results Areas and indicators developed.

Phase 4. Generalization of Indicators

Since this example was not concerned with developing indicators that could be generalized across organizations, Phase 4 was not required.

Phase 5. Implementation

As a simulated field test, no implementation of the indicators was intended. However, it is clear from the results obtained that the measures are, with one or two exceptions, implementable within reasonable cost constraints. Many of the proposed indicators are currently being "tracked" informally. There was a general consensus among squadron management that one contribution of the methodology was to force them to formalize assessment of organizational outcomes that are already being

Table 11

Final Key Results Areas, Indicators and Data Sources

Key Results Area		Indicator(s)	Availability of data
1. Flight Schedule Reliability - The extent to which scheduled missions are delayed or aborted due to avionics related equipment.	1.1	No. schedule delays or aborts due to com/nav. equip. (current period) / No. schedule delays or aborts due to com/nav. equip. (previous period)	Available
2. Component Repair Efficiency - The extent to which repair work is performed in accordance with time estimates and the avoidance of significant work backlogs	2.1	Average (Actual/Estimated) time to complete repairs (current period) / Average (Actual Estimated) Time to Complete repairs (previous period)	Available
	2.2	No. items overdue to supply (current period) / Average No. items overdue to supply (previous period)	Available
	2.3	Man-hour backlog (current period) / Average Man-hour backlog (previous period)	Available
3. Component Repair Quality - The extent to which repair work is performed without errors or discrepancies, completely and in accordance with specified maintenance procedures.	3.1	Mean flying time between failures for com. nav. components (current period) / Mean flying time between failures for com. nav. components (previous period)	Available
	3.2	Percentage of satisfactory quality control reports (current period) / Percentage of satisfactory quality control reports (previous period)	Available
4. Economy of Repair - The extent to which work is performed with a minimum of new parts purchased. (Also a measure of troubleshooting effectiveness.	4.1	Average parts cost per component repaired (current period) / Average parts cost per component reparied (previous period	Available

Table 11 (cont'd)

Final Key Results Areas, Indicators and Data Sources

Key Results Area		Indicator(s)	Availability of data
5. Morale of the Unit - The extent to which individuals take pride in themselves and their unit, attempt to improve their physical and social environment, seek opportunities for self improvement and participation in unit social activation.	5.1	Percentage of personal appointments met (current period) Percentage of personal appointments met (previous period)	Available
	5.2	Percentage of eligibles requesting transfer out of unit (current period) Percentage of eligibles requesting transfer out of unit (previous period)	Available
	5.3	Percentage of personnel overdue shots for mobility (current period) Percentage of personnel overdue shots for mobility (previous period)	Available
	5.4	Percentage of personnel involved in outside education (current period) Percentage of personnel involved in outside education (previous period)	Available
6. Training - The extent to which individuals are assisted to upgrade skills through high quality on-the-job training.	6.1	Percentage completing OJT on schedule (current period) Percentage completing OJT on schedule (previous period)	Available
	6.2	Percentage of eligible individuals promoted (current period) Percentage of eligible individuals promoted (previous period)	Available
	6.3	Percentage of jobs performed correctly by trainees following checkout (current period) Percentage of jobs performed correctly by trainees following checkout (previous period)	Not Available

Table 11 (cont'd)

Final Key Results Areas, Indicators and Data Sources

	Key Results Area		Indicator(s)	Availability of data
7.	Demonstrated Management Concern for People - The extent to which management takes actions to promote the development of individuals in the organization.	7.1	Percentage APR's submitted on time (current period) / Percentage APR's submitted on time (previous period)	Available
8.	Safety - The extent to which work is performed in accordance with prescribed safety practices. Also includes the use and care of safety equipment and the avoidance of lost-time accidents occurring on the job or during off-duty hours.	8.1	No. detected safety violations / No. man-hours worked	
		8.2	No. reportable injuries (current period) / No. reportable injuries (previous period)	Available
9.	Maintenance of tools and test equipment - The extent to which shop tools and test equipment are properly maintained and secured.	9.1	No. items overdue calibration / Total No. items needing calibration	Available
		9.2	No. of lost tools (current period) / No. of lost tools (previous period)	Available
10.	Maintenance Data Collection Reliability - The extent to which entries to the maintenance data collection system are made accurately, completely and on-time.	10.1	No. error free entries to maintenance data / Total No. entries	Available
		10.2	Percentage jobs closed out correctly (current period) / Percentage jobs closed out correctly (previous period)	Available
11.	Innovation - The extent to which the organization initiates needed changes to the technical data system.	11.1	No. acceptable tech. data changes / Total No. 7- level technicians	Available

