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METHODOLOGY FOR GENERATING EFFICIENCY AND EFFECTIVENESS MEASURES (MGEEM): A GUIDE FOR THE DEVELOPMENT AND AGGREGATION OF MISSION EFFECTIVENESS CHARTS

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This paper has been reviewed and is approved for publication.

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<p>This paper discusses the development and use of mission effectiveness charts as the primary performance feedback tool in the Methodology for Generating Efficiency and Effectiveness Measures (MGEEM). Development of performance indicators, and the mission effectiveness charts for each indicator which link levels of performance to effectiveness, is presented in detail. Examples are provided as guides for the MGEEM organizational facilitator. The computation and use of an aggregation correction factor to correct for unequal importance of organizational units are discussed, as is the procedure for aggregating across work centers and higher organizational levels. Aggregation allows managers to derive a single index of performance at any organizational level. Exercises are presented, with suggested solutions as aids to the MGEEM measurement facilitator.</p>			
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**This publication is primarily a working paper. It is published solely to document work performed.**

## SUMMARY

This technical paper documents the development and use of mission effectiveness (ME) charts as the primary organizational feedback tool in the Methodology for Generating Efficiency and Effectiveness Measures (MGEEM) system. ME charts are central to the development of a comprehensive management information system with features which make possible improved leadership, enhanced motivation, and continual improvement of work processes.

The purpose of this paper is to provide the MGEEM facilitator with a guide for developing and using ME charts. Through the MGEEM process, the commander or manager of the target organization, his immediate subordinates, and customers define the organizational key result areas (KRAs). A second group consisting of subordinates and workers develops performance indicators for each KRA and then develops for each indicator an ME chart which relates levels of performance to mission effectiveness.

In explaining the use of ME charts, this paper also provides procedures for combining the performance data for two or more organizational units (e.g., two branches within a division) into a single measure of performance. It also describes how to construct Management Engineering Program Feedback Charts for use in tracking an organization's performance over time.

Several ME chart exercises and suggested solutions are included as facilitator aids to implementing an effective MGEEM system.

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## PREFACE

The work documented in this technical paper supports the transition of an AFHRL-developed organizational performance measurement and enhancement technology. The transition office is the Air Force Management Engineering Agency, with AFHRL providing continuing research support. Effective development and aggregating of measures of organizational performance will enable the Air Force and other DOD agencies to carry out their mission responsibilities in an effective manner.

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TABLE OF CONTENTS

	Page
I. INTRODUCTION . . . . .	1
II. DEVELOPING MISSION EFFECTIVENESS CHARTS . . . . .	1
Refining Indicators . . . . .	2
Weighting Indicators . . . . .	3
Plotting Known Values for Mission Effectiveness Charts . . . . .	6
Specifying Slopes for Management Effectiveness Charts . . . . .	7
Checking Mission Effectiveness Charts . . . . .	9
Facilitator Responsibilities in Securing Management Approval . . . . .	10
III. AGGREGATING MISSION EFFECTIVENESS CHARTS . . . . .	11
Aggregation Within a Work Center . . . . .	11
The Aggregation Problem . . . . .	13
The Mission Effectiveness Chart Solution . . . . .	13
The Management Engineering Program (MEP) Feedback Chart . . . . .	13.
Aggregation Across Work Centers . . . . .	14
The Unequal Contribution Problem . . . . .	16
The Aggregation Correction Factor (ACF) . . . . .	16
The MEP Feedback Chart . . . . .	17
Adding New Branch Indicators . . . . .	17
Aggregating Across Branches . . . . .	20
IV. CONCLUSIONS . . . . .	21
REFERENCES . . . . .	21
APPENDIX A: GENERAL FORM OF A MISSION EFFECTIVENESS CHART . . . . .	23
APPENDIX B: FACILITATOR EXERCISES . . . . .	24

LIST OF TABLES

Table	Page
1 Example of an Indicator Weighting Table . . . . .	3
B-1 Section and Branch Performance Data . . . . .	27

LIST OF FIGURES

Figure		Page
1	Customer Satisfaction Mission Effectiveness Chart with Horizontal Axis Scaled . . . . .	7
2	Indifference Zone and Feasible Worst and Best Data Points Plotted for Customer Satisfaction . . . . .	8
3	Alternative Slopes of Mission Effectiveness Charts for Customer Satisfaction . . . . .	9
4	Aggregating Within A Work Center . . . . .	12
5	Example MEP Feedback Chart . . . . .	14
6	Aggregating Across Work Centers . . . . .	15
7	Aggregating Across Branches . . . . .	19
B-1	Number of Escapes . . . . .	25
B-2	Percent of Engineers . . . . .	26
B-3	Acceptable/Unacceptable Mission Effectiveness . . . . .	29
B-4	Mission Effectiveness Charts Interactions . . . . .	30

METHODOLOGY FOR GENERATING EFFICIENCY AND  
EFFECTIVENESS MEASURES (MGEEM): A GUIDE FOR THE  
DEVELOPMENT AND AGGREGATION OF MISSION EFFECTIVENESS CHARTS

I. INTRODUCTION

The Methodology for Generating Efficiency and Effectiveness Measures (MGEEM) is a set of technologies which makes possible the development in any organization of a complete management information system. A trained measurement facilitator uses the MGEEM to guide target organization members to identify the organization's principal intended accomplishments, called key result areas (KRAs), and measures of organizational performance of the KRAs, called performance indicators. The facilitator also leads the organization to develop ways of using indicator performance results to provide feedback to managers to improve their leadership and to workers to stimulate their motivation, and to serve as a basis for continually improving work processes. Two forms of feedback (the objectives matrix and the line graph) were identified in Tuttle and Weaver (1986). The present paper introduces mission effectiveness (ME) charts, an improved procedure for providing indicator performance feedback. It also provides a practical guide to measurement facilitators in the use of these charts. (Note: An earlier version of the ME chart was called a contingency chart.)

In implementing MGEEM, a measurement facilitator may use several alternative techniques for providing feedback. The simplest of these is the line graph; the more complex are the objective matrix (discussed in Tuttle and Weaver, 1986) and the ME chart. When deciding which of these three techniques to use, the facilitator should consider that target organizations differ as to the sophistication of their members with respect to measurement.

For military organizations, it is usually possible to develop a complete MGEEM system of KRAs, indicators, and ME charts; but some organizations whose members have less measurement sophistication may require an interim process consisting only of KRAs, indicators, and simple line graphs for feedback. Later, after sufficient learning has taken place among organization members, the facilitator can substitute the more sophisticated and useful format for feedback.

The facilitator should also consider that the feedback alternatives vary with respect to their ease of use, their use of weighting to distinguish among the importance of the indicators, their ability to deal with the complex relationships between indicator performance and overall organization effectiveness, their capacity for addressing the interactions among indicators, and the comprehensibility of their results to members of the target organization. Each alternative has strong points, and the facilitator is encouraged to become familiar with the relative strengths of each so that the most appropriate technique may be selected for the implementation at hand.

The following discussion assumes that the reader is familiar with Tuttle and Weaver (1986, Section 4.2) and presents ME charts as an alternative way to report performance results.

II. DEVELOPING MISSION EFFECTIVENESS CHARTS

Mission effectiveness chart development, like KRA and indicator development, requires for its accomplishment consensus among members of the target organization. In terms of the Measurement Development Teams (MDTs) suggested by Tuttle and Weaver (1986, Section 3.2), Team B is the one responsible for developing these charts. (Note: Team A consists of upper-level management and immediate subordinates. Team B consists of immediate subordinates and key workers.)

### Refining Indicators

To facilitate the ME chart development process, indicators should be refined when they are first identified and defined. This adds a refinement step to the Indicator Development process described in Section 3.4 of Tuttle and Weaver (1986). It is better to refine indicators at this initial stage of indicator development rather than later because Team B will have recently completed identifying and defining indicators and, consequently, will have a clear understanding of their meaning. If this refinement is deferred, some members of the team may forget important details about the indicators.

After indicator development has gone through the final step of documentation, as suggested by Tuttle and Weaver (1986, p. 28), the facilitator should lead Team B to consensus on the answers to three questions for each indicator. During this facilitation, an individual should act as a recorder to document the information as it is decided upon. (This individual should not be the facilitator or a member of Team B.) The first two questions to be used to refine each indicator are as follows:

1. IF EVERYTHING GOES RIGHT FOR YOUR ORGANIZATION, WHAT IS THE "FEASIBLE BEST" YOU COULD DO ON THIS INDICATOR?
2. IF EVERYTHING GOES WRONG FOR YOUR ORGANIZATION, WHAT IS THE "FEASIBLE WORST" YOU COULD DO ON THIS INDICATOR?

This pair of values constitutes the best and worst performance possible considering real-world organizational constraints and environmental peculiarities.

The facilitator should ensure that Team B understands that "feasible" best and worst are not the same as "absolute" best and worst. For instance, consider this indicator for customer satisfaction taken from Tuttle and Weaver (1986, Table 11, p. 28): "number of customer inquiries satisfied/number of customer inquiries received (monthly) x 100." The absolute or arithmetic best would be 100%, meaning that all inquiries received are satisfied. This may, however, not be the feasible best if Team B believes that they regularly receive a few inquiries which cannot be satisfied regardless of how hard they try. The feasible best may, thus, be only 95% or even 90%.

The third question to be asked is:

3. BETWEEN THE FEASIBLE BEST AND FEASIBLE WORST, WHAT IS THE LEVEL, POINT, OR ZONE OF PERFORMANCE ON THIS INDICATOR THAT IS NOT GOOD OR NOT BAD, THAT IS THE "BREAK-EVEN" OR "DON'T ROCK THE BOAT" POINT?

The facilitator should explain to Team B that this is also the safety, expected, or indifference point. That is, this is the point at which the work center supervisor will neither become concerned that performance is too low and commit more resources, nor feel that performance is so good that the work center should be recognized for outstanding effort.

For instance, in terms of the customer satisfaction indicator example above, Team B may feel that satisfying 8 of 10 customer inquiries (80%) would be neither bad nor good. That is, the team may believe that the supervisor will become concerned if performance falls below 80%, but that if performance rises above 80%, the supervisor will begin to recognize that the work center is doing a good job. On the other hand, Team B may believe that there is no single indifference point, but instead, there is a range of indifference represented by a zone of, say, from 75% to 85%. In other words, they believe that the supervisor is largely indifferent in a zone of 75% to 85% but will become concerned if the percentage falls below 75% or be impressed if the percentage

rises above 85%. The system can readily accommodate a zone of indifference in lieu of a point if the real-life conditions are best depicted in this manner.

### Weighting Indicators

Once KRAs and performance indicators have been agreed upon and all indicators refined for feasible best/worst and indifference points, the next step is for the facilitator to point out to Team B the likelihood that their indicators are not of equal importance. The facilitator then supports this assertion with several simple examples. For instance, in assessing the overall performance of a baseball player, which of these indicators would be of greater interest to the team manager: "number of home runs hit" or "number of bats broken"? In a military communications-navigation equipment repair shop, would the supervisor be more interested in "radios and radars returned from the flight line for failure to work properly (bounce rate)" or "number of dental checkup appointments missed by personnel"? In answering this second question, remember that although missing dental appointments is serious, the bounce rate directly affects flying capability and is therefore of critical interest to the wing commander, whose success depends in large part on getting aircraft into the air during operational readiness exercises. (Note: The answers are, of course, that the baseball manager is more interested in home runs and the supervisor is more concerned about the bounce rate.)

Getting Team B to achieve consensus on the relative importance of their indicators is the next step in the development of ME charts. The process of making judgments about the relative importance of indicators is expedited by use of an Indicator Weighting Table, which the facilitator presents to Team B on a chalkboard. (See Table 1.)

Table 1. Example of an Indicator Weighting Table

	<u>Feasible</u>		<u>Effectiveness</u>			
	<u>Worst/Best</u>		<u>Ranks</u>		<u>Points</u>	
	<u>Worst</u>	<u>Best</u>	<u>Worst</u>	<u>Best</u>	<u>Worst</u>	<u>Best</u>
	(1)	(2)	(3)	(4)	(5)	(6)
<u>KRA #1. Customer Satisfaction</u>						
<u>Indicator #1.</u> No. of customer inquiries satisfied/no. of customer inquiries received x 100.	50	95	5	3	-50	75
<u>Indicator #2.</u> No. of complaints received.	5	0	4	3	-70	75
<u>KRA #2. Timely Completion of Taskings</u>						
<u>Indicator #3.</u> Tasking completed on time/total tasking x 100.	60	90	3	3	-75	75
<u>KRA #3. Ensure Compliance with AFR 175-37.</u>						
<u>Indicator #4.</u> Exercise ratings passed/total ratings x 100.	75	100	1	1	-90	100
<u>Indicator #5.</u> No. of severe discrepancies found/no. of discrepancies found x 100.	80	0	2	2	-80	90

On the left-hand side of the Indicator Weighting Table, the facilitator writes the KRAs and indicators which were developed for the target organization by Teams A and B, respectively. These KRAs and the indicators which measure KRA accomplishment constitute the rows of the table. At the top of the table, the facilitator then enters the column headings shown in Table 1. For the first and second columns, the facilitator writes, for each indicator, the feasible worst and feasible best values derived earlier in the process of refining indicators. The facilitator should remind Team B that these feasible worst and best values are their own judgments and are different from the absolute (arithmetic) worst and best.

In the example shown in Table 1, there are 3 KRAs and 5 indicators; for each indicator there is a corresponding set of feasible worst and best values shown in columns (1) and (2). For Indicator #1, Team B said in the indicator refinement stage that the feasible best the work center could do in satisfying inquiries was 95%; they believed that some peculiarity would always prevent their achieving 100%. They said the feasible worst was 50%. On Indicator #2, the feasible best and worst in terms of number of complaints received were 0 and 5, respectively; and so on for the feasible best and worst for the other three indicators.

Once the facilitator has entered all feasible worst and best values in columns (1) and (2), the next step is to complete column (4) of the Indicator Weighting Table. This column is used to record the consensus judgment of Team B as to the relative importance or rank of each feasible best value of the indicators. To secure judgments about the ranks of the feasible best values for column (4), the facilitator says:

SUPPOSE EVERYTHING IMAGINABLE GOES RIGHT FOR THE WORK CENTER FOR A GIVEN MEASUREMENT PERIOD. YOU ARE STAFFED AT 100 PERCENT, LITTLE SICK OR ANNUAL LEAVE IS TAKEN, THERE ARE NO READINESS EXERCISES. OTHER ORGANIZATIONS YOU WORK WITH ARE COOPERATIVE. BECAUSE OF THESE AND OTHER POSITIVE INFLUENCES, THE WORK CENTER PERFORMS AT ITS FEASIBLE BEST ON ALL INDICATORS. THE WORK CENTER PERFORMS AT 95% ON CUSTOMER INQUIRIES SATISFIED, 0 ON CUSTOMER COMPLAINTS, AND SO ON. IF THIS WERE TRUE, WHICH OF THE 5 FEASIBLE BESTS WOULD HAVE THE GREATEST POSITIVE EFFECT ON THE OVERALL PERFORMANCE (MISSION) OF THE WORK CENTER?

Group B will then discuss alternative answers to this question until the members reach consensus as to which indicator has the most important feasible best. This indicator is ranked 1 and a "1" is entered in column (4) for that indicator. (In the Table 1 example, the most important feasible best was that for Indicator #4.) In case of ties between two or more indicators, each of the tied indicators will be assigned the same rank. For instance, if two indicators will equally result in the greatest positive impact, both should receive the rank of 1. The facilitator continues:

NOW THAT YOU HAVE IDENTIFIED THE INDICATOR WHOSE FEASIBLE BEST HAS THE GREATEST POSITIVE IMPACT, WHICH INDICATOR'S FEASIBLE BEST HAS THE SECOND GREATEST POSITIVE IMPACT ON THE OVERALL PERFORMANCE OF THE WORK CENTER?

This indicator is ranked 2 and a "2" is marked in the appropriate row of column (4). (In Table 1, Indicator #5 is ranked 2.) The process continues, with Team B ranking the importance of the feasible best on the remaining indicators.

After the feasible bests have been ranked in column (4), the facilitator asks Team B to change these ranks to effectiveness points for column (6), and says:

IF WE AUTOMATICALLY ASSIGN 100 EFFECTIVENESS POINTS TO THE FEASIBLE BEST FOR THE INDICATOR YOU RANKED FIRST, AS HAVING THE GREATEST POSITIVE MISSION IMPACT, HOW MUCH LESS IS THE IMPACT ON THE OVERALL MISSION OF THE INDICATOR WHOSE FEASIBLE BEST YOU RANKED SECOND?

The facilitator then explains that if the indicator ranked second were only about half as important to the mission as the indicator ranked first, it would be assigned 50 effectiveness points. If it were considered three-fourths as important, it would receive 75 points. If its impact were almost as important as that of the indicator ranked first, an effectiveness rating of 95 or 98 points might be assigned. This process continues until all indicator ranks in column (4) have been transformed to effectiveness points and recorded in column (6).

For the indicators shown in Table 1, Indicator #4 (with the rank of 1) automatically received 100 effectiveness points. Indicator #5 (with the rank of 2) was judged to have 90% as positive an impact on the work center's effectiveness as Indicator #4 and was thus assigned 90 effectiveness points. Finally, Indicators #1, #2, and #3 were tied in column (4) at the rank of 3, and Team B agreed that these indicators should receive 75 effectiveness points each.

