and use excessive system resources. For this reason, and because of the rapid rate at which new applications can be developed, it is particularly important in a PCS environment to do an effective job of predicting and tracking system resource usage.

There are three more "technical" problems that currently affect the use of PCS/ADS. First, all PCS transactions run under a single CICS transaction name. To CICS, PCS is a single transaction. This prevents assigning differing priorities to different PCS-based applications. Second, the PCS execution modules are written in CICS macro-level Assembler language. Some new CICS facilities can only be used with command level transactions. Finally, the PCS DCL processor runs as a conversational transaction, causing data areas for DCL-based transactions to tie up virtual storage for long periods of time. We have not considered any of these problems to be prohibitive to our use of PCS. Indeed, some of them are by-products of its overriding advantages. In addition, we are optimistic that the technical problems cited above will be resolved.

Summary

PCS/ADS is a general purpose, CICS-based application generator that has been in use at The University of Iowa Hospitals since 1978. It's primary advantages are:

1. The development cycle is speeded up due to the minimal requirements for conventional programming.
2. PCS/ADS facilitates system prototyping and an iterative development process.
3. The reduction of conventional programming requirements allows the systems developer to concentrate on understanding user requirements and on system analysis and design.
4. The systems developer has the flexibility to use screen descriptions, Data Collection Lists, or conventional programs to implement PCS/ADS transactions.
5. Users are kept involved by the iterative development process and may also create or modify screen and print formats.
6. PCS/ADS includes a good, high-level test facility.

We have found these advantages to far outweigh its disadvantages. In conjunction with the other application-development tools and the development methodologies in use here, PCS/ADS has proven to be an effective and valuable tool.

ABSTRACT

Consistently defined and applied application development and maintenance measurements are essential to a program to improve the application development and maintenance activity in an organization. Those measures are required:

1. To identify and promote practices which help.
2. To identify and avoid practices which hurt.
3. To support rational estimating processes.
4. To portray productivity improvement trends.

These basic objectives of productivity measurement will be used to define a measure called Function Points. Experience with this measure will be described.

-- Draft -- AD/M Estimating and Productivity Measurement Guideline

August 4th, 1983

A. J. Albrecht

IBM Corporate Information Systems and Administration
AD/M Improvement Program
44 S. Broadway
White Plains, N.Y., 10601
CHQVM(CWM26)

ABSTRACT

Introduction

The overall objectives of AD/M productivity measurement are stated. The fundamental concepts of work-product (output), work-effort (input), and attributes (factors affecting productivity) are defined. The relationships among measurement, quality, management, flexibility, non-technical user, and estimating are described.

Definitions

A work-product measure called Function Points is defined. The components of the Function Points measure, namely: input, output, file, interface file, and inquiry types; the adjustment for processing complexity; and the Function Points calculation are defined. The work-hours and work-months measure of work-effort are defined, and a way of describing the attributes is established.

Current Practices

The current recommended practices, for determining the measures defined above, are described. This section is expected to be kept current by periodic update as practices change.

Worksheets

Work-sheets to guide a measurement process, based on the definitions and current practices described above, are provided.

CONTENTS

LIST OF ILLUSTRATIONS

1.0 INTRODUCTION

This guideline covers the measurement, of the productivity results and trends, of the application development and maintenance (AD/M) activities at an AD/M site.

The purpose, of the guideline, is to provide, each AD/M site, a consistent way to measure, portray, and demonstrate the productivity of their AD/M activities. It is also intended, to help distinguish good AD/M actions and characteristics from bad, and to help improve the estimating process. It should, consistently and fairly, promote helpful exchange and use of data among activities at a site, and among sites, divisions, country organizations, and groups.

1.1 OBJECTIVES

A successful AD/M activity, or project, in terms of AD/M responsibilities, is one that satisfies the agreed-to user's requirements, on schedule, and within budget. However, the record of successful activities, or projects, alone, can be misleading, since it is based on estimates and agreements. Without a trend of their measured productivity, or a profile of measured productivity from other sites, it is difficult for a site to determine that the estimates are competitive. (That is, among the most effective alternatives). Site management may not know how much more efficiently the activity, or project, might have been done.

An effective AD/M productivity measure should accomplish several objectives:

1. Consistently **determine** the **productivity** of an AD/M development, enhancement, implementation, or period support activity, or project, relative to other similar activities at the site, and other AD/M sites.
2. **Promote actions** or decisions that can improve the output of the AD/M site.
3. **Demonstrate** the **results** of the actions taken to improve the output of the AD/M site.
4. **Support** the **estimating** process at the AD/M site.
5. **Support** the **management** process at the AD/M site.

1.2 CONSIDERATIONS

Two basic measures must be established for any productivity measure -- one measure must define **work-product** output, and the other must define **work-effort** input, or cost. Work-product divided by work-effort is called "productivity". Its trend should be up. Work-effort divided by work-product is called "unit cost". Its trend should be down. Either measure can be used, depending on the emphasis wanted. (More product or less cost)? In this guideline, both will be considered to be productivity measures.

The productivity measure or unit cost measure places an AD/M activity, project, or site on a relative scale. The **attributes** of the application, activity, project, or site determine the reasons for that relative placement. Attributes

are factors that are expected to influence productivity, such as: application size; user maturity; development environment; team maturity; percent new, modified, or reused as-is; management processes; development processes; tools; and techniques. Since they are the things one must understand, and change, to move the productivity or cost trends in the right direction, attributes must be measured and recorded as diligently as the work-product and work-effort measures.

1.2.1 Non-Technical User

It is desirable that the work-product measure be **meaningful to the** non-technical **user**. The user can then review, and agree with, the work-product measure applied to an activity or project. This can help ensure that a high quality activity or project is being measured. (That is, one that meets the user's requirements). It can also help the user understand the estimates on future activities or projects, and promote more informed discussions about changes.

1.2.2 Flexibility

To provide a number of options for improving productivity, the work-product measure should allow choices among technologies. The measure should **accommodate new approaches**, such as: higher level languages, code generators, and shared applications. If the objective of the AD/M site is to deliver data processing function to the user, then the work-product measure should be based on the application function from the user's view.

1.2.3 Quality

The activities and tasks in AD/M are interdependent. The quality and completeness of early design tasks, can affect the productivity of later development tasks. More significantly, an incomplete or low quality development project, can make the support activity very unproductive. The management and review processes, for each activity, task, phase, or project, must ensure that each work-product **meets the quality required** of the activity. No provision should be made, to measure and include the work-product measure, associated with an unaceptable work-product. Low quality work-products, identified by the management and review processes, or by productivity measurement on the subsequent activities, should be assessed and the weaknesses found should be used to improve the AD/M process.

1.2.4 Estimating

Three activities must be accomplished to estimate an AD/M activity or project effectively:

1. The **tasks must be identified**, listed, and sized.
2. Based on the tasks, **an estimate must be developed.**

3. **The estimate must be validated**, using other methods.

These estimating activities should be accomplished in the early phases of the activity or project. If the work-product measure is to be helpful in validating estimates, it should be formed of elements that can be **determined reliably in the early phases**, of a project.

1.3 CONCEPT

1.3.1 Work-Product

The measure called **Function Points**, based on user application function, has been chosen as the primary measure of AD/M work-product in IBM. Function Points measures an application by quantifying the **standard processing** associated with major external data or control input, output, or file types. This standard processing is then adjusted for **processing complexity** by applying general application characteristics, such as: communications, performance, transaction rate, and ease of installation. The result is Function Points.[1] An overview of Function Points is shown in Figure 1 on page 4.

Function Points are evaluated for an application by listing, classifying, and counting the following major data or control types, to three levels of complexity:

Data or Control Types:	Complexity Level:
o External Input	
o External Output	o Simple
o Logical Internal File	o Average
o External Interface File	o Complex
o External Inquiry	

Each of the 15 possible counting classifications are then weighted by a factor to measure the relative amount of standard processing associated with each data or control type. The resulting sum is then adjusted for processing complexity by applying a factor based on the following:

General Application Characteristics:

1. Data communication	8. On-line update
2. Distributed function	9. Complex processing
3. Performance	10. Reuseability
4. Heavily used configuration	11. Installation ease
5. Transaction rate	12. Operational ease
6. On-line data entry	13. Multiple sites
7. End user efficiency	14. Facilitate change

[1] A complete definition of Function Points is given in Section 2.0. The current counting practices for Function Points are shown in Section 3.0.

