AN ABSTRACT OF THE THESIS OF

Linda C. Long for the degree of Master of Science in Industrial Engineering presented on April 24, 1986.

Title: Service Assessment Matrix

Redacted for Privacy

Abstract approved: _____

James L. Riggs, P.E.

The United States is becoming a service oriented nation. As increasing amounts of the gross national product are spent on services, it becomes vitally important to ensure the productivity of these services. The purpose of this thesis is to identify which elements are needed in a service department productivity measurement tool, what techniques are currently being used, and then to develop a new improved technique. The result is a Service Assessment Matrix -- SAM.

SAM is a combination of two matrices. The primary matrix is used by a service department to evaluate internal productivity and service quality using a multiple criteria approach. It summarizes data and produces a productivity indicator and a quality indicator. Because all of the key information needed for analysis is on this matrix, it represents the total evaluation system and provides the name -- SAM. The second matrix is the Quality Assessment Matrix (QAM). As a subset of the

Service Assessment Matrix, the QAM's format collects information about clients' perceptions of the quality of service. It is a source document for the primary matrix and is used by the clients.

The Service Assessment Matrix uses five methods of evaluation: comparison of criteria analysis, pattern analysis, written analysis, productivity and quality indicator value analysis, and trend analysis.

SAM was tested in the service departments of two large corporations: Electro Scientific Industries (ESI) in Portland, Oregon and Evanite Fiber Corporation in Corvallis Oregon. The results were very encouraging. Both service departments were able to identify critical problem areas in their respective departments. But, more important was the development of a communication system which allowed the clients of the services to get involved and to feel comfortable enough to make critical comments about the services being provided.

The developmental work has been finished. The technique was tested and found successful. But the Service Assessment Matrix can be refined. Two studies could cause major revisions to the current SAM format. One is a study to determine if SAM is cost effective. The second study is to find a method which would allow the SAMs from several departments to be combined. Only utilization will identify more strengths and weaknesses of the Service Assessment Matrix.

Service Assessment Matrix

by

Linda C. Long

A THESIS

submitted to

Oregon State University

in partial fulfillment of
the requirements for the
degree of

Master of Science

Completed April 24, 1986

Commencement June 1986

APPROVED:

Redacted for Privacy

Head of department of Industrial and General Engineering
in charge of major

Redacted for Privacy

Head of department of Industrial and General Engineering

Redacted for Privacy

Dean of Graduate School

Date thesis is presented April 24, 1986

ACKNOWLEDGEMENT

Many people helped to make this thesis and my graduate studies successful. This includes:

Dr. James L. Riggs, P.E., my major professor, who guided me through my frustrations, anxieties, inspirations and the technical problems of writing a thesis.

Horst Raustein, Chris Winkley and the Quality Assurance crew at Electro Scientific Industries (ESI), Portland, OR, and Brian Unwin and the Central Engineering Staff at Evanite Fiber Corp., Corvallis, OR, who were so important in the testing and refining of SAM.

My parents, Dr. & Mrs. J. V. Woodworth, who talked with me, encouraged me, believed in me and who provided emotional, technical, and financial support through this endeavor.

The Department of Industrial Engineering staff who provided friendship and encouragement.

My son James, who kept the house clean while I typed.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF FIGURES (cont.)

SERVICE ASSESSMENT MATRIX

1. INTRODUCTION AND DEFINITION OF TERMS

Service organizations are no longer appendages but the heart and body of the United States' economic structure (Heaton, 1977). In 1900 only 30% of the United States' workers were employed in service organizations. By 1950 that number had grown to 50%. 1982 figures reflect the continuing growth with 70% of U.S. workers holding service jobs. More people are entering the clerical, professional/technical and managerial/administrative fields as automation and technology increase the efficiency of and decrease the need for the production employee. Business and engineering journals agree that there will be a continued growth in the United States white collar/service sector.

As the United States continues to increase the volume of service departments and organizations, the cost of these services, which has sky-rocketed over the past ten years, will continue to grow. In 1981, employment costs for the 51,848,000 white collar workers in the United States totaled more than one trillion dollars. Today,the typical company pays 70% of its total pay roll to the white collar employee (Christopher, 1984). These are the reasons why there is a need to study, evaluate and implement changes to improve the productivity of services in the United States, often through the use of a productivity improvement program.

This thesis is an attempt to develop a tool that can be used in a productivity improvement program for service departments within an organization. It is organized as follows:

Chapter 1 defines some of the terms to be used.

Chapter 2 identifies background information and current methods being used to evaluate services.

Chapter 3 describes the Service Assessment Matrix.

Chapter 4 describes how to develop the criteria and their values and weights for the Service Assessment Matrix.

Chapter 5 reports the implementation of the Service Assessment Matrix in the Document Control Department at Electro Scientific Industries (ESI) in Portland, Oregon.

Chapter 6 reports the implementation of the Service Assessment Matrix in the Central Engineering Department at Evanite Products Inc., Corvallis, Oregon.

Chapter 7 compares the implementation of the two departments and identifies possible changes which might be made.

Chapter 8 lists recommendations for future research.

• DEFINITION OF TERMS

Productivity - Productivity is a buzz word that has been used by economists, engineers, managers and authors. The concept has been used to diagnose the problems of industries around the world. It is often defined as output/input. A more useful definition is, "The measure of how specified resources are managed to accomplish timely objectives stated in terms of quantity and quality (Riggs, 1984)."

Productivity Improvement Program - A program is a coordinated set of events occurring in a predetermined sequence or cycle. A productivity improvement program is a cyclical process with six basic events.

1. Personnel Awareness and Involvement
2. Productivity Measurement
3. Productivity Evaluation
4. Productivity Planning
3. Productivity Improvement
6. Follow-up

The Service Assessment Matrix is to be used in the measurement and the evaluation phases. It cannot be an isolated activity - it must be incorporated as part of a total productivity process. More information about productivity improvement programs and how to set them up with a tool similar to SAM can be found in Appendix A.

Efficiency and Effectiveness - These two words often get interchanged improperly. John Hoffman and Orry Shackney (1983) describe

effectiveness as producing better results and efficiency as producing more results with less effort. Effectiveness for a service department is reaching internal goals while filling clients' needs. Efficiency is achieving maximum output with available resources.

Service Departments - For this thesis a service department is defined as a miniature service organization providing services to other departments within the company. It must control the resources it uses while maintaining open communications with its clients.

The United States is becoming a service society. Service personnel must recognize the need to improve their productivity. In order to achieve this concept, effective tools must be available.

2. REVIEW OF CURRENT METHODOLOGIES

A service department can not be measured like a production department which has an easily counted output. This is because with a service department, the consumer or client must be considered as part of the total system, and therefore must be involved in any evaluation. In other words, not only does a service department evaluation need to measure internal performance parameters, it must also measure the quality of service as indicated by customer performance and satisfaction.

The above does not sound hard. It requires only that people communicate with each other. But communication between a server and client is not always easy. Working with people outside one's own department can be stressful and/or difficult. Communication problems result in minimized effectiveness and efficiency for the service department. Two main reasons exist for this situation: demographics and organization structure.

It was stated by Melville Dalton in 1959 that the differences in age, education, and length of service within the company between production and service employees often creates a diversity in interests, attitudes, and bearing. In 1982 this author personally experienced the communication problems created by these differences when as a young female college graduate she was hired as a first line supervisor to work with seven other supervisors who had spent ten to twenty years working their way up through the manufacturing plant.

The second reason for problems is often caused by the formal organization structure. Leonard Sayles (1979) has developed a set of reasons why intergroup relations between staff and line workers are so difficult and strained. The same reasons can be applied to most service departments. He feels that because there is no daily contact required between lateral departments that understandings created by regular contact is absent. He also states that lack of understanding creates lack of complete communications. An added remark is that when two groups interact irregularly, the sporadic interaction interferes with routines and goals of the individual departments, which increases friction. Because of the above, special tools must be used to have an effective service department evaluation.

Recently, the quantity of techniques available to evaluate white collar/service activities has increased dramatically. Not all fulfill requirements of a good service "measuring stick". Few include both the client and the internal measures. It is important to know what is needed, and what is available to ensure that the potential technique is not a "reinvention of the wheel". Any new program needs to satisfy the needs explained below as well as have advantages over existing programs.

1. Assurance from management that resources will be committed to a productivity improvement program.

2. A methodology which encourages communications between server and client.

3. A means of involving the employees of the service department so that they feel responsible for productivity improvement.

4. A means of involving the clients so they can help identify the quality criteria and participate in the evaluation process.

5. A set of desirable levels of output and service quality to serve as objectives for future performance.

6. A method to analyze results to identify possible improvements.

7. A systematic follow-up routine to ensure that changes can be implemented and evaluated.

8. An index value which can track progress over time.

When setting up a program two additional questions should be considered. First, is the technique cost effective; will the cost of development and data collection absorb the cost savings accrued from the productivity improvements? Second, do you want one key unit which allows easier measurement, but does not provide immediate feedback why a problem is occurring, just a "red flag" highlighting an existing problem? Or, do you want a multiple number of criteria which allows the tool to indicate why a problem is occurring but also requires more data collection, even when there is no problem?

With the above list of what is needed it is time to compare that with what is available. Health Services was the first service industry to be extensively evaluated for quality and productivity. It has long been recognized by the industry that when productivity is analyzed, usually in terms of output per work-hour, the quality of care must also be included. This is usually done using one or more of the following methods (Mannisto, 1980):

1. Expert opinion of skills and procedures.

2. Feedback by means of questionnaires, interviews and reports from patients, their families and medical staff.

3. Auditing of medical records.

These three methods are not unique to hospitals; they are the basis of most service evaluations.

Several factors have given medical services an advantage over other service industries trying to develop a quality measurement tool. First, government and hospitals have recognized the importance of quality and productivity for many years so both agencies have established regulations to guide the industry. Second, many hospitals world-wide perform similar activities, providing a sizable data base for setting standards. Third, a large number of the services in a hospital are repetitive, allowing detailed analysis of each activity that is performed.

The Commission on Professional and Hospital Activities (CPHA) was established in 1955. It has developed a Professional Activity Study which is an international computerized data base that provides reports to hospitals. The reports are made from data acquired from the individual hospital's records. That set of data is compared with the broad base that has accumulated over the years. The report allows a hospital to evaluate and compare its own productivity and quality of services with other hospitals around the world. More information on this service can be obtained by calling the Commission on Professional and Hospital Activities at 1-800-521-6210.

Kaiser Permanente of Portland, Oregon has developed a similar system. What it has done is establish a set of standards based on a

California insurance feasibility study which was trying to establish a system to set malpractice insurance rates by measuring different elements of a hospital's services. Kaiser Permanente measures their medical procedures by auditing every medical record by hand and then compares the results to the standards (Schlaudecker,1986).

The problem with trying to adjust the above types of evaluation tools to a generic service assessment tool is that the methods are too industry specific.

In the food service industry, the standard work measure is usually time/number-of-meals-served. Historically, this industry has used activity sampling, activity analysis, elemental standard data and predetermined motion studies to evaluate productivity (David, 1978). This is fine for measuring quantity, but fails to incorporate quality. One feature it does bring out is that productivity in a service industry is directly related to efficient use of time.

Some studies have been done to compare quality and productivity in hospital food services. The American Hospital Association completed such a study in 1975 (Ridley, 1980). It accepted the hypothesis that as productivity improves, the quality of services decreases. The problem is that this was a specific study and did not provide a generic comparative tool.

It appears that these two major service industries have not developed any general tools that can be used to compare productivity and quality of services. People interested in evaluating both the productivity

and quality of service departments must look to large private industries or management consulting firms to find something they can use, or develop their own technique.

Lawrence Baytos, the Vice President of one such company, Quaker Oats, identified nine strategies for productivity improvement including the evaluation of managerial duties (Baytos, 1979). Most of these strategies dealt with the evaluation of personnel activities, benefits or individual performance ratings. Only one of the strategies dealt with the formal organization structure. His comments in this area stressed the importance of identifying redundancy between departments. If there is duplication of services, there is potential for productivity improvement. About the same time, McKinsey & Company, a major consulting firm, did an analysis of the 23,000 employees located world wide, of Alcoa, headquartered in Pittsburgh, PA. The goal was to improve corporate productivity by identifying duplicated services and to match services with user needs. Although the technique developed did improve productivity and allowed Alcoa to make major cost savings (Riggs R., 1986), it did not look at how services were performed nor their quality. It only indicated if a client was getting a needed task done and if it was duplicated too often through the corporation. It is interesting to note that despite the cost of this study, as time has passed, the pressing needs of daily operations and the natural tendency for staff departments to expand has minimized any follow-up which might have maintained the leaner structure that was developed.

One aspect of productivity improvement is the elimination of redundant activities. The McKinsey and Company study evaluated this element. It does not provide a technique to measure service quality but it does highlight the need for follow-up in any productivity improvement program if benefits are going to endure.

The continued search to locate a method to evaluate productivity and quality of services identified another major technique: personnel performance evaluations through Management by Objectives (MBO). A major study was done by General Electric (Butler, 1984). In 1979, a task force was set up to identify how personnel should be evaluated to increase departmental productivity. The official start-up of their MBO system took place in January 1981, slightly less than 2 years after the initial concept was delegated to the task force. This committee did not involve the customers of services. It evaluated personnel performance rather than departmental achievements. The G.E. study does bring out the fact that development and implementation of a productivity program cannot be done overnight. To implement the new evaluation system, the task force presented seminars and workshops to heighten awareness and provide knowledge about what was going to be expected from all the employees with the new system. It also included follow-up procedures to assess the impact and acceptance of the MBO system. The follow-up found that although there were still problems in personnel evaluation systems, the new system being used was more acceptable than any prior method G.E. had used. A possible reason for this was the involvement of the employees in the program.

Two additional and very similar methods developed by large corporations are the Administrative Productivity Indicator (API) used by Intel (Christopher, 1984) and the Productivity Measurement Index (PMI) used by Tektronix (von Euen, 1984). The PMI is actually a spin-off of the API, and has recently been further developed to include clients and several index values to measure the different aspects of a service . This is in recognition that clients' needs and perceptions are a major factor in service evaluation. More information can be found in Appendix B about the PMI and its extensions. The unit of measure for the PMI is one criterion identified as the key output for the evaluated department. The result is the HPU, Hours per Unit.

$$\text{HPU} = \frac{\text{Labor hours of Input}}{\text{Key Units of Output}}$$

The most common numerator is labor since most services have their primary cost in salaries, but it could also be cost of machinery or equipment, if the output is equipment intensive.

The HPU is then indexed, using the following formula, so that trends can be tracked.

$$\text{Productivity Index} = \frac{(\text{Base Period HPU}) \times (\text{Current Period \# Units Output})}{\text{Current Period Labor Hours Paid}}$$

The Productivity Index is then based on a range around 1, which allows several departments to have their indexes combined for a total division or company Productivity Index.

There are several advantages in using the HPU. It recognizes that servicing departments have control over time but usually not the number of units requested by clients, stressing the importance of controllable

time rather than uncontrollable units produced. By identifying one key unit the index requires only one output element be continually monitored, simplifying data collection. A third advantage is the ability of the index to provide a base HPU unit from the initial evaluation period, like the Consumer Price Index uses 1967 figures, to track productivity trends. The Productivity Index becomes 1 for the initial evaluation and any additional evaluations will reflect increases or decreases in productivity. There is one major problem evident in the PMI. It may be very difficult to find one key unit to measure a service department.

With any tool used to measure productivity, it is important to note that after a productivity value is obtained, the productivity of the department is not guaranteed. Further improvement can only be made with awareness, knowledge and motivation using time management, employee training, work simplification, and other basic job improvement techniques.

Another large company which has developed a service assessment system is the Olin Corporation (Christopher, 1984). Appendix A includes a detailed description of this method along with the commentary on how to implement a productivity improvement program. Instead of using only one index measure, Olin uses a Multiple Output Productivity Indicator (MOPI). They have used the MOPI for measuring and improving productivity in both manufacturing plants and administrative departments. Both subjective and quantitative measures are evaluated and the people who are responsible for performing the service are

involved. Another advantage is that the system recognizes that a service department may perform several important functions which have differing impacts on the department's productivity. The means of implementation is an Employee Involvement Team approach. One of the first service units to be evaluated was the Information Services Division.

The MOPI system of evaluation provides an excellent tool for evaluating a service's productivity, but it lacks any means to obtain ratings or input from clients.

The Oregon Productivity Center, based at Oregon State University, developed a measurement system in 1980 which can be used for many types of administrative departments. It is a generic tool which has been used by companies world-wide. It is known as the Objectives Matrix and was developed by Dr. James Riggs. Its goal is to quantify performance using a multi-dimensional scheme. With the Objectives Matrix, a department obtains an index value which can be tracked over several evaluation periods. It is simple, versatile and conceptually appealing. The Objectives Matrix can incorporate quality criterion when choosing the key elements of departmental performance but it has not been extended to allow customer feedback on the quality of services provided by the department and it lacks the ability to take advantage of client input. A basic description of the Objectives Matrix can be found in Appendix C or in the book Productivity Measurement with the Objectives Matrix by Glenn H. Felix (Felix, 1983).

The Wilson Learning Center of Minnesota has developed a slightly different twist to the analysis or examination of the type of data that might be collected by the Olin Method or Objectives Matrix. This group has put together an Opportunity Profile to evaluate performance criteria with the importance weight or impact each criterion has on total productivity. The Opportunity Profile is a grid with actual performance on the x-axis, using a rating range of 1-9, and the value or importance to the department of that criterion on the y-axis, using a span of 0-100 (see Figure 1).

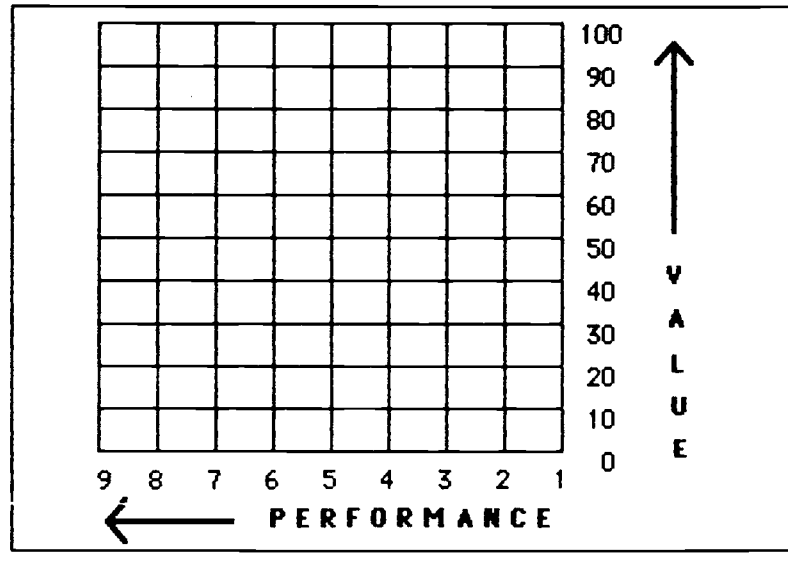


Figure 1 - Opportunity Profile

To develop an Opportunity Profile, a group of responsible employees determines what criteria are important to their work unit. They then measure the level of performance being achieved and the importance of each criterion. This information is then plotted on the grid. The pattern of the relationships between the criteria provides a visual description

of what criteria need to be improved to increase that units' performance.

One excellent element is that the graphs can be compared over several evaluation periods to see what changes are taking place. What this tool does not provide is a system to collect the information, nor does it provide a single index value which can be compared over time.

Since none of these studies and evaluation tools fit all the qualifications that appear necessary to evaluate a service, it appeared that something could be developed by taking the most appealing aspects from several of the studies to come close to an ideal. The result of this combination is the Service Assessment Matrix -- SAM.

3. DEVELOPMENT OF THE SERVICE ASSESSMENT MATRIX

Once management and personnel within a service department have accepted that productivity measurement is important, it is critical to find a tool which can be customized to fit a department's specific needs. SAM is such a tool. It has three objectives: to help evaluate and improve the efficiency and effectiveness of the services being provided (measurement of both productivity and quality parameters); to provide a system for communications between the server and its customer groups; and to track productivity improvement through time. SAM will help a department develop the criteria to track its internal effectiveness, its self-perceptions of service quality, and the clients' perceptions of the service quality.

A matrix is a system which shows relationships among specified elements. In the Service Assessment Matrix the elements are the service department, the customers,and the evaluation factors.