A similar process is then performed to determine the ranks (column 3) and effectiveness points (column 5) of the feasible worsts. The facilitator begins this process of ranking with Team B as follows:

SUPPOSE EVERYTHING GOES WRONG FOR THE WORK CENTER FOR A GIVEN MEASUREMENT PERIOD. YOUR MANNING LEVEL IS VERY LOW. THERE IS A BIG SNOW STORM. THERE IS AN UNEXPECTED READINESS EXERCISE. THE MOON IS FULL. MORALE IS LOW AND THE WORK CENTER OPERATES AT ITS FEASIBLE WORST ON ALL 5 INDICATORS. IF THIS WERE TRUE, WHICH OF THE FEASIBLE WORSTS WOULD HAVE THE GREATEST NEGATIVE IMPACT ON THE OVERALL PERFORMANCE (MISSION) OF THE WORK CENTER? WHICH LOW SCORE WOULD HURT YOU THE MOST?

The feasible worsts are ranked in column (3) with "1" for the one with the greatest negative impact; again, ties are possible. As shown in column (3) of Table 1, for feasible worsts the team judged that Indicator #4 would have the greatest negative impact; Indicator #5, the second greatest negative impact; Indicator #3, the third; Indicator #2, the fourth; and Indicator #1, the fifth.

The next step is to transform the ranks in column (3) to negative effectiveness points for column (5). Though the feasible worst will usually receive -100 effectiveness points, the automatic assignment of -100 is not absolutely necessary to transform to effectiveness points the indicator with the feasible worst rank. For instance, in the case of Indicator #4 in Table 1 (which was ranked 1 for feasible worst), Team B believed that the feasible worst was simply not as bad as -100. They saw a difference in the impact on the work center's effectiveness (mission) between the feasible best and worst on this indicator. They believed that -90 was the impact of the feasible worst; therefore, -90 was recorded in column (5) for Indicator #4.

Once the negative effectiveness rating is determined for the feasible worst ranked number 1, the process continues, with Team B coming to consensus regarding the ratings for the remaining indicators. In the Table 1 example, Team B decided that the next feasible worst indicator (#5) should receive -80 effectiveness points and that the other three indicators (#3, #2, and #1) should be assigned effectiveness points of -75, -70, and -50, respectively.

It should be noted that the effectiveness points for the feasible bests are always positive (e.g., 100, 90, and 75), and the effectiveness points for the feasible worsts are always negative (e.g., -90, -80, -75, -70, and -50). In the unlikely event that a work center has only one

indicator, its feasible best is assigned 100 effectiveness points and its feasible worst is assigned the appropriate negative effectiveness points relative to -100.

This completes the discussion of weighting indicators using an Indicator Weighting Table. The role of feasible bests, feasible worsts, indifference points (or zones), and effectiveness points (weights) in constructing ME charts will now be explained.

### Plotting Known Values for Mission Effectiveness Charts

After refining the indicators and assigning relative weights to each, as suggested in the two previous sections of this paper, the facilitator proceeds to the last step in the development of an ME chart for each indicator; namely, assisting Group B to specify the slopes for each chart. To do so, the facilitator begins by showing them how to plot their previously determined values on the chart.

The general form of an ME chart is shown in Appendix A. The vertical axis of an ME chart shows an indicator's overall effectiveness or mission impact and is scaled from -100 through 0 to +100 in increments of 10. The vertical axis is the same for all ME charts. The horizontal axis is used to record those values specific to a given indicator; these values will range from the feasible worst to the feasible best for that particular indicator. It is recommended that the facilitator prepare a transparency of the chart contained in Appendix A for use on an overhead projector to assist Team B in plotting these values.

Using the vugraph of the chart from Appendix A as an example, the facilitator tells Team B that they are at last ready to construct an ME chart for their Indicator #1. The facilitator further explains that this chart will serve as a vehicle for providing feedback to them as to their performance on this indicator and as to how their level of performance impacts the overall performance (mission) of the work center according to the values shown on the vertical axis.

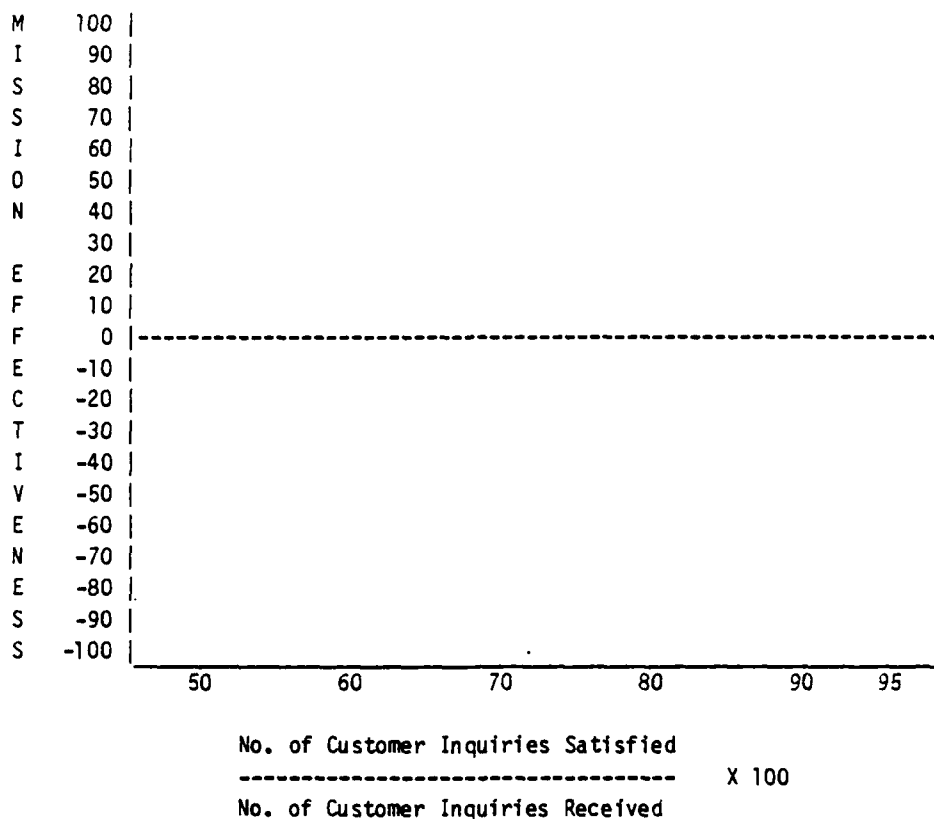
Team B members are then shown that they made some important decisions about the chart when they defined the feasible best and worst for the indicator, in that these values represent the "endpoints" of its horizontal axis. Thereupon, the facilitator labels the horizontal axis with the name of the indicator in question, marks the feasible best as the next-to-the-highest point (to the right) on the horizontal axis, and the feasible worst as the next-to-the-lowest point (to the left) on the horizontal axis. (The feasible best and worst could go in the extreme highest and lowest points on the horizontal axis, but leaving a space at either end of the axis makes a more easily readable presentation.)

Next, the facilitator fills in the intervals along the horizontal axis between the feasible worst and the feasible best. When under pressure to keep the process going, the facilitator may find it difficult to precisely scale between the two extremes, but Team B members will be understanding and satisfied with a series of approximations. Later, when the ME charts are automated or typed, an exact horizontal scale can be developed and the entire ME chart can be presented for Team B's review. Figure 1 shows such a scaling of the horizontal axis of Indicator #1 from Table 1.

Next, the facilitator explains to Team B that they have already developed three points for the ME chart that represent three levels of performance on the indicator. These points are the indifference point (or zone) and effectiveness values for the feasible worst and best discussed previously.

Figure 2 depicts these three parts of the curve for the Table 1 example. For this particular example, in which Team B decided earlier that their supervisor would be indifferent if 75% to 95%

of customer inquiries were satisfied, the zone from 75 to 85 would represent the indifference zone, where performance has no impact (i.e., 0 effectiveness points) on the work center's overall

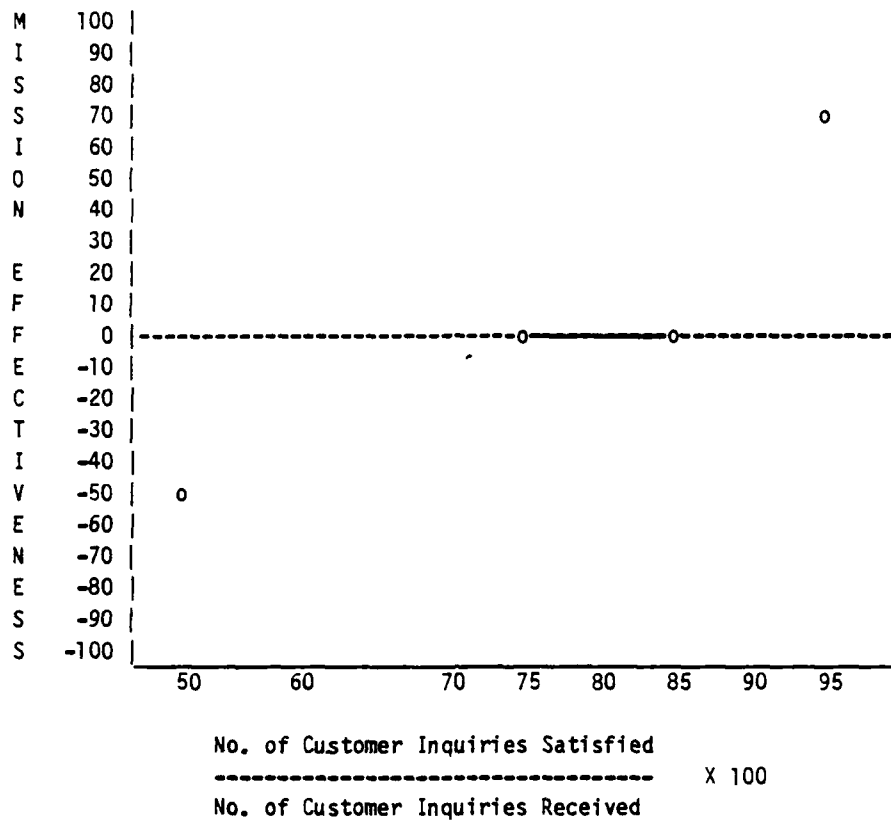


**Figure 1. Customer Satisfaction Mission Effectiveness Chart with Horizontal Axis Scaled.**

effectiveness (mission). This zone is shown by the dark line in Figure 2. Further, Team B in that example must be reminded that they decided the comparative contribution to overall work center effectiveness (mission) of the feasible best (95%) should be assigned 75 effectiveness points and the feasible worst (50%) should be assigned -50 effectiveness points. These points (-50 and 75) and the indifference zone (0 points each for 75, 80, and 85) for this example are plotted in Figure 2.

**Specifying Slopes for Management Effectiveness Charts**

As mentioned, the last step involved in constructing the initial ME chart for an indicator is to specify the slope of the ME curve. This involves determining the intermediate points between these three plotted values; that is, determining the negative impact values between the feasible worst and the indifference point (zone) and the positive impact values between the indifference point (zone) and the feasible best. Though an ME curve may be a straight line between the three previously plotted values, this is rarely the case. Rather, for each value shown on the horizontal axis a separate judgment must be made as to how much that particular level of performance would negatively or positively affect overall mission performance.

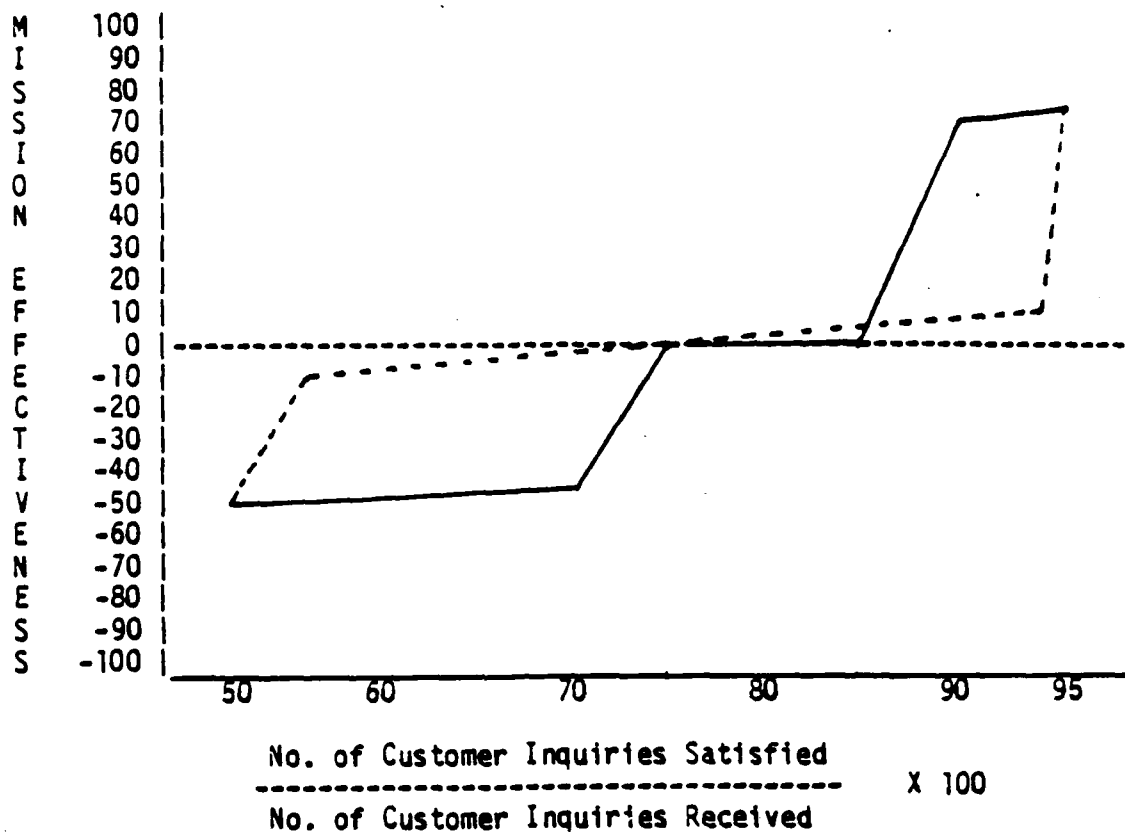


**Figure 2. Indifference Zone and Feasible Worst and Best Data Points Plotted for Customer Satisfaction.**

Before asking Team B to plot the intermediate points for its first chart, the facilitator should provide and interpret several alternative ME charts to illustrate the concept. Figure 3 shows two such alternatives (a dashed-line curve and a solid-line curve), as applied to the three plotted values presented in Figure 2.

The dashed-line curve suggests that a very broad range of performance on the indicator (from 55% to 94% inquiries satisfied) has no really positive or negative impact on mission, in that the effectiveness points vary only from -10 to 10. Performance above or below this range, however, has a substantial impact on the mission (75 and -50 effectiveness points, respectively).

The solid-line curve in Figure 3 exhibits a very different pattern. According to this curve, immediately below the indifference zone (less than 75% inquiries satisfied), the mission impact becomes severe, falling from 0 to almost -50 effectiveness points for a mere difference of 5% in indicator performance. Below the 70% level, however, the impact is already so bad that it can get only slightly worse. On the positive side, when performance exceeds the indifference zone (greater than 85%), the positive impact on the mission is dramatic; that is, an increase from 85% to 90% inquiries satisfied produces an increase in effectiveness points from 0 to almost 75. Above the 90% level, the increase in mission impact is positive but small by comparison.



**Figure 3. Alternative Slopes of Mission Effectiveness Charts for Customer Satisfaction.**

As part of the instruction concerning alternatives, the facilitator should stress to Team B that the slope of the curve is a graphic expression of their policy about the relationship between performance on the indicator and the impact on mission of various levels of performance.

Team B members learn to quickly come to consensus about the shape of curves for ME charts, but the facilitator may wish to begin development of the first chart by asking questions such as these:

IF THE IMPACT ON OVERALL EFFECTIVENESS OF 75% TO 85% INQUIRIES SATISFIED IS ZERO EFFECTIVENESS POINTS, HOW MUCH BETTER IS IT TO HAVE 90% OF INQUIRIES SATISFIED? HOW MUCH WORSE IS IT TO HAVE ONLY 70% SATISFIED? 65% SATISFIED? 60% SATISFIED?

Answers to each question form data points which, when connected, result in the construction of the ME curve.

After the ME chart for the first indicator is completed, the facilitator should then guide Team B in a similar manner through completion of the ME charts for the remaining indicators.

#### Checking Mission Effectiveness Charts

Before the MGEEM system is submitted to management for review, members of Team B should conduct two "sanity checks" of their ME charts to ensure that the charts are both accurate and logical.

The first check should come immediately after the charts are put into the form in which they will be used for providing feedback to workers and management. (This form can range from a fully automated procedure on a computer to simple typed copies which are photocopied for each measurement period.) At this time, Team B members should convene to review their charts in order to ensure that all elements have been recorded and reproduced as originally specified.

Another such meeting to correct and modify charts should take place when actual performance results on indicators are available from the first measurement period. At this stage, Team B members should feel free to modify their ME charts in any way necessary.

In addition to improving the quality of charts, these meetings offer the added benefit of getting organization members into the habit of meeting to discuss their charts. Once the system is in full operation, monthly meetings to review performance on ME charts are essential and are the most powerful feature of MGEEM. Feedback is widely believed to be the most important motivation to the enhancement of performance. Monthly feedback meetings are also used to identify constraints to performance and to discuss "how to work smarter."

#### Facilitator Responsibilities in Securing Management Approval

After Team B is satisfied with its ME charts, the complete system of KRAs, indicators, and charts is briefed to the appropriate higher level of management. Because MGEEM maintains and supports the prerogatives of traditional military management, the facilitator should ensure that some cautions are observed in this approval process.