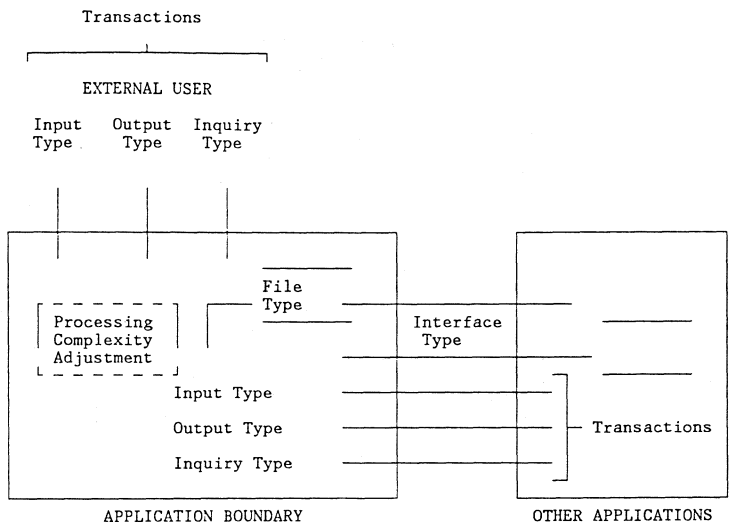

Figure 1. Function Points Overview.

The Function Points measure has been chosen for the following reasons:

1. The measure is based on the users external view of the application. This will allow **choice** in the technology used internally, without changing the measure.

2. The counts, classifications, and general characteristics can all be determined **early** in the development cycle, as soon as the external design has been completed. This will enable Function Points to be used in the estimating process.

3. Function Points can be understood and evaluated by a non-technical user who knows the application. This will enable the **informed user** to review and agree with the AD/M work-product measure.

4. Function Points have shown to be an **effective measure** of AD/M work-product.

   Function Points have been used by 17 IBM AD/M Sites to measure the work-product of 191 application development projects. The measurements have encompassed 137,000 function points of work-product, and 830 work-years of application development work-effort. From another viewpoint the work-product included 9,000,000 source lines of code. The resulting productivity trend lines and profiles appear to be useful.

1.3.2 Work-Effort

To complete a productivity measurement, measures of work-effort are needed. The measures must record the amount of work-effort, and the tasks, activities, and phases included.

Two definitions should be understood:

1. The **net** work-hour, work-month, or work-year, which assumes that all recorded time is spent working. None of the recorded time is used for holiday, vacation, general education, or other personal absence.

2. The **gross** work-hour, work-month, or work-year, which assumes that the recorded time accounts for the time spent working, and the personal absence, as described above.

The work content of a gross work-hour, work-month, or work-year is generally about 75% of the work content of a net work-hour, work-month, or work-year in most organizations.

Conceptually, these measures are straightforward and have been used for many years, but differences in work practices at the various AD/M sites can cause the measures to differ. The definitions should be determined and stated by each organization with their productivity measures.

All the work-effort used to accomplish the tasks, activities, and phases of the pertinent AD/M process should be included, without regard for organization lines. For example, if a user works on design tasks for an application development project, the user's time should be included in the work-effort for the project. The work-effort measures should include the work-hours, work-months, or work-years that were used to accomplish the following phases of the AD/M process:[2]

- **Design** - Study, Requirements, External Design, Internal Design, and Development Planning.
- **Development** - Design, Code, Unit Test, Integration, System Test, Documentation, Installation Planning, and Support Planning.
- **Installation** - Education, Data Conversion, and Installation.
- **Support**[3] - Installed Application Support, Fixing, and Retrospective Analysis.

1.3.3 Attributes

When selecting the Attributes of an AD/M activity, project, or site, to be measured and recorded, one must balance the desire to record only a few factors,

[2] The work-effort measures and activities, phases, and tasks recommended to be measured and recorded are defined more completely in Sections 2.0, 3.0,and 4.0.

[3] Functional changes or enhancements are expected to be reported as projects under the design, development, and installation phases.

against the need to avoid overlooking the factors really influencing productivity. Generally the analysis proceeds as follows:

1. A series of productivity measurements are made and recorded. These measurements are arranged in order of productivity to highlight deviations from normal.

2. The known characteristics of the activity, project, or site are then systematically explored to see which characteristics, or **attributes**, seem to explain the deviations from normal best.

3. Those attributes that seem to be most important are then analyzed more completely to determine their effect on productivity, and how completely they explain the deviations.

4. These results are then used to:

   - Pursuade those responsible to change the attributes of sites, projects, and activities as indicated, thus causing productivity to increase.
   - Estimate and validate the resources planned for future activities and projects.
   - Identify the attributes to be measured and recorded systematically for all activities and projects.

The concept of this guideline will be to measure and record the most important attributes thought to affect productivity significantly, with provision for identifying and recording new attributes as they become more important.[4]

[4] The attributes recommended to be measured and recorded for AD/M activities, projects, and sites will be listed and described more completely in Section 2.0 and Section 3.0.

2.0 FUNCTION POINTS DEFINITIONS

This section provides the basic definitions supporting the measurement, recording, and analysis of Function Points, Work-effort, and Attributes.

2.1 GENERAL

The following considerations are generally applicable to the specific definitions of Function Points, Work-effort, and Attributes in later paragraphs in this section.

2.1.1 Development Work-Product vs Support Work-Product

Development productivity should be measured by counting the **Function Points added or changed** by the development or enhancement project. Therefore,

Development Work-Product = The absolute value sum of all Function Points added or changed by the development or enhancement project. (Deleted Function Points are considered to be changed Function Points).

Support productivity should be measured by counting the total **Function Points supported** by the support project during the support period. Therefore,

Support Work-Product = The original Function Points of the application, adjusted for any changes in complexity introduced, plus any Function Points added, minus any Function Points deleted by subsequent enhancement projects.

2.1.2 Measurement Timing

To provide the work-product, work-effort, and attributes measures needed for each development project, enhancement project, and support project to be analyzed, the indicated measures should be determined at the following times in the application life cycle:

- The estimated development work-product, estimated work-effort, and planned attributes measures should be determined at the completion of the **External Design Phase** for each development and enhancement project. (When the complete user external view of the application has been documented).
- The development work-product, actual work-effort, and attributes measures should be determined at the completion of the **Installation Phase** for each development and enhancement project. (When the application is ready for use).
- The support work-product, actual support work-effort, and attributes measures should be determined at the end of **each calendar year** of support and use for each support project.

2.1.3 Application Boundaries

Normally, as shown in Figure 1 on page 4, a single continuous external boundary is considered when counting Function Points. However, there are two general situations where counting Function Points for an application in parts, is necessary:

1. The application is planned to be developed in multiple stages, using more than one development project.

   This situation should be counted, estimated, and measured as **separate projects**, including all inputs, outputs, interfaces, and inquiries crossing **all** boundaries, because it is intended to be managed as multiple projects.

2. The application is planned to be developed as a single application using one development project, but it is so large that it will be necessary to divide it into sub-applications for counting Function Points.

   The internal boundaries are arbitrary and are for counting purposes only. The sub-applications should be counted separately, but **none** of the inputs, outputs, interfaces, and inquiries, crossing the **arbitrary internal** boundaries to the other sub-applications, should be counted. The Function Points of the sub-applications should then be summed to give the total Function Points of the application for estimation and measurement, because it is intended to be managed as a single project.

2.1.4 Brought-In Application Code

Count the Function Points provided by brought-in application code (reused code), such as: an IBM IUP, PP, or FDP; an internal shared application; or a purchased application if that code was selected, modified, integrated, tested, or installed by the project team. However, do **not** count the Function Points provided by the brought-in code that provided user function beyond that stated in the approved requirements.

Some examples are:

1. Do count the Function Points provided by an application obtained from another IBM site, or project, and installed by the project team.
2. Do **not** count the Function Points provided by software, such as IMS or a screen compiler, if that software had been made available by another project team.
3. Do **not** count ADF updates of **all** files if the user only required updates of **three** files, even though the capability may be automatically provided.

2.1.5 Consider All Users

Consider **all** users of the application, since each application may have provision for many specified user functions, such as:

- End user functions. (enter data, inquire, etc.).

- Conversion and installation user functions. (file scan, file compare discrepancy list, etc.).

- Operations user functions. (recovery, control totals, etc.).

If the user functions are specified to be provided, they are functions that should be included in measuring the development work-product. If the user functions are specified to be maintained, they should be included in measuring the support work- product. It is possible that some conversion and installation user functions may not be specified to be maintained and should not be included in the support work-product.