SAM has three components: a Service Assessment Matrix, the Quality Assessment Matrix, and a worksheet. It is a direct extension of the Objectives Matrix as originated by Dr. James Riggs and described by Mr. Glenn Felix of the Oregon Productivity Center (Felix, 1983). It incorporates some of the ideas of Tektronix's Productivity Measure Index (PMI), and the Overhead Profile from the Wilson Learning Center.

Figure 2 shows an ideal Service Assessment Matrix. Details for the body are added once a department has identified its own criteria and ratings. As will be seen in chapters 5 and 6, the form of the matrix

actually used was changed to fit the needs of the departments where the validity of SAM was tested.

Figure 3 shows the basic Quality Assessment Matrix (QAM). This matrix is used by clients to develop the data needed for customized assessments of each service department. The left column of the QAM lists the quality criteria defined in the Service Assessment Matrix.

Originally, the Quality Assessment Matrix was a duplicate of the quality portion of SAM. Each client was expected to use the same quantitative measure as the server for the quality criteria. While working with ESI it was determined that what the department actually wanted was to compare client perceptions with the self-evaluation of service quality. This adaptation meant that clients' subjective ratings would be compared with the server's quantitative evaluation. The goal was to allow the server to identify how to improve the clients' perceptions.

Figure 4 provides a service assessment worksheet which can be used by the analyst to organize and summarize the various client responses. It shows how each client rates the service department, the client average rating, and the standard deviation among the clients' scores. It can also be modified to assist in the evaluation of the weighting factors if the serving department requests input from within the department or from its clients.

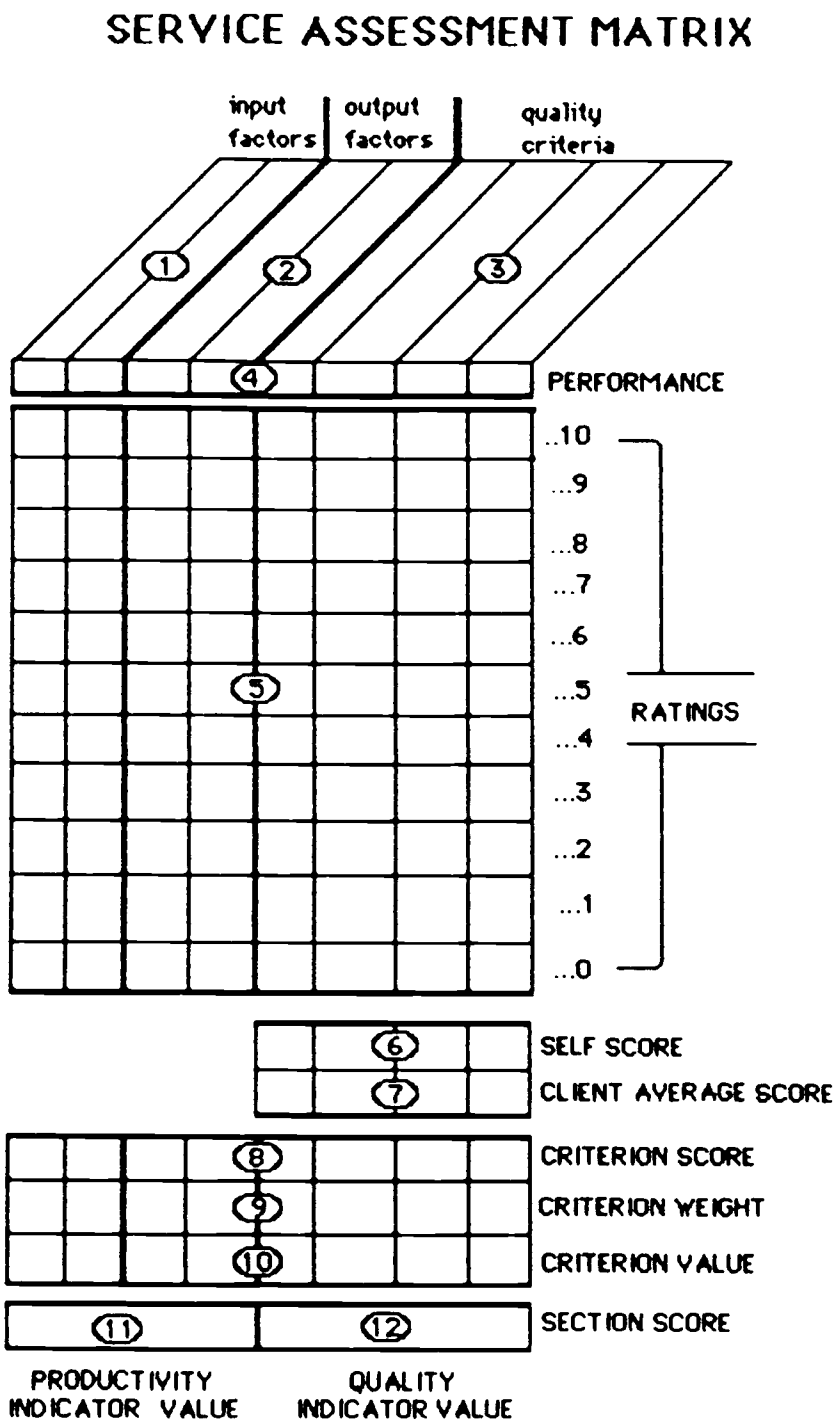


Figure 2 Ideal Service Assessment Matrix

QUALITY ASSESSMENT MATRIX

From ① _____
(Your Department)

CRITERIA ③	Outstanding 10	9	Above Avg. 8	7	② Meets Expectations 6	5	4	Fair 3	2	Poor 1	0
						④					

⑤ INSTRUCTIONS: Please rate the service department on the above listed criteria by placing a check (✓) in the appropriate box. Definitions for the criteria and their ratings can be found on the following pages. Please feel free to add criteria which you think need to be addressed or make additional comments. Your input will help us to serve you better. Thank you for taking time to complete this evaluation.

COMMENTS: ⑥ _____

Figure 3 Quality Assessment Matrix

SERVICE ASSESSMENT WORKSHEET

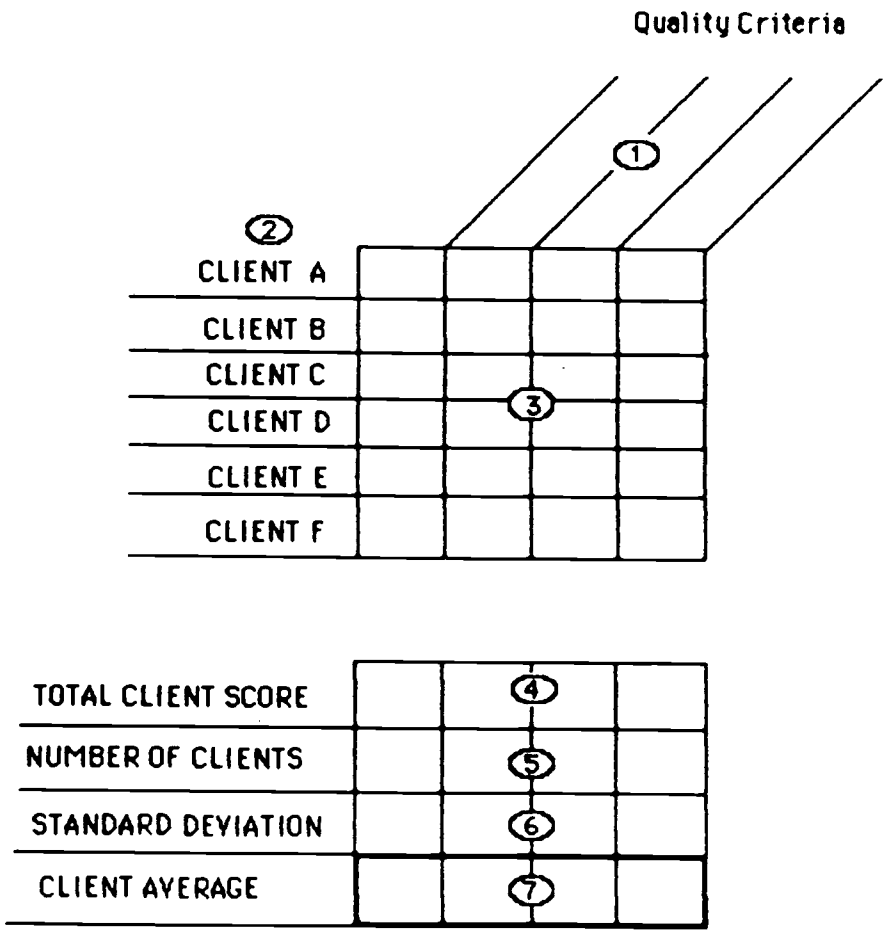


Figure 4 Service Assessment Worksheet

• SERVICE ASSESSMENT MATRIX (Figure 2)

The following list of items describes the features of the ideal generic Service Assessment Matrix, page 18. Each subtitle is keyed to a circled number in Figure 2. The actual mechanics of working the Service Assessment Matrix are the same as those of the Objectives Matrix, and can be found in Appendix C, the journal article which describes the Objectives Matrix.

1., 2. & 3. Assessment Factors - These three factors, input, output and quality criteria, represent the characteristics of performance that define the service department being evaluated. Each criterion is entered as a heading for one column of the matrix. It is necessary, in the development of the criteria, to make sure that all major inputs and outputs are included and that they are relevant to each other and the evaluated department. It is not necessary to have an equal number of input, output or quality criteria. Chapter 4 discusses some of the challenges in developing the criteria.

1. Input Factors - These values are the resources, such as the quantity of labor hours, the number of energy units, or amount of raw materials used during the rating period. Because labor is usually the main input factor in a service department, that might be the only input criterion used in the evaluation.

2. Output Factors - These values depict the department's output during the rating period. They might include criteria such as:

Number of time cards processed
Number of training hours
Number of purchase orders

3. Quality Criteria - The quality criteria should be chosen to depict the factors which are important to the client. Examples are:

Number of minutes
waiting for a response / Total number attempted contacts

Number minutes downtime caused
by serving department error / Total operation time

Total cost of service / Total operating costs

One important and unique aspect of these criteria is that both the server and the client need to be involved with the criteria development. These criteria may be difficult to quantify and thus can be subjective in nature. However, quantitative measures should be utilized whenever possible.

4. Performance - The department's performance during the evaluation period, measured for each criterion, is entered in the appropriate position in this line. In the implementation stage at Evanite, this section was eliminated as being redundant, since it just repeated the number which would be circled in the rating section. Later, during the final evaluation of SAM, it was realized that the actual performance of the department may not be reflected exactly by the rating number, and that the performance section would be beneficial. The value indicating the level of performance might be obtained from production, accounting or personnel records, or from information gained by a systematic collection of data. With the quality criteria, the service department

will need to find a method to obtain the needed numbers. The values will probably be different than the clients' ratings, but this is one of the purposes of this technique, to provide a comparison between the server's evaluation and the clients' perceptions regarding the quality of service.

5. Ratings - The body of the matrix is composed of levels of achievement for all the assessment factors. There are eleven levels, ranging from unsatisfactory performance at level 0 to a realistic objective for superior accomplishment at level 10. When a Service Assessment Matrix is initiated, the prevailing level of performance is considered to be at level 5.

6. Self Score - This line immediately below the body of the matrix identifies the rating achieved by the performance shown in area 4.

7. Client Average Scores - These scores are taken from the worksheet which collates the data from the clients' Quality Assessment Matrices.

8. Criterion Score - For input and output criteria, this score represents the rating received for the level of performance. For the quality criteria, this is a combination of the self and client average scores. The self score can be given equal importance to the client average score, or greater or less importance by weighting. This value can be found as follows:

$$\text{Quality Criterion Score} = \frac{A(\text{Self Score}) + B(\text{Client Average Score})}{A + B}$$

where A and B are the value of the importance for the indicated scores. Chapter 7 shows how the two different companies testing the SAM used different concepts when determining the importance of the client score.

9. Criterion Weight - An importance rating is attached to each of the criterion to indicate its relative impact on the evaluated department's quality and productivity goals. These ratings can be developed by a management group above the level of the department being monitored, by the department head, from feedback from personnel within the serving department, or with input from the clients. Both Evanite and ESI utilized client feedback and departmental judgment to determine their importance factors.

The productivity and quality weights are determined independently. The input and output criteria are combined to form a single productivity subsection. For each subsection the sum of the individual criterion weights should total 100. For instance, if the weight for number of labor hours in the input criteria is 30, then the remaining 70 points would be distributed among the other input and output criteria. The same system is then used for the quality subsection.

10. Criterion Value - The criterion value is each criterion score multiplied by its weight.

11. Productivity Indicator Value - The summation of output and input criteria values provides the current level of the service department's internal productivity.

12. Quality Indicator Value - This block contains the summation of the quality criteria's values. Management can easily see how quality factors are changing in response to the productivity indicator value.

• QUALITY ASSESSMENT MATRIX (Figure 3)

The following list of items describes the features of the Quality Assessment Matrix. Again, the named portions of the matrix, starting from the top section, are keyed to the circled numbers. This matrix utilizes the quality criteria of the Service Assessment Matrix and is the form the client fills out to provide the input needed by the serving department. To use it all the client needs to do is check the level of service it is receiving for each criterion, and then make comments as to why the rating was made, how the service could be improved, or where the serving department needs to apply more resources for better performance.

1. Client's Department - This line identifies the client performing the evaluation for the serving department.

2. Likert Attitude Scale - In 1932 Rensis Likert wrote about his study on how to measure and quantify social attitudes (Likert, 1932). This study produced the most widely used scale for quantifying subjective ratings. It assigned consecutive numerical values to a range of attitudes.

The Quality Assessment Matrix names five attitudes: outstanding, above average, meets expectations, fair, and poor. Since SAM uses a 0-10 rating these values are distributed among the five groups. The final result can be seen in figure 3. It is important to remember that when the QAM is given to the clients the alternatives must be well defined and related to the department being evaluated. The definitions used at

ESI and Evanite are part of figures 6 and 11 located on pages 46 and 57 respectively.

3. Criteria - These are the same quality criteria which the serving department is using to rate itself in the Service Assessment Matrix.

4. Performance Evaluation - This block is where the client checks the level of the service department's performance for each criterion.

5. Instructions - A brief explanation of what is expected from the client is given here.

6. Comments - A most important area, this space provides encouragement and a place for clients to provide information to the server about how the service could be improved, why it does not meet expectations, or any other response about the service being provided. It is a key part of the communication process between the client and the server.

- SERVICE ASSESSMENT WORKSHEET (Figure 4)

The worksheet provides a convenient tool for the analyst to use to collect and evaluate the client data. The data is found in the Quality Assessment Matrix filled out by each of the clients. This worksheet provides a means of comparing each client's quality criteria score with the self score. The elements of the service assessment worksheet are as follows:

1. Quality Criteria - These are the same quality criteria found on the service and quality assessment matrices.

2. Clients - This is a list of the serving department's clients participating in the evaluation.

3. Matrix Body - This area allows a summary of the rankings given by each client, for each quality criterion. The data can be found in Section 4 of the Quality Assessment Matrix for each client.

4. Total Client Score - This is the summation of the scores found in the matrix body.

5. Number of Clients - This is the number of clients who responded to each quality criterion. Normally, it will be the total number of clients participating in the assessment. Occasionally a client will not be able to rate a particular criterion, and therefore marks "not applicable". This block allows the analyst to prevent any blanks from influencing the final results.

6. Standard Deviation - This information allows the serving department to see how much variation there is between the different clients.

7. Average Client Score - This is the total client score divided by the number of clients for each criterion. These values are placed in Section 7 of the Service Assessment Matrix.

The three forms defined by the above sections are the only ones needed for implementation. The most difficult phase of the Service

Assessment Matrix process is the development of the criteria. This process is described in the next chapter.

SAM was ready to be tested. Two companies agreed to try SAM: Electro Scientific Industries (ESI) of Portland, Oregon, and Evanite Fiber Corp. of Corvallis, Oregon.

4. DEVELOPMENT OF CRITERIA

One reason why service departments' productivity has not been measured is because of the difficulty of developing the criteria and the problems involved with getting the customer and staff department to communicate. This chapter describes: three types of productivity measures, two methods available to help determine criteria which will also help to get server and customer communicating, and some comments which should help identify general criteria that can be used to specify unique characteristics of a department to make the generic Service Assessment Matrix a customized tool.

• TYPES OF PRODUCTIVITY MEASURES

There are three major types of productivity ratios (Sumanth, 1984):

Total productivity ratio - Total output to all input factors

Total factor productivity ratio - Net output to the sum of associated labor and capital inputs.

Partial productivity ratio - Ratio of a specific group of output to one set of inputs.

The most commonly used measures are the partial productivity measures. This is because they are easy to understand, and it is easy to obtain the needed data and to compute productivity indices. It is for these reasons that the Service Assessment Matrix described in Chapter

3 utilizes partial productivity measures. But, caution must be used with partial productivity measures.

> "the exclusive reliance on just one or even a few partial measures can be an erroneous if not dangerous practice. . . Using only one measure often over emphasizes one input factor so that the effect of other inputs are underestimated or ignored." (Sumanth, 1984)

The reason for this is clear. "A performance evaluation based on a single factor gives a biased picture of performance (Connolly, 1980)."

Yet a massive set of criteria can become too complex and unmanagable for the evaluation to be relevant and cost effective. It is important, therefore, for each department to identify and develop its own list of performance criteria and then to recognize that it is limited because it is only a partial list of all the elements that actually define the boundaries of the department.

• TWO METHODS TO HELP IDENTIFY CRITERIA

In order to perform an evaluation of a service department the first step is to determine the criteria which will be used to identify productivity and the quality of service. The difficulty of this job is one of the reasons why services have not received as much attention as manufacturing processes.

> "Where output is difficult to measure, attention shifts to the process of identifying criteria which becomes doubly difficult because not only does output need to be measured but the quality of service performed needs to be quantified (Heaton, 1977)."

Another reason for problems is because a service department's mission or roles may not be well defined.

There are two basic ways to develop the desired criteria.

1. Management can look at the department and determine which criteria it feels are important to that department and the company, with or without input from that department or its clients.

2. Management can designate a team consisting of company managers, the service department's personnel and the clients of that department, and allow the team to determine what it feels are the important criteria for that particular department.

There are advantages to both systems. The first system takes less coordination and time, and gives management the authority to determine what is important. The second system allows the people involved to take responsibility for the criteria. It also is a means of getting members of a service department in direct contact with its clients and will help members to more fully understand exactly what management and clients expect from their department. Although this method is more time consuming, it is an excellent format for developing open communication channels. The team approach is the recommended format for the Service Assessment Matrix.

If a team approach is used, there are several recommendations to forming a viable group (Allender,1984):

> 1. Management must support the group by giving it the necessary authority to accomplish its goals. The team must be able to communicate with management, and have clear cut goals and objectives which the team accepts as realistic and

achievable with the given time and resources. It also needs to receive acknowledgment and help from management when needed.

2. The team needs to see its ideas and plans recognized and implemented when feasible.

3. An appropriate team leader must be designated.

4. Team members need to be drawn from all groups that will be affected by the results. This includes management, supervisors and the line workers or clerical help if applicable.

Once a team has been organized there are several methods which can be used to identify desirable criteria. Some are:

Brain storming
Nominal Group Technique
Discussion and vote with majority rule
Discussion and require total or partial consensus
Discussion and leader designated criteria
Delphi-type methods

It is up to management or the team facilitator to determine which method will provide the desired results.

- IDENTIFYING GENERAL CRITERIA FOR SERVICE DEPARTMENTS

There are nine steps recommended to help identify the criteria to customize the generic SAM. Some of the steps refer to information following the list.

1. Identify the service department and its clients, then designate the team members, and set a date for the team to meet. The team then processes through the remaining steps.

2. Define the serving department's mission or goals.

3. Identify potential criteria.
4. Check the potential criteria list to see if they meet the criteria requirements identified below.
5. Make a final determination of which criteria will be used.
6. Identify current levels of operations for the criteria.
7. Identify benchmarks or levels of achievement for each criterion.
8. Identify importance factors or weights for each criterion.
9. Design the final format of the customized SAM.

Once the team has been chosen, it should identify the service department's mission or goals. This will help focus attention on the task at hand and often provides key words to assist in the actual development of the criteria. Then the team can start to identify potential criteria. There are two things the team should remember at this point. First, productivity can not be measured directly, it must be measured indirectly as a relationship between the outputs and inputs that can be assembled. This means that the criteria only reflect productivity. Second, productivity ratios have meaning only when measuring changes over time, so values of the criteria chosen should be able to fluctuate over time (Kendrick, 1984).