First, the facilitator should pre-brief the commander or manager to reaffirm the basic philosophy of MGEEM. A key point in MGEEM implementation is that the greatest gain in organizational performance comes from increasing worker motivation and restoring or increasing workers' pride in their work and sense of craftsmanship. These factors are especially important in a resource-constrained environment. In any case, management should be reminded that workers must feel a sense of ownership of the MGEEM system if its feedback component is to be motivational. Workers "buy into the MGEEM system" by creating the system themselves. Thus, management must appreciate that the central issue is not whether the system measures with great precision but that it provides a platform or vehicle for continual improvement. Although overall accuracy is important, fine-tuning by management should be resisted.

Continual improvement is the essence of good management. So, it really does not matter if a feasible best is 65 or 70 or that an indifference point is 25 or 30. What is important, however, is that workers accept feedback from the ME charts and are willing to use them to identify better ways of doing business. And it is appropriate and reasonable for management to disagree with and ask questions about the system so long as workers maintain a feeling of ownership; in fact, management interest is stimulating to workers.

Certainly, management must be assured that the system is measuring the important components of the mission; for if the system does not capture the important components of the mission, then time and resources could be improperly diverted by the system into less important areas of work. However, if management changes the system unnecessarily--perhaps merely to show who is "boss"--workers will lose their sense of ownership and become resigned to "business as usual," where they do only what they are told and without much enthusiasm. They will be unwilling to make suggestions about improvement. This, of course, would mean that the main purpose of the MGEEM project has been defeated. Another way for MGEEM to be defeated is for management to be unresponsive to worker suggestions about how to improve the processes by which work is conducted. Rather than being rule-bound and rigid, managers must play a supportive role and be willing to endorse improvement.

A second concern of the facilitator should be to convince the commander and other higher-level managers not to expect to routinely monitor work center ME charts. ME charts are not part of any reporting requirement to higher management. Instead, management will receive aggregated or "rolled-up" results of performance for use as a management tool, as will be explained later. Managers therefore need to appreciate that the charts are intended for use only by the work center supervisor and workers as tools to improve work center performance.

The facilitator should also make it clear to personnel involved in an MGEEM implementation that they need not fear management disapproval of the MGEEM system submitted for review. In fact, such disapproval, if handled correctly, can prove to be one of the most valuable facets of an MGEEM implementation. Initial disapproval requires that managers and workers engage in a dialogue to seek agreement on the details of the system. After reflection, most workers welcome this dialogue because management is expressing an interest in their work and they, in turn, have an opportunity to present their viewpoint to management. Managers also welcome such dialogue because its underlying purpose is improving organizational performance, which is, of course, of vital importance to them. In such discussions, both sides usually make concessions to some degree and consensus is soon reached on the final system to be used.

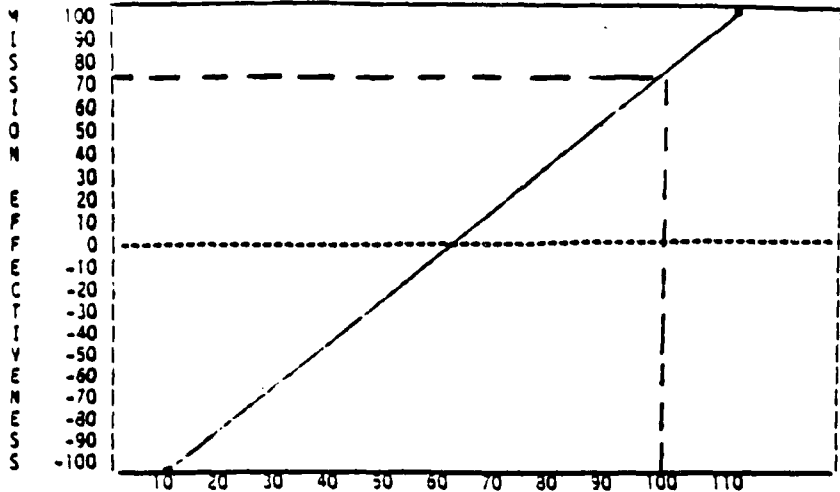
As mentioned earlier, MGEEM supports the prerogatives of traditional military management. That is, the commander maintains the right to approve or modify the MGEEM system. Consequently, the facilitator should present the MGEEM to workers realistically and in this light. The facilitator should stress that MGEEM represents an opportunity for workers to make suggestions to management about the best way to measure and improve organizational performance. The facilitator should create a positive outlook, with the expectation that most suggestions will likely be accepted by management, especially since the manager is a member of the team (Team A) that initially developed the KRAs. Although workers are encouraged to develop a sense of ownership of the system, the facilitator must also ensure they are fully aware of management prerogatives and do not naively believe that everything they suggest will automatically be accepted by management. If the facilitator allows workers to believe that acceptance of their suggestions will be automatic, changes which result from management review are likely to surprise and disillusion workers. Then, instead of having workers who are interested and motivated, the opposite may occur.

### III. AGGREGATING MISSION EFFECTIVENESS CHARTS

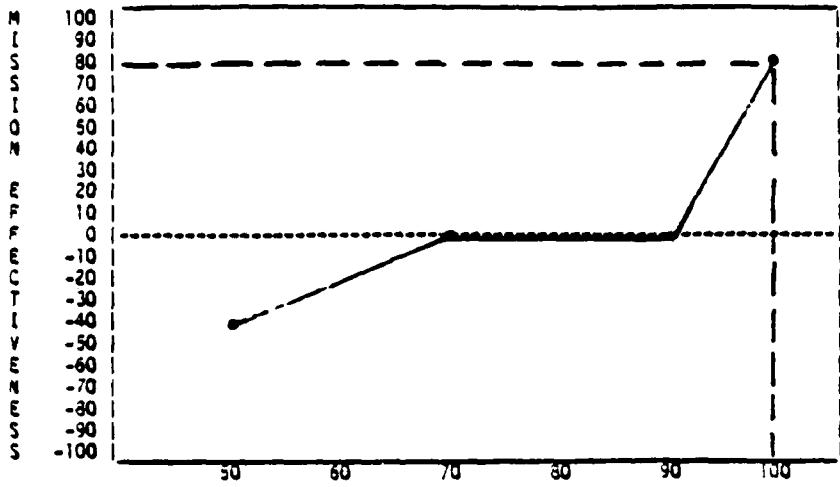
Among the most appealing features of MGEEM is that it provides the capability to combine ME effectiveness scores from different ME charts. The system makes it possible to determine overall performance by adding measures on several different indicators, such as percent of suspense dates met and number of action items accomplished. Further, through aggregation, the system also makes it possible to measure the combined performance of several unlike work centers, such as avionics and supply squadrons. There are a number of different organizational settings within which aggregation is useful. One such setting is the work center itself.

#### Aggregation Within a Work Center

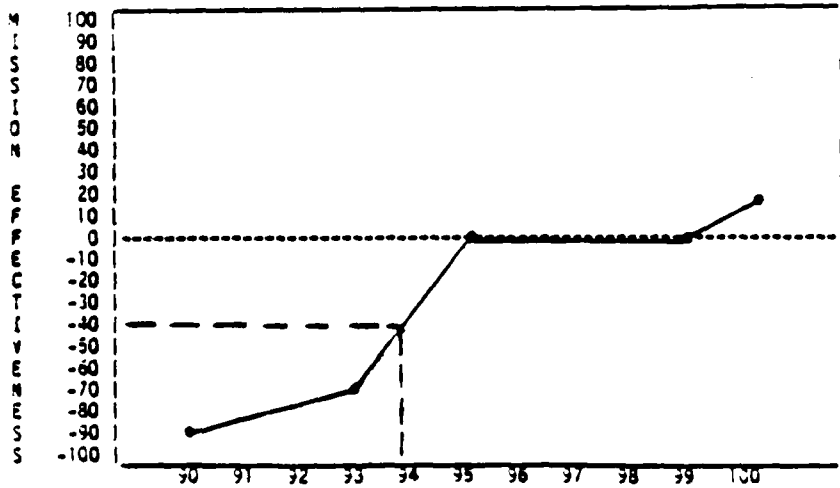
Aggregation would be useful to the work center manager who wishes to have a single measure or index of the overall work center performance. Consider, for example, a work center with 2 KRAs and 3 indicators, whose ME charts (one for each indicator) are shown in Figure 4. Suppose for the current measurement period the performance of this work center is 100 effectiveness points on Indicator #1, Percent Time Spent; 100 on Indicator #2, Percent Suspense Dates Met; and 94 on Indicator #3, Number of Action Items Completed. The work center manager would like to know how well the work center is doing overall.



Indicator 1: Percent Time Spent



Indicator 2: Percent Suspense Dates Met



Indicator 3: Number of Action Items Completed

Figure 4. Aggregating Within a Work Center.

### The Aggregation Problem

How is it possible to aggregate the three levels of performance in Figure 4 (100, 100, and 94) into a single number that constitutes a measure of the overall productivity of the work center? The three measures cannot simply be added together because they are on different scales. The result of simply adding them together would be uninterpretable.

### The Mission Effectiveness Chart Solution

The answer to the aggregation problem would be to use ME charts to convert indicator values (on different horizontal scales) to a scale they share in common (effectiveness points on the vertical axis). Consider the example in Figure 4. For each performance indicator value (100, 100, and 94) on the horizontal axis of each respective chart, there is a corresponding value in effectiveness points on the vertical axis. On Indicator #1, the 100% in time spent translates to 75 effectiveness points. On Indicator #2, the 100% on suspense dates met constitutes 80 effectiveness points. And, on Indicator #3, the 94 action items completed reads as -40 effectiveness points. These three effectiveness values (75, 80, and -40) can be arithmetically summed to provide a current effectiveness score (CES), a value of 115, which represents the overall performance of the work center for the current measurement period. Aggregation was made possible because each of the values (75, 80, and -40) was changed to a common metric.

This aggregation procedure has important advantages. First, it takes into account the fact that indicators may not be of equal importance. In the example, Indicator #1 is the most important since its feasible best and worst would result in 100 and -100 effectiveness points, respectively. Second, it allows indicators to be measured on any scale since ME charts convert them to a common scale. Third, the procedure is unaffected by the existence of non-straight-line relationships between the indicators and mission effectiveness ME, as is the case for Indicators #2 and #3 in Figure 4.

The aggregation of effectiveness points for the ME charts within a work center provides the CES score that, in itself, is very useful in assessing work center performance. Such scores are especially useful when compared at different points in time (e.g., monthly). Aggregation may be even more meaningful to the manager if applied in a slightly different manner, as explained below.

### The Management Engineering Program (MEP) Feedback Chart

A means of graphically displaying CES scores is the Management Engineering Program (MEP) Feedback Chart<sup>1</sup>. Use of the MEP procedure involves defining a baseline, as shown in the example MEP Feedback Chart in Figure 5. In Figure 5, which is based on the information depicted in Figure 4, the baseline CES of 115 is simply defined as 100 and plotted for July, the measurement period involved. There is no formula involved in this step. The baseline CES is always defined as 100. Thus, in this case,  $115 = 100$ . Each succeeding month's CES is converted by a simple calculation to percentages relative to the baseline of  $115 = 100$ . Any successive month's CES can be changed to a percentage for use in the feedback chart by dividing the CES for the current period by the CES for the baseline period and multiplying by 100, as shown in the following equation:

$$\frac{\text{Current Period CES}}{\text{Baseline CES}} \times 100 = \text{MEP Value}$$

<sup>1</sup>The MEP Feedback Chart was suggested by Maj Don M. Riemensnider, Chief of the Program Management Division of the Air Force Management Engineering Agency (AFMEA), and bears the name of the program where the procedure is used, the Management Engineering Program (MEP).

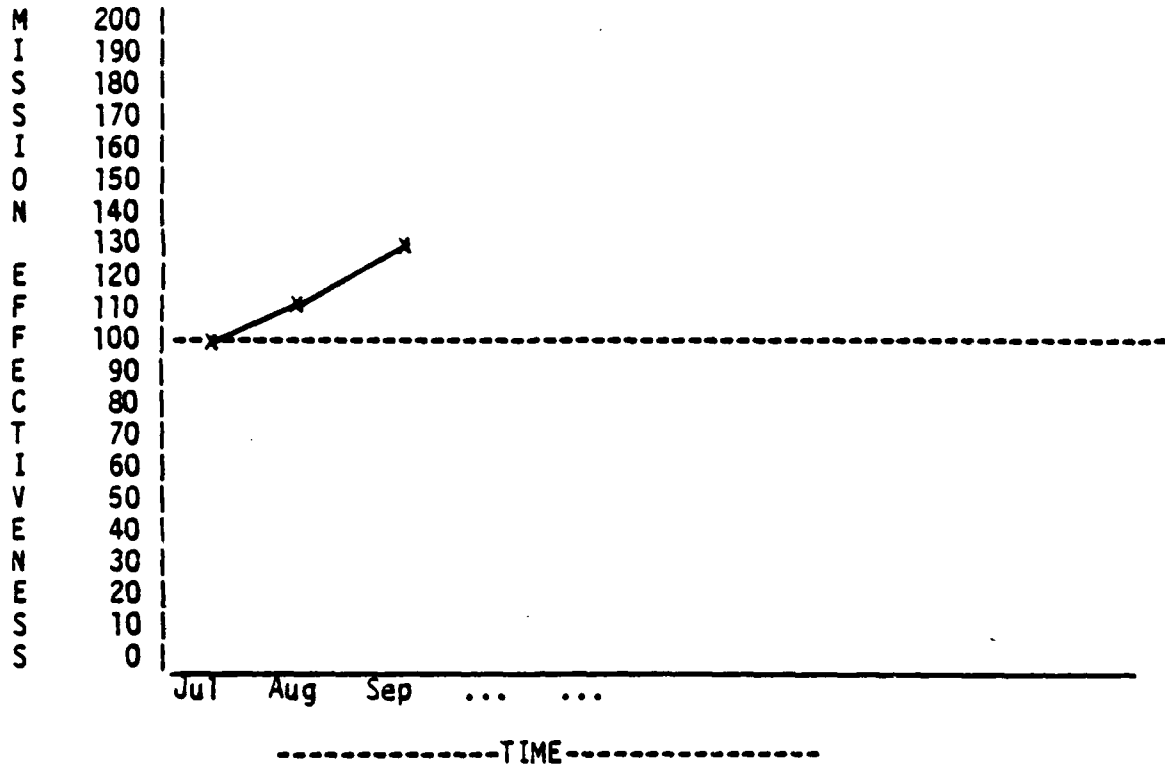


Figure 5. Example MEP Feedback Chart.

For Figure 5, suppose that in August the CES increases from 115 to 130. The current period CES of 130 is made comparable to the baseline CES by  $130/115 \times 100 = 113$ . The value 113 is then plotted for August on the MEP Feedback Chart in Figure 5. Similarly, a CES of 150 for the month of September would be made comparable to the baseline CES of 115 by  $150/115 \times 100 = 130$ . The value 130 is then plotted for September on the chart. For each successive period, the current period changes but the MEP Feedback Chart's baseline number in the denominator remains the same. That is, all values to be plotted on the chart are computed relative to the baseline.

For the MEP Feedback Chart shown in Figure 5, the baseline was determined based on the first month's CES. However, in order to have a more representative baseline, data for several months may also be used in establishing the baseline value. For example, if the MGEEM system is developed using data that already exist in the information system of the target organization, it may be possible to reconstruct a baseline period CES value by computing the average of the monthly CESs for a period of months prior to the month of the MGEEM implementation. If sufficient historical data do not exist, another option is also possible. After the MGEEM has been in operation for a period of time, a baseline can be redefined as the average of CESs for, say, the first 6 months or a year. However, it is well to remember that the baseline should represent a typical or average period of organizational performance. If the baseline is set in a period that is atypical of performance, subsequent percentages for CESs will be unrealistically above or below the baseline. If it is necessary that the baseline be established during such a period (either above or below average), this fact must be considered in making interpretations.

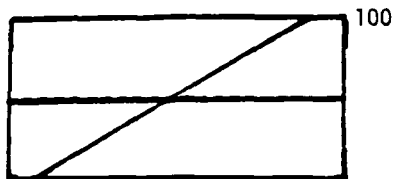
#### Aggregation Across Work Centers

Aggregation would also be useful to managers of two or more work centers who wish to have a single index of the combined overall performance of these organizations. This measure might be

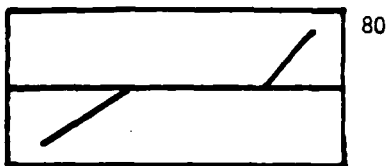
used for a branch, division, or higher organizational unit. For the sake of illustration, consider Figure 6, which shows Branch A composed of two work centers, one with 3 ME charts and one with 5 ME charts.

Branch A

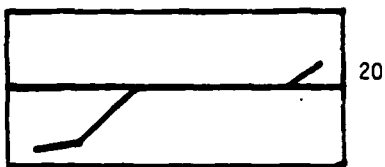
Work Center 1



Indicator #1

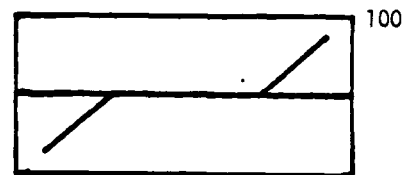


Indicator #2

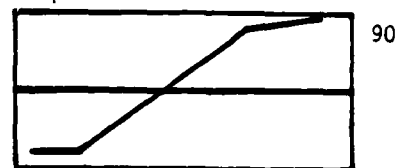


Indicator #3

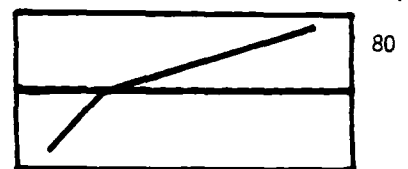
Work Center 2



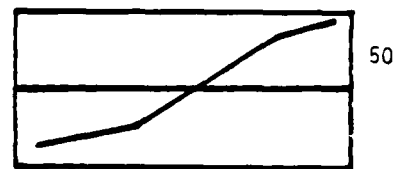
Indicator #1



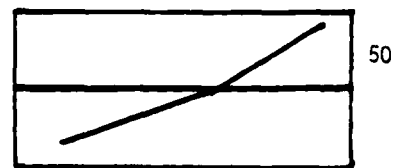
Indicator #2



Indicator #3



Indicator #4



Indicator #5

Figure 6. Aggregating Across Work Centers.