2.2 FUNCTION POINTS MEASURE

After the general considerations described in the preceding paragraphs have been decided, the Function Points measure is accomplished in three general steps:

1. Classify and count the five user function types

2. Adjust for processing complexity

3. Make the Function Points calculation

The paragraphs in this section define and describe each of these steps. The first step is accomplished as follows:

Classify, to three levels of complexity, the following user functions that were made available to the user through the design, development, testing, or support efforts of the development, enhancement, or support project team:

1. External input types

2. External output types

3. Logical internal file types

4. External interface file types

5. External inquiry types

Then **list** and **count** these user functions. The counts should be recorded for use in the Function Points calculation, on an appropriate work-sheet. Examples of useful Function Points work-sheets are provided in Section 4.0, Function Points Work-sheets.

The definitions of each of the user functions to be counted, and the levels of complexity, are provided in the following paragraphs.

2.2.1 External Input Type

Count each unique user **data** or user **control** input type that enters the external boundary of the application being measured, and **adds** or **changes** data in a logical internal file type. An external input type should be considered unique if it has a different **format**, or if the external design requires a **processing logic** different from other external input types of the same format. As illustrated in Figure 1 on page 4, include external input types that enter directly as transactions from the user, and those that enter as transactions from other applications, such as, input files of transactions.

Each external input type should be classified within three levels of complexity, as follows:

- **Simple** - Few data element types are included in the external input type, and few logical internal file types are referenced by the external input type. User human factors considerations are not significant in the design of the external input type.

- **Average** - The external input type is not clearly either simple or complex.

- **Complex** - Many data element types are included in the external input type, and many logical internal file types are referenced by the external input type. User human factors considerations significantly affect the design of the external input type.[5]

Do **not** include external input types that are introduced into the application only because of the technology used.

Do **not** include input files of records as external input types, because these are counted as external interface file types.

Do **not** include the input part of the external inquiry types as external input types, because these are counted as external inquiry types.

2.2.2 External Output Type

Count each unique user **data** or **control** output type that leaves the external boundary of the application being measured. An external output type should be considered unique if it has a different **format**, or if the external design requires a **processing logic** different from other external output types of the same format. As illustrated in Figure 1 on page 4, include external output types that leave directly as reports and messages to the user, and those that leave as reports and messages to other applications, such as, output files of reports and messages.

Each external output type should be classified within three levels of complexity, using definitions similar to those for the external input types. (paragraph 2.2.1). For reports, the following additional complexity definitions should be used:

- **Simple** - One or two columns. Simple data element transformations.
- **Average** - Multiple columns with sub-totals. Multiple data element transformations.
- **Complex** - Intricate data element transformations. Multiple and complex file references to be correlated. Significant performance considerations.[5]

Do **not** include external output types that are introduced into the application only because of the technology used.

Do **not** include output files of records as external output types, because these are counted as external interface file types.

Do **not** include the output response of external inquiry types as external output types, because these are counted as external inquiry types.

[5] More specific practices for determining complexity are defined in the Current Practices Section 2.3.

2.2.3 Logical Internal File Type

Count each major logical group of user **data** or **control** information in the application as a logical internal file type. Include each logical file , or within a data base, each logical group of data from the viewpoint of the user, that is **generated, used,** and **maintained** by the application. Count logical files as described in the external design, not physical files.

The logical internal file types should be classified within three levels of complexity as follows:

- **Simple** - Few record types. Few data element types. No significant performance or recovery considerations.
- **Average** - The logical internal file type is not clearly either simple or complex.
- **Complex** - Many record types. Many data element types. Performance and recovery are significant considerations.[5]

Do **not** include logical internal files that are **not** accessible to the user through external input, output, interface file, or inquiry types.

2.2.4 External Interface File Type

Files **passed** or **shared** between applications should be counted as external interface file types within **each** application. Count each major logical group of user **data** or **control** information that enters or leaves the application, as an external interface file type. External interface file types should be classified within three levels of complexity, using definitions similar to those for logical internal file types. (paragraph 2.2.3).

File types that are **used** by the application **and** are also **shared** with other applications should be counted as both Logical Internal File Types and External Interface File Types.

2.2.5 External Inquiry Type

Count each unique input/output combination, where an input causes and generates an immediate output, as an external inquiry type. An external inquiry type should be considered unique if it has a **format** different from other external inquiry types in either its input or output parts, or if the external design requires a **processing logic** different from other external inquiry types of the same format. As illustrated in Figure 1 on page 4, include external inquiry types that enter directly from the user, and those that enter from other applications.

The external inquiry types should be classified within three levels of complexity as follows:

1. Classify the input part of the external inquiry type using definitions similar to the external input type. (paragraph 2.2.1).

2. Classify the output part of the external inquiry type using definitions similar to the external output type. (paragraph 2.2.2).

3. The complexity of the external inquiry type is the greater of the two classifications.

To help distinguish external inquiry types from external input types, consider that the input data of an external inquiry type is entered only to direct the search, and no update of logical internal file types should occur.

Do **not** confuse a query facility as an external inquiry type. An external inquiry type is a direct search for specific data, usually using only a single key. A query facility provides an organized structure of external input, output, and inquiry types to compose many possible inquiries using many keys and operations. These external input, output, and inquiry types should **all** be counted to measure a query facility.

2.2.6 Processing Complexity

The previous paragraphs define the external input, external output, internal file, external interface file, and external inquiry types to be listed, classified, and counted. The Function Points Calculation (paragraph 2.2.7) describes how to use these counts to measure the standard processing associated with those user functions. This paragraph describes how to apply some general application characteristics to adjust the standard processing measure for processing complexity.

The adjustment for processing complexity should be accomplished in three steps, as follows:

1. The **degree of infuence**, on development and support, of each of the 14 general characteristics, should be estimated from the user's view of the application.

2. The 14 degree of influence(s) should be summed, and the total should be used to develop an **adjustment factor** ranging from 0.65 to 1.35. (This gives an adjustment of +/- 35%).

3. The **standard processing measure** should be multiplied by the adjustment factor to develop the work-product measure called Function Points.

The first step is accomplished as follows:

Estimate the degree of influence, on the application, of each of the 14 general characteristics that follow. Use the degree of influence measures in the following list, and record the estimates on a work-sheet similar to Figure 7 on page 34

Degree of Influence Measures:

- o Not present, or no influence if present = 0
- o Insignificant influence = 1
- o Moderate influence = 2
- o Average influence = 3
- o Significant influence = 4
- o Strong influence, throughout = 5

General Application Characteristics

1. The **data** and control information used in the application are sent or received over **communication** facilities. Terminals connected locally to the control unit are considered to use communication facilities.

2. **Distributed** data or processing **functions** are a characteristic of the application.

3. Application **performance** objectives, in either response or throughput, influenced the design, development, installation, and support of the application.

4. A **heavily used** operational **configuration** is a characteristic of the application. The user wants to run the application on existing or committed equipment that will be heavily used.

5. The **transaction rate** is high and it influenced the design, development, installation, and support of the application.

6. **On-line data entry** and control functions are provided in the application.

7. The on-line functions provided, emphasize **end user efficiency**.

8. The application provides **on-line update** for the logical internal files.

9. **Complex processing** is a characteristic of the application. Examples are:
   - Many control interactions and decision points.
   - Extensive logical and mathematical equations.
   - Much exception processing resulting in incomplete transactions that must be processed again.

10. The application, and the code in the application, has been specifically designed, developed, and supported for **reuseability** in other applications, and at other sites.

11. Conversion and **installation ease** are characteristics of the application. A conversion and installation plan was provided, and it was tested during the system test phase.

12. **Operational ease** is a characteristic of the application. Effective start-up, back-up, and recovery procedures were provided, and they were tested during the system test phase. The application minimizes the need for manual activities, such as, tape mounts, paper handling, and direct on-location manual intervention.

13. The application has been specifically designed, developed, and supported to be installed at **multiple sites** for multiple organizations.

14. The application has been specifically designed, developed, and supported to **facilitate change**. Examples are:

    - Flexible query capability is provided.
    - Business information subject to change is grouped in tables maintainable by the user.

2.2.7 Function Points Calculation

The previous paragraphs describe how the function types are listed, classified, and counted; and how the processing complexity adjustment is determined. This paragraph describes how to make the calculations that develop the Function Points measures.

Using the definitions in Paragraph 2.1.1, two equations have been developed to more specifically define the **development work-product** measure and the **support work-product** measure:

Development Work-Product FP Measure = (Add + ChgA)PCA2 + (Del)PCA1 = _____.

Support Work-Product FP Measure = Orig FP + (Add + ChgA)PCA2
- (Del + ChgB)PCA1 = _____.