Table 11 (Cont'd)

Final Key Results Areas, Indicators and Data Sources

Key Results Area		Indicator(s)	Availability of data
12. Unit Self-Sufficiency - The extent to which comm/nav components can be repaired at the local facility.	12.1	Percentage of components repaired locally (current period) / Percentage of components repaired locally (previous period)	Available
13. Health Status - The extent to which members of the organization exhibit health problems that are diagnosed as job related or the result of job stress.	13.1	Percentage of dispensary visits for stress related problems (current period) / Percentage of dispensary visits for stress related problems (previous period)	Available

monitored by informal "management" processes. The procedure also benefits organizational members. By making explicit the criteria on which managers make judgements, it promotes improved communication among managers, supervisors and members with respect to the important dimensions of organizational performance.

Summary and Critique

This chapter describes a field demonstration of a methodology recommended for use in generating productivity criteria in Air Force organizations. The demonstration was conducted in an avionics maintenance squadron within the Military Airlift Command. This demonstration was intended as an illustration, rather than a test of the methodology. Nevertheless, the demonstration provided some support for the feasibility of applying Phases 1 to 3 of the methodology in an Air Force organization. Further evaluation of the methodology will await the outcome of an extensive field test to be conducted under the present contract.

Based on the results of the field demonstration, there is preliminary evidence that the methodology will provide criteria which satisfy the requirements specified for desirable productivity measures in Chapter IV of this report. Compared to existing productivity measurement programs underway in the Air Force, this methodology appears to have more potential benefits in terms of providing meaningful feedback to local commanders. The measures resulting from this methodology are congruent with the mission of the organization, and they are measurable, frequently through the use of existing data. Acceptability to local commanders and organizational members is enhanced by their participation in the process. This participation leads to a set of measures which are choosable and understandable from the point of view of the organization in question.

Questions regarding the validity, cost-effectiveness, and usefulness of the measures to researchers and managers will be answered in part by the planned field test. However, further research in the operational environment, if judged desirable based on the results of the field test, will ultimately be required to answer these questions. A major benefit to the Air Force from this line of research, will be the ability to evaluate the impact of management and policy changes on both operational efficiency and effectiveness. Objective criteria of both efficiency and effectiveness are required in order to evaluate tradeoffs between efforts to promote peacetime efficiency and maintenance of operational readiness. The ability to evaluate such tradeoffs is a primary concern of both Air Force managers and researchers, and is a planned outcome of this present line of productivity measurement research.

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APPENDIX A

PROGRAMS TO ENHANCE PRODUCTIVITY: REVIEW OF RESEARCH RESULTS

The primary purpose of this report is to review and critique productivity measurement methods. However, since the ultimate purpose of measurement is to enhance productivity, it is appropriate to review the highlights of the productivity enhancement literature. This is the purpose of this Appendix.

In recent years, there have been at least four significant reviews of the literature pertaining to the effectiveness of behavioral and management strategies for improving productivity (Cummings & Molloy, 1977; Katzell, Yankelovitch, Fein, Ornati, & Nash, 1975; Locke, Feren, McCaleb, Shaw, & Denny, 1979; Spector & Hayes, 1979). Each has reviewed a substantial number of research studies and has categorized the impact of various improvement programs on a range of criteria including productivity, withdrawal, disruptions and employee attitudes. While the literature covered by these reviews overlapped (to an unknown degree), the total number of citations reviewed, including duplicates was approximately 290. This Appendix provides a summary of the results of these reviews organized according to the major types of improvement programs.