The obvious answer to developing one number as an index of overall performance would appear to be to simply aggregate the effectiveness scores from the 8 ME charts as was explained in the previous section dealing with aggregation within one work center, but things are not as simple as

they seem. If we suppose the CESs (effectiveness scores for current performance) in the illustration in Figure 6 for a given month are 75, 80, and -40 for the ME charts of Work Center 1 and 90, 50, 50, -10, 22 for the ME charts of Work Center 2, why not simply add these CESs for both work centers together for a total of 317 and post this total on a MEP Feedback Chart? To do so would be a serious error in that their relative contributions to Branch A's productivity have not been taken into account.

### The Unequal Contribution Problem

It is an error to aggregate across work centers by simply adding CESs, such as those for the two work centers in Figure 6. We can combine the scores for Work Center 1 or the scores for Work Center 2, but we cannot combine the scores for the two work centers as these work centers do not contribute equally to branch productivity. Consider that if both of these work centers did their feasible bests, the maximum effectiveness score (MES) for Work Center 1 would be 200 MES (100 + 80 + 20), whereas the MES for Work Center 2 would be 370 MES (100 + 90 + 80 + 50 + 50). The Branch Chief may regard both work centers as equally important in their contributions to the branch mission, or the Branch Chief may consider the contribution of Work Center 1 to be twice as important as the contribution of Work Center 2. In either case, it is inaccurate to allow Work Center 2 to contribute a potential maximum of 370 points while the equally important or twice as important Work Center 1 contributes a potential maximum of only 200 effectiveness points. This is the problem of "unequal contribution," and it arises when the MESs of organizations to be aggregated are not in proportion to the management's assessment of their relative contributions to the mission of the organization within which they are to be aggregated.

### The Aggregation Correction Factor (ACF)

A solution to the problem of unequal contribution has been found and should be used to compare organizational units after all the ME charts have been developed for each of the organizational units to be aggregated. It should be noted that the aggregation correction factor (ACF) is used only for purposes of aggregating across different organizational units. It is important to stress that the procedures used in developing ME charts, and the use of these charts within a single work center, are not affected by the computations needed to aggregate across work centers.

In order to apply the ACF, the facilitator must meet with the manager of the organizational units to be aggregated and must obtain a judgment about the relative contribution of each organizational unit to the mission of the next hierarchical level. For the example illustrated in Figure 6, the facilitator would meet with the Branch Chief to ask which of the two work centers contributes most to the accomplishment of the branch mission. The two work centers could contribute equally or unequally.

If the Branch Chief believes they contribute unequally, he/she is asked to assign ranks: 1 for the most important work center, 2 for the second most important, and so on. Next, the Branch Chief is asked to assign percentages to the ranks, with rank 1 automatically set to 100%. In the example in Figure 6, if Work Center 1 is ranked 1 and Work Center 2 ranked 2, then Work Center 1 would be set to 100%. If the Branch Chief believes Work Center 2 is only half as important as Work Center 1, Work Center 2 would be assigned a value of 50%. If the work centers are deemed of equal importance, each would be assigned 100%. Or, if there were three work centers and one contributed twice as much as the other two, the most important would be set at 100%, with the others tied at 50%.

To further illustrate the ACF, assume the Branch Chief believes Work Center 2 is only half as important to the branch mission as Work Center 1. Therefore, since the MES for the feasible best

of Work Center 1 is 200 (100 + 80 + 20), the MES for the feasible best for Work Center 2 should be only half of 200, or 100. To compute the ACF for reducing the 370 MES for Work Center 2 to half of 200, or 100 MES, the following formula would be used:

$$\frac{\text{MES Before Adjustment}}{\text{MES After Adjustment}} = \text{Aggregation Correction Factor (ACF)}$$

For Work Center 2, the MES before adjustment is 370 (100 + 90 + 80 + 50) and the MES after adjustment is 100. Thus,  $370/100 = 3.7$  is the ACF.

The second step in aggregating contributions across these work centers is to apply the ACF to the actual performance scores for Work Center 2. To do this, the 202 CES (90, 50, 50, -10, and 22) for Work Center 2 is divided by the ACF (3.7) to compensate for the fact that the contributions of Work Center 2 are only half as important as those of Work Center 1. The adjusted CES for Work Center 2 (54.6) can then be added to the 115 CES (75, 80, and -40) for Work Center 1 to arrive at the branch CES of 169.6 (54.6 + 115).

For another example of using the ACF to solve the unequal contribution problem, assume the Branch Chief considers that the two work centers in Figure 6 make equal contributions to the branch mission. In such a case, the 370 MES of Work Center 2 needs modification to equal the 200 MES of Work Center 1. The MESs for both work centers should be made equal if they are of equal importance to the branch; thus, both work centers should have MESs of 200. Next, remember that the CES for Work Center 1 is 115 and for Work Center 2 is 202. To make the two work centers contribute equally, the 202 CES for Work Center 2 needs to be adjusted with the ACF. The computation of the ACF in this case is  $370/200 = 1.85$ . This ACF is then used to adjust the 202 CES ( $202/1.85$ ) and results in 109. The 109 adjusted CES for Work Center 2 can now be added to the 115 CES from Work Center 1 to get 224 (109 + 115), the CES for the branch.

(Note: If the Branch Chief believes the two work centers are equally important, the MES for the feasible best of both work centers should be equal. Work Center 1's 200 MES could be adjusted upward to equal the 370 MES of Work Center 2, or the 370 MES for Work Center 2 could be adjusted downward to equal the 200 MES of Work Center 1. For the sake of simplicity, we chose to present the downward adjustment only.)

### The MEP Feedback Chart

Once the problem of unequal contribution has been corrected, it is possible to use the MEP Feedback Chart format described earlier. To demonstrate this, consider the example above where the contributions of both work centers are of equal importance and the branch CES is 224. To use the MEP Feedback Chart, the CES of 224 is defined as the baseline (i.e., 100). Afterward, if the branch CES increases from 224 to 240, the branch point on the feedback chart would increase from the baseline of 100 to 107 ( $240/224 \times 100$ ). Then, if during the next measurement period the branch CES increased from 240 to 250, the new monthly value for the feedback chart would be 112 ( $250/224 \times 100$ ). In other words, each increase (or decrease) is computed relative to the baseline value.

### Adding New Branch Indicators

Facilitators should be aware that managers of the organizational units being aggregated frequently want to add an indicator or indicators which apply to the higher-level organizational unit (e.g., branch) but which may or may not be associated with the work performed in the

lower-level units being aggregated. For instance, in aggregating across work centers to a branch, the Branch Chief may want indicators which are unique to branch-level work in managing the work centers. Such indicators might have nothing to do with the actual work done in the work centers themselves. Such additional indicators may be measures of activities that take place only at the higher organizational level or they may be activities that occur in all of the lower-level organizations being aggregated. Managers want such higher-level indicators because they feel that such indicators measure important parts of the work of their organization and are needed to make the aggregation complete.

Using the example shown in Figure 6, suppose the Branch Chief wishes to add a new indicator that applies to the branch and not to the two subordinate work centers. To add this new indicator, the facilitator leads the Branch Chief through the usual process of identifying the feasible best/worst points and the indifference point (or zone) to develop an ME chart for this one branch indicator. The feasible best is automatically assigned 100 effectiveness points (since this is the only branch indicator) and after some discussion, the feasible worst is determined to be -100 points. This new ME chart is then used to assess performance on the activity measured.

In order to aggregate performance on this branch indicator with performance for the two work centers, the procedures for computing and applying the ACF must be followed. The first step is for the Branch Chief to answer the question "How important to the branch mission are the activities performed by the two work centers relative to the activity assessed by this single branch indicator?" The facilitator presents the question to the Branch Chief in this manner:

YOU HAVE SAID THAT WORK CENTER 1 MAKES THE GREATEST CONTRIBUTION TO BRANCH EFFECTIVENESS AND SET ITS VALUE AT 100% WHILE WORK CENTER 2 MAKES ONLY HALF AS MUCH OF A CONTRIBUTION WHICH IS SET AT 50%. BY COMPARISON, WHAT IS THE CONTRIBUTION OF THE ACTIVITY MEASURED BY THE SINGLE BRANCH INDICATOR?

If the Branch Chief believes the contribution of the activity measured by the single branch indicator is only one-tenth as important as the contribution of Work Center 1, then the MES for the feasible best of the branch indicator should be adjusted to .1 of 200, or 20 MES, and branch indicator CESs should be adjusted with the ACF computed as follows:

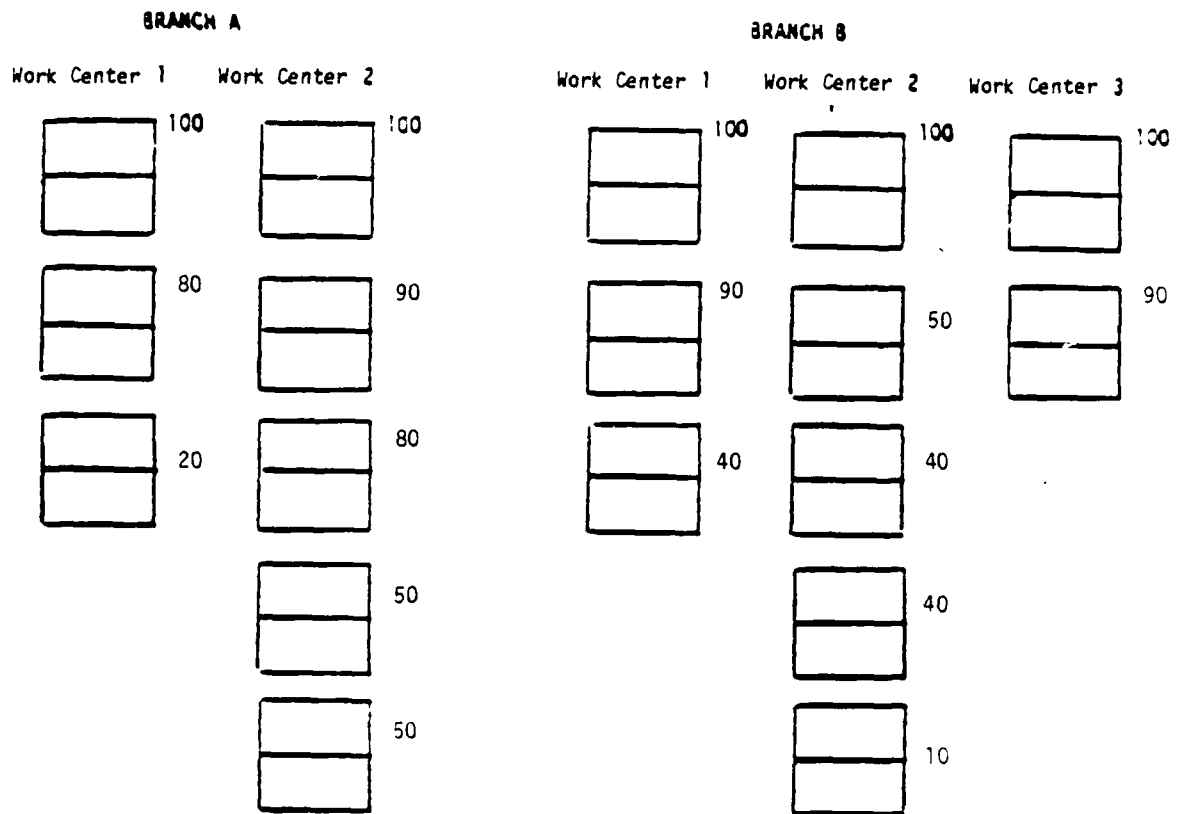
$$\begin{array}{r} \text{MES Before Adjustment} \\ \text{-----} \\ \text{MES After Adjustment} \end{array} = \text{ACF}$$

In this instance, the ACF is  $200/20 = 10$ . Thus, the CES of 85 on the branch indicator is adjusted to 8.5 (85/10) before being added to the corresponding CESs from Work Centers 1 and 2, and posted to the branch-level MEP Feedback Chart.

If the Branch Chief wants two or more branch-level indicators, the development and aggregation process is identical to that previously described. The feasible best/worst values and indifference points (or zones) are developed for all branch indicators. The Indicator Weighting Table (see Table 1) is used to assess branch indicators in terms of maximum effectiveness points, and slopes on the ME charts are specified (as in Figure 3). Again, the Branch Chief evaluates the importance to the branch mission of activities assessed by the branch indicators relative to the contributions of Work Center 1, whose importance to the branch mission is 100%. Suppose, as in the earlier example, the contribution of each branch indicator is only one-tenth as important as Work Center 1 at 100%. If so, the total MES for all ME charts of the branch would be adjusted down to 10% of the MES (200) of Work Center 1. Then branch CESs

would be adjusted with the ACF before being added to the CESs of the other work centers and before being posted to the branch-level MEP Feedback Chart.

The logical extension of having aggregated across work centers to provide a single measure of the performance of a branch is to aggregate branches to the division and ultimately up the chain-of-command to larger organizational units. The process of aggregating across increasingly larger organization units follows the procedures described previously. For example, consider Figure 7. Suppose Branch A and Branch B both have MGEEM systems in place. The Division Chief, the manager immediately above the two branches, expresses an interest in having a single measure of the performance of the division. To accomplish this, aggregation is needed.



Maximum Effectiveness Score (MES)	200	370	230	240	190
Current Effectiveness Score (CES)	115	202	200	160	100
Adjusted MES	...	100	76	171	...
Aggregation Correction Factor (ACF)	...	3.7	3.0	1.4	...
Adjusted CES	...	54.6	67	114	...
Branch CES	169.6 (115 + 54.6)		281 (67, 114, 100)		

Figure 7. Aggregating Across Branches.

### Aggregating Across Branches

Before explaining how to aggregate two branches to a division, it is perhaps useful to describe the MGEEM systems in place in the branches and to walk through the adjustments which have been made previously to aggregate to the branch level. After that, it will be easy to aggregate to the division level.

Figure 7 shows Branch A with the two work centers described earlier (Figure 6). For Branch A, the MESs are 200 MES (100 + 80 + 20) for Work Center 1 and 370 MES (100 + 90 + 80 + 50 + 50) for Work Center 2. Since the Branch Chief believes Work Center 2 is only half as important as Work Center 1, the MES for Work Center 2 is adjusted to 100 (50% of 200). This value is shown in Figure 7 as the Adjusted MES for Work Center 2. The ACF for Work Center 2 is 3.7 (370/100). The CES for the 3 mission effectiveness charts for Work Center 1 is 115 (75, 80, -40). To aggregate the data across the two work centers, Work Center 2's CES of 202 (90, 50, 50, -10, 22) must first be adjusted by applying the ACF. Finally, the CES for Branch A is obtained by adding 115, the CES for Work Center 1, to 54.6 (202/3.7), the adjusted CES for Work Center 2, for a sum of 169.6 (115 + 54.6). The performance of Branch A of 169.6 can now be posted to a branch-level MEP Feedback Chart.

Figure 7 also shows Branch B, which has 3 work centers. The three MES values are 230 MES (100 + 90 + 40) for Work Center 1, 240 MES (100 + 50 + 40 + 40 + 10) for Work Center 2, and 190 MES (100 + 90) for Work Center 3. For the current measurement period, the CESs for the three work centers, respectively, are 200, 160, and 100. The Branch Chief believes Work Centers 1 and 2, respectively, are only 40% and 90% as important to the branch as is Work Center 3. Therefore, for aggregation purposes, the MESs for Work Centers 1 and 2 must be reduced by these percentages. These adjusted MESs would be 76 (190 X .40) for Work Center 1 and 171 (190 X .90) for Work Center 2. The corresponding ACFs would be 3.0 (230/76) for Work Center 1 and 1.4 (240/171) for Work Center 2. To aggregate across work centers for Branch B, the CESs for Work Centers 1 and 2 must be adjusted by the ACF to take into account their lesser importance relative to Work Center 3. These adjusted values are 67 CES (200/3.0) for Work Center 1 and 114 CES (160/1.4) for Work Center 2. After adjustment, aggregation for the current period's performance can be accomplished by adding the three CES values (67 + 114 + 100) to obtain a combined CES of 281. The performance of Branch B (281) can now be posted to a branch-level MEP Feedback Chart.

Before explaining how to aggregate the two branches to the division level, it is important to emphasize again that original ME charts and MEP Feedback Charts which exist at the work center level are not affected by adjustments for aggregation to the branch, division, or higher levels. Supervisors and workers in the work centers will continue to use these items as initially developed.

The first step in aggregating across branches to the division level is for the facilitator to secure from the division chief a judgment about the relative contributions of the two branches to the overall division mission. Using the example shown in Figure 7, the branch which makes the most important contribution is ranked 1 and automatically given an effectiveness value of 100%; the other is ranked 2 and scaled according to the importance of its contribution relative to 100%. Of course, the branches could be judged to make equal contributions. If so, both would receive an effectiveness score of 100; and the unequal MESs for both branches, 300 MES (200 + 100) for Branch A and 437 MES (76 + 171 + 190) for Branch B, would have to be made equal. Consequently, Branch A is adjusted to 300 because its importance must be made equal to the importance of Branch B, and its corresponding ACF is 1.46 (437/300). As a result, the combined division MES is 600 (300 + 300).

To aggregate CESs for the two branches--169.6 CES (115 + 54.6) for Branch A and 281 CES (67 + 114 + 100) for Branch B--Branch B's CES must be adjusted with the ACF to 192.5 (281/1.46) to make

the branches' contributions equal. The two CES values may then be summed to 362.1 (169.6 + 192.5). This value may then serve as the baseline for the division-level MEP Feedback Chart.