Orig FP = adjusted FP of the application, evaluated as they were before the project started.

Add = unadjusted FP added to the application, evaluated as they are expected to be at the completion of the project.

ChgA = unadjusted FP changed in the application, evaluated as they are expected to be at the completion of the project.

Del = unadjusted FP deleted from the application, evaluated as they were before the project started.

ChgB = unadjusted FP changed in the application, evaluated as they were before the project started.

PCA1 = the processing complexity adjustment pertaining to the application before the project started.

PCA2 = the processing complexity adjustment pertaining to the application after the project completion.

The lists of the function types developed, using Figure 8 on page 35 and Figure 9 on page 36 as work-sheets, provide the information for calculating the unadjusted FP. A portion of the filled-in form might look like this:

In., Out., Inq., Function List				Complexity Record							
				Before				After			
Type	ID	Ref	Description	DET	FTR	Del	Chg	DET	FTR	Add	Chg
IT	TSO1	001	Sign-on screen	4	1	S	___	___	___	___	___
IT	PSCC	001	Cost center transaction	___	___	___	___	29	2	C	___
IT	PSDC	001	Department change transaction	5	1	___	S	12	2	___	A

Type = the general function type.

ID, Ref, and Description = the specific function type.

Before = the complexity record of the specific function type as it was before the project was started.

After = the complexity record of the specific function type as it was expected to be after the project was completed.

DET = number of data element types in the function type.

FTR = number of file types referenced by the function type.

Del = the complexity of the deleted function type.

Chg = the complexity of the changed function type.(before and after).

Add = the complexity of the added function type.

If the application consists of **only new or added** function types, the development work-product FP measure **equals** the support work-product FP measure. The form shown in Figure 7 on page 34 can be used to calculate both measures as follows:

1. Using the lists discussed above, the general function types at each complexity level are counted and entered in the **function count matrix**.
2. The weights shown on the form are applied and the results are summed to give the **unadjusted function points**.
3. The **processing complexity adjustment** pertaining to the application at the completion of the project is developed using the general application characteristics described in Paragraph 2.2.6.
4. The processing complexity adjustment is applied to the unadjusted function points to give the **Function Points measure**.

If the application is an **enhancement project**, consisting of added, deleted, and/or changed function types, the development work-product FP measure **does not equal** the support work-product FP measure. The appropriate forms are shown in Figure 10 on page 37 for the development work-product, and Figure 11 on page 38 for the support work-product. They are used as follows:

1. The general function types are counted and entered into the appropriate **added, deleted, or changed matrices**.
2. The added, deleted, or changed **unadjusted function points** are determined on each form.
3. The processing complexity adjustments pertaining to the beginning or the end of the project are applied to each form to give the **Function Points measures**.

These measures of work-product can then be used with the measures of work-effort (section 2.3), and the attributes of applications and projects (section 2.4), to accomplish the following analyses:

1. Identify and **promote** the attributes associated with **higher** productivity.
2. Identify and **avoid** the attributes associated with **lower** productivity.
3. **Develop and use** rational estimating processes.
4. **Portray** productivity trends.

2.3 WORK-EFFORT

2.3.1 Labor Claiming

For each project that is to be used in productivity measurement and analysis, or estimate validation, the record of estimated and actual work-effort is needed. The following work-effort information should be known:

1. The original estimate.
2. The estimate of approved changes.
3. The actual results.

To record the actual results most reliably, a systematic method of accounting for work-effort should be used. This is commonly called **labor claiming**. Labor claiming should result in an objective and accurate record of past work-effort so that past projects can be analyzed objectively and accurately, and reliable estimates can be made for future projects.

Labor claiming should be used to establish three measures:

1. The net work-effort on the project.
2. The time away from the project on authorized absence.
3. The gross work-effort on the project.

Labor claiming can also be used to establish the average conversion factors for an organization to apply to the net and gross work-effort definitions in the following section.

2.3.2 Work-Effort Definitions

- **Net Work-Hour** - One hour of work by one person, including normal personal breaks.
- **Net Work-Month** - About 174 net work-hours of work.
- **Net Work-Year** - About 2087 net work-hours of work.
- **Gross Work-Year** - The net work-hours normally worked by one person in one year. (About 1565 net work-hours).
- **Gross Work-Month** - The net work-hours normally worked by one person in one average month. (About 130 net work-hours).
- **Gross Work-Hour** - The net work-hours normally worked by one person in one average hour. (About 0.75 net work-hours).

2.3.3 Work-Effort Measure

Since the measures are all stated in terms of the net work-hour, they can be consistently interpreted if the average ratio between net and gross work-hours is stated for each organization. This can be most conveniently recorded and remembered as the net work-nours per gross work-month. (It should be about 130 net work-hours).

Two work-effort measures are called for in this guideline. Namely, work-months for the development productivity measure, and work-hours for the support productivity measure. For consistency and more natural relating to head-count, these measures should be stated in **gross work-months** and **gross work-hours**. Work-sheets are shown in Figure 12 on page 39 and Figure 13 on page 40.

The gross work-months or gross work-hours can generally be determined in two possible ways:

1. The gross work-months or gross work-hours are recorded directly from the project work-effort record.
2. The net work-months or work-hours are recorded directly from the project work-effort record, and are then converted to gross measures by a conversion factor derived from the work- effort record of the site.

Method number two is recommended because the first method can give incorrect productivity results on short projects. Since vacations are usually concentrated in the summer months, the work content of a gross work-month in the summer can be significantly less than the work content of a gross work-month in the winter. The recommended approach avoids this problem by measuring the work content specifically in net work-effort.

2.4 ATTRIBUTES

2.4.1 Attribute Selection

Each characteristic or **attribute** of a project that might be measured and recorded for future analysis should be considered as follows:

1. **How important is it?**

   In the context of this guideline, how significant is its expected effect on productivity?[6]

2. **Can it be changed?**

   Can the attribute be changed at the site, or is it only interesting information that cannot be used to effect improvement? The answers to this question depend heavily on level of management involved, and time available to make the change. A factor, such as development environment, that is not changeable by a first line manager may well be changeable by a site director of I/S. A factor, such as development team maturity, that cannot be changed for a project already underway, may certainly be changed given hiring or training objectives, time, and resources. Generally, if an issue is important and the facts are available, change can be accomplished.

3. **Is it a variable at the site?**

   A characteristic or attribute that is unvarying across all the activities and projects at a site cannot be used to explain deviations among the projects at the site. However, it may be needed to analyze the productivity differences between two sites. An attribute should not be excluded from the record only because it is a part of every activity and project at the site.

The key issue is clearly the importance of the attribute to productivity. Therefore, **all attributes that are thought to affect productivity significantly should be measured and recorded.**

2.4.2 Attribute Recording

The initial approach to recording the attributes of a project or activity is almost always overly simplistic. Then, the inadequacies of a simple checklist are discovered. **Yes** and **No** do not describe the degree to which a tool or technique applies to the project. It is realized that far different results should be expected from the following extremes:

[6] It is interesting to note how quickly these expectations can change. For example, who would have seen the need three years ago, to differentiate between subsecond response time and one or two second response time, in productivity analysis?

For example,

1. A mature tool, that the team has used before successfully, that can influence 100% of the work-effort on the project.

2. A newly released tool, being used by the team for the first time, that is potentially applicable to only 10% of the work-effort.

A technique for recording these levels of applicability is needed. Therefore, the following information should be recorded for each attribute recorded for analysis:

- **Maturity of the tool or technique?**
  - **Low** - Tool or technique is new. No people experienced in its use are available for consultation.
  - **Moderate** - Tool or technique has been in use long enough that people experienced in its use are available for consultation.
  - **High** - Tool or technique has been in use long enough that experience has been incorporated in improvements to the tool or technique.
- **Maturity of the project team in regard to the tool or technique?**
  - **Low** - Project team has not used the tool or technique before.
  - **Moderate** - Project team has used the tool or technique once before.
  - **High** - Project team has used the tool or technique more than once before.
- **Applicability of the tool or technique to the work-effort on the project?**
  - **Low** - Tool or technique is potentially applicable to less than 1/3 of the work-effort on the project.
  - **Moderate** - Tool or technique is potentially applicable to between 1/3 and 2/3 of the work-effort on the project.
  - **High** - Tool or technique is potentially applicable to over 2/3 of the work-effort on the project.

A form for recording these attributes is shown in Figure 14 on page 41. This record will provide the information to more accurately weight the contribution to productivity expected from the tool or technique.