A classification scheme proposed by Katzell, Bienstock, and Faerstein (1977) will be used to organize this discussion of enhancement methods. This scheme considered enhancement programs under the following categories:

1. Selection and Placement
2. Job Development and Promotion
3. Training and Instruction
4. Appraisal and Feedback
5. Management by Objectives
6. Goal Setting
7. Financial Compensation
8. Job Design
9. Group Design
10. Supervisory Methods
11. Organizational Structure
12. Physical Working Conditions
13. Work Schedule
14. Socio-technical Systems

Assigning the studies included in the four reviews to the 14 categories presented some difficulty. The categories represent the "independent variables" manipulated in an effort to improve labor productivity. Frequently programs involved manipulations of more than one "action lever" or variable. For example, an experiment in job redesign may be accompanied or followed by a change in the compensaton system. When this was the case, Katzell et al., (1975) included the study in each of the relevant categories. The other three reviews assigned articles to discrete categories based on the dominant change strategy involved. In this discussion, categories defined in all four reviews were assigned to the one of the 13 Katzell et al. (1977) categories which was judged to be most similar.

The four published reviews focused primarily on the effects of the change programs in terms of their impact on productivity. However, reflecting the confusion in the literature regarding the meaning of the term, the definition of productivity used was not precise. Probably the most frequent definition found in the articles reviewed was the definition of productivity as production, although production costs and quality were also considered. Other criteria, in addition to productivity used to assess the results of improvement efforts, included withdrawal (absenteeism, turnover, tardiness, etc.), disruptions (accidents, strikes, slowdowns, grievances, etc.) and employee attitudes.

This Appendix presents the frequency and percentage with which the results of each type of enhancement program reported improvement in criteria of productivity, withdrawal, disruptions and attitudes. In interpreting these results, it should be kept in mind that the percentages probably provide an inflated estimate of the true percentage of success since unsuccessful programs rarely get published. In any event, the numbers provide a crude estimate of the level of research activity in each of the improvement program areas.

Selection and Placement

Table A-1 summarizes the results of studies that assessed the consequences on productivity of a change in how the organization was staffed. Staffing refers to activities associated with recruitment, selection, and placement.

Job Development and Promotion

This category was created to consider the impact of career development and promotion systems on productivity. However, there were no expermental evaluations of such programs. Thus, no table is presented for this category.

Training and Instruction

Results of a variety of training and instruction programs are presented in Table A-2. These included supervisory training and worker training involving a variety of training techniques. As a means of summarizing these programs, Katzell, et al. (1977) have found that training programs have

Table A-1

Number and Percentage of Studies Showing Improvement from Selection and Placement Programs

Review	CRITERION			
	Productivity	Withdrawal	Disruptions	Attitudes
Katzell, et al. (1975)	-	1/3 (33%)[a]	-	1/1 (100%)
Cummings & Molloy (1977)	-	-	-	-
Locke, et al. (1979)	-	-	-	-
Spector & Hayes (1979)	-	-	-	-

[a] 1 out of 3 studies reviewed showed improvement on the withdrawal criterion

been used with success in a variety of settings. However, not all programs tried have been successful, "...in short, training may fail when tried as a remedy for the wrong disease" (Katzell, et al., 1977, p. 13).

Table A-2

Number and Percentage of Studies Showing Improvement from Training and Instruction Programs

Review	CRITERION			
	Productivity	Withdrawal	Disruptions	Attitudes
Katzell, et al. (1975)	22/26 (85%)	7/12 (58%)	1/1 (100%)	2/3 (67%)
Cummings & Molloy (1977)	-	-	-	-
Locke, et al. (1979)	-	-	-	-
Spector & Hayes (1979)	-	-	-	-

Appraisal and Feedback

Table A-3 summarizes results of programs designed to provide guidance to employees regarding their work performance through feedback, counseling, or coaching. Most of the studies differ from old-style performance appraisal programs when an appraisal interview is held every 6 to 12 months. These approaches frequently involve what is termed "behavior modification" or positive reinforcement procedures that are characterized by feedback that is more focused, frequent and specific. Desired behaviors are clearly specified, and each employee's performance or the group's performance is frequently assessed and reported in relation to these specific objectives. Feedback is frequently assessed and reported in relation to these specific objectives. Feedback is frequently accompanied by praise for good performance.