There are three areas of measurement that determine the productivity of a service department.

1. How well is it meeting its objectives (internal performance)?
2. How efficient are resources utilized (cost of service)?
3. What quality of service is provided (customer satisfaction)?

The criteria examined should cover all these areas.

Even though a department may be meeting its objectives with a minimum amount of available resources, it may not be doing the best job possible. The difference between adequate output and client satisfaction is quality. The Service Assessment Matrix should include criteria which measure resources used as well as quality. It could include a combination of factors such as quantity, quality, timeliness, material yield, resource utilization, operating consistency, time management, or safety.

When developing the criteria, it often helps to think about categories which describe the service being performed. Sumanth (1984) identifies several general categories.

Human resources
Capital resources
Material resources

These can be broken into subcategories as follows:

Human Resources

Attitude - Willingness to help

Responsiveness - Open to help with problems
Willingness to adapt to contingencies

Timeliness - Provides services when needed
Reports are furnished on time
Persons can be contacted for help without delay
Hours available are convenient

Communications- Clarity in memos and reports
Notified for emergencies or changes
Changes are clear
Information is available
Server is aware of client's goals
Deadlines are clear and followed

Safety- Server considers safety when applicable

Training - Server insures proper use of equipment or materials

Flexibility - Server can adapt to change when the need occurs

Capital Resources

Cost - Informs clients of costs of special services
Keeps cost for special services to desired percentage of total costs
Minimizes costs to customer
Offers different levels of service for different costs

Material Resources

Consistency - Customers know the quality of items to be received

Quality - Service or supplies do not cause downtime or extra costs

Flexibility - Server provides an adequate substitute when original is not available

Timeliness - Orders arrive when they are needed

Quantity - The correct number of items are provided as requested

Efficiency - Minimizes waste
Sufficient resources available to meet emergencies

This is only a partial list of possible ideas. Almas Ahmed, a graduate student of Industrial Engineering at Oregon State University, completed a graduate project in 1985 which described a system to help identify criteria and a more complete list of possible criteria for service departments.

Once a list of potential criteria have been identified a check must be made to: insure that the input and output factors are related, include

the major elements that define the department, and fulfill the following requirements.

Criteria Requirements

Reportable: Is the data easy to collect?
Presentable: Is the data readily understood?
Consistent: Is the method repeatable?
Inclusive: Are all critical features included?
Adaptable: Does the model fit different situations?
Fair: Is the methodology accepted as unbiased and trusted?
Timely: Does the evaluation provide prompt feedback?
Economical: Does the the value of the study exceed the cost?
Responsive: Is the evaluation sensitive to changes?

When the final factors have been chosen, it is time to determine the rankings for each ratio. The rankings in the body of the Service Assessment Matrix run from 0 to 10. This makes eleven levels of accomplishment for each criterion. A single criterion occupies a column that stretches from the top to the bottom of the matrix. Levels of accomplishment extend across the body of the matrix as indicated by the rows marked from 0 through 10. Assignment of results expected at each level is the crucial part of scaling because the results set specific hurdles that reflect accomplishments of a department's objectives. The scale is anchored by designated numbers at three levels:

Level 10 - A realistic estimate of results that can be attained in the foreseeable future, say two years, with essentially the same resources that are now available; a stimulating productivity objective.

Level 5 - operating results indicative of performance proficiency at the time the rating scale was established; current ratio reading at the time measuring is initiated.

Level 0 - the lowest level recorded for the criterion ratio over a recent period of time, say the last year, in which normal operating

conditions existed; nominally the worst ratio reading that might be expected.

The first step is to determine the current level of activity for each criterion. This can be accomplished by looking at current records, or by performing a pre-matrix-assessment.

Once the 5th level is identified, then the lowest level, Level 0, as well as the highest level, Level 10, should be set as described earlier. Equal intervals of ratio results are commonly assigned to each score in the ratings, between 0 and 5 and between 5 and 10. The increments of these two sections do not need to be the same size. This is not an absolute requirement, and as an alternative some type of nonlinear interval can be utilized.

In many situations one or more of the criteria will involve attributes of performance for which no natural quantitative scales exist. It is desirable to try and stay away from subjective scales, but when quality of service is being rated, this may be impossible.

There are many methods available to help develop a subjective scale. The Likert attitude scale, described in chapter 3, is the most popular subjective scale. The problem with it is that the attitudes are not clearly defined, so that the same level of activity could easily be given different rankings by different individuals, making it difficult to compare one rating period with another. Because of the nature of the Service Assessment Matrix, when subjective scales are used, complete descriptions of the ratings must be established which characterize the

criteria as accurately as possible. These descriptions need to be given to the evaluators. Defining the ratings may be difficult.

The bottom score should describe the worst level of activity which has occurred in the recent past such as within a year. The top ranking should describe a level of activity which can be achieved within a reasonable set of time with available resources. The 5th level score should clearly describe the current level of activity being achieved. The following may help to develop a subjective scale. It was developed for a criterion describing a service department's attitude.

---

(10) Outstanding in every way. The department has developed a positive and helpful attitude and assists without complaint any problem its clients may encounter and actively pursues creative means to establish increasingly higher standards of performance in all aspects.

(9) Exceptional to Outstanding. The department has developed a positive attitude and assists without complaint any problem its clients may encounter.

(8) Exceptional in most activities. The department has developed a positive attitude and assists its clients whenever possible and as quickly as possible.

(7) Excellent

(6) Good to Excellent

(5) Good. The department will help its clients and responds within a reasonable time to complaints.

(4) Average

(3) Leaves something to be desired

(2) Below average

(1) Needs immediate attention for major changes.

(0) Unacceptable. The department is unwilling to help with any problem it created, is never willing to discuss a new situation and will not listen when the client tries to express its needs.

At this point most of the developmental work is finished. The remaining task is to put weights to each criterion. This can be done using group consensus or by looking at resources involved with that factor. The SAM uses a method of dividing up 100 points among the productivity indicators and 100 points among the quality criteria. The following scale might help to determine what is important to the service department. How resources should be allocated often identifies the value of an individual criterion. Following is a 10 point scale which might help when determining the weights or values for the criteria.

---

[10] Vitally important: Deserves maximum resources
[9]
[8] Very Useful: More resources should be applied to get more benefits
[7]
[6] Valuable contribution: Consider applying more resources
[5] Definitely Useful: Current level of resources enough
[4] Generally Helpful: Consider less resources
[3]
[2] Occasionally Useful: Does not deserve current attention
[1]
[0] Useless: No purpose served, eliminate resource allocations

---

Now that the formulation of the criteria is finished, the only remaining task is to finalize the now customized format and perform the initial evaluation.

5. THE ESI EXPERIENCE

In October 1985, Electro Scientific Industries' (ESI) Vice President of Manufacturing agreed to have one of his service departments test the untried Service Assessment Matrix. The author was introduced to the manager of the Quality Assurance department. It should be noted that ESI was familiar with the SAM format because of prior work with Dr. Riggs' Objectives Matrix.

After several meetings with the managers who ran the four functional areas of the Quality Assurance department, the decision was made to test the SAM in Document Control. Document Control is one of the functional areas in Quality Assurance. Its primary task is to facilitate the processing of requests for equipment or manufacturing changes in the company using Engineering Change Orders (ECOs) for major changes and No Product Effect Revisions (NPERs) for minor changes. They maintain all master product documents and manage the system that controls changes to these documents. Document Control was chosen because they were going through a change that would allow clients computer access to the current status of active ECOs and NPERs. Cooperation from the ESI Quality Assurance department helped establish needed refinements to SAM.

It was an ideal time to measure the department's productivity because the on-line information system had not yet been implemented. It was hoped that SAM would identify how much productivity improvement there was after the program was implemented. The

Quality Assurance department had high hopes for opening up a line of communications for customer feedback to the department.

During January this author helped the Document Control manager identify the major input, output and quality criteria which might define his department. Once the department's services and internal tasks were identified, a meeting was arranged with four client departments. Even though the quality criteria which had been identified prior to the meeting were not mentioned, the clients brought up or mentioned many of the same details. This server/client meeting was imperative to the process. It was found that the four client departments appreciated the chance to express their problems about the services provided by Document Control. The meeting also involved the customers in the process so that they were more willing to participate, and could understand their roles in the evaluation.

February was a critical time for the Service Assessment Matrix. Major refinements and the final phrasing of the criteria to be used took place. The first question concerned the input factors. Since Document Control was labor intensive it was clear that this would be the major input. But, the two categories of work, ECOs and NPERs, needed to be separated. The labor input was subdivided into the two categories of number of hours spent on ECOs and number of hours spent on NPERS. Another input element was the percentage of time members of the department spent training and providing information to clients. This became the third input factor.

Output for this department was the number of No Product Effect Revisions and Engineering Change Orders processed. Because the quantity of these was not controlled by the department it became important to identify controllable output. The only factor that indicated the work load was the number of days it took to complete a request in either of the categories. This is similar to the HPU (Hours Per Unit) used by Intel and Tektronix.

Several of SAM's problems were now identified. Originally the SAM had a productivity ratio developed by dividing the sum of the output factor values by the sum of the input factor values. This was fine until it was discovered that the chosen criteria for ESI were not what many people would consider pure input or output factors and they were already ratios (elements divided by a period of time). The resulting ratio of input/output did not make sense. Instead of dividing the output by the input, it was determined that the elements of the two subsections should be added to get one productivity indicator section.

The next step was to take the clients' remarks and determine the quality criteria. The client meeting indicated several concerns:

1. Once an ECO or NPER was initiated, how long would it take to process?

2. When a change was requested, was the impact on each department evaluated? Were the changes clearly stated, complete in concept, legibly written and accurately expressed before being passed through the approval system?

3. When a requested change was in process, it was difficult to find out the status of the request without a lot of detective work.

4. When a change request was approved, many peripheral departments had to change their activities; i.e., purchasing of parts, manufacturing processes and inventory control. Sometimes these departments needed a sizable lead time to prepare for a change to eliminate waste and obsolete materials or parts. Clients felt that Document Control should be the liaison in the process.

The original SAM would have required both the client and Document Control to keep track of the above factors by counting some quantitative measure which would control these components. The feasibility of this was unrealistic for several reasons:

1. The numbers generated by each department would be the same as those gathered by the server.

2. The gathering of data would require a large scale and possibly costly paper chase which would deter any department from willingly participating in the evaluation.

3. What Document Control really wanted was to have some way of getting client perceptions that could be compared with a self-measured quantitative quality criteria. This would allow the department to observe what it takes to increase or decrease client satisfaction.

The above problems generated a second refinement. SAM would incorporate a qualitative scale for the clients and a quantitative scale for the self-evaluation. The final format which allowed room for comments after the subjective rating was designed when working with the Evanite Fiber Corp. Having a subjective scale for the Quality Assessment Matrix would simplify the work load required of the clients, provide the desired feedback, open up communications, and allow comparison of actual department performance to perceived performance. The final QAM and the definitions of the criteria and ratings can be found in figures 5 and 6. With the QAM format finished, it was ready to give to the clients.

QUALITY ASSESSMENT MATRIX FOR DOCUMENT CONTROL

From _____
(Your Department)

CRITERIA	Outstanding		Above Avg.		Meets Expectations			Fair		Poor	
	10	9	8	7	6	5	4	3	2	1	0
COORDINATION											
SCREENING											
TURN AROUND / RESPONSE TIME											
INFORMATION AVAILABILITY											

INSTRUCTIONS: Please rate the service department on the above listed criteria by placing a check (✓) in the appropriate box. Definitions for the criteria and their ratings can be found on the following pages. Please feel free to add criteria which you think need to be addressed or make additional comments. Your input will help us to serve you better. Thank you for taking time to complete this evaluation.

Comments: _____

Figure 5 ESI Quality Assessment Matrix

RATINGS

9 - 10 OUTSTANDING - Group frequently comes up with process innovations which yield significant reduction in cost or implementation time of ECO's without sacrificing results.

7 - 8 ABOVE AVERAGE - Occasionally exceeds expectations.

4-5-6 MEETS EXPECTATIONS - Performance expected from a competent staff familiar with the processes used in our designs, in relation to the ECO system.

2-3 FAIR - Work is only adequate and sometimes fails to meet expectations.

0-1 POOR - Lacking technical competence and/or experience levels to satisfy present needs.

CRITERIA

The following list of criteria are defined with lists of descriptors to assist in the evaluation of the Document Control Department. They have been placed in random order, so there is no priority or preference to the list.

COORDINATION - Coordination of Processes; Drafting time, Inventory, Purchasing and other areas that can be affected by an ECO.

- Awareness of Effects on Other Departments
- Notification of Changes
- Accessibility
- Cooperation

SCREENING - The effectiveness in identifying the overall impact of an ECO before routing for approval.

- Completeness
- Clarity
- Legibility
- Accuracy

TURN AROUND / RESPONSE TIME - The length of time an ECO is in process from initiation to implementation.

- Effectiveness
- Responsive to Bottlenecks
- Timliness

INFORMATION AVAILABILITY - Ability to easily access information relating to a specific ECO.

- Feedback
- Supportive
- Cooperative
- Accessibility
- Responsiveness
- Notification of Changes

Figure 6 Description of ESI Ratings and Criteria

Developing the internal quality criteria was a different matter. Measures were needed that would quantify the four client quality criteria. It was decided that if Document Control was failing to coordinate or screen ECO's or NPERs adequately, it would be reflected by customer complaints. The number of complaints in the respective areas became the internal performance criteria.

Turn Around/Response Time was limited by three distinct activities controlled by Document Control. The screening, drafting and filming activities each had their own waiting time or queue. All three were important so it was decided to account for them individually. By separating out these events, Document Control could identify where the delay had occurred when the value of the Turn Around/Response Time criterion dropped. To get the average self score, which could be compared to the client perceptions, the three values would be averaged

The final quality criterion of Information Availability had two distinct categories: computer down time, which minimized the time available for clients or server to get information; and the number of failed routings. Both of these became parts of the Information Availability criterion and were averaged to determine its final value. The beauty of the above criteria was that information was already available so that the current performance levels and desired benchmarks or hurdles could be identified with minimal "special" data collection.

Two steps remained before initial evaluation could be completed. The weights had to be set and the Service Assessment Matrix format finalized. The Document Control manager decided he wanted client input

to supplement his own judgment to determine the quality criteria's importance factors. He felt that the opinions from the four clients were as important as his own. Therefore, when the QAM was handed out, clients were asked to rate the importance of each criterion. They were directed to divide 100 points among the quality criteria. The results of these judgments were placed on an importance worksheet along with his evaluation listed as Document Control (figure 7). The resulting average found at the bottom of the worksheet would be put on the final SAM.

The initial evaluation could be made. The Quality Assessment Matrix was sent out to the four clients in mid-February, 1986. While the clients were doing their evaluations the Document Control manager was setting the values and determining his weights for both the productivity and quality criteria. The format for the ESI-Document Control SAM (figure 8) was complete. The initial evaluation was performed in March, 1986. A description of the methods used for the analysis can be found in Chapter 6.

The next phase will be a second evaluation to see what productivity changes and quality improvements occur after installing and debugging the on-line computer system. Presently the time frame for this is unknown. Ideally the evaluation should be made on a quarterly or bi-annual basis. Faster evaluations demand that clients respond too often within too short a time span for departmental changes to occur. An early re-evaluation could jeopardize the validity of future responses. Follow-up of this study will be reported in a later journal article.

DOCUMENT CONTROL
SERVICE ASSESSMENT WORKSHEET

IMPORTANCE FACTORS FOR QUALITY CRITERIA

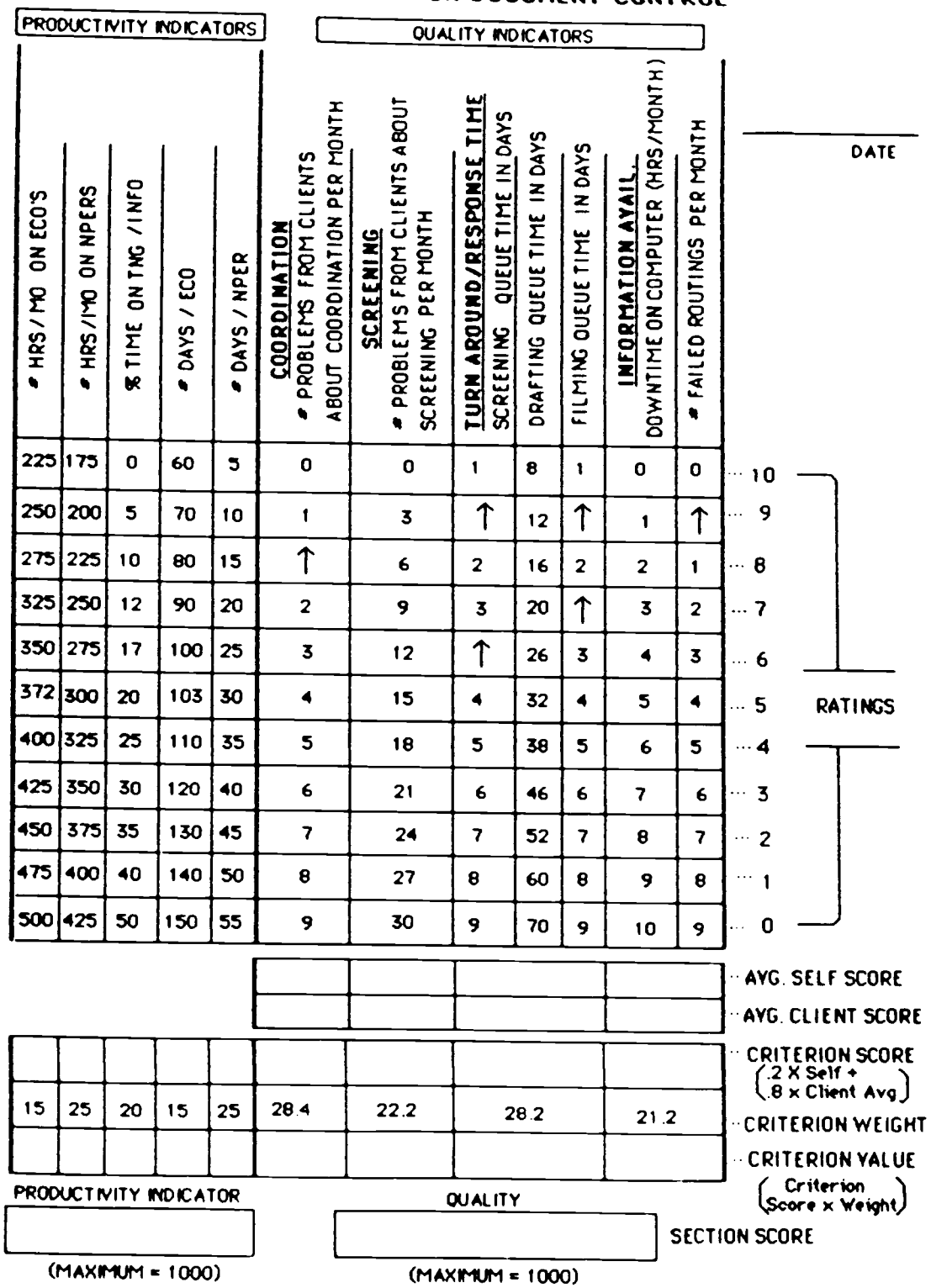
MARCH 1986
DATE

CLIENTS	COORDINATION	SCREENING	TURN AROUND / RESPONSE TIME	INFORMATION AVAILABILITY		
Client A	10	30	50	10		
Client B	25	20	25	30		
Client C	52	16	16	16		
Client D	30	20	25	25		
Document Control	30	15	40	15		

TOTAL IMPORTANCE FACTOR SCORE	147	101	156	96		
NUMBER OF EVALUATORS	5	5	5	5		
STANDARD DEVIATION	15.0	5.9	13.6	8.1		
AVERAGE SCORE	29.4	20.2	31.2	19.2		

Figure 7 ESI Importance Factors Worksheet

SERVICE ASSESSMENT MATRIX FOR DOCUMENT CONTROL



PRODUCTIVITY INDICATORS					QUALITY INDICATORS							
# HRS / MO ON ECO'S	# HRS/MO ON NPERS	% TIME ON TNG / INFO	# DAYS / ECO	# DAYS / NPER	COORDINATION # PROBLEMS FROM CLIENTS ABOUT COORDINATION PER MONTH	SCREENING # PROBLEMS FROM CLIENTS ABOUT SCREENING PER MONTH	TURN AROUND/RESPONSE TIME SCREENING QUEUE TIME IN DAYS	DRAFTING QUEUE TIME IN DAYS	FILMING QUEUE TIME IN DAYS	INFORMATION AVAIL. DOWNTIME ON COMPUTER (HRS/MONTH)	# FAILED ROUTINGS PER MONTH	DATE
225	175	0	60	5	0	0	1	8	1	0	0	... 10
250	200	5	70	10	1	3	↑	12	↑	1	↑	... 9
275	225	10	80	15	↑	6	2	16	2	2	1	... 8
325	250	12	90	20	2	9	3	20	↑	3	2	... 7
350	275	17	100	25	3	12	↑	26	3	4	3	... 6
372	300	20	103	30	4	15	4	32	4	5	4	... 5
400	325	25	110	35	5	18	5	38	5	6	5	... 4
425	350	30	120	40	6	21	6	46	6	7	6	... 3
450	375	35	130	45	7	24	7	52	7	8	7	... 2
475	400	40	140	50	8	27	8	60	8	9	8	... 1
500	425	50	150	55	9	30	9	70	9	10	9	... 0
												... AVG. SELF SCORE
												... AVG. CLIENT SCORE
												... CRITERION SCORE (.2 X Self + .8 x Client Avg)
15	25	20	15	25	28.4	22.2	28.2			21.2		... CRITERION WEIGHT
												... CRITERION VALUE (Criterion Score x Weight)

RATINGS

PRODUCTIVITY INDICATOR _____ (MAXIMUM = 1000)

QUALITY _____ (MAXIMUM = 1000)

SECTION SCORE

FIGURE 8 ESI Document Control SAM

6. THE EVANITE EXPERIENCE

Evanite Fiber Corporation provided a different environment for the testing of the Service Assessment Matrix. The manager of the Central Engineering department, was looking for a technique that would help evaluate his department's performance. He had no prior experience with the Objectives Matrix.