Suppose, however, that the Division Chief believed that Branch B was only 80% as important to the division mission as Branch A. Branch B's MES of 437 would have to be adjusted to 240 (300 X .80), and the corresponding ACF would be 1.82 (437/240). As a result, the division MES would be 540 (300 + 240). Before Branch B's CES (281) can be combined with the CES of Branch A (169.6), it must be adjusted to 154.4 (281/1.82). The two branch CESs may then be summed to 323.7 (169.3 + 154.4), and this value could serve as the baseline for the division-level MEP Feedback Chart.

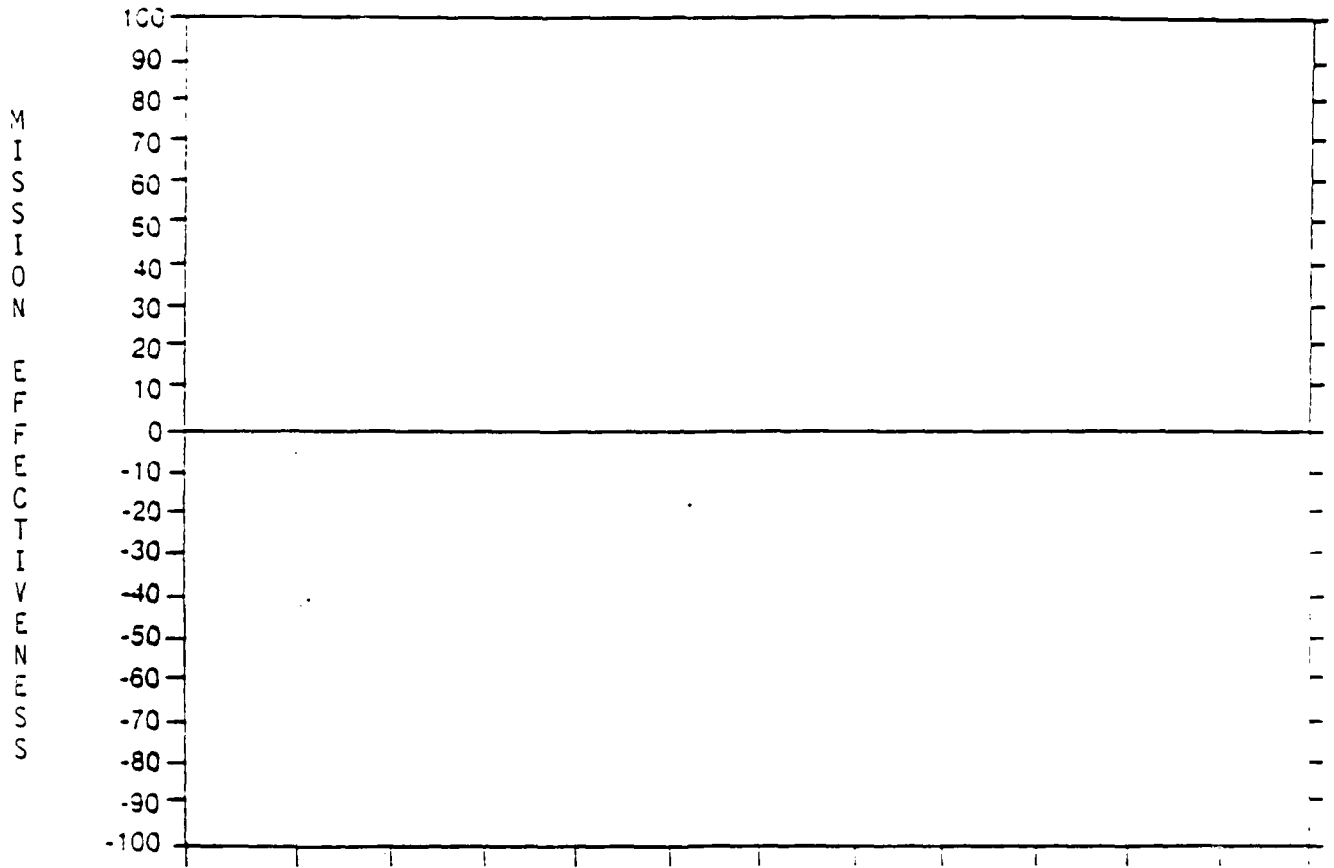
#### IV. CONCLUSION

Thus, after developing ME charts, it is possible to aggregate mission effectiveness scores within and across work centers, and within and across increasingly higher organizational levels. This technology for "rolling up" performance measures has wide application and can be very useful to managers. A forthcoming report (Weaver, in preparation) will explain how the MGEEM system can be used to improve leadership, enhance motivation, and continually improve work processes.

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APPENDIX A: GENERAL FORM OF A MISSION EFFECTIVENESS CHART



## APPENDIX B: FACILITATOR EXERCISES

The following exercises are presented to increase facilitator insight into the implementation of MGEEM. These exercises are the result of dealing with issues and problems encountered during actual implementation of MGEEM in over 30 target organizations over a 2-year period. They draw upon material contained in this guide on developing and aggregating ME charts, as well as material presented in the companion guide on developing KRAs and indicators (Tuttle & Weaver, 1986). Because these exercises are based on "real-world" situations, some have no single correct answer but rather, a set of possible solutions.

### Exercise 1: Degree of Control

**Problem.** A facilitator is developing indicators with Team B from a target organization which provides monthly qualification training for personnel in other organizations on the base. The target organization maintains records that show which base personnel need training. When an individual is identified as needing training, a training date is scheduled and notification of the date is forwarded to the commander responsible for the individual's attendance. Often, however, individuals do not show up for scheduled training. Their failure to show up is beyond the control of the training organization and is almost always because their workload is too great for their commander to spare them. Through the MGEEM process, Team B has developed some good indicators of performance, such as "average monthly test scores for trained personnel," but the manager of the target organization says she could plan better if she had a monthly measure of "training appointments kept" (training appointments kept/training appointments scheduled X 100). Should this measure be incorporated into the training organization's MGEEM system even though they have no control over it?

**Suggested Solution.** It is an error to hold a target organization responsible for performance over which they have no control. Despite the best efforts of these training personnel, factors beyond their control cause attendance at their training classes to fluctuate. It would be demotivating to give them low scores on this dimension of performance when they may have done the very best they can.

This is not to say that the supervisor should not track "training appointments kept" and whatever else she wishes to use in her management information system. A target organization's MGEEM system and management information system may contain many or all of the same indicators; however, there are often important differences. A key difference, of course, is that MGEEM indicators should be only those which measure activities over which the target organization has control. Also, MGEEM indicators should encourage worker involvement, be visible, be easy to understand, and measure what is important.

For an excellent treatment of measuring the things that are important, see Chapter VI, S-1 in Peters (1987). There are good reasons for measuring only the most important areas of performance rather than measuring everything available. One reason is the smaller paperwork burden. Undermanned organizations with heavy workloads are highly resistant to devoting manhours to monitoring a complex measurement system. Another reason is that as organizations improve on their few but critical KRAs, other parts of their work tend to improve as well. This is true because the components of organizations are functionally related. Components must work together to accomplish the KRAs and mission. To do well on the KRAs almost always necessitates doing well in even the most indirect functions that support the accomplishment of KRAs. This outcome will not result, however, if an important KRA is omitted from the MGEEM system. Rather, the measurement system will pull resources and management attention away from the unmeasured area.

This is a serious problem which should not happen if Team A does its job of identifying a comprehensive set of KRAs.

**Exercise 2: No Indifference Point**

**Problem.** A facilitator is developing a measurement system with Team B from a target organization that is a confinement facility. Team B wishes to have an indicator which measures "number of escapes" (or "number of instances of loss of control"). The feasible best is "no escapes" and the feasible worst is "one escape." When asked to identify the indifference point, Team B members say that there is no point on this indicator where performance is neither good nor bad: 0 escapes is good; 1 escape is bad. There is no in-between. In using the Indicator Weighting Table to assess the relative importance of the indicators, Team B decides that "number of escapes" is the most important of all their indicators. "No escapes" contributes more to the facility's mission than does the feasible best of any other indicator, and "one escape" detracts more from the mission than does the feasible worst of any other indicator. Is it possible to develop an ME chart for an indicator that has no indifference point? Can an ME chart be developed for an indicator that has only two values, in this case 0 and 1?

**Suggested Solution.** It is possible to develop an ME chart for an indicator with no indifference point and values of 0 and 1. Since this indicator is more important than the others, its effectiveness scores are -100 for 1 escape and 100 for 0 escapes. It is misleading, however, to connect these two points because the resulting straight line will pass through the zero point on the vertical axis, giving the impression that an indifference point exists. It is probably best to use a dashed straight line to show there really is no connecting line or indifference point because there can be no 1/4, 1/2, or 3/4 escape. Figure B-1 shows how this chart should appear. The two points are connected so that all ME charts for the facility will be similar in appearance, but the dashed line serves to remind organization members that there are really only two levels of performance: 0 escapes with 100 effectiveness points and 1 escape with -100 effectiveness points.

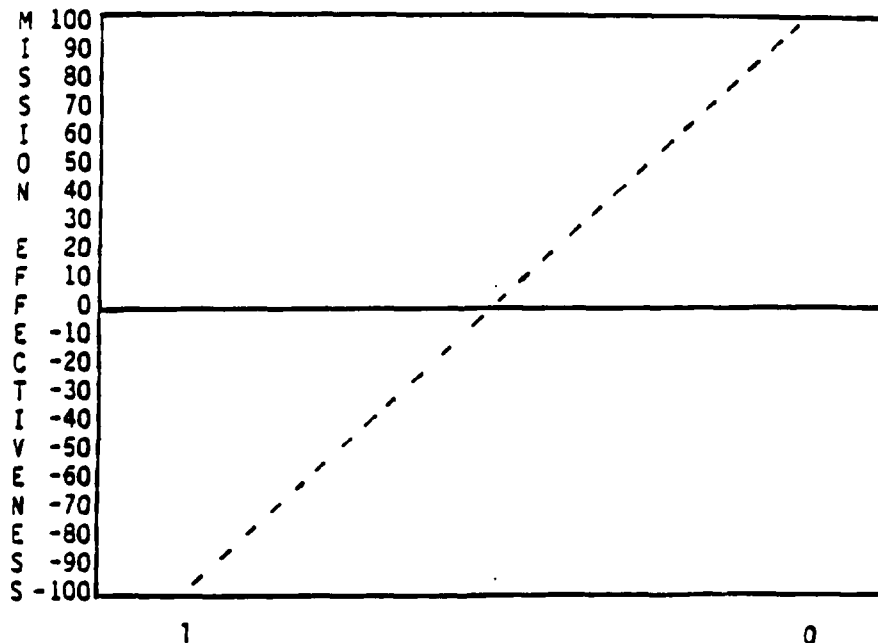


Figure B-1. Number of Escapes.

**Exercise 3: Exceeding Feasible Best/Worst**

**Problem.** A certain target organization has spent a week with a facilitator developing an MGEEM system. Later, when data are gathered for the first measurement period, actual performance

on a certain indicator is below the feasible worst the organization said it could do. It is, therefore, impossible to record this level of performance on the indicator's ME chart. Does this invalidate the chart?

Suggested Solution. Actual performance below a feasible worst or above a feasible best on an indicator invalidates the ME chart, but happens in almost every MGEEM implementation. Such an occurrence should not, however, be viewed as a serious problem. This simply requires that Team B meet again to consider a new feasible worst and revise the scaling on the horizontal axis of the indicator in question. They should also review the Indicator Weighting Table (retained from the original session) with the new feasible worst, for possible changes in the relative importance of other feasible bests and worsts. Experience suggests that very few changes usually result from this review. Any ME chart affected by this review would, of course, simply be revised. An MGEEM system belongs to organization members and they may revise it at any time. The purpose of the system is not to be a rigid rule-bound reporting requirement, but a flexible self-help tool used to work continuously toward improvement.

#### Exercise 4: Horseshoe Curve

Problem. A certain test and evaluation work center is developing an indicator to monitor the composition of its personnel force. The center needs both college-trained engineers and field-experienced technicians, and the feasible best mix is about half engineers and half technicians. In fact, the mix is ideal if the percentage of either group is between 45% and 55%. As the mix differs from this range, the mix is still satisfactory but less so until the percentage of either group reaches 40% or 80%. Being below 40% or above 80% has negative effects on the mission, increasing in negative effect up to mixes of 10% and 90% which are the feasible worsts that could occur. Compared with other indicators, the feasible best earns 50 effectiveness points and both feasible worsts incur -90 effectiveness points. It is possible to create an ME curve for this indicator?

Suggested Solution. Figure B-2 shows that the ME chart for this situation is horseshoe-shaped because there are two points of feasible worst, two indifference points, and one zone of feasible best. The effectiveness points for the feasible worsts are both -90 and the feasible best zone is at 50 effectiveness points. If it reflects the judgment of Team B, straight lines can connect these points. Of course, the feasible worsts are not required to have the same effectiveness points if having far too many of one group is worse than having far too many of the other. Nor is it required that the connecting lines be straight. In any case, this example demonstrates that curves do not always run from lower-left to upper-right.

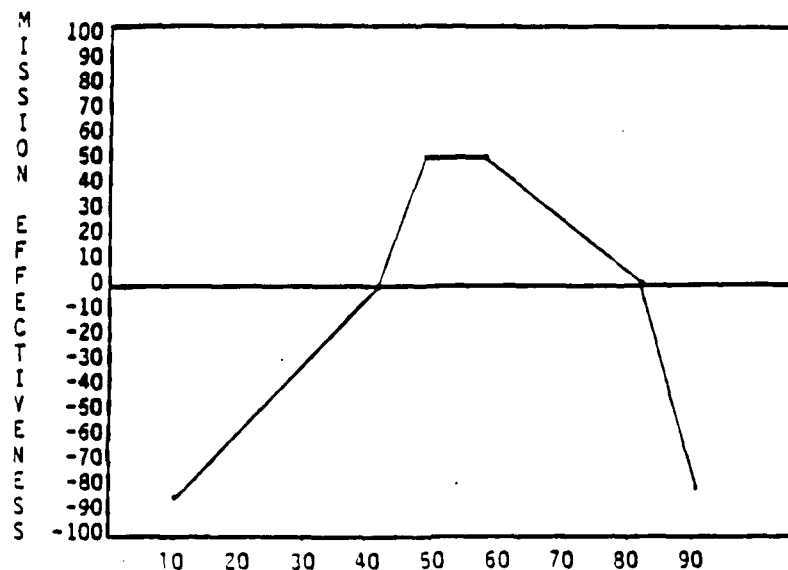


Figure 3-2. Percent of Engineers.

### Exercise 5: Aggregating to Branch Level

**Problem.** A certain Materiel, Storage, and Distribution (MS&D) Branch in a Supply Squadron recently implemented an MGEEM system. The MS&D Branch has 4 sections, which the Branch Chief believes contribute equally to the accomplishment of the branch mission. The MESs and CESs for the 4 sections and for one branch indicator are shown in Table B-1.

Table B-1. Section and Branch Performance Data

	<u>Materiel, Storage and Distribution Branch</u>				Branch Indicator
	Receiving	Storage and Issue	Pick up and Delivery	Inspection	
No. of Indicators	5	7	9	11	1
MES	450	585	600	734	85
CES	423	531	387	631	65

Section chiefs use these data to evaluate how well the sections are doing. The CESs for each section (423, 531, 387, and 631) are each plotted on MEP Feedback Charts for monitoring by their section chiefs. The one branch-level indicator CES of 65 is also monitored by the Branch Chief with a MEP Feedback Chart. Since the sections are of equal importance, the overall effectiveness of the MS&D Branch is determined by summing the function CESs to 2,037 (423 + 531 + 387 + 631 + 65) effectiveness points. The Branch Chief plots the "rolled up" branch CES of 2,037 on a MEP Feedback Chart, which is used to monitor overall branch performance. Is there anything wrong with this approach to measuring the performance of the sections and aggregating to the branch?

**Suggested Solution.** The procedure used to evaluate the performance of the sections within the MS&D Branch is correct. Within each section, ME charts translate performance on indicators into effectiveness scores which may be summed to provide section CESs. Changes in CESs for each section, for the one branch indicator, and for the overall branch are correctly shown on MEP Feedback Charts.

However, aggregation across sections by simply adding section CESs and MESs is an error despite the fact that the Branch Chief has asserted that the sections contribute equally to the branch mission. If the sections are to contribute equally, the MESs must also contribute equally--not unequally as they currently do with MESs of 450, 585, 600, and 734. This is the "unequal contribution problem" discussed in Section III. An ACF must be computed and applied to make these MESs equal. In keeping with the methods explained in this report, use of the smallest MES (i.e., adjustment downward) is probably most convenient. In the case of this MS&D Branch, this number is 450 for Receiving; therefore, all section MESs are changed to 450.

The next step to correct the "unequal contribution problem" is to use the ACF to modify the unequal CESs to reflect the equal contributions of the sections. This involves computing the ACF (MES before adjustment/MES after adjustment) for each section. No modification is needed for the Receiving section since its MES was selected as the common number. That is, the Receiving Section's MES remains 450. In any case, the ACF for the other 3 sections are 1.30 (585/450) for Storage and Issue, 1.33 (600/450) for Pickup and Delivery, and 1.63 (734/450) for Inspection. The CESs for the 4 sections are modified with the ACF as follows: The 531 CES for Storage and Issue is adjusted to 408 CES (531/1.3); and the other adjustments are 387 CES to 290 CES (387/1.33) for Pickup and Delivery, and 631 to 387 CES (631/1.63) for Inspection. It would be appropriate for sections to plot an adjusted CES for their MEP Feedback Charts, and the branch

CES of 1,535 based on adjusted section CESs (450 + 408 + 290 + 387) could be plotted on a MEP Feedback Chart to track periodic changes in the performance of the branch. However, this aggregation, while correct, would fail to take into consideration the single branch indicator shown in the rightmost column of Table B-1.