Management by Objectives

This approach has become well-established in the field of management practice. While it involves the features of appraisal and feedback, the key feature is the definition, in light of more comprehensive organizational objectives, of performance targets or "bogeys" for each individual manager's job. The number of experimental evaluations of this approach

Table A-3

Number and Percentage of Studies Showing Improvement from Appraisal and Feedback Programs

Review	CRITERION			
	Productivity	Withdrawal	Disruptions	Attitudes
Katzell, et al. (1975)	5/6 (83%)	1/3 (33%)	1/1 (100%)	2/3 (67%)
Cummings & Molloy (1977)	3/3 (100%)	3/3 (100%)	-	0/1 (0%)
Locke, et al. (1979)	-	-	-	-
Spector & Hayes (1979)	-	-	-	-

has been few and the results mixed. While performance improvements, Table A-4, occurred, grievances increased in one establishment and the performance improvements declined in another after 6 months.

Table A-4

Number and Percentage of Studies Showing Improvement From Management by Objectives

Review	CRITERION			
	Productivity	Withdrawal	Disruptions	Attitudes
Katzell, et al.(1975)	1/2 (50%)	1/1 (100%)	0/1 (0%)	1/1 (100%)
Cummings & Molloy (1977)	-	-	-	-
Locke, et al. (1979)	-	-	-	-
Spector & Hayes (1979)	-	-	-	-

Goal Setting

Closely related to feedback and management by objectives, goal setting is characterized by the specification of difficult but attainable goals for limited--but not unimportant--aspects of employee performance. Normally, these programs also involve frequent and specific feedback regarding goal attainment. The similarity of this approach to the "positive reinforcement" programs included under the category of Appraisal and Feedback prompted the following observation by Locke, et al.: "...behavior modification has been widely touted, but in practice involves little more than a re-labeling of one or more of the (other) techniques, especially money and goal setting" (1979, p. 1). The results of goal setting programs are shown in Table A-5.

Table A-5

Number and Percentage of Studies Showing Improvement From Goal Setting

Review	CRITERION			
	Productivity	Withdrawal	Disruptions	Attitudes
Katzell, et al.(1975)	8/8 (100%)	2/3 (67%)	1/2 (50%)	2/3 (67%)
Cummings & Molloy (1977)	-	-	-	-
Locke, et al. (1979)	17/17 (100%)	-	-	-
Spector & Hayes (1979)	-	-	-	-

Financial Compensation

This section includes studies focusing on the impact of pay. While the linking of pay to performance has had a long history in manufacturing operations, there are many variations of incentive programs using financial rewards. Table A-6 presents an overall summary of the impact of pay. Table A-7 presents more specific breakdowns by type of financial incentive program. The table presents results for individual piecework plans, individual bonus plans (combining goal setting plus financial reward for achieving bonus), and group incentives (Scanlon plans and non-Scanlon group plans).

Table A-6

Number and Percentage of Studies Showing Improvement From Financial Compensation Programs (All Types Combined)

	CRITERION			
Review	Productivity	Withdrawal	Disruptions	Attitudes
Katzell, et al.(1975)	6/8 (75%)	3/4 (75%)	-	-
Cummings & Molloy (1977)	8/8 (100%)	1/1 (100%)	-	7/8 (88%)
Locke, et al. (1979)	33/37 (89%)	-	-	-
Spector & Hayes (1979)	41/46 (89%)	-	-	-

Table A-7

Number and Percentage of Studies Showing Productivity Improvement From Financial Compensation by Program Type

	PROGRAM TYPE			
Review	Individual Piecework	Individual Bonus	Scanlon	Other Group Incentive
Katzell, et al. (1975)	-	-	-	-
Cummings & Molloy (1977)	-	-	-	-
Locke, et al. (1979)	10/10 (100%)	18/20 (90%)	5/7 (71%)	4/4 (100%)
Spector & Hayes (1979)	18/19 (95%)	13/16 (81%)	2/2 (100%)	6/6 (100%)

Job Design

One of the popular topics in manpower management over the past decade has been job redesign to facilitate worker motivation. While the principal motivator for this effort has been improvement in workers quality of working life, some have also argued that job redesign can improve performance. Job enrichment, modifying jobs to provide workers more variety, autonomy, feedback, and challenge, has been the most widely used form of job redesign. Table A-8 summarizes the results of job design efforts.