Because the engineering department had not participated in any specific productivity studies, what they wanted was something that could provide immediate results and identify major service problems. Once these problems and possible solutions were identified, then the department could extend the program to examine productivity in more detail. The Evanite Engineering department was ready to work with an evaluation/communication tool such as SAM.

The first group meeting at Evanite was with the seven engineers within the department, including the manager. The purpose was to introduce SAM, and to have the engineers start thinking about criteria which could define the boundaries of their services. A preliminary list of criteria was developed and the engineers were given a week to return their comments to the department manager.

Later a general set of criteria based on the engineers' comments were identified. At this time the department manager expressed his desire to tell the clients only about the Quality Assessment Matrix. He felt they did not have a "need to know" about the internal portion of

the evaluation. This, and the initial need for the tool to quickly identify any general problem areas, had a major influence on the final format of the SAM. It became a totally subjective tool measuring only internal and external perceptions about the quality of service.

A meeting the following week with Central Engineering's four major clients, the managers of four of the five local Evanite production plants, proved very interesting. Their expectations about the services they thought engineering should provide differed from the internal ideas. The verification that differences existed between the server's and clients' perceptions confirmed the validity of SAM as a communication tool. It was at the meeting with this group that the Quality Assessment Matrix was refined. Originally there had been no specific place for client comments. The clients requested an area for comments and it became a valuable addition. Because of the need for comment space, the list of criteria and the subjective scale were placed horizontally across the top with instructions and room for comments immediately following. It was obvious that the definitions of the criteria and ratings would need to be placed on a separate page.

Using the ideal generic SAM as a guide, it was time to identify the input and output criteria and to finalize the quality criteria. Labor was the major input but counting how many hours went into a project or how many projects were completed in any one time period became unreasonable. Some small projects might take a day or a week, and some major capital improvement projects might take a year or more. With this in mind, it was initially determined that what was needed was

to identify how time was being managed. Six distinct activites of how the engineers spent their time were identified:

1. Feasibility studies
2. Equipment cost estimates
3. Preliminary engineering
4. Funding requests
5. Completed projects
6. Miscellaneous technical assistance

The engineers had few problems with what activities belonged in each category. A seventh category should have been included that would account for time not spent on engineering services. At that time the omission of this category was not important. The whole section was eliminated in the final format because the engineering department was not sure if it would be feasible to allocate the time, which would need to be committed for data collection and analysis, for an untested technique.

The quality criteria to be used combined the engineers' remarks with the clients' comments. They were identified by asking the question, "What do we do for our clients?". During this stage of development, it was determined that the clients should have some type of statement about the engineering department's mission and goals. A mission statement was written and added as an addendum to the clients' Quality Assessment Matrix. Since it was not part of the SAM format, it has not been included in this thesis.

Figures 9 and 10 show the initial draft of the Evanite Service Assessment Matrix, and the Quality Assessment Matrix. The description of the ratings and the criteria can be found in figure 11. Since the

involved personnel had provided input about the criteria, it was felt that they should be able to understand the definitions. When handing out the Quality Assessment Matrix it was made clear that if there were any questions they should feel free to call the Engineering department.

Since the QAM was a subjective tool, it needed no quantitative rating values. It was ready to give to the clients. The Engineering manager wanted to include the clients' judgements about how important each criterion was to service quality so when the four production plant managers were given the Quality Assessment Matrix they were asked to weight each criterion by dividing 100 points among them. An afterthought determined that one other client, a maintenance superintendent within one of the production plants, should be involved with the evaluation. The final result was that three plant managers provided information about importance factors for each criterion and five clients participated in actual service evaluations.

While the clients were completing the QAM, the SAM was being finalized. It was determined earlier that the quality portion would contain the same criteria and attitude scale as the Quality Assessment Matrix. It was also established that internal performance measures would not be evaluated at this time. The manager felt that if he and his six staff engineers completed a QAM and judged the importance of each quality criteria, he would get the information he needed on internal performance without having to develop a number crunching data collection system. The Evanite Service Assessment Matrix was complete.

SERVICE ASSESSMENT MATRIX FOR ENGINEERING

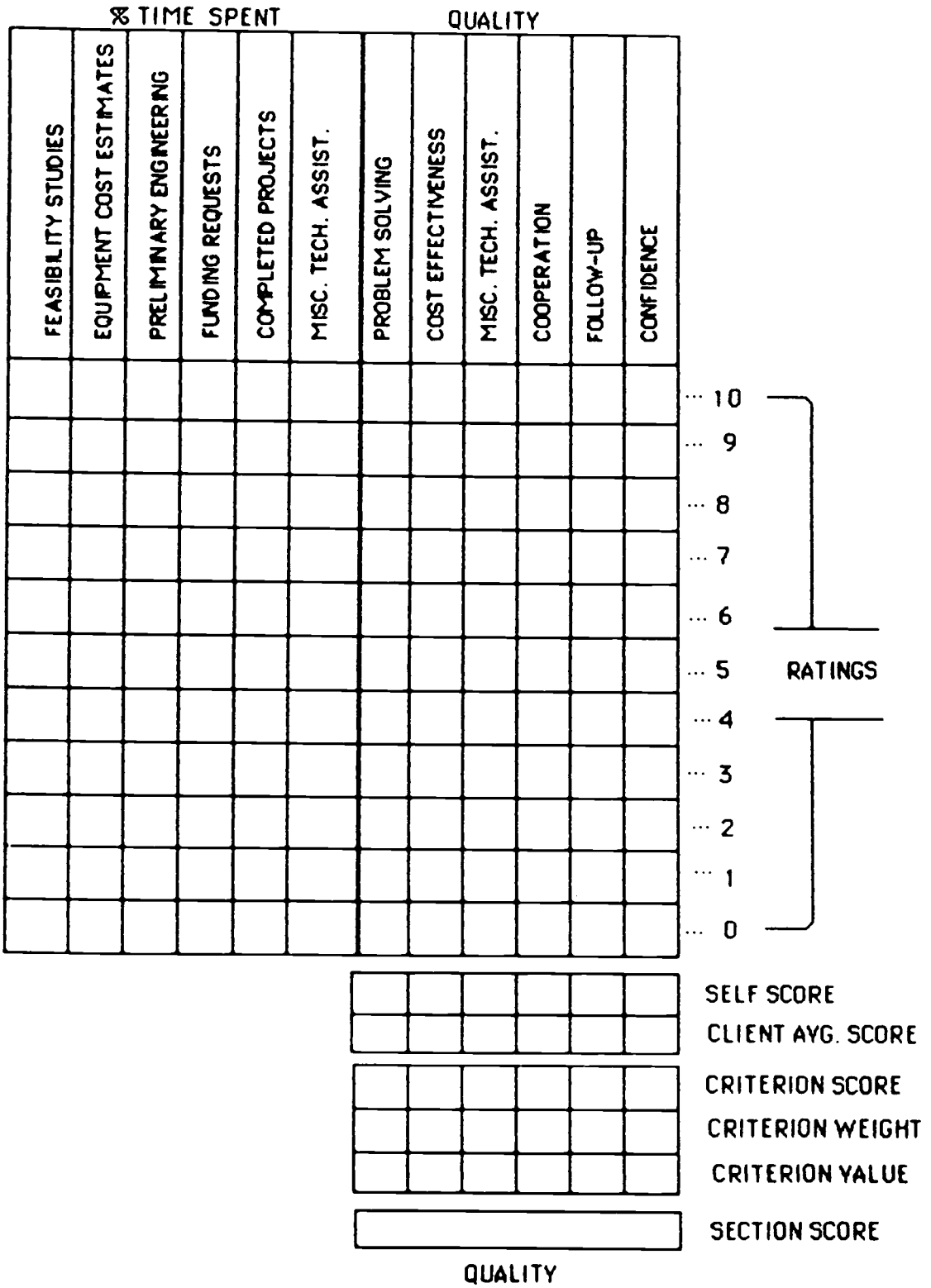


Figure 9 Initial Evanite SAM

QUALITY ASSESSMENT MATRIX FOR ENGINEERING

From _____
(Your Department)

CRITERIA	Outstanding		Above Avg.		Meets Expectations			Fair		Poor	
	10	9	8	7	6	5	4	3	2	1	0
Problem Solving											
Cost Effectiveness											
Misc. Tech. Assist.											
Cooperation											
Follow-up											
Confidence											
_____											
_____											

INSTRUCTIONS: Please rate the service department on the above listed criteria by placing a check (✓) in the appropriate box. Definitions for the criteria and their ratings can be found on the following pages. Please feel free to add criteria which you think need to be addressed or make additional comments. Your input will help us to serve you better. Thank you for taking time to complete this evaluation.

COMMENTS: _____

Figure 10 Evanite Quality Assessment Matrix

RATINGS

9 - 10 OUTSTANDING - Group frequently comes up with design innovations or equipment purchases which yield significant reduction in cost or implementation time of a project without sacrificing results.

7 - 8 ABOVE AVERAGE - Occasionally exceeds expectations.

4-5-6 MEETS EXPECTATIONS - Performance expected from a competent staff familiar with equipment and processes used in our plants and their related industries.

2-3 FAIR - Work is only adequate and sometimes fails to meet expectations.

0-1 POOR - Lacking technical competence and/or experience levels to satisfy present needs.

CRITERIA

The following list of criteria are defined with lists of descriptors to assist you in the evaluation of the Engineering department. They have been placed in random order, so there is no priority or preference to the list.

PROBLEM SOLVING - Assistance in resolving day to day short-term problems, equipment malfunctions, etc.

Availability	Technical Skill Level	Responsiveness
Communications	Timeliness	Work Outside Regular Hours

COST EFFECTIVENESS - Meeting or exceeding project performance objectives within time and budget constraints.

Ease of Implementation	Parts Availability	Durability
Equipment Selection	Unexpected Continued Maintenance	

MISCELLANEOUS TECHNICAL ASSISTANCE - Trouble-shooting production equipment problems. Providing technical information and opinions on present or proposed equipment or processes, of a relatively minor nature, i.e. pump or valve replacements, piping diagrams, estimates for facility repairs or minor changes, etc.

Responsiveness	Completeness
Legibility of Documentation	Technical Competence

COOPERATION - Willingness to work with personnel in other departments.

Responsiveness	Willingness to listen
Flexibility	Scheduling

FOLLOW-UP - Verification that project objectives were achieved and completion of engineering, operating and maintenance documentation.

Wiring Diagrams	Spare Parts Lists	Certification
Model Numbers	Verification of Design Assumptions	

CONFIDENCE - The expectation that the work will be done right, the first time, on time, and in budget.

Figure 11 Description of Evanite Ratings and Criteria

The final draft of the Evanite SAM included only a quality indicator. This raised serious questions. Was the final Evanite matrix really a SAM, or a hybrid which failed to utilize the key elements of the system? It lacked internal productivity parameters making it uncomparable with the generic or ESI models. But it did include internal perceptions, opened up communications, and identified the department's major service problems. Once engineering determined what it wanted to do to solve the service quality problems, then it could incorporate the time management productivity section to develop a complete Service Assessment Matrix. It is suspected that a time management evaluation would have helped to determine why certain quality factors were not meeting expectations and would have shown where improvement could have been made, but for the reasons explained earlier, the idea was rejected.

Since the SAM did not include the time management portion it was a simple matter to hand out the QAMs to each engineer within the department and use a worksheet to find their self average scores. These averages would be used to fill in the top portion of the SAM. While the engineers were evaluating themselves, they were also asked to determine how important each quality criterion was to the department's productivity.

The returned data provided information from both internal and external sources on service quality and on the importance of each criterion. To determine the weights for the criteria some number crunching was required. Two worksheets were used, one for the

engineers (figure 12) and one for the clients (figure 13). These numbers then needed to be combined. The method used was to multiply the client average by .6 and the engineers' average by .4 for each criterion. These factors were chosen in recognition that client perceptions were more important than self perceptions. The scores were added together and the results posted on the final SAM (figure14).

Within two weeks both the engineers and the clients had returned the Quality Assessment Matrices for evaluation. An initial evaluation was performed (results in next chapter) using the data from the engineers and all five clients.

Following the evaluation the Engineering department manager wrote a letter on how much he had appreciated working with SAM. He also commented on the methods used by the clients to gather their data. One manager used an in-house committee assessment, another performed the evaluation on his own. A third manager was influenced by recollections of past services rather than current performances. This meant that there was little consistency in the manner in which the appraisals were completed. It did allow the clients latitude in how they wanted to participate in the SAM process. An extended study could be made to determine the most accurate method to have clients fill in the QAM.

ENGINEERING
SERVICE ASSESSMENT MATRIX
WORKSHEET

SELF EVALUATION FROM ENGINEERS WITHIN THE DEPARTMENT FOR IMPORTANCE OF CRITERIA

MARCH 1986

DATE

EVALUATOR	PROBLEM SOLVING	COST EFFECTIVENESS	MISC. TECH. ASSIST.	COOPERATION	FOLLOW-UP	CONFIDENCE		
Engineer A	20	30	8	10	7	25		
Engineer B	18	18	16	18	14	16		
Engineer C	20	12	20	15	15	18		
Engineer D	20	30	10	20	10	10		
Engineer E	20	20	15	15	15	15		
Engineer F	20	15	10	20	15	20		
Engineer G	25	15	20	15	15	10		
TOTAL SELF SCORE	143	140	99	113	91	114		
NUMBER OF EVALUATORS	7	7	7	7	7	7		
STANDARD DEVIATION	2.14	7.28	4.9	3.53	3.21	5.38		
SELF AVERAGE SCORE	20.4	20	14.1	16.1	13	16.3		

Figure 12 Evanite Engineers' Importance Factor Worksheet

ENGINEERING
SERVICE ASSESSMENT MATRIX
WORKSHEET

EVALUATION FROM CLIENTS FOR IMPORTANCE OF CRITERIA

MARCH 1986
DATE

CLIENTS	PROBLEM SOLVING	COST EFFECTIVENESS	MISC. TECH. ASSIST.	COOPERATION	FOLLOW-UP	CONFIDENCE		
CLIENT A	5	10	15	15	15	40		
CLIENT B	15	5	15	10	27	28		
CLIENT C	20	20	20	10	15	15		
TOTAL CLIENT SCORE	40	35	50	35	57	83		
NUMBER OF CLIENTS	3	3	3	3	3	3		
STANDARD DEVIATION	7.6	7.6	2.9	2.9	6.9	12.5		
CLIENT AVERAGE SCORE	13.3	11.6	16.6	11.6	19	27.7		

Figure 13 Evanite Clients' Importance Factors Worksheet

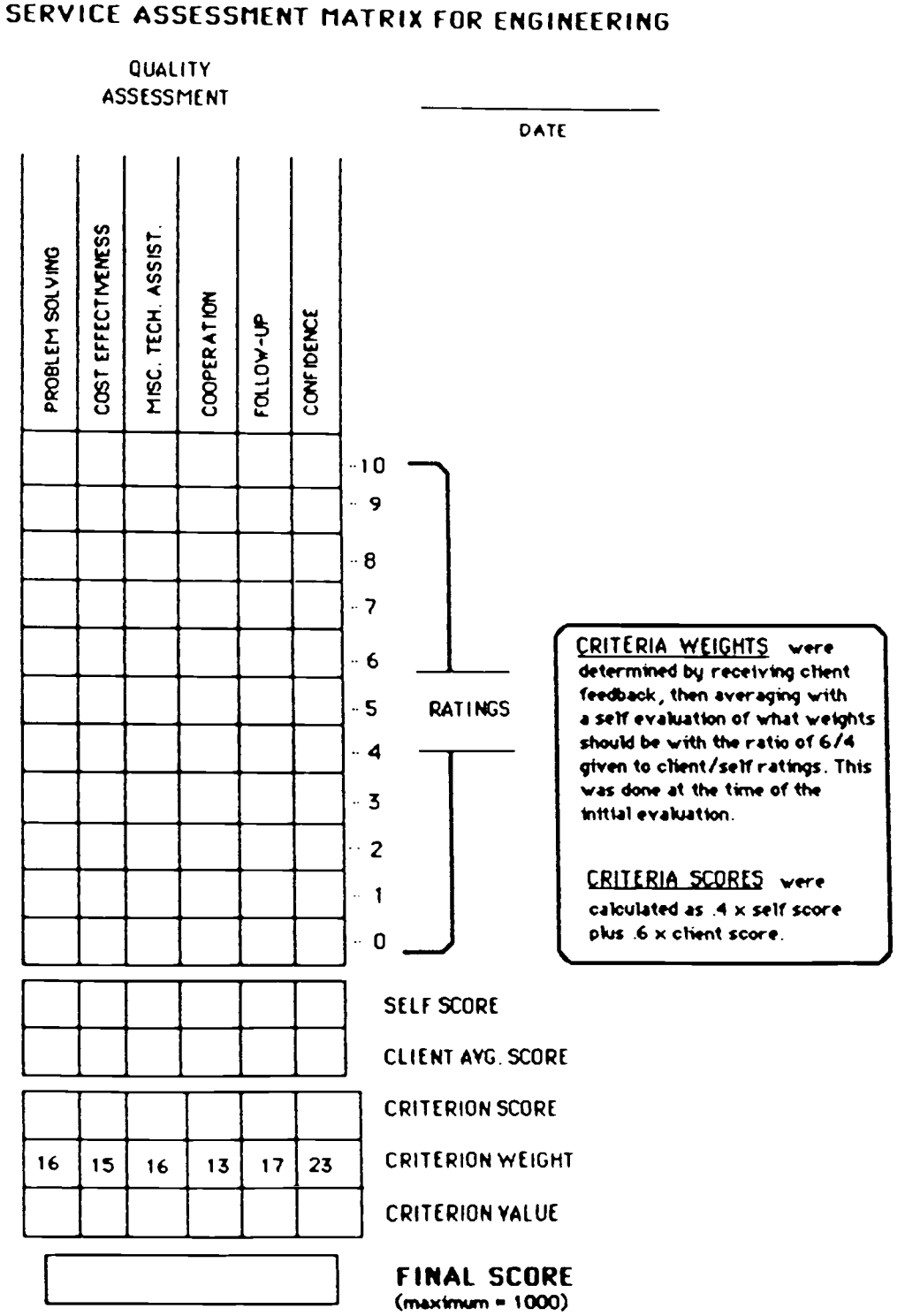


Figure 14 Evanite Engineering Department Service Assessment Matrix

7. EVALUATION OF DATA

When all of the Quality Assessment Matrices had been returned to the serving departments and they had finished their self-evaluations, it was time to analyze the results. It was easy to work with the data using a SAM worksheet.