In order to add the branch indicator, the facilitator would ask the Branch Chief for a judgment as to the contribution to the branch mission of the activity measured by the branch indicator. The facilitator says, "IF THE SECTION CONTRIBUTIONS ARE EQUAL AT 100%, WHAT IS THE PERCENTAGE CONTRIBUTED BY THE ACTIVITY MEASURED BY THE BRANCH INDICATOR?" Suppose the Branch Chief says "15%." This means that since the sections contribute equal MESs of 450, the one branch indicator can contribute for its MES only 15% of 450, or 67.5 ( $450 \times .15$ ). Thus, the branch indicator's MES is 67.5.

Next, the branch indicator's CES must be modified with the ACF, MES before adjustment/MES after adjustment. This ACF is 1.26 ( $85/67.5$ ). Therefore, the branch indicator CES of 65 is modified to 51.6 ( $65/1.26$ ). Thus, the correct aggregation for the branch, including the 4 sections and the one branch indicator, results in an MS&D Branch CES of 1,586.6 ( $450 + 408 + 290 + 387 + 51.6$ ), which can be plotted on a MEP Feedback Chart to track periodic changes in the performance of the branch on all indicators.

#### Exercise 6: Feedback Alternatives

Problem. Consider the case of the Receiving Section of the MS&D Branch discussed in Exercise 5. The section's CES and MES for 5 indicators were 423 and 450, respectively. Instead of monitoring CESs over time with a MEP Feedback Chart, the Section Chief decides to use a different procedure. The Section Chief reasons that the MES of 450 represents the effectiveness points of the feasible best the section can do, and the CES of 423 is the section's current-month performance. Thus, the section's current performance of 423 is 94% ( $423/450 \times 100$ ) of the feasible best that can be done (450). The Section Chief labels this result as the "Percent of Maximum Achievable" and monitors it over time, referring to it in monthly feedback sessions with workers. Is there anything wrong with using "Percent of Maximum Achievable" instead of a MEP Feedback Chart?

Suggested Solution. There are two serious problems associated with use of the "Percent of Maximum Achievable." The first problem has to do with the arithmetic involved in calculating the percentage. This percentage is only meaningfully interpretable for CES values that are zero or positive. Suppose, for instance, that the CES for the Receiving Section falls below 0 effectiveness points; that is, the sum of the effectiveness points for all 5 ME charts is less than zero, say -25. The calculation for the "Percent of Maximum Achievable" would be  $-25/450 \times 100$ , or -5.6%. In other words, for this month the section's performance is -5.6% of the best it can be. This negative percentage is meaningless. An equally unsatisfactory solution is to use the other end of the scale to compute "Percent of Minimum Achievable." If the minimum achievable were, say, -400, the calculation would be  $-25/-400 \times 100$ , or 62.5%. The answer is interpretable, but not reasonable as a measurement device. It would sound absurd to say, "The Receiving Section is doing 62.5% of the worst it can do."

Another reason to use the MEP Feedback Chart instead of the "Percent of Maximum Achievable" is that graphics which identify and focus on the maximum performance achievable, the MES, may tempt some managers to drive the organization to higher and higher performance. Indeed, continual improvement is the goal of the MGEEM, but it should be achieved through increased worker motivation stimulated by feedback and the removal of constraints. The MGEEM process will soon fail if it is used as a tool for coercion and control. Fortunately, most Air Force managers are aware that autocratic, self-serving styles of management result, at best, in only short-term improvements.

### Exercise 7: Interdependent Indicators

Problem. While developing ME charts for an organization, a facilitator overhears several members of Team B discussing the construction of one particular chart. One member of the team says, "But, how well we do on that indicator depends on how well we are doing on a different indicator." The facilitator explores the situation further and learns that team members think that the two indicators are related in such a manner that if the organization is performing poorly on one of the indicators (Indicator #3), it does not make much difference how they are doing on the other (Indicator #1).

As a remedy, the facilitator suggests that the team construct at least two different ME charts for Indicator #1 whose curves will differ depending on the level of Indicator #3. How can the two charts be constructed and how would they be integrated into the work center's existing set of ME charts?

Suggested Solution. One possible answer to this problem is that there may be no real problem; that is, it may be that the conditions under which one indicator becomes dependent upon the other seldom, if ever, occur in the real-world situation. Such is the case in Figure B-3, where the ME chart for an indicator shows a wide range of acceptable performance (from the dashed line upward to the top right corner). Though there is a possibility that performance on this indicator might reach the "worst" level, it is very unlikely to happen. If and when it does, the measurement of mission effectiveness for that indicator would have to be handled on an ad hoc basis until the crisis passed. If conditions persist more than one or two measurement periods, Team B should reconvene to reassess the worst and best possible levels for the interacting indicators.

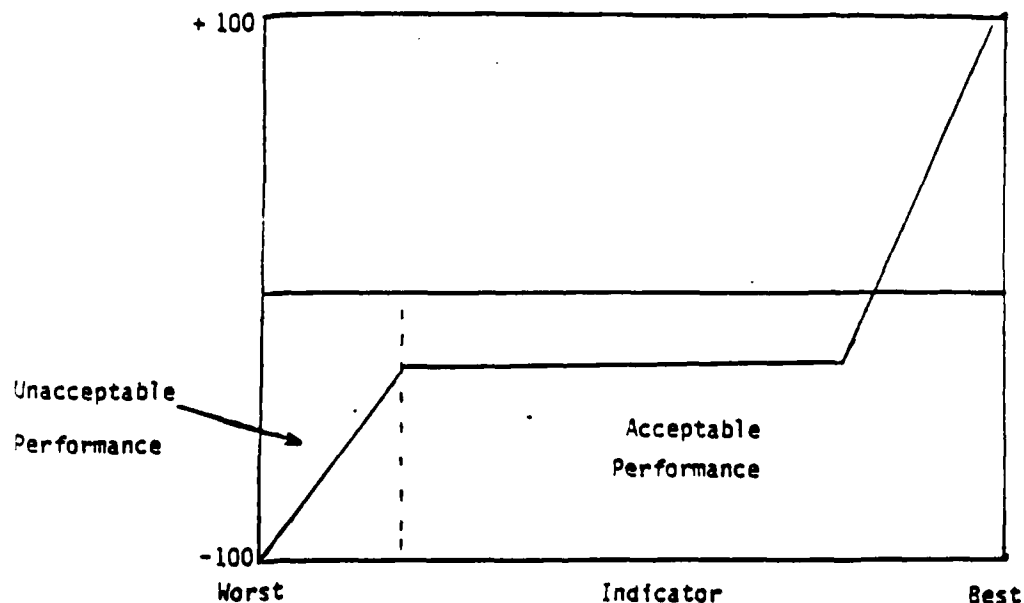


Figure B-3. Acceptable/Unacceptable Mission Effectiveness.

If there is a real problem, however, and the conditions under which one indicator's mission effectiveness is dependent on the performance level of another indicator occur fairly often, then an approach similar to the one shown in Figure B-4 could be taken. Figure B-4 shows the situation where the shape of the ME chart for one indicator (Indicator #1) is dependent on the

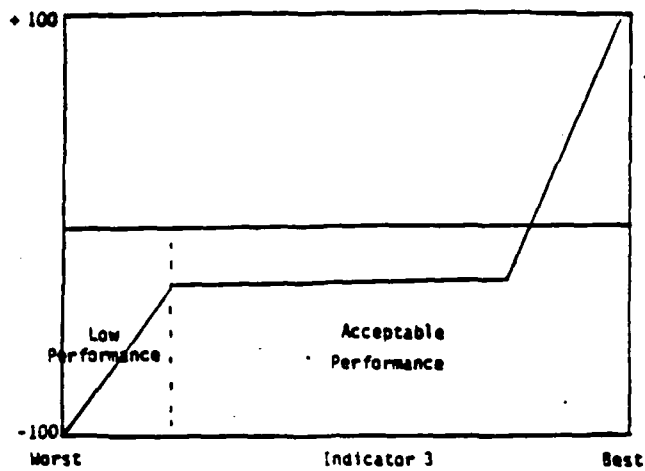


Figure a

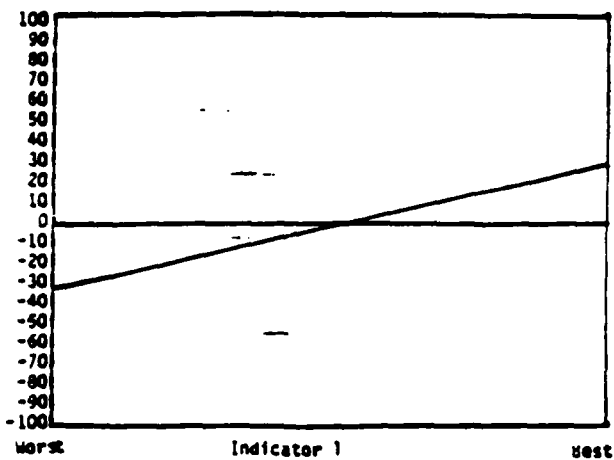


Figure b

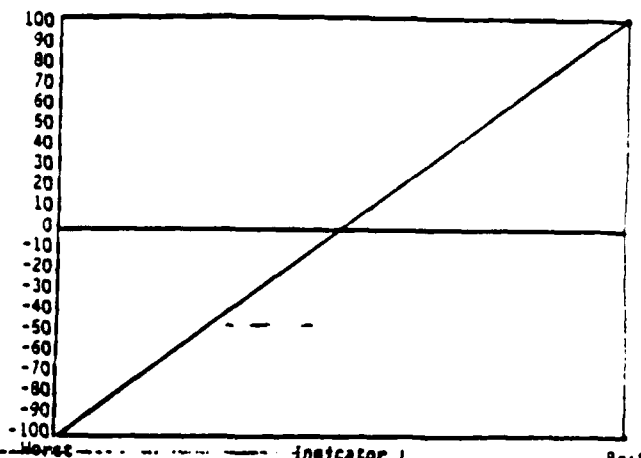


Figure c

Figure B-4. Mission Effectiveness Charts Interactions.

level of performance on another indicator (Indicator #3). Figure B-4(a) shows the ME chart for Indicator #3. In this case, it might be useful to have two ME charts for Indicator #1, so that when Indicator #3 performance is in the low performance level part of its ME chart, then the chart shown in Figure B-4(b) applies, but when Indicator #3 performance is at the higher performance level, the chart in Figure B-4(c) applies. (Note: For this example, only 2 alternative ME charts are used, but additional levels for Indicator #1 are permissible.)

Note that the values on the horizontal axis do not change for the dependent indicator (Indicator #1); however, the slopes of the ME chart curves change, as do the effectiveness scores associated with performing at the feasible worst and best levels. In the present example, the feasible best and worst are worth 30 and -30 in Figure B-4(b) but shift to 100 and -100, respectively, in Figure B-4(c). In order to accommodate this change, the Team B members would have to reallocate the change in total effectiveness points to other indicators for the work center. For example, suppose the work center originally had three indicators whose total positive effectiveness score was 250 (from Indicators #1, #2, and #3 which have a maximum positive effectiveness score of 100, 90, and 60 points, respectively). If Indicator #1's maximum positive effectiveness score of 100 is dependent on the level of performance on Indicator #3 and Indicator #3 is at its low performance level, then the maximum effectiveness score for Indicator #1 becomes 20 points. Therefore, 80 points (100-20) would have to be reapportioned among Indicators #2 and #3 in the same ratio as their original contributions to overall effectiveness.

The relative contributions compared to the original most important indicator (Indicator #3) were 90% for Indicator #2 and 60% for Indicator #1. Therefore, in dividing up the 80 points, Indicator #2 gets  $90/(90 + 60) = .6 \times 80 = 48$  effectiveness points added to its current maximum of 90, to give 138 points. Indicator #1 gets  $60/(90 + 60) = .4 \times 80 = 32$  effectiveness points added to its maximum of 60, giving 92 points.

When Indicator #3 is at its higher performance level, no change in the original 250 total effectiveness points is necessary. In any case, however (whether Indicator #3 is at its high performance level or not), only 3 indicators are used and they still have a total positive effectiveness score of 250 (20 + 138 + 92).

The maximum negative score would be reallocated in a similar manner.

## MANAGING WITH MGEEM

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Air Force Regulation 25-5 (May, 1988) requires that every Air Force functional area have an adequate management information system (MIS) and this is reviewed during the functional review process. The Methodology for Generating Efficiency and Effectiveness Measures (MGEEM) is incorporated into the Performance Measures Document (PMD) of this regulation (Chapter 6) as the recommended measurement component. The MGEEM is a comprehensive MIS which makes possible improved leadership, enhanced motivation, and the continual improvement of the processes by which work is conducted. The MGEEM provides a framework for implementing the philosophy and principles of Total Quality Management (TQM).

HRL has published technical reports (Tuttle & Weaver, 1986; Weaver & Looper, 1989) explaining how to build an MGEEM system. There is need, however, for guidance to workers, supervisors, and commanders on how to use an MGEEM system when one exists in their organization. HRL is completing a technical report which will contain this guidance. This paper is an overview of this information.

For purposes of illustration, assume a certain Security Police work center has an MGEEM system with two key result areas (KRAs), "to protect base resources" and "to document security actions." For each KRA, there is one indicator. For protecting base resources the indicator is "number of reportable incidents" and for documenting security actions the indicator is "percent of reports completed on time." (Number of reportable incidents is the absolute number and percent of reports completed on time is the number of reports completed on time divided by the number of reports required x 100). Mission Effectiveness (ME) charts for these two indicators are shown in Figure 1.

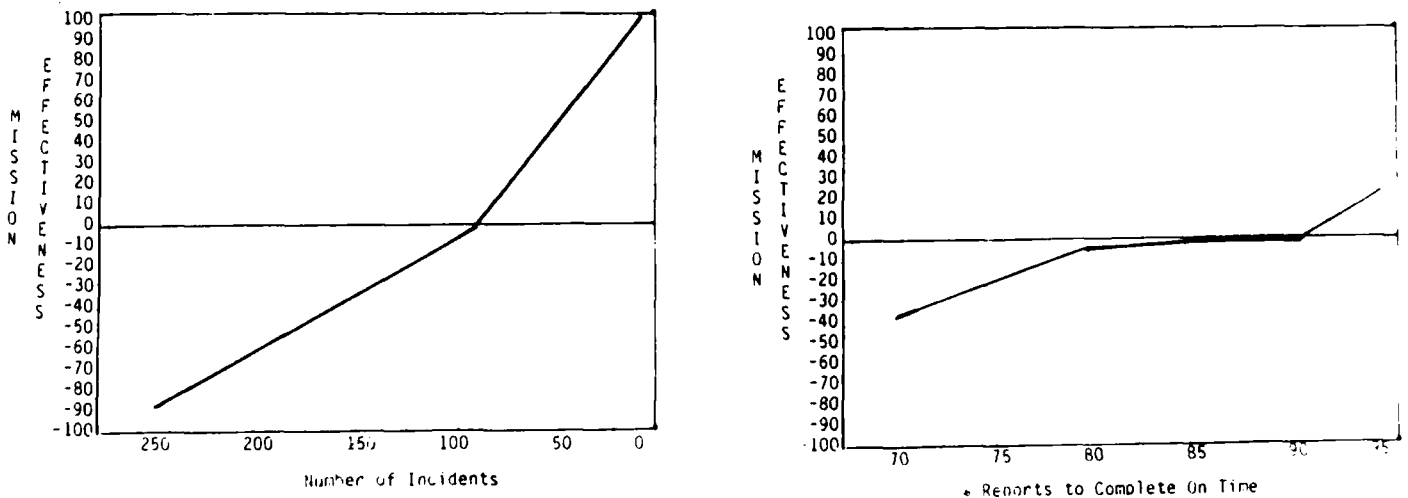


Figure 1. ME Charts

MGEEM as an MIS. The MGEEM provides much useful information about the operation of the work center. For instance, KRAs show that the mission of the work center is to protect base resources and document security actions. Indicators measure the work center's performance in accomplishing the KRAs. There is one ME chart for each indicator showing the relationship between levels of performance on indicators (on the horizontal axis) and the work center's overall mission effectiveness (on the vertical axis). Slopes on ME charts show the importance of indicators: flat slopes mean indicators are less important than indicators with steep slopes. For instance, the slopes on the ME charts in Figure 1 indicate that number of incidents is more important to mission effectiveness than reports completed on time. When the work center performs as well as feasible on both indicators, "no incidents" has a +100 impact on mission effectiveness while "completing 95% of reports on time" has only a +20 impact on mission. Thus, comparing the slopes on the two ME charts shows policy about the importance of the two indicators: controlling incidents is more important than completing reports on time. This is not to say that the work center can neglect completing reports on time. Completing less than 85% of reports on time has a negative impact on mission effectiveness but it is not so serious as a high number of incidents. Furthermore, when the work center completes as many reports on time as feasible (95%) it only has a moderately positive effect on mission effectiveness (+20).