3.0 FUNCTION POINTS CURRENT PRACTICES

3.1 GENERAL

3.2 FUNCTION POINTS MEASURE

The following numbered paragraphs provide the current recommended practices in IBM I/S for classifying the complexity and counting the five major data or control types, adjusting for processing complexity, and calculating Function Points:

1. External Input
2. External Output
3. Logical Internal File
4. External Interface File
5. External Inquiry
6. Processing Complexity
7. Function Points Calculation

These current practices are based on the definitions in Section 2.2 and are intended to provide more objective consistency among individuals and sites in measuring work-products with Function Points. Where current practices are provided each of the numbered paragraphs will follow a similar format:

1. Objective definitions of complexity classification.
2. A checklist of potential data or control types.
3. Specific counting recommendations for particular described data or control types.

Since the current practices are interpretations based on the definitions in Section 2.2, any issues not covered in the current practices must be resolved by use of the definitions.

3.2.1 External Input Type

Complexity Classification:

	1 to 4 DET	5 to 15 DET	16 or more DET
0 or 1 FTR	S	S	A
2 FTR	S	A	C
3 or more FTR	A	C	C

DET = data element types

FTR = file types referenced

RET = record types

S = simple

A = average

C = complex

Additional complexity factors:

Consider the following factors relative to average to adjust the complexity up or down not more than one level:

- o Automatic cursor movement
- o Other human factors
- o Data conversion
- o Application performance

Figure 2. External Input Type Complexity.

Potential Input Types:

- o Keyed Document
- o OCR Document
- o Screen
- o Automatic Transaction
- o Card
- o Diskette Transaction
- o Paper Tape Transaction
- o
- o Switch
- o Digital Sensor
- o Analog Sensor
- o Magnetic Stripe
- o PF Key
- o Light Pen
- o User Application Control
- o

Counting Recommendations:

DESCRIPTIONS:	COUNT AS:
o Data screen input	1 IT
o Function screen input	1 IT
o Function screen with multiple different functions	1 IT/Function
o Automatic data or function transactions from other applications	1 IT
o Inquiry followed by an update input	1 QT, 1 IT
o Backup input with same processing logic as primary input	0 IT
o PF Key duplicate of a screen already counted as an input	0 IT
o Light pen duplicate of a screen already counted as an input	0 IT
o Two input screens with the same format and processing logic	1 IT
o Two screens with the same format and different processing logic	2 IT
o Selection menu screen input	0 IT
o Selection menu screen input with save capability	1 IT
o ADF Target screen input	1 IT
o ADF Key Selection screen input	0 IT
o ADF Master Rules screen input	0 IT
o Screen that is both input and output	1 IT, 1 OT
o User maintained table or file	implies at least 1 IT
o User application control input	1 IT
o Repeat screen input	0 IT
o Input forms (OCR)	1 IT

3.2.2 External Output Type

	1 to 5 DET	6 to 19 DET	20 or more DET
0 or 1 FTR	S	S	A
2 or 3 FTR	S	A	C
4 or more FTR	A	C	C

DET = data element types

FTR = file types referenced

RET = record types

S = simple

A = average

C = complex

Additional Complexity Factors:

Consider the following factors relative to average to adjust the complexity up or down not more than one level:

- o Layout or human factors
- o Number of subtotal types
- o Data transformations
- o Application performance

Figure 3. External Output Type Complexity.

Potential Output Types:

- o Screen Report
- o Terminal Report
- o Batch Report
- o Automatic Transaction
- o Card
- o Diskette Transaction
- o Paper Tape Transaction
- o Screen Message
- o
- o Digital Line
- o Digital Actuator
- o Analog Actuator
- o User Application Control
- o Magnetic Stripe
- o Invoice
- o Check
- o Bill of Material
- o

Counting Recommendations:

DESCRIPTIONS:	COUNT AS:
o Data screen output	1 OT
o Automatic data or function transactions to other applications	1 OT
o Operator message from the application	1 OT
o Message frame (format) for multiple error messages or confirmation messages associated with 1 IT	1 OT
o Individual error message output within a message frame	0 OT
o Individual confirmation message output within a message frame	0 OT
o Batch printed report	1 OT
o Batch run report	1 OT
o Batch error report	1 OT
o Terminal printed report	1 OT
o Control total output	1 OT
o Audit list or check list report	1 OT
o User maintained table or file	implies at least 1 OT
o Selection menu screen output	0 OT
o Selection menu screen output with save capability	1 OT
o ADF menu output	0 OT
o ADF Key Selection screen output	0 OT
o ADF Master Rules screen output	0 OT
o Repeat screen output	0 OT
o Start screen output	1 OT
o End screen output	1 OT

3.2.3 Logical Internal File Type

	1 to 19 DET	20 to 50 DET	51 or more DET
1 RET	S	S	A
2 to 5 RET	S	A	C
6 or more RET	A	C	C

DET = data element types

FTR = file types referenced

RET = record types

S = simple

A = average

C = complex

Additional Complexity Factors:

Consider the following factors relative to average to adjust the complexity up or down not more than one level:

o Application performance

o Search Criteria

o Recovery and backup

Figure 4. Logical Internal File Type Complexity.

Potential File Types:

- o Logical Internal File
- o Data Base
- o User Table
- o
- o File for Control of Batch Sequential Processing
- o File for User Query
- o

Counting Recommendations:

DESCRIPTIONS:	COUNT AS:
o Logical entity of data from user viewpoint	1 FT
o Logical internal files generated or maintained by the application	1 FT
o Files accessible to the user through keyword(s) or parameter(s)	1 FT
o User maintained table or file	1 FT
o File used for data or control by sequential (batch) application	1 FT
o Each hierarchical path (leg) through a data base (include paths formed by secondary indices and logical relationships)	1 FT
o Hierarchical paths not stated in the user requirements	0 FT
o Intermediate or sort work file	0 FT

3.2.4 External Interface File Type

	1 to 19 DET	20 to 50 DET	51 or more DET
1 RET	S	S	A
2 to 5 RET	S	A	C
6 or more RET	A	C	C

DET = data element types

FTR = file types referenced

RET = record types

S = simple

A = average

C = complex

Additional Complexity Factors:

Consider the following factors relative to average to adjust the complexity up or down not more than one level:

o Application performance

o Search criteria

o Recovery and backup

o Multiple distribution

Figure 5. External Interface File Type Complexity.

Potential Interface File Types:

o Logical Internal File Accessible from Another Application	o Logical Internal File Accessible to Another Application
o Shared Data Base	o
o	o

Counting Recommendations:

DESCRIPTIONS:	COUNT AS:
o File of records from another application	1 EI
o File of records to another application, even though counted as 1 FT in this application	1 EI
o File of records to multiple other applications (multiple distribution is a complexity consideration)	1 EI
o Data base shared to other application	1 EI
o Data base shared from other applications	1 EI

3.2.5 External Inquiry Type

Input Part:

	1 to 4 DET	5 to 15 DET	16 or more DET
0 or 1 FTR	S	S	A
2 FTR	S	A	C
3 or more FTR	A	C	C

DET = data element types

FTR = file types referenced

RET = record types

S = simple

A = average

C = complex

Output Part:

	1 to 5 DET	6 to 19 DET	20 or more DET
0 or 1 FTR	S	S	A
2 or 3 FTR	S	A	C
4 or more FTR	A	C	C

Additional Complexity Factors:

Consider the following factors relative to average to adjust the complexity up or down not more than one level:

- o Automatic cursor movement
- o Layout or other human factor
- o Application performance
- o Number of subtotal types
- o Data transformations

Figure 6. External Inquiry Type Complexity.

Potential Inquiry Types:

- o User Inquiry with NO File Update
- o Help Message and Screen
- o Selection Menu Screen
- o
- o ADF Menu
- o ADF Key Selection Screen
- o ADF Master Rules Screen
- o

Counting Recommendations:

DESCRIPTIONS:	COUNT AS:
o Online input and online output with no update of data in files	1 QT
o Inquiry followed by an update input	1 QT, 1 IT
o Help screen input and output	1 QT
o Selection menu screen input and output	1 QT
o ADF menu input and output	1 QT
o ADF Key Selection screen input and output	1 QT
o ADF Master Rules screen input and output	1 QT
o A major query facility or language should be decomposed into its hierarchical structure of IT(s), OT(s), and QT(s) using the existing definitions and current practices.	

3.2.6 Processing Complexity

(No recommended Current Practices).

3.2.7 Function Points Calculation

(No recommended Current Practices).

3.3 WORK-EFFORT

(No recommended Current Practices).

3.4 ATTRIBUTES

(No recommended Current Practices).