Figure 15 is the quality criteria worksheet from ESI. With ESI the Criterion Score was based on a simple average with Document Control getting the same value as each client. Since there were four clients the Criterion Score was calculated as:

$$\text{Criterion Score} = \frac{.2 \times \text{Self Score} + .8 \times \text{Client Average}}{.2 + .8}$$

Figure 16 is the first ESI SAM which was completed in mid-March.

Figures 17 & 18 are the two quality criteria worksheets from Evanite. With the Evanite SAM, the averages from the bottom of the engineers' evaluations are the values used to fill in the top of the Evanite SAM and the averages from the bottom of the clients' evaluations are the Client Average values. To get the final quality criteria scores the same 4/6 ratio used to determine the importance factors' values was used for the criteria weights.

$$\text{Criterion Score} = \frac{.4 \times \text{Self Score} + .6 \times \text{Client Average}}{.4 + .6}$$

Figure 19 is the Evanite SAM completed in early March.

DOCUMENT CONTROL

SERVICE ASSESSMENT WORKSHEET

CLIENT QUALITY CRITERIA

MARCH 1986

DATE

CLIENTS	COORDINATION	SCREENING	TURN AROUND / RESPONSE TIME	INFORMATION AVAILABILITY		
CLIENT A	6	5	1	7		
CLIENT B	6	6	6	8		
CLIENT C	6	7	4	5		
CLIENT D	3	8	5	4		
TOTAL CLIENT SCORE	21	26	16	24		
NUMBER OF CLIENTS	4	4	4	4		
STANDARD DEVIATION	1.5	1.3	2.2	1.8		
CLIENT AVERAGE SCORE	5.25	6.5	4	6		

Figure 15 ESI Quality Criteria Worksheet

SERVICE ASSESSMENT MATRIX FOR DOCUMENT CONTROL

MARCH 1986
DATE

PRODUCTIVITY INDICATORS					QUALITY INDICATORS							
# HRS / MO ON ECO'S	# HRS/MO ON NPERS	% TIME ON TNG / INFO	# DAYS / ECO	# DAYS / NPER	COORDINATION # PROBLEMS FROM CLIENTS ABOUT COORDINATION PER MONTH	SCREENING # PROBLEMS FROM CLIENTS ABOUT SCREENING PER MONTH	TURN AROUND/RESPONSE TIME SCREENING QUEUE TIME IN DAYS	DRAFTING QUEUE TIME IN DAYS	FILMING QUEUE TIME IN DAYS	INFORMATION AVAIL. DOWNTIME ON COMPUTER (HRS/MONTH)	# FAILED ROUTINGS PER MONTH	
225	175	0	60	5	0	0	1	8	1	0	0	10
250	200	5	70	10	1	3	↑	12	↑	1	↑	9
275	225	10	80	15	↑	6	2	16	2	2	1	8
325	250	12	90	20	2	9	3	20	↑	3	2	7
350	275	17	100	25	3	12	↑	26	3	4	3	6
(372)	(300)	(20)	(103)	(30)	(4)	(15)	(4)	(32)	(4)	(5)	(4)	5
400	325	25	110	35	5	18	5	38	5	6	5	4
425	350	30	120	40	6	21	6	46	6	7	6	3
450	375	35	130	45	7	24	7	52	7	8	7	2
475	400	40	140	50	8	27	8	60	8	9	8	1
500	425	50	150	55	9	30	9	70	9	10	9	0

RATINGS

5	5	5	5	AVG. SELF SCORE
5	6	4	6	AVG. CLIENT SCORE

5	5	5	5	5	5	5.8	4.2	5.8	CRITERION SCORE (.2 x Self + .8 x Client Avg)
15	25	20	15	25	29.4	20.2	31.2	19.2	CRITERION WEIGHT
75	125	100	75	125	147	117.1	131.0	111.3	CRITERION VALUE (Criterion Score x Weight)

PRODUCTIVITY INDICATOR	QUALITY	
500	506.4	SECTION SCORE
(MAXIMUM = 1000)	(MAXIMUM = 1000)	

Figure 16 ESI Initial SAM Evaluation

ENGINEERING
SERVICE ASSESSMENT MATRIX
WORKSHEET

SELF EVALUATION FROM ENGINEERS WITHIN THE DEPARTMENT QUALITY OF SERVICE EVALUATION

MARCH 1986

DATE

EVALUATOR	PROBLEM SOLVING	COST EFFECTIVENESS	MISC. TECH. ASSIST.	COOPERATION	FOLLOW-UP	CONFIDENCE		
Engineer A	7	5	6	7	4	5		
Engineer B	8	8	6	9	6	7		
Engineer C	8	7	8	7	6	7		
Engineer D	7	5	7	5	5	5		
Engineer E	7	6	7	7	6	7		
Engineer F	7	5	6	7	5	6		
Engineer G	6	6	7	8	4	6		
TOTAL SELF SCORE	50	42	47	50	36	43		
NUMBER OF EVALUATORS	7	7	7	7	7	7		
STANDARD DEVIATION	.69	1.15	.75	1.21	.90	.90		
SELF AVERAGE SCORE	7.1	6.0	6.7	7.1	5.1	6.1		

Figure 17 Engineers' Quality Criteria Worksheet

ENGINEERING
SERVICE ASSESSMENT MATRIX
WORKSHEET

CLIENT QUALITY OF SERVICE EVALUATION

MARCH 1986
DATE

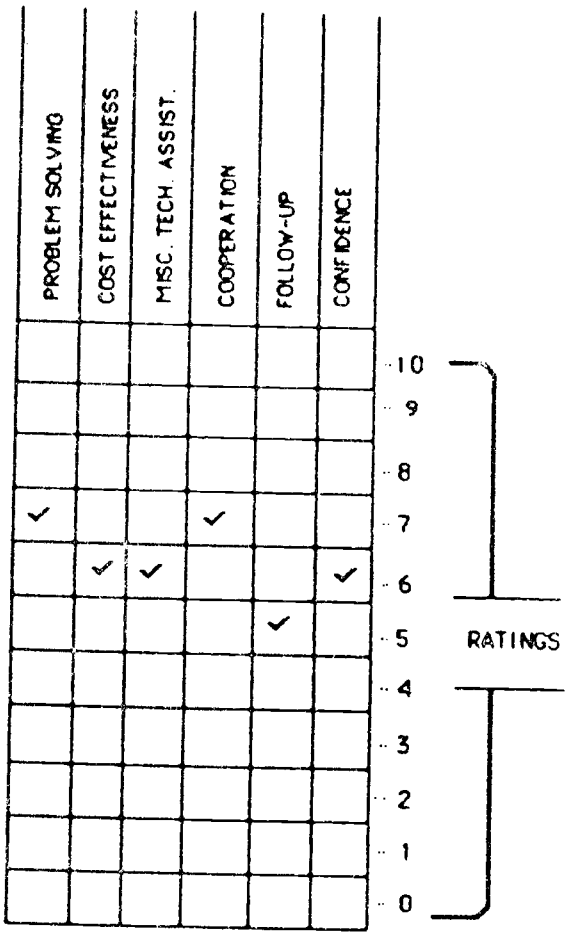
CLIENTS	PROBLEM SOLVING	COST EFFECTIVENESS	MISC. TECH. ASSIST.	COOPERATION	FOLLOW-UP	CONFIDENCE		
CLIENT A	3	4	3	7	4	2		
CLIENT B	7	8	6	7	5	(3)/4		
CLIENT C	5	5	6	10	1	1		
CLIENT D	8	7	8	8	7	7		
CLIENT E	6	6	7	8	1	5		
TOTAL CLIENT SCORE	29	30	30	40	18	18		
NUMBER OF CLIENTS	5	5	5	5	5	5		
STANDARD DEVIATION	1.9	1.58	1.87	1.22	2.6	2.41		
CLIENT AVERAGE SCORE	5.8	6.0	6.0	8.0	3.6	3.6		

Figure 18 Evanite Clients' Quality Criteria Worksheet

SERVICE ASSESSMENT MATRIX FOR ENGINEERING

QUALITY CRITERIA

MARCH 1986
DATE



7	6	6	7	5	6	SELF SCORE
5	6	6	8	3	3	CLIENT AVG. SCORE
5.8	6	6	7.6	3.2	4.2	CRITERION SCORE
16	15	16	13	17	23	CRITERION WEIGHT
92.8	90	96	98.8	54.4	96.6	CRITERION VALUE

528.6 **FINAL SCORE** (maximum = 1000)

CRITERIA WEIGHTS were determined by receiving client feedback, then averaging with a self evaluation of what weights should be with the ratio of 6/4 given to client/self ratings. This was done at the time of the initial evaluation.

CRITERIA SCORES were calculated as .4 x self score plus .6 x client score.

Figure 19 Evanite Initial SAM Evaluation

When considering types of analyses, the first thought was to use a student t-test or an F-test to check for statistical differences between self and client perceptions. Because there was neither randomness in choice of clients nor independence between criteria, parametric tests were invalid. The use of non-parametric measures, such as a Wilcoxen sign test, was also contemplated. Lack of sensitivity with non-parametric tests and excellent results with charts determined that a statistical analysis was inappropriate and unnecessary.

The result was a three part evaluation: a graphical representation which compares client ratings with self ratings, a pattern analysis, and a written statement. Two additional evaluations should be made when there has been more than one evaluation; an analysis of the productivity and quality indicator values, and a trend analysis.

• COMPARISON OF CRITERIA ANALYSIS

These evaluations used bar graphs to compare the clients' perceptions with the service department's evaluation by criteria and by client. The first set of graphs helped to evaluate each criterion. They showed how each client's score and the client average compared with the self score.

Figure 20 is the resulting graph for the ESI Turn Around/Response Time criterion. Figure 21 is the Evanite Follow-Up criterion graph. These graphs showed the differences between each department's evaluation, which department has the lowest opinion about service

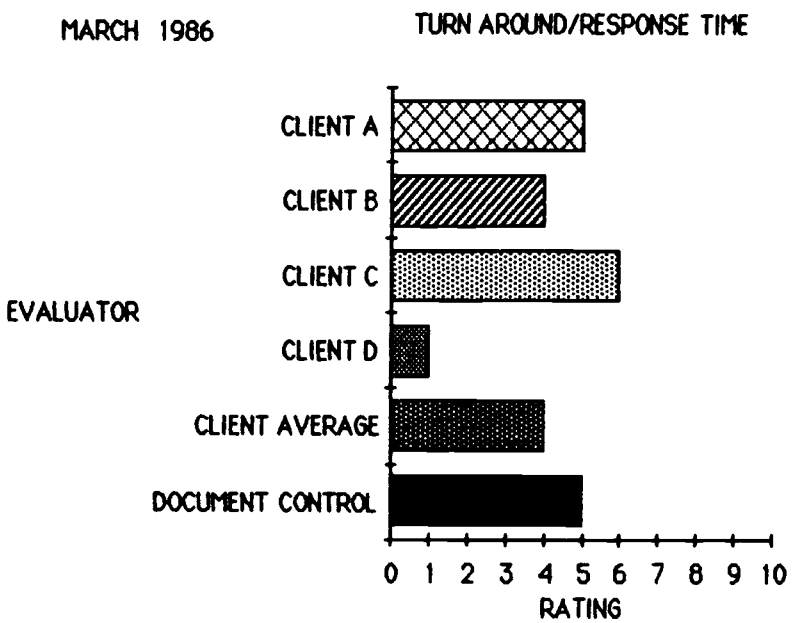


Figure 20 ESI Comparison of Scores for Turn Around/Response Time

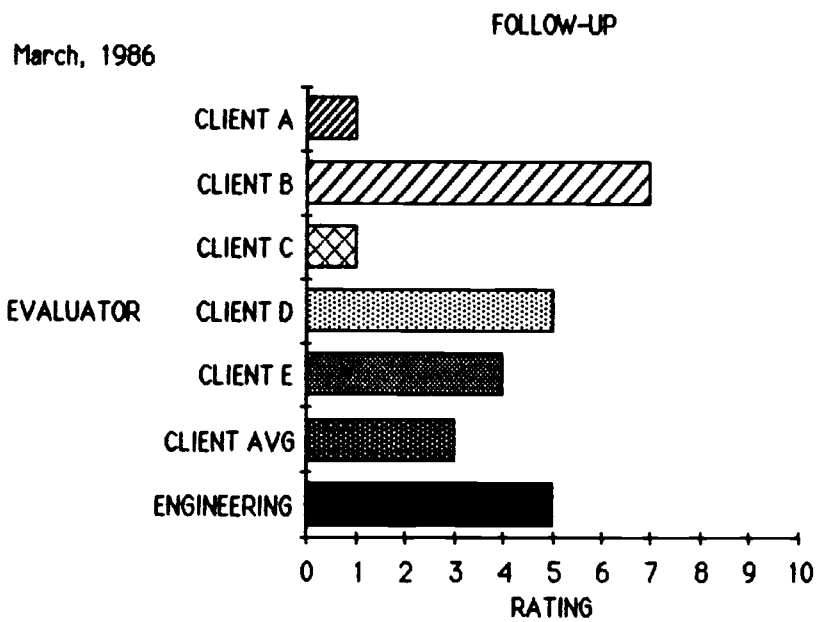


Figure 21 Evanite Comparison of Scores for Follow-up Criterion

quality, and how much the self-evaluation differed from each client and the average.

The next graphs took each client's scores and plotted them directly against the self-evaluations for all of the criteria. Figure 22 is client A's ratings vs. Document Control for ESI. Figure 23 is Evanite's client average ratings vs. Engineering. This data was a duplication of the information in the SAM worksheet, but it drew attention to a particular department or the client average when it was consistently different from the self evaluation. This can be observed in figure 22, where client A rated Document Control high for all the quality criteria.

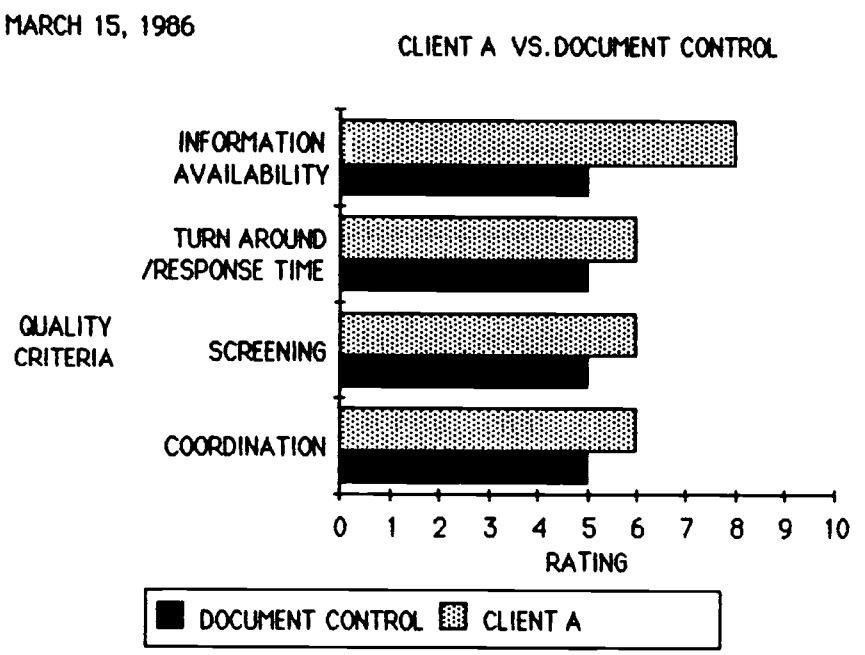


Figure 22 ESI Client Scores Vs. Document Control's Scores

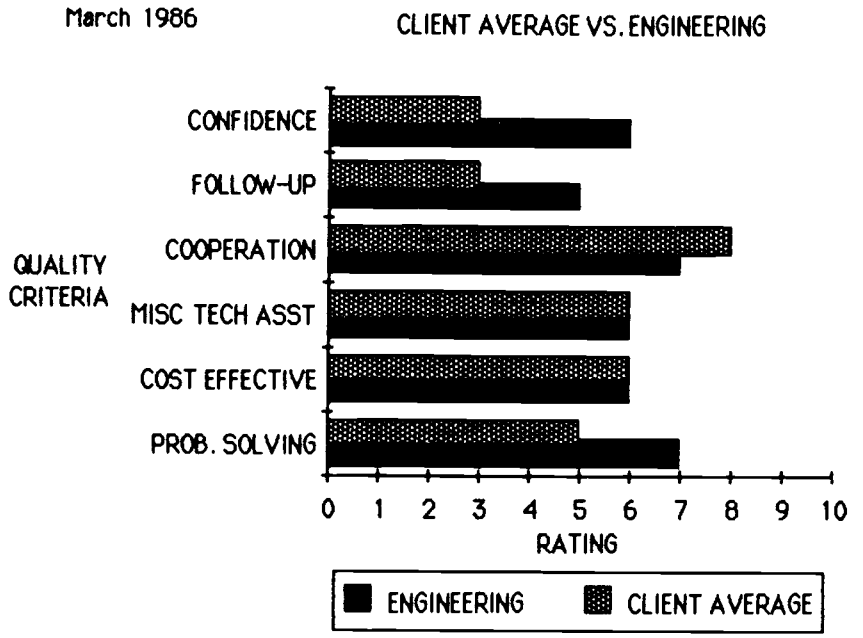


Figure 23 Evanite Clients' Average Scores Vs. Engineering's Scores

• PATTERN ANALYSIS

The third part of the evaluation was a pattern analysis, an extension of the Opportunity Profile mentioned in chapter 2. This graph showed the serving department which criteria needed attention and how they could improve quality of service.

The initial step was to develop a two coordinate grid with the X-axis showing weights (0-100), and the Y-axis showing the possible ratings (0-10). The weights and scores for each criterion were then taken from the Service Assessment Matrix and plotted on the graph.

The ESI pattern analysis, figure 24, shows the points centered around 5 on the x-axis. The reason for this was that ESI's performance at the time of the initial evaluation was set at level 5. The benefit of this graph will be greater when future evaluations are completed. As the weights of the criteria (y-axis) remain constant and the ratings change, the graph will display whether or not attention is being paid to the most important criteria. Over time the general direction of the slope should be either vertical near the right side of the graph or show a general trend of a positive slope with the highly important criteria getting better ratings than the less important ones.

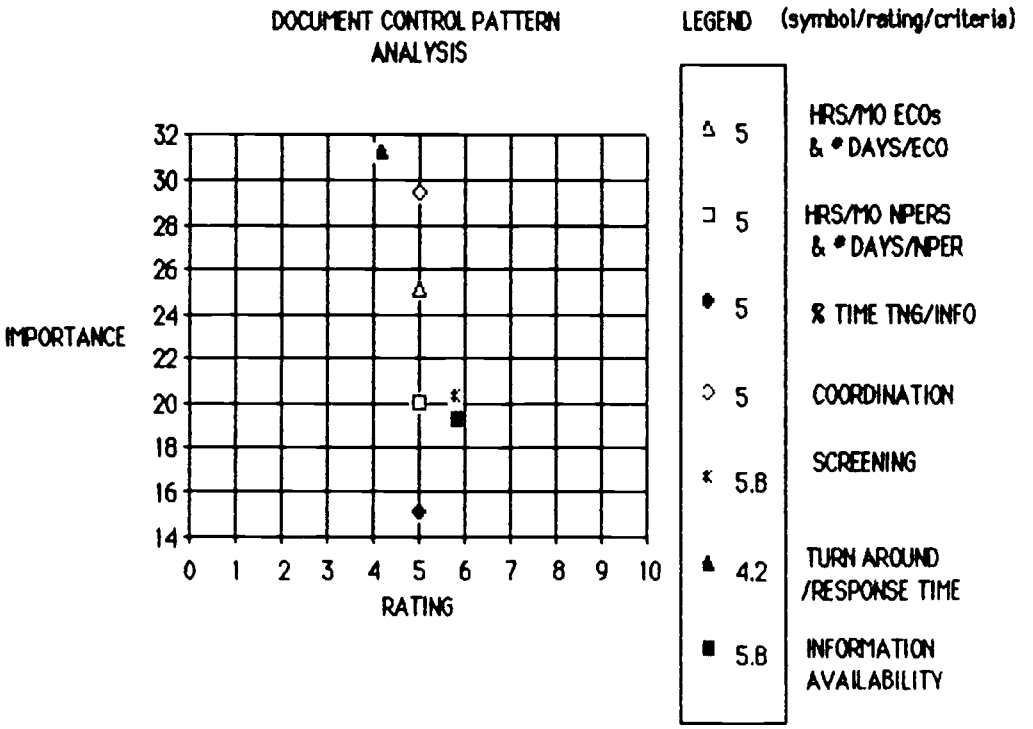


Figure 24 ESI Pattern Analysis

The Evanite pattern analysis, figure 25, shows some interesting results. The criteria which were most important had the lowest ratings. The best opportunity to improve service quality is to improve performance in these areas. Future evaluations will indicate if improvement has been made if these top points shift to the right.