As the work center strives to improve, ME charts provide feedback on how successful the work center has been. Each month the results of performance on the indicators are recorded on ME charts and provided to the supervisor and workers and posted on bulletin boards in the work centers for all to see. Suppose, for instance, that last month's performance on the two indicators in Figure 1 was 50 incidents and 80% of reports completed on time. These results are posted (in Figure 2 with a letter representing the month. Here the letter is O for October.) on ME charts and provided as feedback to the supervisor, NCOs, and enlisted personnel. These results show that the work center is

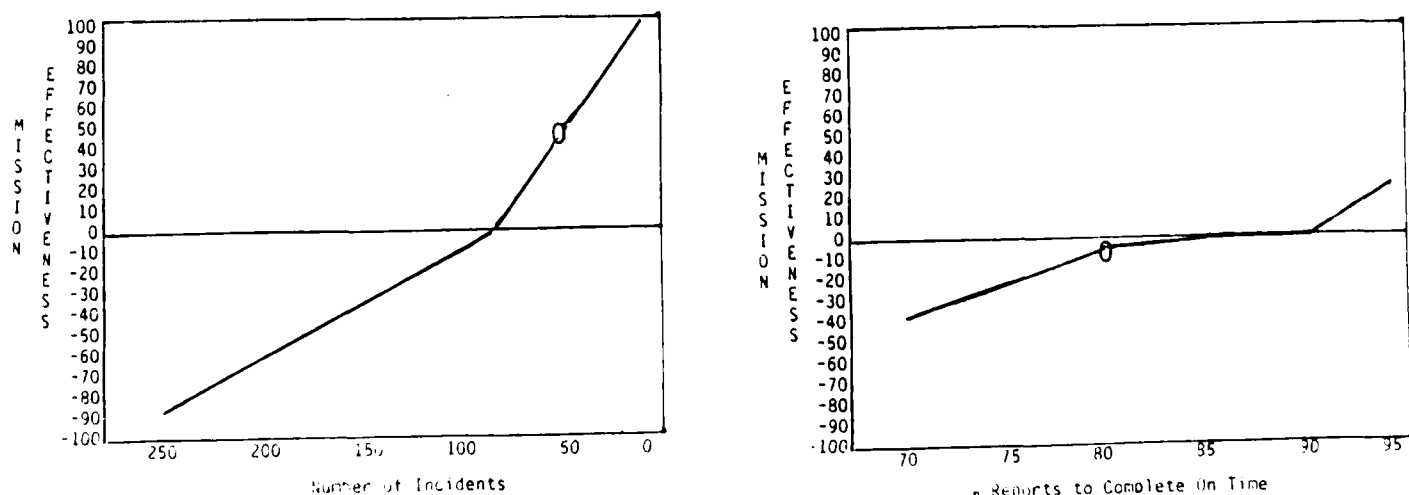


Figure 2. One Month's Performance

doing well on the most important aspect of its business, protecting base resources. A 50 on number of incidents (on the horizontal axis) translates into a +45 effectiveness point (on the vertical axis) and shows that there is room for improvement but, in general, that things are going well on this indicator.

On the second indicator, however, 80% of reports completed on time shows that the second important aspect of business, documenting security actions, is not being accomplished very well. Completing 80% of reports (on the horizontal axis) has a negative impact of about -10 on mission effectiveness (on the vertical axis). With this information, the supervisor and workers should discuss, evaluate, and employ initiatives for improvement. At the end of the month following such initiatives, performance results are again added to the ME charts and provided to the supervisor, NCOs, and enlisted personnel. The new results are indicated on the ME charts with another letter, here N for November, so that current period performance can be compared against the performance of the previous period(s). With an MGEEM system in place the supervisor can monitor work center performance from month-to-month to track the results of management initiatives and other influences, such as inspections and deployments. Of course, efficiency (outputs divided by inputs) should also be considered in managing work centers.

Another part of the MGEEM MIS is that a summary of the performance of a work center can be rolled up monthly to the next higher level of supervision on an MEP chart. This information provides a quick overview of work center performance. Overall work center effectiveness (the sum of the current period vertical axis effectiveness scores on each ME chart) for a given period is simply being plotted as shown in Figure 3. In Figure 3 suppose the summed or rolled up effectiveness scores are 35 for October and 65 for November. The scale of the vertical axis is adjusted to accommodate the feasible range of rolled up values. The vertical axis may contain negative values.

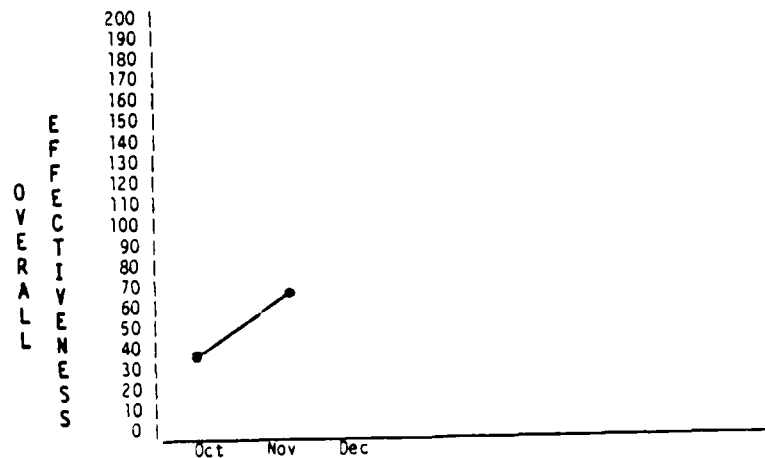


Figure 3. Example MEP Chart

Improved Leadership. Before an MGEEM system becomes operational (or modified after a period of use) it is coordinated with the squadron commander. This coordination preserves traditional military prerogatives but should also demonstrate the squadron commander's respect for the work center supervisor's judgment and experience. The squadron commander should assure that coordination on the MGEEM system strengthens the bond with his/her work center supervisors. The squadron commander should be a model of good leadership to work center supervisors and NCOs. Good leadership for all levels is not based on micromanagement with quotas, suspense dates, and fear. It should be based on a coaching, team building, teaching relationship.

After the MGEEM system has been approved, it provides the supervisor with a number of management tools. For instance, consider the ME charts in Figure 2 where the letters O represent current performance. Is it better to manage the work center to maintain or reduce "number of incidents" or to increase "reports completed on time?" The slope of the charts shows that the greatest payoff to effectiveness is in maintaining or reducing incidents. Reports cannot be neglected, but the ME charts show that they are not so important as incidents to the mission. In addition, what happens when the month-to-month results posted on an ME chart go in the wrong direction? This, of course, means there is a problem somewhere. Work center morale and cohesion is improved when supervisors solicit ideas about the problem from all work center personnel in "feedback sessions" (described below). Instead of seeking to blame someone when a problem is detected, supervisors should focus on improving the processes by which work is conducted. Supervisors must listen. They should seek to solve problems together with workers. They should seek more data and analyses about the problem, depending less on judgment and guesswork. They shouldn't be hurried, taking more time for precision and care. They should solicit worker's ideas about constraints to higher performance. Supervisors should say, "What can I do to help you achieve excellence? What can I do to help you lead a better work center?"

Enhanced Motivation. The most important motivational feature of the MGEEM system is monthly "feedback sessions." As soon as current monthly performance results are posted on ME charts, the charts should be provided to the work center supervisor. As soon as the charts are available they should be distributed at monthly meetings of key work center personnel. The supervisor and NCOs should be present throughout the meeting, along with other members of the work center and customers and suppliers, as needed. (In a large work center other personnel should attend on a rotating basis, say every other month.) Everyone should have frequent opportunities to attend and get in their "2 cents worth." No member of the work center should be left out of the feedback sessions. At these meetings the supervisor should encourage feedback about how to improve work center performance as measured on the ME charts. The supervisors and NCOs should listen to the reactions and suggestions of enlisted personnel. Enlisted personnel should be asked, "What keeps us from doing a better job? What holds us back?" Remember that the work center is a team. In the feedback sessions, team building and teamwork should be encouraged. Supervisors should not look for someone to blame for a performance problem, but should seek to figure out ways to improve the work processes involved. Supervisors must understand that the vast majority of personnel want to do a good job. They want to take pride in their work.

Experience shows that some inadequacy in the management systems is usually the real cause of performance problems. For instance, is everyone adequately trained? Is there enough time to do a good job? Are supplies and materials appropriate and available? Are instructions clear? Is supervision supportive and encouraging? Has time been taken to build morale and esprit de corps? Do managers at every level take time to listen to their subordinates? Is self-improvement encouraged among subordinates?

Continually Improving the Way Work is Conducted. In feedback sessions the supervisor should lead a discussion of how to make things better: "How can we improve on our ME charts? What's holding us back from greater excellence?" As explained above, experience shows that most performance problems result from inadequacies in the way the work center does its business, not from people unwilling to work hard. It is, therefore, almost always a waste of time to expect to get lasting gains in performing by exhorting subordinates to work harder. Most personnel are already working at their limit. Many already work 10-12 hours a day. To ask them to work more hours is an insult to them and an unnecessary burden on their families. Rather than asking them to work harder, supervisors must accept responsibility for simplifying and streamlining the way the work is done. It is the manager's responsibility to figure out how her/his people can work smarter, not harder, to accomplish the mission. The key question is, of course, how do we work smarter rather than harder?

Evidence shows that working smarter rather than harder is the result of a certain management philosophy and a number specific initiatives. The philosophy, already identified above, is that rather than exhorting subordinates to work harder managers accept the responsibility to improve the way work is conducted. There are a number of specific initiatives to improve the way work is conducted. First, supervisors should accept MGEEM ME charts as measures of how well the work center mission is being accomplished. They hold should monthly feedback sessions with subordinates to study the charts and "brainstorm" ideas on how to improve performance. They should use simple statistical tools to search for ways to improve work processes. (For discussions of these tools, see Ishikawa, 1982, and Brassard, 1988.) Subordinate input should be valued and encouraged. The focus should not be on finding someone to blame for problems but on how to improve the way business is conducted. Second, squadron commanders and supervisors should be willing to experiment with new ideas that have potential for simplifying and streamlining the work. They authorize the implementation of new ideas on a test basis and evaluate the impact of the test with their ME charts. They are willing to "write off" several failures to get to one winning idea that significantly improves work center performance. They should, of course, coordinate the implementation of new ideas and utilize existing Air Force change programs, including the Model Installations Program (MIP), the Suggestion Program (SUG), and Management Decision Package (developed during functional reviews). Managers should read and reread any books by TQM experts such as Deming, Juran, and Peters.

In an organizational climate of harmony and respect the MGEEM provides an MIS which makes possible improved leadership, enhanced motivation, and the continual improvement of the processes by which work is conducted. Experience shows that use of the MGEEM as the PMD MIS improves morale, improves quality, and increases organizational effectiveness.

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IMPLEMENTING TQM WITH MGEEM  
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There is widespread interest in the Department of Defense (DoD) in implementing Total Quality Management (TQM). There are a number of different definitions of TQM, but it is almost universally agreed that its essence is embodied in the philosophy and teachings of W. Edwards Deming. Dr Deming's wisdom is available in his 4-day seminar, his books (e.g., Deming, 1986), and video tapes. Other books on Dr Deming and his wisdom are by Gitlow and Gitlow (1987), Killian (1988), Mann (1985), Sherkenback (1988), and Walton (1986). Commanders and managers tasked to implement TQM in their organizations often report, however, that implementing TQM is far more difficult than understanding it. In our experience, implementing TQM is almost always characterized by uncertainty, confusion, false starts, management's delegation of its TQM responsibilities, a burst of activity to "fill a square" and then back to business as usual, and money virtually wasted on contractors and consultants.

To our knowledge, efforts to implement TQM follow two basic approaches. The first is the use of a high-level steering committee which originates and directs problem-solving teams, commonly called process action teams (PATs). The second involves (a) management in authority teaching TQM philosophy so that a critical mass of employees becomes involved in the necessary cultural transformation and (b) hiring a master statistician who provides statistical assistance throughout the organization. Under ideal conditions these approaches produce favorable results, but experience shows that conditions are usually far from ideal. For instance, a common result of the steering committee/PAT approach is that it is an easy way for commanders and managers to avoid their TQM responsibilities. They merely set up a few PATs and return to work as usual. They "fill squares" by pointing to the number of PATs in place, the number of people who get PAT training, the number of PAT reports provided, and the resources spent on their TQM effort. It is true that when the steering committee/PAT approach is used, processes are improved but the real problem is that no attempt is usually made to bring about the transformation called for by Dr Deming.

There are other improper uses of the steering committee/PAT approach. Steering committees almost always set up PATs based on solely on judgment, usually in areas where they hear the most complaints. This approach will often be successful in improving processes until the obvious problem areas are improved. But after the obvious problem areas are improved, what next? Where are new PATs established? Beyond the very serious few, steering committees seldom know which other areas have problems that are serious enough to deserve the attention and resources of a PAT. Steering committees seldom have a systematic approach to the establishment of PATs. Ideally, the most serious problem areas should be addressed first. Often steering committees will establish PATs everywhere (even where they are not needed) or delegate the decisions about where to establish them to the judgment of lower-level personnel. In such cases a memorandum goes out, "Who wants to be on a PAT in such-and-such division? Volunteer please contact the division chief by such-and-such date." Volunteers are then given training in the Deming cycle

and the 7 tools and turned loose to work any problems they wish. No guidance is provided concerning the importance of alternative problem areas. PATs developed in this way often operate for a few months, analyze one process, file a mandatory report, and disband. A PAT is especially likely to decay if management untrained in Deming philosophy fails to act upon the team's recommendations. Dr Deming says that management's unwillingness to respond to suggestions to improve the system is the main reason for the failure of quality circles in this country.

Another common misuse of the steering committee/PAT approach is that PATs usually work problem areas on a short-term basis. After a PAT achieves some initial results, such as submitting frequency data on "loops" in the flow chart of an important process, a report is written and the PAT disbands. Then a different PAT is established for another problem area. The misuse is that the problem area worked by the disbanded PAT ceases being systematically improved. This violates a central tenant of Dr Deming's philosophy: continuous and never ending improvement. Another problem in the usual approach to PATs is that recommended changes may help a process or department where a PAT is assigned but may have harmful effects elsewhere in the organization. (In his 4-day seminar, Dr Deming discusses this general problem with a handout entitled "On Cooperation: An Exercise for the Working Groups." The example in the handout stresses that "management allots to [organizational components] individually the responsibility for certain goals of improvement. Each [component] is then driven to actions that will maximize its own individual benefit, without concern for the other areas." Another problem with the steering committee/PATs approach is that workers who are not on a PAT can be virtually uninvolved in TQM. This violates Dr Deming's point 14, "Put everyone to work to accomplish the transformation."

Implementing TQM by the second approach, "management teaching Dr Deming's philosophy and employing a master statistician," can also have limitations. Perhaps the most serious limitation is that this approach does not provide sufficient structure and guidance on exactly how to implement TQM. Commanders and managers who are highly motivated to implement TQM confide they are uncertain and confused about exactly what to do with this approach. They report feeling the need to seek the services of one of the very costly TQM consultants that have recently sprung up around Dr Deming and the beltway. Even when such consulting services are secured, the assistance turns out to be workshops on the consultant's version of Dr Deming's 14 points, deadly diseases, and obstacles or Statistics 101. Usually no substantive guidance is provided in implementation beyond perhaps the use of the Steering Committee/PAT approach. Another problem with the teach philosophy/hire a statistician approach is the requirement to hire a master statistician. Many DoD organizations, especially in the test and evaluation (T&E) and research and development (R&D) areas, have on their staffs some of the best trained and most experienced statisticians in the country. It is claimed, however, that these statisticians can't do the TQM job because they were taught statistics incorrectly, namely they were incorrectly taught that enumerative statistics can be applied to analytic problems. Furthermore, it is claimed that they fail to fully appreciate that variations in any process can be partitioned, usually with control charts, into special (or assignable) and common causes as a basis for management action to make processes predictable. There is no

disputing the great value of control charts, especially in assembly line-type operations, or of Dr Deming's teaching on special and common causes. However, a past president of the prestigious Japanese Union of Scientists and Engineers (JUSE) made an observation worth considering. He said that Japanese experience shows that the first 90% of quality and performance problems can be identified for solution with 6 of the so called "7 tools," another 5% can be identified for solution with the other one of the 7 tools, the control chart, and the last 5% can be identified for solution with the so-called "7 new tools," also known as the Taguchi methods. (The list of 7 tools varies but includes Ishikawa diagrams (also known as cause-and effect and fishbone diagrams), Pareto charts, checksheets, histograms, scatter diagrams, control charts, stratification, flow charts, run charts, and various graphs (see Ishikawa (1982) and Bossard (1988)). The 7 new tools include the relations diagram method, matrix data analysis method, PDPC (process decision program chart) method, and arrow diagram method (see Mizuno (1988)). Six of the 7 tools (not including the control chart) listed above are understood by every statistician, regardless of training, and by almost every person who sees them daily in the newspaper. Our experience confirms that much can be accomplished by using the 6 simple tools. These tools can be used by virtually any practicing statistician, any statician, in-house or hired on a part-time basis from the teaching staff of a local college. Using control charts and guiding action based on an understanding of special and common causes are very important, but experience shows that enormous improvement can be achieved by conscientious people working with the 6 simplier statistical tools and a clear understanding of how to use them to problem detect problems.

Another approach to implementing TQM is becoming increasingly popular. It was developed by AFHRL and is recommended for use in the functional areas by Air Force Regulation (Chapter 6) 25-5 and used in a number of Air Force and Navy organizations. The approach is called the Methodology for Generating Efficiency and Effectiveness Measures, or MGEEM. Implementing TQM with MGEEM not only avoids the problems associated with the more common approaches, but provides a framework that greatly facilitates the adoption of Dr Deming's philosophy and teachings. MGEEM also provides commanders and managers with a comprehensive performance measurement and information system that includes a number of powerful tools for improved management and increased worker morale. An explanations of how MGEEM facilitates TQM follows. However, the explanation will be more meaningful to readers who are familiar with these materials and with Dr Deming's work. It is not meant to be a complete technical description of the implementation and use of MGEEM. This information is available in Tuttle and Weaver (1986a, b), Tuttle and Weaver (1986a, b), Weaver and Looper (1988a), and several unpublished manuscripts, Weaver and Looper, no date), and Weaver (no date), all available from AFHRL. In the following explanation of how MGEEM implements TQM, references to Dr Deming's 14 points (Deming, 1988, Chapter 2) are in parentheses.