4.1 FUNCTION POINTS CALCULATION

Application: ______________________________________. Appl ID: _______.

Prepared by: ______________ __/__/__. Reviewed by: ______________ __/__/__.

Notes:

o Function Count:

Type ID	Description	Complexity: Simple	Average	Complex	Total
IT	External Input	___ x 3 = ___	___ x 4 = ___	___ x 6 = ___	_____
OT	External Output	___ x 4 = ___	___ x 5 = ___	___ x 7 = ___	_____
FT	Logical Internal File	___ x 7 = ___	___ x10 = ___	___ x15 = ___	_____
EI	Ext Interface File	___ x 5 = ___	___ x 7 = ___	___ x10 = ___	_____
QT	External Inquiry	___ x 3 = ___	___ x 4 = ___	___ x 6 = ___	_____
FC	Total Unadjusted Function Points				_____

o Processing Complexity:

ID	Characteristic	DI	ID	Characteristic	DI
C1	Data Communications	__	C8	Online Update	__
C2	Distributed Functions	__	C9	Complex Processing	__
C3	Performance	__	C10	Reuseability	__
C4	Heavily Used Configuration	__	C11	Installation Ease	__
C5	Transaction Rate	__	C12	Operational Ease	__
C6	Online Data Entry	__	C13	Multiple Sites	__
C7	End User Efficiency	__	C14	Facilitate Change	__
PC	Total Degree of Influence				___

o DI Values:

- Not present, or no influence = 0
- Insignificant influence = 1
- Moderate influence = 2
- Average influence = 3
- Significant influence = 4
- Strong influence, throughout = 5

PCA Processing Complexity Adjustment = 0.65 + (0.01 x PC) = _______.

FP Function Points Measure = FC x PCA = _______.

Figure 7. Function Points Calculation Worksheet

CI/S & A Guideline - Draft -

4.2 IN., OUT., INQ., FUNCTION AND COMPLEXITY RECORD

Application: ______________________________________. Appl ID: _______.

Prepared by: ______________ __/__/__. Reviewed by: ______________ __/__/__.

Notes:

In., Out., Inq., Function List				Complexity Record							
				Before				After			
Type	ID	Ref	Description	DET	FTR	Del	Chg	DET	FTR	Add	Chg

DET = Number of Data Element Types in the In., Out., Inq.
FTR = Number of File Types Referenced by the In., Out., Inq.
Add., Del., Chg. = Complexity of the In., Out., Inq. added, deleted changed.

Figure 8. IN., OUT., INQ., Function and Complexity Record Worksheet

4.3 FILES, INTERFACES, FUNCTION AND COMPLEXITY RECORD

Application: ____. Appl ID: _______.

Prepared by: ______________ __/__/__. Reviewed by: ______________ __/__/__.

Notes:

Files, Interfaces, Function List				Complexity Record							
				Before				After			
Type	ID	Ref	Description	DET	RET	Del	Chg	DET	RET	Add	Chg
___	___	___	______________________	___	___	___	___	___	___	___	___
___	___	___	______________________	___	___	___	___	___	___	___	___
___	___	___	______________________	___	___	___	___	___	___	___	___
___	___	___	______________________	___	___	___	___	___	___	___	___
___	___	___	______________________	___	___	___	___	___	___	___	___
___	___	___	______________________	___	___	___	___	___	___	___	___
___	___	___	______________________	___	___	___	___	___	___	___	___
___	___	___	______________________	___	___	___	___	___	___	___	___
___	___	___	______________________	___	___	___	___	___	___	___	___
___	___	___	______________________	___	___	___	___	___	___	___	___
___	___	___	______________________	___	___	___	___	___	___	___	___
___	___	___	______________________	___	___	___	___	___	___	___	___
___	___	___	______________________	___	___	___	___	___	___	___	___
___	___	___	______________________	___	___	___	___	___	___	___	___
___	___	___	______________________	___	___	___	___	___	___	___	___
___	___	___	______________________	___	___	___	___	___	___	___	___
___	___	___	______________________	___	___	___	___	___	___	___	___
___	___	___	______________________	___	___	___	___	___	___	___	___
___	___	___	______________________	___	___	___	___	___	___	___	___
___	___	___	______________________	___	___	___	___	___	___	___	___
___	___	___	______________________	___	___	___	___	___	___	___	___
___	___	___	______________________	___	___	___	___	___	___	___	___
___	___	___	______________________	___	___	___	___	___	___	___	___
___	___	___	______________________	___	___	___	___	___	___	___	___
___	___	___	______________________	___	___	___	___	___	___	___	___
___	___	___	______________________	___	___	___	___	___	___	___	___
___	___	___	______________________	___	___	___	___	___	___	___	___
___	___	___	______________________	___	___	___	___	___	___	___	___
___	___	___	______________________	___	___	___	___	___	___	___	___
___	___	___	______________________	___	___	___	___	___	___	___	___

DET = Number of Data Element Types in the Files, Interfaces.
RET = Number of Record types in the Files, Interfaces.
Add., Del., Chg. = Complexity of the Files, Interfaces added, deleted, changed.

Figure 9. FILES, INTERFACES, Function and Complexity Record Worksheet

4.4 DEVELOPMENT WORK-PRODUCT

Application: ____. Appl ID: _______.

Prepared by: ______________ __/__/__. Reviewed by: ______________ __/__/__.

Notes:

o **Added** Function Count:

Type ID	Description	Complexity			Total
		Simple	Average	Complex	
IT	External Input	___ x 3 = ___	___ x 4 = ___	___ x 6 = ___	_____
OT	External Output	___ x 4 = ___	___ x 5 = ___	___ x 7 = ___	_____
FT	Logical Internal File	___ x 7 = ___	___ x10 = ___	___ x15 = ___	_____
EI	Ext Interface File	___ x 5 = ___	___ x 7 = ___	___ x10 = ___	_____
QT	External Inquiry	___ x 3 = ___	___ x 4 = ___	___ x 6 = ___	_____
Add	Total New or Added Unadjusted Function Points				_____

o **Changed "Evaluated After"** Function Count:

IT	External Input	___ x 3 = ___	___ x 4 = ___	___ x 6 = ___	_____
OT	External Output	___ x 4 = ___	___ x 5 = ___	___ x 7 = ___	_____
FT	Logical Internal File	___ x 7 = ___	___ x10 = ___	___ x15 = ___	_____
EI	Ext Interface File	___ x 5 = ___	___ x 7 = ___	___ x10 = ___	_____
QT	External Inquiry	___ x 3 = ___	___ x 4 = ___	___ x 6 = ___	_____
ChgA	Total Changed "After" Unadjusted Function Points				_____

o **Deleted** Function Count:

IT	External Input	___ x 3 = ___	___ x 4 = ___	___ x 6 = ___	_____
OT	External Output	___ x 4 = ___	___ x 5 = ___	___ x 7 = ___	_____
FT	Logical Internal File	___ x 7 = ___	___ x10 = ___	___ x15 = ___	_____
EI	Ext Interface File	___ x 5 = ___	___ x 7 = ___	___ x10 = ___	_____
QT	External Inquiry	___ x 3 = ___	___ x 4 = ___	___ x 6 = ___	_____
Del	Total Deleted Unadjusted Function Points				_____

DEV Development Work-Product FP Measure = (Add + ChgA)PCA + (Del)PCA = _____.

Figure 10. Development Work-Product Function Points Worksheet.

4.5 SUPPORT WORK-PRODUCT

Application: _____. Appl ID: _____.