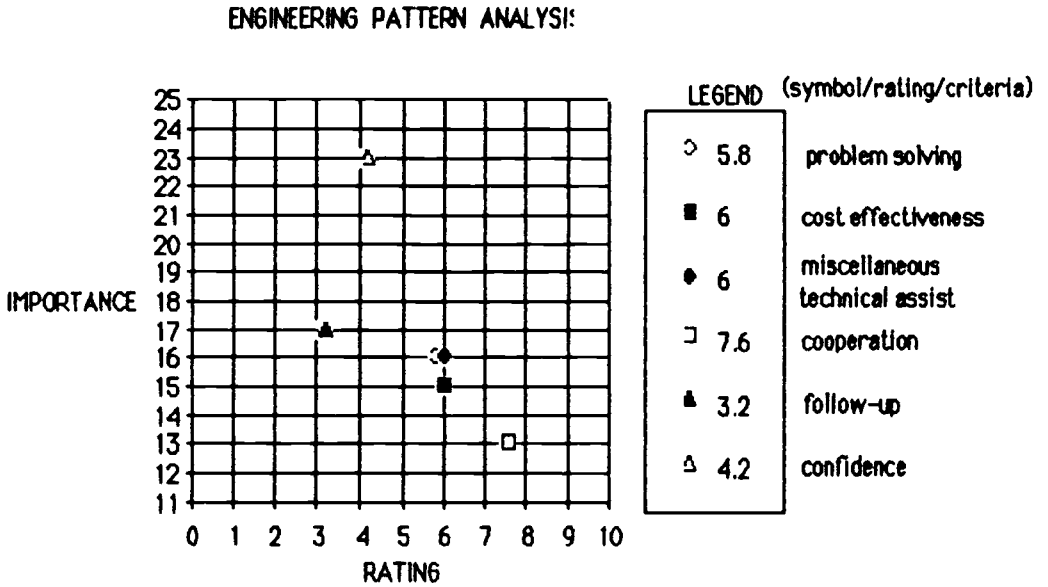


Figure 25 Evanite Pattern Analysis

- WRITTEN ANALYSIS

Written analyses were made which summarized the problems that showed up in the graphics. This became important to help identify discrepancies between client and self perceptions. Since the results of these studies were pertinent only to the participating departments, copies are not included in this thesis.

• PRODUCTIVITY AND QUALITY INDICATOR VALUE ANALYSIS

There are nine relationships which can occur between the two indicator values when more than one evaluation has occurred. Each value could increase, decrease or remain constant. The desirability of the change depends on the direction each element moves and on the goals of the department being evaluated. Figure 26 shows the nine possible relationships which could occur between the two values. The key to understanding this chart is to recognize that any time the value of an indicator goes down or if both stay constant, that is a negative effect. Any time quality improves without a decrease in productivity, a desirable change has occurred. Any time both indicators increase, excellent progress has been made since both productivity and service quality have improved. The above judgments are the author's personal opinions.

Productivity Indicator	Quality Indicator	Desirability of Change
Up	Up	Positive
Up	Same	Positive
Up	Down	Negative
Same	Up	Positive
Same	Same	Negative
Same	Down	Negative
Down	Up	Negative
Down	Same	Negative
Down	Down	Negative

Figure 26 Productivity and Quality Indicator Value Relationships

• TREND ANALYSIS

The productivity index value used for the Service Assessment Matrix evaluation will track the rate of change in the productivity and quality of service indicators over time. The recommended formula is:

$$\text{Productivity Index} = \frac{(\text{Current Index Value} - \text{Initial Index Value})}{\text{Initial Index Value}} \times 100\%$$

This value tracks the change of the indicators from the base or initial period. The result is a value centered around 0. If the index is positive, productivity or service quality has improved, if the index is negative, the productivity or quality of service has decreased.

An example would be to take the initial ESI value of 506 as the base value. If on the next evaluation they receive 513 then the Productivity Index would be: $\frac{(513 - 506)}{506} \times 100\% = 1.138\%$

an increase of 1%.

The evaluations were complete. The service departments now had a solid base to improve their productivity and quality of service.

8. CONCLUSION

Now that the Service Assessment Matrix has been created and tested, it needs to be evaluated. This chapter provides a copy of the final format for SAM (figure 27), compares the results of implementing SAM at ESI and Evanite with the eight items which should be included in a service evaluation, and checks to see if the original goals of the Service Assessment Matrix were met. It then identifies future work that could be done to improve SAM.

First, an important comment must be made. The Service Assessment Matrix is <u>not</u> designed to evaluate individuals, it is designed to evaluate departments. By using this type of matrix to evaluate individuals, internal competition could develop which would dissolve any teamwork and might reduce potential productivity improvements.

• <u>REQUIREMENTS OF A SERVICE ASSESSMENT TOOL</u>

The following list from chapter 2 repeats the eight items which should be part of any service assessment technique and comments on how well SAM meets each requirement.

1. Assurance from management that resources will be committed to a productivity improvement program.

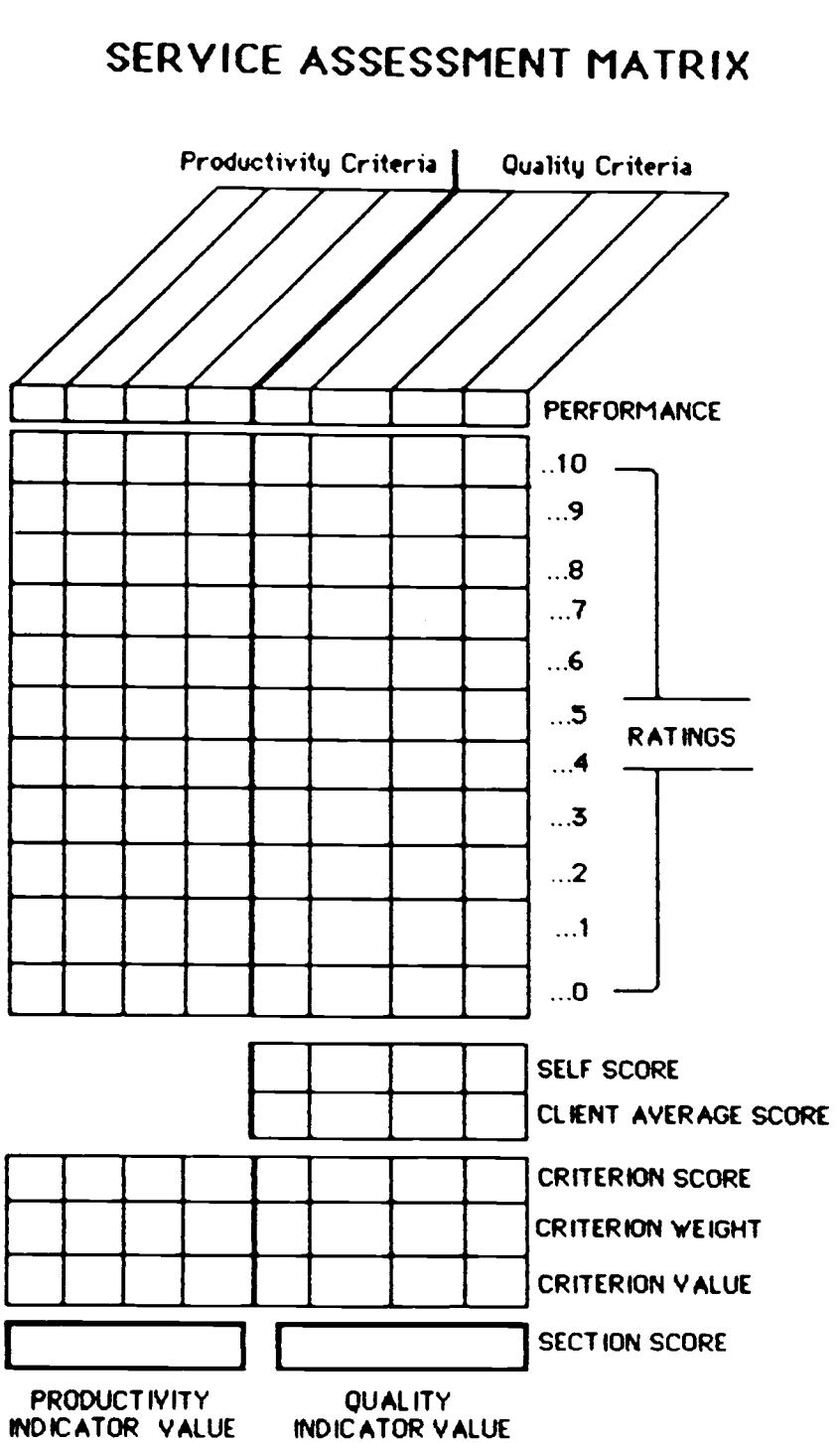


Figure 27 Current Service Assessment Matrix Format

Management accepted SAM and the Quality Assessment Matrix and became involved with the technique. At ESI the Quality Assurance manager encouraged his department managers and their people to work with the tool. The Document Control manager spent many hours helping to develop and implement SAM. At Evanite the cooperation was the same. Central Engineering's manager eagerly accepted the opportunity to work with SAM. Not only was he involved, but his supervisor became involved and supported the project with time and interest.

2. A methodology which encourages communications between server and client.

SAM proved to be an excellent format to encourage client participation. Some of the clients did not utilize the Quality Assessment Matrix's section for specific comments, but generally the remarks from the clients were positive about their roles in the evaluation.

3. A means of involving the employees of the service department so that they feel responsible for productivity improvement.

Internal employee involvement was a key element in the implementation of SAM at Evanite. Without the engineers' evaluations the Evanite format would not have worked.

At ESI improvements in the Document Control Department will be based on the knowledge gained from working with the tool. Although the author did not have a chance to meet with the Document Control

personnel, she has no doubt that the department manager will involve his people as he tries to increase the productivity of his department.

4. A means of involving the clients so they can help identify the quality criteria and participate in the evaluation process.

SAM definitely provided a format which included the client in the development of the criteria.

5. A set of desirable levels of output and service quality to serve as objectives for future performance.

Both matrices had benchmarks toward which to work. Since ESI's criteria were quantified, when a benchmark was reached everyone knew how it had been accomplished. Evanite had the opportunity to use quantified criteria if it had wanted to.

6. A method to analyze results to identify possible improvements.

Three methods were used to analyze the performance of each department. This included graphs which showed relationships between the server and the client, a pattern analysis, and a written analysis. Two additional techniques, evaluation of the productivity and quality indicator values, and an index value to measure trends, should be included after two or more sets of results are collected.

7. A systematic follow-up routine to ensure that changes can be implemented and evaluated.

Follow-up is an attitude more than it is a stated part of the tool. Both companies plan on a follow-up evaluation which will be reported in a future journal article about the Service Assessment Matrix.

8. An index value which can track progress over time.

The productivity index can track the rate of change for the productivity and quality indicators over time. The recommended formula for SAM is:

$$\text{Productivity Index} = \frac{(\text{Current Index Value} - \text{Initial Index Value})}{\text{Initial Index Value}} \times 100$$

This value tracks the change of the indicator values from the base period, as explained in chapter 7. It can also track the change of productivity and quality of service from the prior period if the initial index value is changed to the last index value.

- THREE GOALS OF SAM

The Service Assessment Matrix has the potential to include all eight items needed in a service evaluation tool but does it meet the three original goals? With the use of both productivity and quality criteria, it does measure both internal and quality parameters. To include the client in the evaluation, the Service Assessment Matrix provides the opportunity for clients to be involved. They are also involved in the evaluation through the use of the Quality Assessment Matrix. The final goal is to provide an index which can be tracked over

time. This was explained in item 8 above. SAM meets its original objectives.

- FUTURE WORK

Even though SAM meets the eight criteria and its three objectives, there are many questions that are yet unanswered. Will it work effectively in a long term productivity improvement program? What happens if there are several functions within a department using separate SAMs; can the index values be compared or combined for a total departmental evaluation? Is the use of the Service Assessment Matrix cost effective? What improvements in application should be made?

The only way to test the effectiveness of the Service Assessment Matrix is to continue to make additional evaluations with it. Both the Evanite and ESI managers were hoping to re-evaluate themselves using SAM. A tool such as this is proved with use and time.

To combine several index values is a more complex issue. The SAM index value tracks change from an initial evaluation for one department or area. What happens when a department has several functional areas, such as the ESI Quality Assurance Department which has four functional areas? Each department would have its own SAM, and if one sets benchmarks that are easy to achieve, and another has a set of criteria that cause the people to strive for almost impossible goals, the rate of improvement between the departments, as shown by the index value,

would not be comparable. A feeling of competitiveness could develop that might be bad for the department or company.

So, how can these matrices be combined? One system where department indices were combined was the Tektronix's Productivity Measurement Index explained in chapter 2 and appendix B. This system used a single key unit (the HPU) to quantitatively measure the department's output. The HPU divided the hours of labor used by the department by the number of key units processed during the rating period. In order to combine several departments' indexes, Tektronix took the sum of the total labor hours from each department and divided that by the total number of units produced by each department. Developing a means for SAM to equalize and combine the matrices would be beneficial for a department manager with several functional areas to manage.

The cost effectiveness of the tool is critical. Does the improved productivity cover the expenses which include setting up the matrix, collecting the data, and the cost of labor? The initial matrix at Evanite identified a macro-level of problems which did not require the collection of data but did perform the service of increasing client/server communications, but it did not measure the internal performance parameters as needed in a good productivity improvement program. At this level almost any type of evaluation would be cost effective. Once the general problems are solved, will the cost of determining more detailed quantifiable criteria and then collecting the data to measure them be too high? In the past micro-motion studies have been the source of information for studying manufacturing

processes. Because of the cost of collecting such data, many major companies, such as Tektronix, have eliminated the use of this detailed work because the savings did not justify the costs. Is the in-depth study of a service's productivity at the point where further study is not cost efficient? Reading the literature and examining the companies that have incorporated such tools, it appears that productivity studies are very cost effective. A future study could be a cost analysis of what it takes to implement the SAM and the resulting value of the improvements.

• A FINAL OVERVIEW

Because of the growth of the service sector in the United States and its rising costs, it is becoming imperative that the service department be evaluated. This evaluation must include both the server and the customer of the service. SAM, the Service Assessment Matrix, is a technique which can be used by companies trying to evaluate a service department's productivity. It evaluates both the efficiency and effectiveness of the department and provides a tool which can be used as part of a service department's productivity improvement program.

BIBLIOGRAPHY

Allender, Michael C., "Productivity Enhancement: A New Teamwork Approach", National Productivity Review, Spring 1984.

Baytos, Lawrence M., "Nine Strategies for Productivity Improvement", Personnel Journal, Vol. 58, No. 7, July 1979, pp. 449-456.

Butler, Robert J. and Yorks, Lyle, "A New Appraisal System As Organizational Change: G.E.'s Task Force.", Personnel, January-February 1984, pp. 31-42.

Christopher, William F., "How to Measure and Improve Productivity in Professional, Administrative, and Service Organizations", Issues in White Collar Productivity, Industrial Engineering and Management Press, Norcross, GA, 1984, pp. 29-37.

Connolly, Terry et al., "Organizational Effectiveness: A Multiple-Constituency Approach", Academy of Management Review, Vol. 5, No. 2, 1980, pp. 211-217.

Dalton, Melville, Men Who Manage, John Wiley & Sons, Inc., New York, 1959.

David, Beatrice Donaldson, "Work Measurement in Foodservice Operations", School Food Service Research Review, 2(1), 1978, pp. 5-9.

Felix, Glenn, H., Productivity Measurement with the Objectives Matrix, Oregon Productivity Center Press, Corvallis, Oregon, 1983.

Heaton, Herbert, Productivity in Service Organizations, McGraw-Hill Co., New York, 1977.

Hoffman, John and Shackney, Orry, "Assessing the Productivity of Corporate Staff Services", Business Horizons, July-August 1983, pp. 53-57.

Kendrick, John W., Improving Company Productivity, Johns Hopkins University Press, Baltimore, Maryland, 1984.

Likert, Rensis, A Technique for the Measurement Of Attitudes, Archives of Psychology, No. 140, New York University, 1932.

Mannisto, Marilyn, "An Assessment of Productivity in Health Care", Hospitals, September 16, 1980, pp. 71-76.

Ridley, Susan J. et al., "Quality of Meals and Labor Productivity", Nursing Home, July/August 1980, Vol. 29, No. 4, pp. 40-45.

Riggs, James L., "Monitoring With a Matrix That Motivates As It Measures", Industrial Engineering, Vol. 18, No. 1, January 1986.

Riggs, Randy, Industrial Engineer, Alcoa Company, Wanatchee, Washington, Personal Interview, March 1986.

Sayles, Leonard, Leadership: What Effective Managers Really Do and How They Do It, McGraw-Hill Inc., New York, 1979.

Schlaudecker, Kathy, Quality Assurance department, Bess Kaiser Permanente Hospital, Portland, Oregon, Personal Interview, March 1986.

Sumanth, David, J., Productivity Engineering and Management, McGraw-Hill Inc., New York, 1984.

von Euen, Peter, "Productivity Improvement Through Organizational Measurement", Instrument Society of America, 1984.

APPENDICES

APPENDIX A

PRODUCTIVITY IMPROVEMENT PROGRAMS

A productivity improvement program requires three key ingredients: awareness, knowledge, and skill. All personnel must be aware that productivity is important, what it means to them, and that it is their responsibility to diagnose and correct a productivity problem. Knowledge is knowing what to do to solve problems and how to use the correct tools. Skill is being able to apply ones knowledge. Without these three elements a productivity improvement program will fail to produce some of the potential improvement.

Chapter 1 listed six cyclical activities to describe a productivity improvement program. The first, awareness and involvement, is a matter of committment. If everyone is not committed to the program, throughout the entire cycle, it will fail to achieve its full potential.

The next four items, measurement, evaluation, planning, and improvement, are well described in Sumanth's book Productivity Engineering and Management (1984). John Kendrick (1984) provides one of the best comments on the need to measure.

> "To know where you are going, it is necessary to know where you are and also where you have been. Only sound productivity measurement can provide this guideline to management."

Evaluation is the process of understanding what was measured. The Service Assessment Matrix is an excellent tool which can be used to measure and evaluate a service department.

Once the problems have been recognized from the evaluation, it is time to implement changes to achieve the desired improvements. This is done best if some systematic plan is developed that will involve all responsible persons.

Once the plan is in place it is important to make the improvements as planned and then to follow-up and check the results. Management must ensure that the desired changes take place and that there are no unexpected and/or negative consequences. This then returns the department to the beginning of the cycle. It is time to re-confirm personnel awareness and involvement as the department re-measures the new level of productivity.

An excellent description of how to impement a productivity improvement program with a tool very similar to the SAM is described in the following excerpt from a presentation made by William F. Christopher at the 1984 Annual International Industrial Engineering Conference Proceedings titled, "How to Measure and Improve Productivity in Professional, Administrative, and Service Organizations." The presentation was reprinted in the book Issues in White Collar Productivity, published in 1984 by the Industrial Engineering and Management Press, Institute of Industrial Engineers. It describes the Olin Corporation's method using Multiple Output Productivity Measures.

Developing Multiple Output Productivity Measures

In many professional, administrative, and service units a single output measure is not considered adequate. Instead, several outputs are defined as representing the successful achievement of the purpose of the unit. Some of these outputs may be quantifiable, others require a subjective appraisal. In such situations, multiple output measures can be used. A rating scale technique can then be used to combine these measures into a single, overall measure - a Multiple Output Productivity Indicator (MOPI)

The Procedure is as follows:

(1) Define the purpose of the unit.

(2) Test the definition of purpose by relating it to the purpose and objectives of the company, or of the next higher level organization of which the unit is a part.

(3) Identify the outputs which represent the successful achievement of purpose.

(4) Determine how each of these outputs can be measured.

(5) Use the "going in" period for a base, and calculate the measures for each output for this base period.