MGEEM applies to organizational components at every hierarchical level, including the commander and staff, each division, each branch, and each function or work center. (Point 1. Put everyone to work to accomplish the tranformation.) An in-house facilitator leads members of each component through a series on consensus-seeking excercises. (Point 8. Encourage two-way communications to drive out fear.) The MGEEM is tailored to each

component based on inputs from members. First, component members establish or review the component's mission statement and may become involved in strategic planning. Reviewing the mission is important because Dr Deming observes that probably 80% of America's workers don't know their job and are afraid to ask (Mann, 1985, p. 101). (Point 1. Create Constancy of Purpose.) Second, component members use input-output analysis to (a) identify internal and/or external customers, identify customer needs, and consider that quality is defined in terms of anticipating and satisfying customer requirements (Point 1. Create constancy of purpose) and (b) identify suppliers and consider that the contribution of suppliers to quality goes beyond lowest price to include cooperation (Point 4. End the practice of awarding business solely on the basis of price). Third, component members break their mission statement into measurable parts, called key result areas (KRAs), and develop indicators which measure how well KRAs are being accomplished. Fourth, component members develop graphics, called mission effectiveness (ME) charts, through which they express their judgment about the relationship between feasible levels of performance on each indicator and the component's overall effectiveness. Performance results on ME charts are periodically (monthly) fed back to managers for improved leadership and to workers in feedback sessions to improve morale. Feedback sessions are among the most important part of MGEEM. Workers on "feedback teams" identify barriers to improvement on their ME charts (Point 8. Encourage two-way communication to drive out fear) and management takes action where appropriate on the recommendations of the feedback teams. (Point 12. Remove barriers that rob workers of their right to pride of workmanship. Point 5. Improve constantly and forever the systems of production and service. Point 7. Adopt and initiate leadership). Remember that Dr Juran estimates that 15% of organization problems can be corrected by the workers. This leaves management with the responsibility for improving the other 85% through changes in the system (Mann, 1985, p. 7). Removing barriers may involve training (Point 6. Institute training on the job) or may require greater coordination with another organizational components (Point 9. Break down barriers between departments). Managers who practice Dr Deming's teachings do not use slogans, exhortations, targets (Point 10), work standards (quotas) (Point 11a), or management by objectives (Point 11b) to bring about improvements on ME charts. Instead they accept their responsibility to constantly and forever improve the systems in which they and their subordinates work (Point 5). Such managers realize that quality is built in the product or service by improving the processes that produced it, not through inspection (Point 3). They realize that in an ever-changing world adaptable and innovative workers are developed by education and self-improvement that extends beyond training for the skills required by their present jobs (Point 13).

Use of the MGEEM includes two versions of PATs. First, members of every organizational component received monthly feedback on how they performed as a group on their ME charts. Members in every organizational component are a feedback team which is a PAT. This means there are permanent "feedback PATs" throughout the organization, and everyone is a member of a PAT (Point 14. Put everyone to work to accomplish the transformation). As feedback PATs improve constantly and forever the system of production (Point 5) they recognize that some barriers to improvement extend beyond the boundaries of their component and authority. Such problems are worked by cross-functional teams, a second

type of PAT, a "cross-functional PAT". Cross-functional PATs are initiated by management when a problem that extends across the boundaries of two or more organizational components is identified. (Point 9. Break down barriers between department). The membership of a cross-functional PAT includes an advocate from staff who represents the PAT to the commander, representatives from each functional component involved with the problem, a subject matter expert, and an action officer responsible for day-to-day measurement and reporting.

Neither of the MGEEM PATs use judgment to identify barriers or processes that require their attention. Instead the slopes on ME charts provide this guidance. Poor performance (or barrier) on a steep slope should usually be worked before poor performance (or barrier) on a flat slope. In addition, having ME charts throughout an organization reveals if changes to benefit one component have inadvertently caused harmful effects elsewhere.

Both types of MGEEM PATs use the Deming cycle to identify and solve/eliminate problems/barriers to performance member of both types of MGEEM PATs are trained in the use of the 7 tools (Ishikawa, 1982; Brassard, 1988) and Dr Juran's (1988) PAT team techniques. MGEEM PATs are informed that 90% of problems can be worked successfully with simple statistical tools. They are, however, taught and encouraged to use control charts where appropriate and to apply Dr Deming's perspective of special and common causes so that they don't tamper with a stable, predictable system.

In addition to being a framework for implementing TQM, MGEEM provides commanders and managers with a comprehensive organizational performance measurement and information system which includes a number of powerful tools for improved management and increased worker morale. These additional benefits of the MGEEM surpass anything offered by other approaches to implementing TQM. The benefits are derived from use of the ME charts. MGEEM is an organizational performance measurement system because ME charts provide measures for managers and workers which allow them to monitor how well they are doing in accomplishing their KRAs. Furthermore, measures on ME charts can be rolled up so that higher level managers can monitor the overall performance of one or several units. The measures of performance used in the MGEEM can include but go beyond the traditional measures available from accounting and engineering. It is these nontraditional measures, such as timeliness and customer satisfaction, that Dr Deming says are so important. The MGEEM is an information system because, in addition to their measurement capabilities, ME charts provide signals that problems exist and that problems are solved. This, of course, makes PATs more effective because the charts point to problem areas where PATs should be established. ME charts also measure the results of the PATs efforts to correct problems. Furthermore, ME charts provide guidance on resource allocation. Activities with charts with steep slopes (indicating that the activity is important to effectiveness) are usually the first to benefit from new resources and the last to give resources up.

No approach to implementing TQM can guarantee the transformation of management urged by Dr Deming. No approach can guarantee practice of the 14 points, avoidance of the deadly diseases, and overcoming of the obstacles. However, the MGEEM provides a series of opportunities in which the Deming

philosophy can take root and be practiced. With the MGEEM in place, however, it is necessary to institute a vigorous in-house program of education in Dr Deming's philosophy and teaching. There are a variety of ways to conduct this education, but according to Dr Deming, direct and continuous management involvement is necessary. Here are some suggestions about how to conduct this education. Each key manager, including the commander, could be tasked to read a variety of materials (see references) on one of the 14 points, deadly diseases, or obstacles and prepare a 30-minute briefing on it. These briefings should be video taped for viewing periodically at various meetings such as feedback sessions, working lunches, staff meetings, and commander's call. Showing of the tapes should be followed by round table or panel discussions. Other presentations by managers or other quality experts, such as Juran (1988) and Peters (1987), can be similarly arranged. Education on the Deming philosophy must be routinely included in all organization activities on a continuing basis.

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MGEEM: New Methods of Measuring and Enhancing Organizational Productivity

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The AFHRL has recently completed a series of research projects resulting in a powerful new tool for measuring and enhancing organizational performance, the Methodology for Generating Efficiency and Effectiveness Measures or MGEEM. Through the efforts of a measurement facilitator, the MGEEM can be developed in from two hours (for a work center) to two days (for the headquarters of a major field activity). Organization members are guided through the MGEEM process to construct a comprehensive performance measurement system unique to their organization. This system encourages the creation of an organizational culture focused on quality by employing a variety of enhancements, such as those proposed by Deming (1986), Peters (1987), and Weaver (in progress), which continuously improve performance.

Use in a wide variety of Air Force and Navy organizations is demonstrating that the MGEEM can significantly increase organizational performance, is highly acceptable to organization member/participants because the implementation process develops a sense of ownership, is cost effective in the sense that it creates little additional paperwork burden, satisfies commanders' need for a device which comprehensively measures organizational performance, makes possible vastly improved management, increases morale, and is easy to understand and use. The MGEEM is a multistep procedure which is a unique combination of technologies designed especially for these purposes.

The decision to use the MGEEM requires the strong commitment and continual visible support of the commander of the target organization to the measurement and enhancement of performance. Implementation requires the effort of a measurement facilitator, generally external to the organization, who is skilled in group process activities (e.g., running meetings, facilitating group discussions, listening, and bringing about consensus) and who understands the basics of organizational performance measurement. After becoming familiar with the target organization through existing documentation, such as the mission statement, organization structure charts,

work center descriptions, and conversations with organization members in a site visit, the facilitator begins the MGEEM process by convening Team A. This team is composed of the commander of the target organization, his/her immediate subordinates, and representative customers. The facilitator leads this team through an input-output systems analysis so that everyone understands the target organization in terms of its suppliers, inputs, mission, value adding activities, outputs (products), and customers. Customers use the outputs of the target organization to accomplish their missions and may be separate organizations or other branches, divisions, etc. of the same organization.

The facilitator continues the MGEEM process by asking members of Team A to assume that they are commander for a day. He then poses to Team A the question, "What does the Air Force (Navy or whatever is appropriate) pay this organization to accomplish?" Answers are clarified and prioritized using the nominal group technique (NGT), a structured process for bringing about consensus. The results, called key result areas (KRAs), are the principal intended accomplishments of the organization. Development of 5 to 7 KRAs concludes the work of Team A. Next, Team B is formed of the commander's subordinates and key workers. Members of Team B are also asked to play commander for a day. The facilitator shows Team B each KRA, in turn, and asks what the commander needs to know to evaluate how well the organization is doing on each. Answers, called indicators, are again clarified and prioritized using the NGT. For each KRA there is usually one to three indicators. Examples of KRAs and indicators are shown in Table 1.

Table 1

<u>Organization</u>	<u>KRA</u>	<u>Indicator</u>
Jet Engine Repair Shop	To keep engines in ready/serviceable condition	Percent of inspections passed
Warehouse	Make deliveries in a prompt/timely manner	Minutes required to deliver priority items
Engineering	To complete projects on time	Percent of suspenses met

Thus, the first stage in the MGEEM process results in the creation of a measurement system of KRAs and indicators developed by organization members with the assistance of a facilitator.

Team B continues its involvement into the second stage of the MGEEM by constructing graphical representations of the relationship between performance on each indicator and overall organizational effectiveness. These representations of team consensus are called mission effectiveness (ME) charts and display not only current levels of performance but also show where the organization can improve planning, identify productivity constraints, and increase morale and productivity through feedback and goal setting. An ME chart is developed for each indicator and takes into account that some indicators are more important than others. The facilitator begins ME chart construction by guiding Team B to a consensus about the feasible worst and best values possible for each indicator and labels the X-axis with the name of the indicator, placing the worst feasible performance value on the left and the best feasible performance value on the right. For instance, the X-axis label of feasible worst and best values for the indicators in Table 1 could be: (1) for inspections passed, from 40 to 100 percent; (2) for time required to deliver priority items, 0 to 15 minutes, and (3) for percent of suspense dates met, 65 to 95 percent. The Y-axis is overall mission effectiveness labeled from -100 at the bottom through 0 to +100 at the top in increments of 10. These best and worst values constitute the first two points on the curve on an ME chart. Figure 1 shows the standard form of an ME chart.

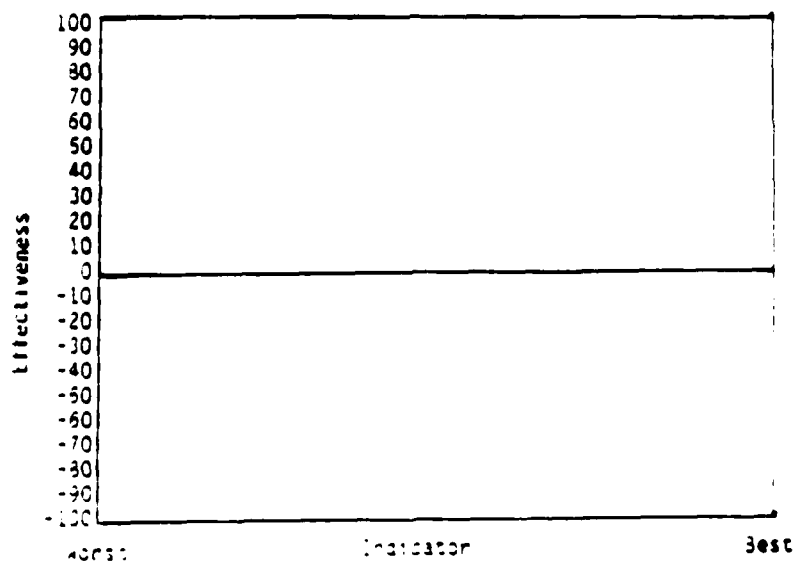


Figure 1

The facilitator then poses questions to Team B which produce a third point on the ME chart for each indicator: "What is the level on this indicator (X-axis) that has no impact on organizational effectiveness (Y-axis)?" or, "What level of performance won't rock the boat?". Another way to put this question is "What level of performance on this indicator won't cause management to commit more resources or reduce resources?" This answer on the X-axis is the zero point on the Y axis. The facilitator continues the questioning by asking the impact on effectiveness of other levels on the indicator until the relationship between the indicator and effectiveness is captured. Curves on ME charts can be linear or nonlinear and reflect consensus of Team B concerning the impact on mission effectiveness of different levels of performance on indicators. ME charts are submitted for review and approval to higher management.

Where the organization is performing on each indicator is provided monthly to managers to improve planning and leadership and to workers in "feedback sessions" to encourage discussion about how to improve performance on the key indicators, including identifying constraints to increased performance. It is essential that management take seriously suggestions which result from feedback sessions by improving the systems by which work is accomplished. Workers produce outputs and managers work continuously to improve the system. This may require a new philosophy of leadership at all levels. Feedback motivates both workers and management to higher levels of performance and ensures that managers work continually to improve the work process.

Figure 2 shows two completed ME charts.

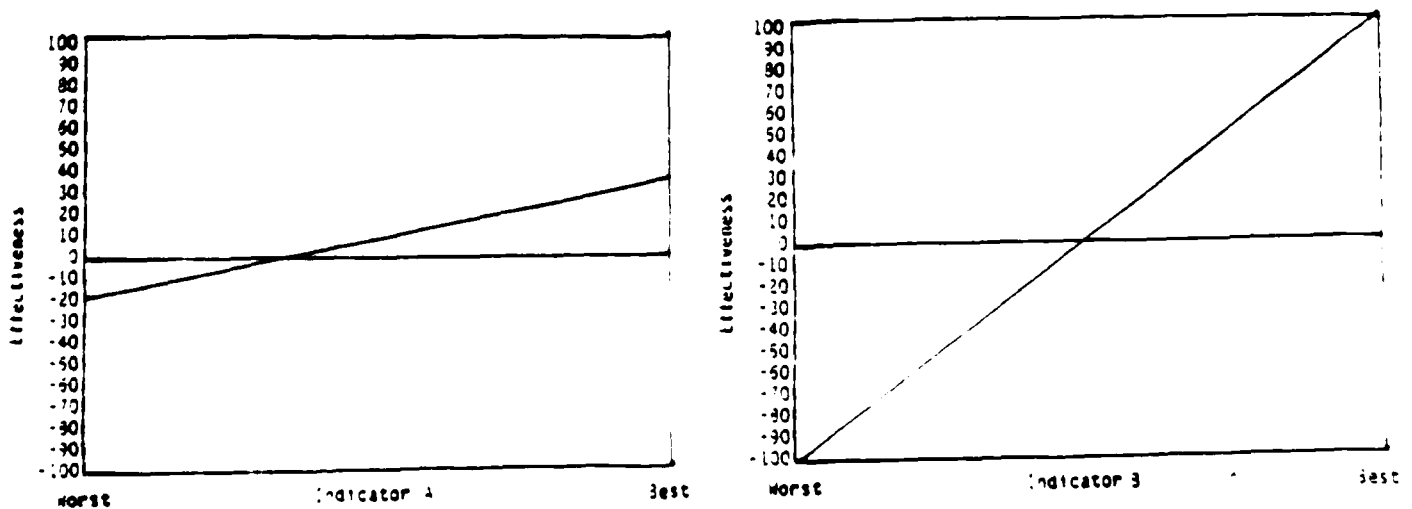


Figure 2

These charts represent the impact on mission effectiveness (overall organizational performance) of two indicators. Which indicator is more important to the accomplishment of the mission? The answer is Indicator B because the slope on its ME chart is steeper. Steep slopes mean that changes in performance have great impact on the mission. Suppose an organization is performing to the far left on the horizontal axes of both ME charts in Figure 2. Where should the manager of this work center devote effort and resources to get the greatest positive impact on mission? Again, because of the steeper slope, the answer is Indicator B. This kind of analysis provides many other advantages, such as early warning of problems and knowledge that problems are fixed.

Since ME charts transform indicators to the common scale of effectiveness (the Y-axis), effectiveness points from ME charts can be summed to measure a work center's overall performance, different work centers can be directly compared, and work centers can be aggregated to measure the overall performance of the higher level organization. ME charts displayed monthly in work areas reveal to workers the impact on overall effectiveness of the current level of their efforts. Also, workers know how their level of effort compares with what is expected. Through time, they see the results of increased or decreased efforts. Beyond feedback, curves on ME charts can be used to set goals for achievement. Transforming measures on indicators to overall effectiveness and preparing reports as feedback to management and workers can be accomplished with the target organization's existing data automation system.

Air Force Regulation 25-5 requires that every Air Force functional area have an adequate management information system. The MGEEM is incorporated in the Performance Measures Document (PMD) of this regulation as the recommended measurement component. In addition, a number of field activities of Navy Air Systems Command, including the Naval Plant Representative Office (NAVPRO) at McDonnell-Douglas Corporation and the Naval Air Test Center, have begun MGEEM implementations.

AFHRL has training manuals (such as the Tuttle & Weaver, 1986, and Weaver and Looper, in press) and videos available for field use of the MGEEM. The points of contact on the MGEEM at AFHRL are Mr Larry Looper at (512) 536-3942 and Dr Charles N. Weaver at (512) 536-3551.

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