Prepared by: _____ __/__/__. Reviewed by: _____ __/__/__.

o **Added** Function Count:

Type ID	Description	Complexity			Total
		Simple	Average	Complex	
IT	External Input	___ x 3 = ___	___ x 4 = ___	___ x 6 = ___	_____
OT	External Output	___ x 4 = ___	___ x 5 = ___	___ x 7 = ___	_____
FT	Logical Internal File	___ x 7 = ___	___ x10 = ___	___ x15 = ___	_____
EI	Ext Interface File	___ x 5 = ___	___ x 7 = ___	___ x10 = ___	_____
QT	External Inquiry	___ x 3 = ___	___ x 4 = ___	___ x 6 = ___	_____
Add	Total New or Added Unadjusted Function Points				_____

o **Changed "Evaluated After"** Function Count:

IT	External Input	___ x 3 = ___	___ x 4 = ___	___ x 6 = ___	_____
OT	External Output	___ x 4 = ___	___ x 5 = ___	___ x 7 = ___	_____
FT	Logical Internal File	___ x 7 = ___	___ x10 = ___	___ x15 = ___	_____
EI	Ext Interface File	___ x 5 = ___	___ x 7 = ___	___ x10 = ___	_____
QT	External Inquiry	___ x 3 = ___	___ x 4 = ___	___ x 6 = ___	_____
ChgA	Total Changed "After" Unadjusted Function Points				_____

o **Deleted** Function Count:

IT	External Input	___ x 3 = ___	___ x 4 = ___	___ x 6 = ___	_____
OT	External Output	___ x 4 = ___	___ x 5 = ___	___ x 7 = ___	_____
FT	Logical Internal File	___ x 7 = ___	___ x10 = ___	___ x15 = ___	_____
EI	Ext Interface File	___ x 5 = ___	___ x 7 = ___	___ x10 = ___	_____
QT	External Inquiry	___ x 3 = ___	___ x 4 = ___	___ x 6 = ___	_____
Del	Total Deleted Unadjusted Function Points				_____

o **Changed "Evaluated Before"** Function Count:

IT	External Input	___ x 3 = ___	___ x 4 = ___	___ x 6 = ___	_____
OT	External Output	___ x 4 = ___	___ x 5 = ___	___ x 7 = ___	_____
FT	Logical Internal File	___ x 7 = ___	___ x10 = ___	___ x15 = ___	_____
EI	Ext Interface File	___ x 5 = ___	___ x 7 = ___	___ x10 = ___	_____
QT	External Inquiry	___ x 3 = ___	___ x 4 = ___	___ x 6 = ___	_____
ChgB	Total Changed "Before" Unadjusted Function Points				_____

SPT Support Work-Product FP Measure = Orig FP + (Add + ChgA)PCA

- (Del + ChgB)PCA = _____.

Figure 11. Support Work-Product Function Points Worksheet.

4.6 DEVELOPMENT OR ENHANCEMENT WORK-EFFORT RECORD WORK-SHEET

Application: _____. Appl ID: _____.

Prepared by: _____ __/__/__. Reviewed by: _____ __/__/__.

Development or Enhancement Standard Tasks:	Work-Effort Record in Gross Work-Months - gwm			
	Initial Estimate gwm	Approved Changes gwm	Final Estimate gwm	Final Actual gwm
Project Management	_____	_____	_____	_____
Requirements	_____	_____	_____	_____
System Design	_____	_____	_____	_____
External Design	_____	_____	_____	_____
Internal Design	_____	_____	_____	_____
Program Development	_____	_____	_____	_____
Detail Design	_____	_____	_____	_____
Coding	_____	_____	_____	_____
Unit Test	_____	_____	_____	_____
Program Integration	_____	_____	_____	_____
System Test	_____	_____	_____	_____
User Documentation	_____	_____	_____	_____
User Education	_____	_____	_____	_____
File Conversion	_____	_____	_____	_____
STANDARD TASK TOTAL	_____	_____	_____	_____
Non-Standard Tasks:				
Studies	_____	_____	_____	_____
Package Modification	_____	_____	_____	_____
Other	_____	_____	_____	_____
NON-ST'D TASK TOTAL	_____	_____	_____	_____
DEVELOPMENT TOTAL	_____	_____	_____	_____

Net Work-Hours per Gross Work-Month _____ nwh

Figure 12. Development or Enhancement Work-Effort Record Worksheet.

4.7 SUPPORT WORK-EFFORT RECORD WORK-SHEET

Application: _____. Appl ID: _____.

Prepared by: _____ __/__/__. Reviewed by: _____ __/__/__.

Maintenance or Support Standard Tasks:	Annual Work-Effort Record in Gross Work-Hours - gwh			
	Initial Estimate gwh	Approved Changes gwh	Final Estimate gwh	Final Actual gwh
Application Support				
Problem Analysis				
Fixing				
SUPPORT TOTAL				

Application History:	Annual Support Record		
	Total Annual Enhancement Activity FP	Year-End Support Work-Product FP	Annual Support Work-Effort gwh
End-of-Development	//////////		//////////
Yr 1 _____			
Yr 2 _____			
Yr 3 _____			
Yr 4 _____			
Yr 5 _____			
Yr 6 _____			
Yr 7 _____			
Yr 8 _____			

Net Work-Hours per Gross Work-Month _____ nwh

Figure 13. Support Work-Effort Record Worksheet.

4.8 ATTRIBUTES RECORD WORK-SHEET

Application: _____. Appl ID: _____.

Prepared by: _____ __/__/__. Reviewed by: _____ __/__/__.

Notes:

Attribute Description	Applicability Level		
	Attr Matu	Team Matu	Attr Appl

Factors: (See Section 2.4.2).

Attr Matu = Maturity of the Attribute.
Team Matu = Maturity of the Team regarding the Attribute.
Attr Appl = Applicability of the Attribute to the Work-Effort.

Instructions: (See Section 2.4).

1. List the Attributes of the Project expected to have a significant effect on productivity.
2. Record the Applicability Level of each of the Factors using the definitions in Section 2.4.2. (**Low, Mod, High, or NA**).

Figure 14. Attributes Record Worksheet.

AD/M Maturity Grid

July 1, 1983

A. J. Albrecht

IBM Corporate Information Systems and Administration
AD/M Program
44 S. Broadway
White Plains, N.Y., 10601
CHQVM(CWM26)

Introduction:

Management is responsible for establishing the **purpose** of an operation, determining **measurable objectives**, and ensuring that the **necessary actions** are taken to achieve those objectives. This is as true for the AD/M (Application Development and Maintenance) operation as it is for other operations.

Management of the AD/M operation is sometimes erroneously viewed as being hard to define and measure. It is often seen as a "level-of-effort" operation rather than a planned operation with specific, expected, and measured objectives and results. The "folklore" sometimes assumes that if you assign enough "good" people to the AD/M task, you will have done all that is managerially possible toward achieving excellence in AD/M.

When we accept these views, we mislead ourselves about what might be done to improve the AD/M operation. AD/M management has become too important to leave to chance. Thus it is necessary that we have ways of portraying the character or level of maturity of our AD/M operations.

As a first step, an **AD/M Maturity Grid** has been developed.[1] It is designed to help determine where the AD/M operation (or site) stands. By selecting a varied set of participants for the grid evaluation, the results can portray the views of different **levels** of the AD/M organization or different **departments**; the perceptions of the **user** can also be contrasted to those of the AD/M organization. With such a portrayal, a manager can deduce the need for, determine the nature of, and initiate programs to take the site to maturity and excellence, **step-by-step**.

How It Works:

Along one dimension, the grid is divided into five levels of maturity. Along the other dimension, five categories and 25 subcategories of AD/M activities and considerations are listed. Using the description in each box, it is possible to identify where the operation is now, and to plan improvements to take the operation to the next level.

The **Summary Grid** shows the relationship among the grid scale, the grid levels, and some descriptive names for the grid levels. A general statement in each box of the summary grid shows the general relationship of the categories and the grid levels.

The scale between **0** and **5.0** provides a convenient description of the scale position of maturity. If the statements, about your unit, in a box are all **positive**, the grid position is at least the upper bound of the box. If the statements, about your unit, in a box are all **negative** the grid position is at most the lower bound of the box. Combinations of positive and negative statements, in a box, would give a grid position between the extremes just described. (For example, a scale position of **2.5** would indicate, that the site had complied with the statements in the boxes at levels 1 and 2, and half the statements in the box at level 3). With this scale, the scale position of each category can be determined by averaging the five related subcategories. The Overall Maturity Index can be determined by averaging the five categories.

---

[1] Similar to the Quality Management Grid in "Quality Is Free" by Philip B. Crosby.

The pages following the Summary Grid are the **AD/M Maturity Grid.** The definitions are keyed to the subcategories and a worksheet is provided as a convenient record of the evaluation.