(6) Establish a rating scale (1 to 10, or 1 to 20). Define performance levels for each output along the scale, with base period performance generally around the mid-point of the scale to permit performance trend measurement up or down from the base period levels.

(7) Prepare a rating form listing each output, and showing current period rating and position on the scale.

(8) Determine weights for each output, and combine the several outputs.

(9) Identify inputs and measures for them.

(10) Monitor performance trends for each output, the combined outputs, inputs, and for output related to input (MOPI).

Olin Corporation has made extensive use of the multiple output measurement method for measuring and improving administrative productivity. The Olin method is to establish Employee Involvement Teams for administrative functions in plant operations and in headquarters staff departments. Each of these teams provides a forum for:

(a) Training and education
(b) Dialog
(c) Developing and monitoring productivity measures
(d) Problem solving

Olin began its work in measuring, monitoring, and improving administrative and service productivity with the administrative functions in manufacturing plants. Productivity measures had been developed for plant operations, and extending the productivity improvement efforts to plant administration was a logical next step. With successful experience in plant administration productivity improvement, the work was extended to divisional and headquarters professional, administrative, and service units.

The corporate director of productivity, in collaboration with the corporate training department, motivates and coordinates program efforts, with the actual work done through the Employee Involvement Teams established in each unit. Work began with a pilot group and was then extended gradually to additional groups. Participating professional, adminsitrative, and service groups were selected on the basis of:

(a) Resources employed (people, capital)
(b) Importance of outputs
(c) Potential leverage from productivity improvement
(d) Management and employee interest in the program

One of the first units to participate in the Olin program was the Information Services Division - computer operations and systems development. A project team organized the work, following the general approach of the Query Form outline. The project team, working under the direction of an overall ISD steering Committee and in collaboration with the various organizational units of the division:

(1) Developed a written statement of purpose for the Division.

(2) Defined four Division performance areas, and the purpose for each:

Batch Processing Operations
Time Share
Transaction Processing
Systems Development

(3) Defined purpose for subsets of the four Division performance areas.

(4) Defined outputs for each of the performance areas and subsets.

(5) Determined appropriate measures for the outputs.

(6) Worked out how data for measurement could be collected.

(7) Established productivity measures and a feedback reporting system.

(8) To the extent practical, developed a commonality in measurements used in the four performance areas.

A measure of "service units" was developed as a standard that could be used as an output measure for several performance units. Using, where possible, this standard unit of measure provides the capability for analyzing the changes over time of each unit, of one unit in relation to another, and the impact on each other's performance.

Outputs and productivity measures were defined for each of the four Division performance areas. The outputs for Time Share, for example, were defined as:

System Availability
Network Load
Response Time
Log-Ons
Number of Service Units

Productivity measures were defined for each, and rating scale values established. Figure 28 illistrates the reporting format used.

	Productivity Measure	Rating 1 2 3 4 5 6 7 8 9 10	Rating	Weight	Points
TIME SHARE					
System Availability					
Network Load					
Respone Time					
Log-ons					
Connect Hours					
Service Units					
		Total Earned Points / Maximum Points			1,000

Productivity Index: $\frac{\text{Total Earned Points}}{1000} \times 100 = PI$

Note: Weights total to 100

Figure 28 Olin Corporation Productivity Index Format

Rating scale values were determined for each measure. For example, 98% was considered "par" for system availability, and the following rating scale values established:

1	94 %	6	98.5 %
2	95.5 %	7	98.75 %
3	97 %	8	99 %
4	97.5 %	9	99.25 %
5	98 %	10	99.5 %

In establishing rating scale values, the midpoint of the range, 5, was selected for the current level of performance, or the standard for performance. Changes up or down would then represent relative change from "going in"

performance levels, or performance up or down from an agreed-upon standard. The significant consideration in the measurement system is not the absolute rating, or number, but the performance change over time. Monitoring of performance trends, feedback of information, dialog among the Employee Involment Teams, and problem solving are all important contributors to improving productivity.

Weights were determined for each output so that a total productivity performance measure can be determined for Time Share for each reporting period. A similar measurement system was developed for each of the other three Division performance areas.

To calculate a total Information Services Division productivity indicator, weights were assigned to each of the four performance areas - Batch Processing Operations, Time Share, Transaction Processing and System Development - so that a combined productivity measure for total Division performance can be calculated and monitored.

In addition to the multiple output and rating scale measures, selected measures of output in relation to Input of person/hours and capital are monitored in each of the four performance areas, and for the total Division. Person/hours of work is measured and monitored in relation to a major output of the unit. Capital input is calculated for the total information Services Division and measured as an input in relation to service units. Capital input measures are made in the same way for plant productivity measures. For the Inforormation Services Division, person/hours of work is the major input, but capital input is substantial:

ISD Inputs	
Person/Hours	61%
Capital	39%
Total	100%

Several important conclusions developed from the Olin experience:

(1) Employee Involvement Teams can successfully improve professional and administrative productivity performance.

(2) The process is a practical, "hands on" kind of learning experience.

(3) "Effectiveness as well as "efficiency" can be improved.

(4) Measures that are not strictly productivity measures will be included in the measurement and monitoring program.

(5) With experience from using the measures, the "going-in" system of measures will be changed and improved over time.

(6) Measurement is an essential element for productivity improvement for:

(a) Setting goals and providing feedback on achievement
(b) Motivating performance improvement
(c) Sustaining the productivity effort over time.

(7) An administrative productivity improvement program contributes to planning and budgeting procedures by clearly defining purpose, outputs and performance measures.

(8) In administrative and service organizations, and in organizations of individually contributing technical and professional employees, the process gives everyone a voice and a means to contribute to the success of the organization.

APPENDIX B

THE TEKTRONIX SYSTEM

Peter von Euen, Productivity Manager, Tektronix, Inc., developed a productivity improvement tool for his company called a Productivity Measurement Index (PMI). He measured productivity by identifying and counting one key unit of output for a department and then dividing this number into the number of labor hours the department used during the measuring period. This became the Hours Per Unit or HPU. The HPU was then put into the following formula to create the PMI.

$$PMI = \frac{(\text{Base Period HPU}) \times (\#\ \text{of Key Work Units Accomplished in Current Period})}{\text{Total Labor Hours Worked in Current Period}}$$

The Base period HPU is the HPU value set at the time of the initial evaluation.

Once Tektronix had accepted the PMI, Mr. Von Euen extended his work to include two additional indices to be used in conjunction with the PMI (1984). These are the Quality Measurement Index (QMI) and the Service Level Index (SLI). He also adapted the PMI so that it could measure either hours per unit or a cost per unit if the service being provided had major costs other than labor.

The Quality Measurement Index tests for goodness or fitness for use and/or timliness of the service. It is an internal measurement of service quality and should not be related to the cost of quality. The QMI requires that one or more quantifiable quality measures be identified. Each criteria is given an importance rating between 0 and 1 in relative

importance to each other. To determine the QMI, a quality factor per unit is calculated by taking each defective output unit during that period and multiplying that by the importance rating which correlates to the reason for it being defective. The sum of all the weighted factors is then divided by the total number of key output units produced. The initial value is used as a base period quality factor per unit and is then used in the same manner in the QMI as the HPU is used in the PMI.

The Service Level Index (SLI) indicates how well the server is performing in relation to what its customer expects it to deliver. It requires direct involvement from the customer, possibly through customer surveys or by counting repeat business activities. The SLI is calculated the same way as the QMI using a sum of weighted criteria values divided by the total number of key units produced.

Once the Productivity Measurement Index, the Quality Measurement Index and the Service Level Index are calculated, it is possible to plot these on one graph. Because they all have a base period index of 1, it is easy to see the relationships between the indexes.

The above brief remarks about the Tektronix system do not give justice to the technique. Although it may be difficult to identify one key unit of output in a service department, this technique was the first one found by this author that recognizes the need to examine both internal productivity and client expectations at the same time. It also sets up a system that tracks productivity trends over time and provides a method to combine different departments' indexes.

More information can be gained by reading the article "Productivity Improvement Through Organizational Measurement" written by Mr. Peter D. von Euen, Productivity Manager, Corporate Services/U.S. Field Support, Tektronix, Inc., Beaverton, Oregon, copyrighted by the Instrument Society of America 1984.

APPENDIX C

THE OBJECTIVES MATRIX

The following article is a description of the Objectives Matrix created by Dr. James Riggs, P.E., Oregon State University. It was published in the January, 1986 Industrial Engineering Journal. More information on how to implement and use the Objectives Matrix may be obtained by calling the Oregon Productivity Center ((503) 754-2349).

The purpose of including this article is twofold. It is an excellent reference on some of the major steps to be taken when implementing a Productivity Improvement Program. It also provides a clear description of the mechanics of a productivity matrix.

The mechanics of the Service Assessment Matrix (SAM) created in this thesis are the same as the mechanics of the Objectives Matrix (OBMX). There are several differences. The SAM uses 5 as the current level of performance instead of 3, used in the OBMX. The SAM also has two indicators instead of 1, so that internal productivity and quality can be measured independently and the relationship between the two can be observed. It is also important to note that the SAM involves a second matrix, a Quality Assessment Matrix, which allows the inclusion of the customers' perceptions about the department being evaluated.

Permission to reprint this article was received by the author, Dr. James Riggs, on March 21, 1986.

Productivity & Motivation

Monitoring With A Matrix That Motivates As It Measures

By James L. Riggs, P.E.
Oregon State University

Numbers tend to dominate the language of engineers. We analyze, optimize and dramatize with numbers. Reputations are built on the accuracy of number generation and manipulation. Businesses are run "by the numbers." Success is usually measured in numbers.

But numbers can be elusive and misleading. Human behavior is particularly difficult to measure accurately. Not only do many aspects of worker performance resist quantification, but the numbers assigned may not serve their intended purpose. The *objectives matrix* and its associated implementation practices were developed to combat these measurement problems.

Slippery numbers

The matrix originated from the author's efforts to quantify "tender loving care" during hospital productivity studies in 1975. Although it never completely satisfied the nurses, a multi-dimensional scheme for including TLC in performance measures was designed. The same approach, defining activity levels for several criteria that collectively represented a work unit's mission, gradually evolved into a participative process in which the people whose performance was being measured helped set up their own measurement system.

The current form of the objectives matrix (OMAX) took shape in 1980 when managers were asked to rate the relative importance of each unit's productivity criteria. This weighting feature allowed calculation of a single score to indicate the level of performance during an evaluation period. Assigning weights also got upper-level managers directly involved in the process. With this added refinement in place, the matrix has since been widely adopted, mostly because it is simple, versatile and conceptually appealing.

When first introduced to the objectives matrix process, most IEs say that they are in effect applying it already. They probably are. Whenever employees are given an opportunity to participate, and values are included to supplement conventional work measures in performance evaluations, the concept is being applied. OMAX merely systematizes the application.

The graphic format of the matrix, shown in Figure 1, is a convenient scorecard, but the actual shape is immaterial to its function. How it is used is what counts.

Matrix mechanics

The mechanics of matrix construction are briefly described in the box on page 42. The process begins with development of criteria that define productive performance for a work unit. Members of the unit normally participate in identifying descriptive ratios.

The defining phase would be valuable even if the matrix development went no further, because it clarifies performance expectations and explores the diverse factors involved in achievement.

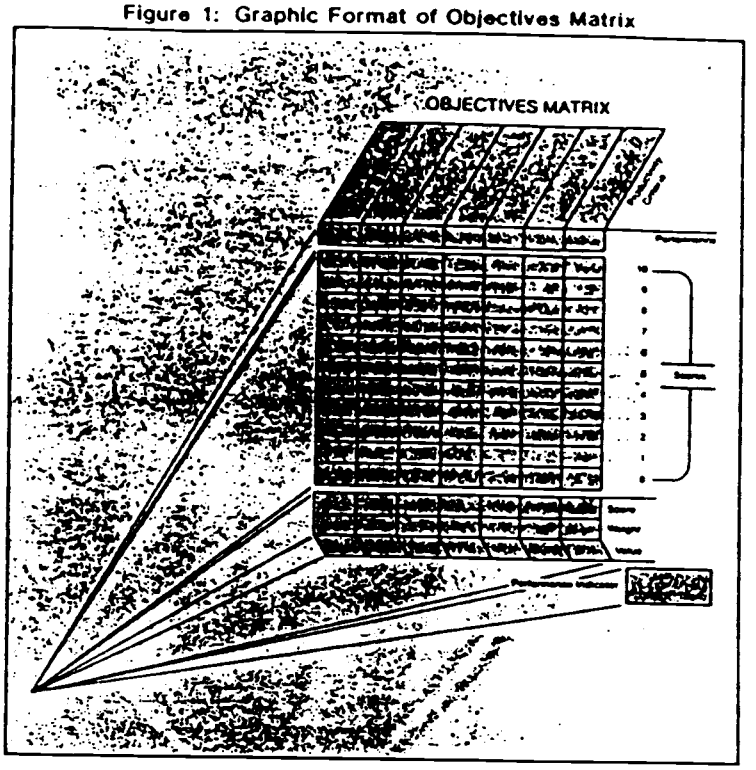
Quantification of accomplishment levels is also a group exercise, usually assisted by a facilitator, who may be an IE in larger organizations. Goal setting for Level 10 is the most critical operation. This is where workers "buy in." They set a performance objective for each criterion that is neither too ambitious nor too conservative. Each should be a challenge that can be met by superior work over the next 12 to 24 months.

Once Level 10 is set, the rest of the numbers in the body of the matrix are easily derived, typically by linear interpolation between levels 0 to 3 and 3 to 10, although theory says that equal percentage steps are preferable. By either method, the 11 rungs on the scoring ladder provide a clean set of challenges customized for each work unit.

The criteria do not have equal effects on productivity. It is management's responsibility to indicate the relative importance of each criterion to the unit's mission. This is no trivial undertaking. It tells employees which ratios to stress, perhaps at the expense of those rated less important. Weight assignments are precise evidence of management priorities. They cannot be casually changed without causing confusion and loss of respect. They are powerful stimulants.

In most situations, weighting is done without great difficulty. Because the managers who take part in the weighting exercise are familiar with the operations being rated, their

Figure 1: Graphic Format of Objectives Matrix



opinions usually agree. This agreement is facilitated by reviewing ratio values derived from a work unit's past performance. After a general discussion of the unit's ratios, each manager distributes 100 points among the criteria. The distributions are averaged to provide a compromise profile of weights. Another discussion typically leads to a consensus profile; this is the one entered in the "weight" line of the matrix.

Criteria, scores and weights come together in the calculations of the performance indicator, a single number that represents a unit's composite performance during the review period. Ratios figured from operating data are converted to scores which are multiplied by associated weights. The sum of the weighted scores is the performance indicator.

Starting and sustaining

A flow chart of the *objectives matrix process* is laid out in Figure 2. The 11 stages show the basics of implementation. More is involved than simply constructing a matrix and keeping score.

Management actions—represented by black bordered boxes—organize the process. Without the commitment of upper management, the process can begin, but it is unlikely to survive. An exercise that encourages commitment is having managers develop a master matrix for their plant or major division. This matrix is a ratio-oriented business plan. It gives dimensions to the business unit's mission. Level 10 states the goals. Unlike work units, the master matrix often uses ultimate objectives, such as achieving zero defects and zero late deliveries. These objectives serve as guidelines for matrix construction lower in the organization.

It is usually advisable to introduce OMAX gradually. But even a confined introduction should be thorough. Friendly work units should be selected for the trial. Union or employee representatives should be brought in early and kept informed.

The first meeting should be upbeat, stressing the good things that should result from improving productivity and instituting a measurement method that credits the people who produce. The promise of recognition is particularly appealing to staff and administrative personnel who feel that line units receive more than their share of credit because they are rewarded for meeting output goals, whereas workers whose output cannot be readily measured are ignored.

As indicated by Box 3, whose shaded border indicates that it is primarily a work unit activity, the introduction leads to management follow-up and matrix construction. Conducting a productivity audit of participating work units can generate data about potential improvements, establish benchmarks for assessing attitude changes and provide proof of management's commitment.

Stages 5, 6 and 7 represent several meetings during which each work unit develops its matrix. Considerations that expedite the development include the following:

- Not all the ratios on the master matrix will be represented on a work unit's matrix. A master matrix naturally has more ratios than a work unit because the larger organization has a more complex mission. A single generic criterion, such as quality, may require more than one ratio.
- The criteria should represent conditions and activities that are essentially controlled by the work unit. However, it should be realized that no group is completely independent. Each relies on inputs from the other units and suppliers, as well as being subject to such external factors as emergencies and production fluctuations.
- At least one criterion should represent the unit's customers. In service organizations, output quality is often measured by a customer evaluation. A 10-point scale for the evaluation should be carefully crafted to ensure consistent scoring. It helps to have customers involved in the scaling.
- The interrelationships between

criteria must be considered in setting Level 10 objectives. A goal to reach a new high in units produced per hour may be reasonable only if quality expectations are relaxed to allow, say, 5% rejects. A lower output goal would have a correspondingly lower reject percentage.

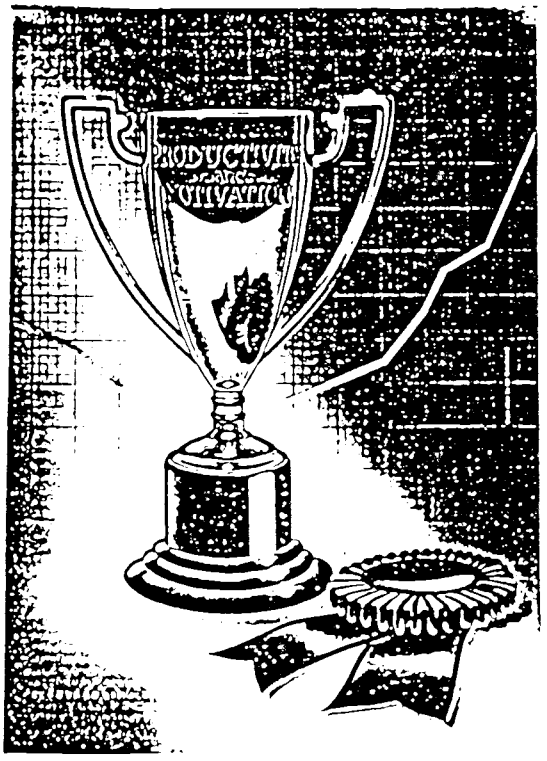
- When conventional work standards are included in the matrix, the accepted standard of performance is given a score of 5.

After members of a work unit have presented their completed matrix for management review, and in turn have had the management-assigned weights justified to them, the improvement phase begins. Although the purpose of measuring performance is to improve it, measures alone do not reveal how to make improvements. With help in identifying and pursuing promising possibilities, work units can undertake significant projects. Sometimes, they score impressively.

Most gains accrue from small advances—such as being more conscientious in conserving material and time. Periodic training sessions on such topics as creativity, problem analysis, data collection and methods study can assist in identifying and implementing improvements.

A "project team" can be formed from volunteers in a work unit to investigate any improvement suggestions that require a large investment or affect the operation of other work units. Such teams should be encouraged to seek staff help when they encounter any technical problems. A team is disbanded once its project has been completed or proven unfeasible. Training and project teams serve the dual purpose of developing skills and maintaining interest in productivity improvement.