Table A-8

Number and Percentage of Studies Showing Improvement From Job Design Programs

	CRITERION			
Review	Productivity	Withdrawal	Disruptions	Attitudes
Katzell, et al. (1975)	16/18 (89%)	5/6 (83%)	-	2/4 (50%)
Cummings & Molloy (1977)	16/21 (76%)	6/7 (86%)	-	17/23 (74%)
Locke, et al. (1979)	11/13 (85%)	-	-	-
Spector & Hayes (1979)	-	-	-	-

Group Design

This category differs from job design in that it includes programs that deal with redistribution of tasks among group members or members of a work team. Job enrichment, on the other hand, deals with changes in individual jobs. Group Design results are summarized in Table A-9

Supervisory Methods

One of the most common ways to impact performance in work groups is to change the way supervisors perform their jobs. This category cross-lists studies cited among other categories, and feedback. In addition, this category includes studies that investigate increased participation (democracy) in the workplace. These results are summarized in Table A-10.

Table A-9

Number and Percentage of Studies Showing Improvement From Group Design Programs

Review	CRITERION			
	Productivity	Withdrawal	Disruptions	Attitudes
Katzell, et al. (1975)	3/4 (75%)	2/3 (67%)	0/1 (0%)	1/2 (50%)
Cummings & Molloy (1977)	-	-	-	-
Locke, et al. (1979)	-	-	-	-
Spector & Hayes (1979)	-	-	-	-

Table A-10

Number and Percentage of Studies Showing Improvement From Changes in Supervisory Methods

Review	CRITERION			
	Productivity	Withdrawal	Disruptions	Attitudes
Katzell, et al.(1975)	12/13 (92%)	4/5 (80%)	-	2/2 (100%)
Cummings & Molloy (1977)	4/7 (57%)	4/5 (80%)	-	5/5 (100%)
Locke, et al.(1979)	7/16 (44%)	-	-	-
Spector & Hayes (1979)	-	-	-	-

Organizational Structure

Table A-11 summarizes results of organizational changes which alter existing working relationships. The types of changes referred to are patterns of responsibility and authority that are outside the immediate work group. An example is a study that redesigned the chain of command thereby creating new work roles, and changed existing roles in the management hierarchy. Changes are not so extensive as to create a new socio-technical work system, a topic covered later.

Table A-11

Number and Percentage of Studies Showing Improvement From Changes in Organizational Structure

Review	CRITERION			
	Productivity	Withdrawal	Disruptions	Attitudes
Katzell, et al.(1975)	4/4 (100%)	1/1 (100%)	1/1 (100%)	-
Cummings & Molloy (1977)	4/4 (100%)	2/3 (67%)	-	4/5 (80%)
Locke, et al. (1979)	-	-	-	-
Spector & Hayes (1979)	-	-	-	-

Physical Working Conditions

In the past, a great deal of attention has been given to consequences of physical working conditions (e.g., noise, illumination, layout) However, none of these reviews covered experimental evaluations of these variables.

Work Schedule

Table A-12 summarizes results of changes in work scheduling. Changes studied were compressed work week (4 ten-hour days rather than 5 eight-hour days) and flexitime (allowing individuals to alter starting and stopping time as long as they work a standard number of hours).

Table A-12

Number and Percentage of Studies Showing Improvement From Changes in Work Schedule

	CRITERION			
Review	Productivity	Withdrawal	Disruptions	Attitudes
Katzell, et al. (1975)	6/9 (67%)	6/7 (86%)	-	2/3 (67%)
Cummings & Molloy (1977)	5/5 (100%)	4/4 (100%)	-	6/6 (100%)
Locke, et al. (1979)	-	-	-	-
Spector & Hayes (1979)	-	-	-	-

Socio-Technical System

This category includes studies reporting changes in a sufficiently large number of dimensions of the organization so as to create a new socio-technical work system. Examples of the changes made include most of the following: redesign of jobs and teams, wider sharing of responsibility influence and authority, wide sharing of information about goals, problems, and results, improvements in operation, personnel selection, and training. Results of socio-technical changes are presented in Table A-13.

Table A-13

Number and Percentage of Studies Showing Improvements From Changes in Socio-Technical Systems

Review	CRITERION			
	Productivity	Withdrawal	Disruptions	Attitudes
Katzell, et al. (1975)	11/12 (92%)	8/10 (80%)	1/1 (100%)	3/3 (100%)
Cummings & Molloy (1977)	14/15 (93%)	5/7 (71%)	-	9/10 (90%)
Locke, et al. (1979)	-	-	-	-
Spector & Hayes (1979)	-	-	-	-