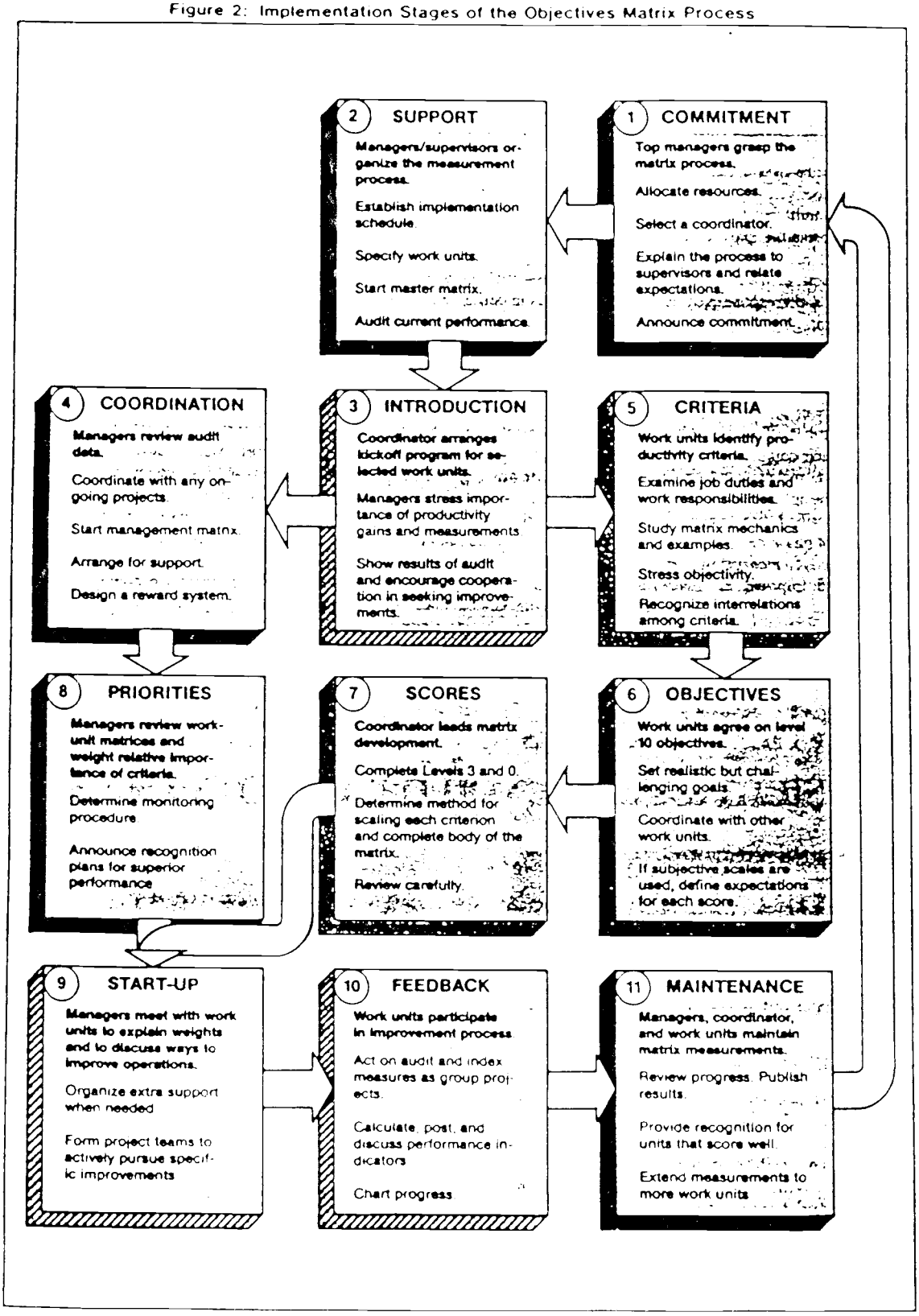
Improvements show up as higher scores on the matrix. They also boost morale and provide cost reductions or revenue increases. These achievements deserve recognition. Three common methods of rewarding superior performance are (1) productivity sharing formulas, (2) bonuses and (3) nonmonetary awards. There are several well known gain-sharing plans—a few companies have designed their own plans based on objective matrix scores. A lump sum award can be split among members of a work unit when their effort produces special economic gains—a promptly paid bonus spurs more activity.



Oregon Productivity Center
100 Merryfield Hall
Oregon State University
Corvallis, Oregon 97331
Phone: (503) 754-3249

OREGON PRODUCTIVITY CENTER

Figure 2: Implementation Stages of the Objectives Matrix Process



Format and Mechanics for Measuring Work Performance

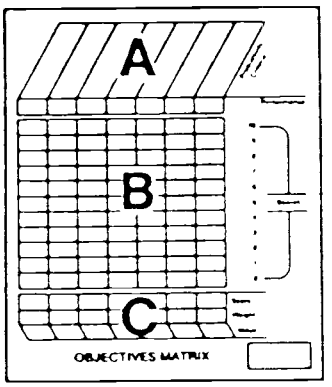
(A) Defining

The productivity criteria shown in the heading of the matrix are ratios that define the productive performance of a work unit. They should be independent and readily measurable factors. Dimensions with respect to volume and time must be specified. Frequently encountered generic categories, along with sample ratios from the manufacturing and service sectors, are shown in Table 1.

Measurement methods should be considered as the productivity criteria are being developed. When the criteria accurately define the responsibilities of a work unit, the rest of the matrix is completed quite easily.

Table 1: Categories and Ratios

Quantity:	
Output	Sales
Labor hour	Employee
Case load per worker	
Quality:	
Rejects	Errors
Units produced	Page
Complaints per number served	
Timeliness:	
Waiting time	Actual
Total time	Scheduled
Late deliveries per sales volume	
Yield:	
Time used	Goods sold
Time available	Goods received
Pounds of finished product per pound of raw material	
Utilization:	
Peak employment	Downtime
Average employment	Uptime
Hourly per exempt employee	
Group traits	
Absent hours	Accident cost
Total hours	Days worked
Quits per number employee	
Overtime per regular time	
Waste per shift	
Suggestions implemented per employee	



(B) Quantifying

The body of the matrix indicates achievement levels for the productivity criteria. Levels corresponding to a 10-point scale represent performance hurdles. A score of 3 corresponds to the performance level when matrix measurement begins. Less than minimum acceptable performance rates a zero. Realistic goals for the evaluation period are shown at the 10 level; these are the performance objectives that give the matrix its name.

Members of the work group being measured should participate in developing entries for the 0, 3, and 10-point rows. All remaining entries are set by interpolation among the three reference rows. For example, the difference between levels 10 and 3 for units/labor hour leads to step increases of $(3.2-1.8)/7 = 0.2$ at each level in the mini-matrix shown below.

(C) Monitoring

The base of the matrix is where the performance indicator is calculated. Current operating levels are entered in the performance row above the matrix body and are transformed to scores in the row below the body; circles show how operating levels relate to scores on the right side of the matrix.

- *Example:* 2.1 units per hour earns a score of 4 because it does not meet the level 5 hurdle.

Numbers in the *weight* row indicate the relative importance of each productivity criterion, as established by management. Scores are multiplied by the importance ratings and the products are entered in the *value* row. The sum of the values is the *performance indicator* for the time period.

- *Example:* A score of 3 with a weight of 40 has a value of 120.

Progress is measured by the rate of change of the indicator from one period to the next.

- *Example:* An indicator of 350 yields a gain of 16.7% (50/300) when compared to a performance level of 300. This is the productivity index.

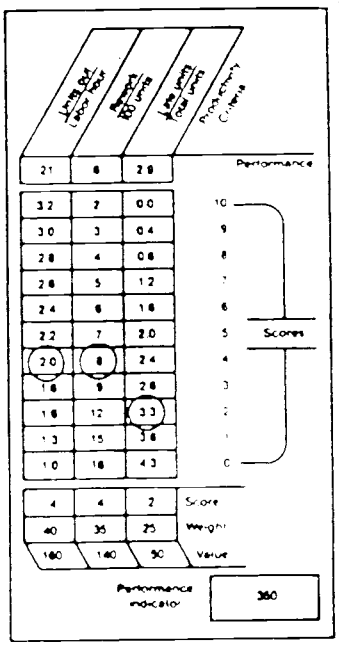
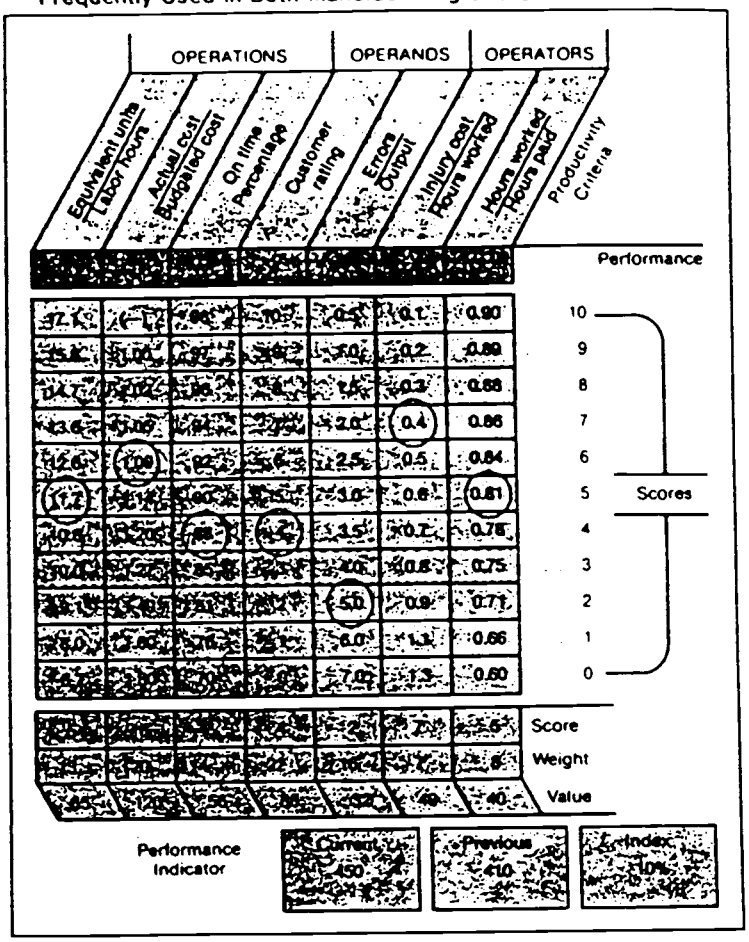


Figure 3: Representative Objective Matrix Containing Criteria Frequently Used in Both Manufacturing and Service Sectors



Nonmonetary—meaning non-cash—awards can take many forms, ranging from mementoes to elaborate entertainment. All awards should be shared by the entire group represented by the matrix in order to build cohesiveness and motivation.

The level of proficiency among work units cannot be compared directly according to their performance-indicator numbers. Some units set modest goals and may consequently have high performance indicators. Each unit should therefore be judged by the rate of increase (or decrease) of its performance indicator. A unit productivity index is obtained by dividing the change in the indicator over a period of time by the reading at the beginning of the period.

Charts are frequently drawn in order to display current performance records and to monitor progress over several time periods. The latest matrix may be displayed by posting a copy in the work area, showing it on a TV monitor or exhibiting it on large placards hanging from the ceiling. Computerized trend charts may track performance of individual criteria, as well as the composite indicator. Visual reporting provides potent feedback.

Typical application

The matrix in Figure 3 is offered as a typical OMAX example of performance measurement for a work unit. Such a matrix characteristically has about six or seven ratios, but there can be many more for larger work units. Nearly all matrices contain at least one criterion for the unit's output quantity, financial contribution, time or material utilization efficiency, output quality and personnel performance. The example illustrates several of the most frequently encountered measures. They are elaborated on below.

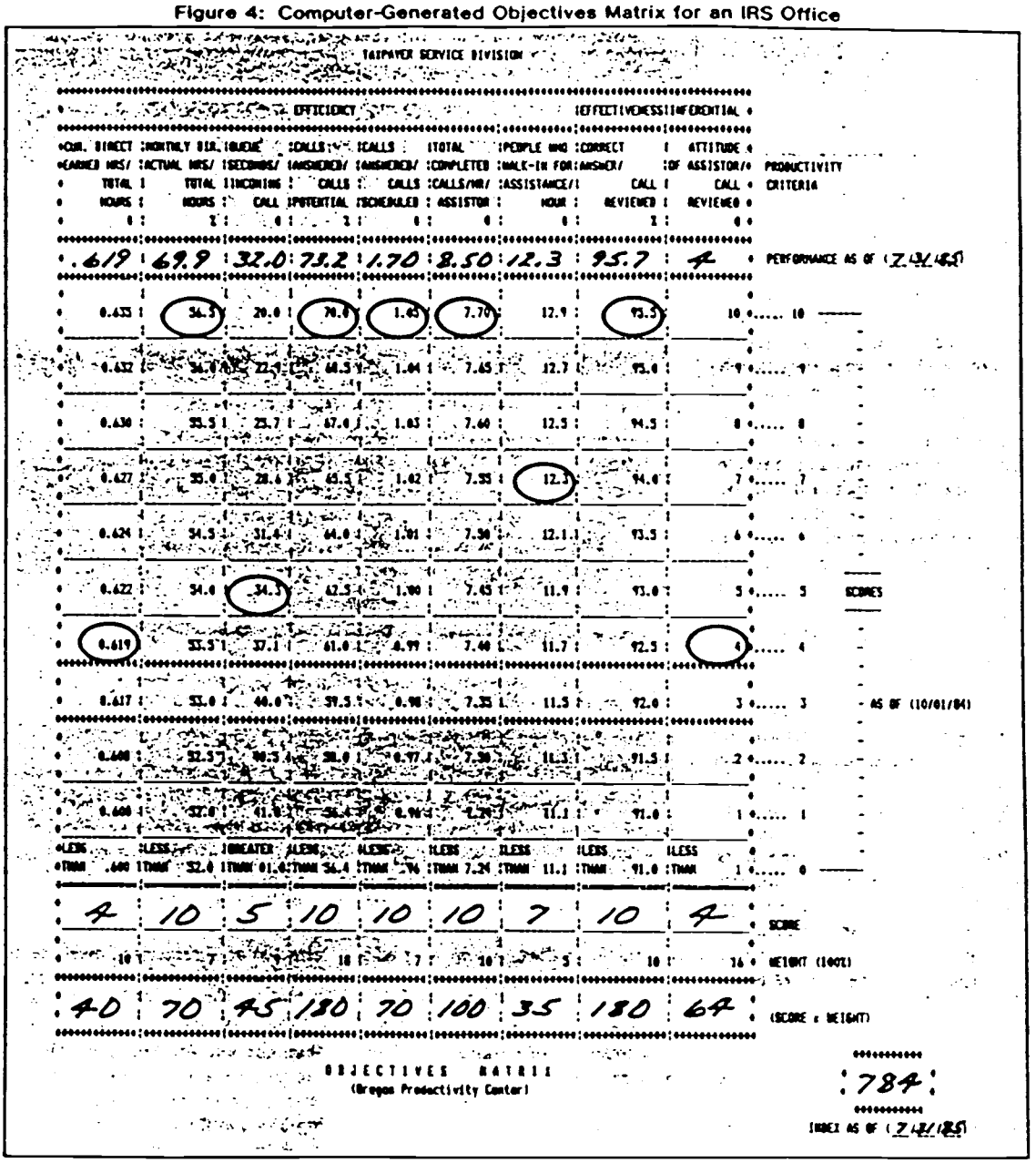
- Equivalent units of output are developed when there is no readily countable product. A unit may be a package of services.
- Actual versus budgeted costs can be applied to materials, energy, labor or a collection of resources.
- Actual versus expected times pertains to any output or function of the work unit.
- The customers who provide the ratings may be outside buyers or in-house clients. Results of several surveys may be combined into one scale.
- Errors can take the form of rejects, misdeeds, complaints, inaccuracies or any type of mistake that wastes resources.
- Safety cost, a factor in most manufacturing matrices, is often replaced by turnover cost in a service organization.
- An available-hours ratio may be directed at absenteeism, overtime or other personnel utilization factors.

The matrix format in Figure 3 classifies the criteria into categories that account for financial/scheduling performance (47%), quality of output (38%) and work-force/working-life quality (15%). It also provides space to record totals for both the current and previous performance indicators and the resulting index.

OMAX at IRS

Users of the objectives matrix have made many clever modifications to the basic design. It has been adapted as a progress reporting system for construction projects in Europe. A large energy company in Africa has developed performance criteria for its engineering and R &

Figure 4: Computer-Generated Objectives Matrix for an IRS Office



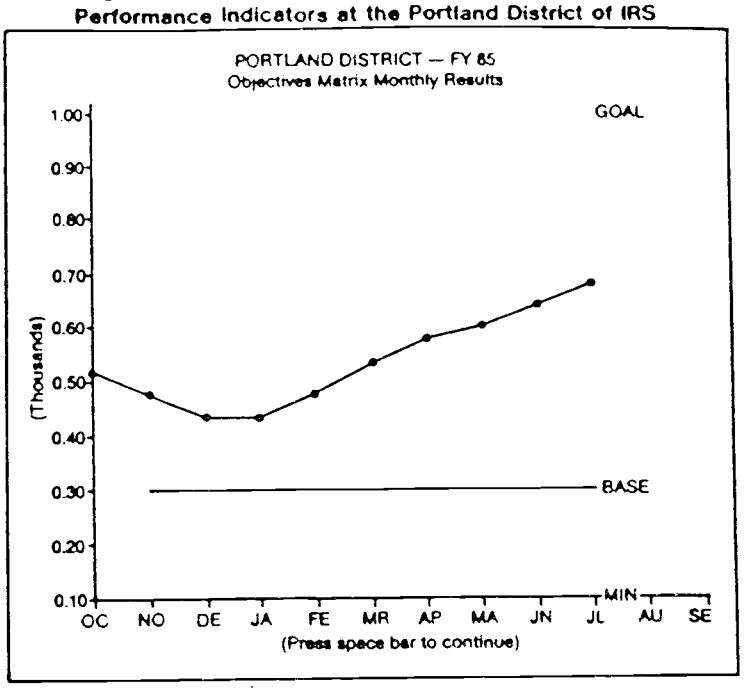
D groups.

In the United States, a major division of an aircraft company measures its performance on a spectacular color-coded, 22-column matrix that features four main categories—manufacturing performance (30%), customer satisfaction (30%), internal development (20%) and quality of work life (20%). In another aircraft company, a matrix has been designed for monitoring the performance of individual managers. In a somewhat similar application at a university, bonuses for superior achievement are awarded annually to engineering professors according to scores earned on a matrix designed by the faculty.

A computer-generated version developed by Bob Cach, an industrial engineer with the Internal Revenue Service, is shown in Figure 4. According to Bob, "The matrix enables IRS managers to keep all goals in their proper perspective. It is simple to use and maintain and it provides graphic feedback if one goal is suboptimized at the expense of another."

The displayed matrix represents the taxpayer service division. The following explanations pertain to the

Figure 5: Productivity Trend Line Based on Monthly Performance Indicators at the Portland District of IRS



ratios in Figure 4:

- Earned hour = (Unit produced) (Standard hour per unit).
- Actual hour = (Unit produced) (Actual hour per unit).
- Direct hour = All hours except management, clerical, leave, training.
- Queue seconds = Time a taxpayer waits before a telephone call is answered.
- Hours/assistor = Time to resolve the problem of a taxpayer.
- Correct answers are based on statistical sampling by the division's quality review staff.
- Attitude of assistor is rated by the division's quality review staff.

All five divisions in the Portland district of the IRS have matrices, and an overall matrix provides a weighted composite of the district's productivity. An indication of the district's success is apparent in the progress chart shown in Figure 5.

More refinements

The objectives matrix process is far from being a mature productivity improvement method. The shape of the matrix mutates to conform to different types of applications. And the process by which the matrix is developed continues to evolve. Techniques are customized for businesses of different sizes and for organizations with different structures. Any changes that foster greater employee participation without increasing complexity are welcome.

In terms of general theory, a better technique for aggregating scores is needed. It is not adequate to simply collect weighted work-unit performance indicators to obtain a composite indicator for the parent unit. This dimensional difficulty also limits the use of objectives matrices for determining incentive wages. A related need is for a more systematic and reliable method for generating ratings for subjective criteria.

Several studies are under way at the Oregon Productivity Center to refine and extend the uses of the objectives matrix. A work-sheet approach to simultaneously developing productivity criteria and identifying promising areas of improvement for small businesses is being explored. A two-phase matrix that utilizes management-by-objectives principles to measure and improve managerial performance is being implemented.

An adaptation of the matrix—called a service assessment matrix (SAM)—has been under development for two years. It is a customer-driven method of measuring the quantity and quality of service provided by staff departments. The objectives matrix has been folded into a larger productivity improvement process called AIM—awareness, improvement, maintenance—to make the introduction of a new measurement system less threatening and more sustainable.

These refinements are commendable, but they are subject to the woodcarver's curse: Too much whittling can reduce a carving to chips. Similarly, too much refining could reduce employee participation in the objectives matrix process. Its most valued property would be lost—practicality. With these attributes intact, the objectives matrix process effectively motivates as it measures. And this promotes productivity.

James L. Riggs, P.E., is founder and head of the Oregon Productivity Center and department head and professor in the Department of Industrial Engineering at Oregon State University. He holds degrees in industrial engineering, mechanical engineering and forest engineering from Oregon State and is the author or co-author of 16 books in the areas of engineering economics, production, operations research and management. Riggs is consulting editor for the McGraw-Hill series in industrial engineering and management science. He is a senior IIE member.