Summary Grid

Scale: 0 — 1.0 — 2.0 — 3.0 — 4.0 — 5.0

LEVELS	1	2	3	4	5
CATEGORIES	UNCERTAINTY	AWAKENING	ENLIGHTENMENT	WISDOM	MATURITY
MANAGEMENT	NO CONSISTENCY	RECOGNIZE POSSIBILITIES NO ACTION COMMITTED	ACTIVE IMPROVEMENT PROGRAM	FULLY UNDERSTAND BENEFITS PERSONAL ACTION	EXCELLENCE IS AN INTEGRAL PART OF SITE OPERATION
RESOURCES	NO CONSISTENT MEASURES EXPENSE MAY BE TRACKED	RECOGNIZE NEED PRIMARILY CONTROL	BENEFIT AND COST USED FOR PLANNING	ALL ACTIVITY MEASURED	CONSISTENT MEAS/ANAL INTEGRAL TO SITE OPERATION
PROCESSES	NO CONSISTENCY EACH DOES OWN THING	RECOGNIZE POSSIBILITIES SOME USE	MAJOR EFFORTS FOLLOW SELECTED PROCESSES	BENEFIT OF DISCIPLINED PROCESSES WIDELY UNDERSTOOD	QUALITY, ON TIME, WITHIN BUDGET ARE ROUTINE
STANDARDS & GUIDELINES	DO NOT EXIST OR NOT USED	RECOGNIZE USEFULNESS BUT LEFT TO INDIVIDUAL PROJECTS	USED ON MAJOR EFFORTS	USED THROUGHOUT REGULAR FEEDBACK TO KEEP CURRENT AND USEFUL	MANAGEMENT RESOURCES, PROCESSES, STANDARDS & GUIDE-LINES AND TOOLS & TECHNIQUES
TOOLS & TECHNIQUES	SPORADIC USE RESULTS NOT UNDERSTOOD	RECOGNIZE USEFULNESS OF COORDINATION SHORT TERM EFFORTS TRIED	GROWING COORDINATED SET IN PLACE	ROUTINE USAGE OF WELL SELECTED TOOLS AND TECHNIQUES	ALL INTEGRATED

AD/M MATURITY GRID

07-01-83

Worksheet: Site:_____ Date:_____

0 1.0 2.0 3.0 4.0 5.0

Overall Index _____

Management

- Businesslike Mgmt of AD/M
- AD/M Improvement
- Exec/User/I/S Mgmt Involve'
- Business Case
- Application Backlog

Resources

- Effort Tracking
- Accomplishment Tracking
- Productivity Measurement
- Estimating
- Job Satisfaction

Processes

- Fundamental Approaches
- Project Management
- AD/M Methodologies
- AD/M Architecture
- Objective Outside Review

Stds & Guide'

- Management
- Resources
- Processes
- Standards & Guidelines
- Tools & Techniques

Tools & Tech'

- Management
- Resources
- Processes
- Standards & Guidelines
- Tools & Techniques

Category: **Management**

The **management** category relates to the overall **businesslike management** of AD/M resources, projects, and activities. A key concept is the prediction and measurement of benefits on an equal basis with quality, costs, and schedules. This enables objective identification, prioritization, and selection of the applications to be developed, enhanced and supported. Another key concept is the need for **active** involvement of User (Functional), I/S (Data Processing), and Executive (Both) **management** with defined responsibilities; Executive and User management being responsible for the overall direction setting, business function, benefits, and affordability, and I/S management being responsible for the technical feasibility and the management of the development and maintenance activities.

AD/M Improvement is included as a management responsibility to continually evaluate and improve the excellence of the organization.

Consider whether User and I/S management are sensitive to the other's **problems**, and understand the other's **capabilities**. Consider the attention given to: the **long range** structure and responsibilities of I/S and the User, **new approaches** to delivering I/S Services (such as,information center concepts), **new opportunities** (such as, office automation), and the need for continuing **cross-education** between the User and I/S.

AD/M MATURITY GRID

07-01-83

Category: **Management**

Subcategory: **Businesslike Management of AD/M** covers the site management considerations and actions to balance business **needs, priorities,** and **affordability** to have AD/M do the **right things** as **efficiently** as possible.

Grid Level Descriptions:

0

No effective businesslike **management** of AD/M. Executive and User management do not understand or manage, their AD/M resources, and development and support opportunities.

1

User, Executive, and I/S managers begin to **recognize the need** for businesslike management of AD/M; that is, the need to understand and manage resources, costs, and benefits. They begin meaningful dialogs to that end.

2

Formal written commitments and guidelines are provided for businesslike management of AD/M. Benefit value and resources are determined and managed for major AD/M projects. User, Executive, and I/S management commitment is reflected in their **actions**.

3

Businesslike management of AD/M is **consistent and routine** in the organization. Delegation within levels of User, Executive, and I/S management maintains perspective and balance between control, cost, and responsiveness for all AD/M projects.

4

A consistent and routine plan and strategy, based on value-justified AD/M projects provides a strong base for businesslike management of AD/M. Objectives and **measured results** for both benefit value and cost are used to guide decisions to initiate or change all AD/M projects.

5

Note: **For grid position determination see last paragraph page 2:**

Category: **Management**

Subcategory: **AD/M Improvement** considers **organized** and **stable** ways to introduce **effective changes** into the AD/M function.

Grid Level Descriptions:

0

Problems are fought **only** as they become **unavoidable.** Characteristics might be: inadequate definition; lots of yelling and accusations; no organized activities; no resolution; waiting for problems to go away.

1

Teams are set up to attack major problems, but **root causes** are **not recognized.** Symptoms are treated as problems. Obvious "motivational" short range efforts are tried instead of long range solutions.

2

Major problems are faced openly and resolved in an orderly way. Special efforts to **find root causes.** Implementation of an AD/M improvement program as an excellence program begins.

3

Problems and opportunities are identified early. All functions are open to suggestion and improvement. An effective AD/M improvement program is an **integral part** of the operation.

4

AD/M improvement and excellence is a **normal** and **continuing** activity. All trends are moving in the right directions. Special corrective measures no longer necessary because feedback and correction occur as a routine function of management reporting.

5

Note: **For grid position determination see last paragraph page 2:**

Category: **Management**

Subcategory: **Exec/User/I/S Management Involvement** covers the need for Executive, User, and I/S management to understand the **needs** and **priorities** of the **business** and the **capabilities** and **accomplishments** of **AD/M** and direct AD/M effectively.

Grid Level Descriptions:

0

User and Executive management are, either, **uncertain** about the capability and accomplishments of AD/M, or are convinced that AD/M is not performing to its potential. Neither of these feelings are based on objective measurements.

1

User, Executive, and I/S management **recognize** the potential of an effective AD/M process to improve AD/M effectiveness. They further recognize the potential of an effective AD/M organization to help improve their business.

2

User, Executive, and I/S management have an objective perspective of the value and potential of AD/M to their operation and the company, based on measured results. They **participate** in reviews and decisions on major projects.

3

User, Executive, and I/S management understand, accept, and perform their responsibilities relative to AD/M. They are **involved** in business cases, project objectives, project results, success trends, and productivity trends.

4

User, Executive, and I/S management have an **excellent perspective** of the value of AD/M. They regularly receive (and give) executive level reports on the current status and trends in value and success of AD/M.

5

Note: **For grid position determination see last paragraph page 2:**

Category: **Management**

Subcategory: **Business Cases** provide for systematic consideration of the **benefits, costs, affordability** and **priority** of alternatives when deciding on initiation or change of an AD/M activity.

Grid Level Descriptions:

0

Business cases are **not consistent**ly used to justify and prioritize projects. Most AD/M projects are claimed to be mandatory, and no consistent attempt is made to put a value on the expected benefits. Priorities may shift frequently and unpredictably.

1

Recognition that business cases can be valuable in guiding decisions and setting priorities. Some guidance to develop business cases has been documented and provided.

2

For major projects, business cases are **required** and used to justify and prioritize AD/M efforts. Benefits are beginning to be measured, just like costs and schedules. Priority setting and business case guidance has been documented and provided for projects of all sizes.

3

Business cases are **consistently used** to guide all application development priorities and AD/M plans. Benefits are consistently measured on all AD/M projects.

4

The value of AD/M is measured and demonstrated as a **regular part** of AD/M business management. The measured benefits are used to feed back results to improve future business cases as in the case of cost and schedule estimating.

5

Note: **For grid position determination see last paragraph page 2:**

Category: **Management**

Subcategory: **Application Backlog - a prioritized list** of **applications** under development and to be done, that provides an **organized** and **complete** base for planning.

Grid Level Descriptions:

0

No formal application backlog **management** to identify, study, plan, prioritize, and schedule future applications to be developed or enhanced. There may be no identifiable application backlog.

1

Recognition that collecting and organizing application backlog information is necessary.

2

Listing, prioritizing and maintaining the application backlog based on benefit, cost, and affordability is **done for major projects.**

3

All AD/M projects **are prioritized** in the application backlog based on benefit, cost, and affordability. The selected projects have been studied and are "ready to start" as current projects are completed.

4

The application backlog is a **consistently used** management tool so that benefit, cost, priority, and affordability decisions can be made with stability. AD/M people look forward with confidence to starting their next project as planned.

5

Note: **For grid position determination see last paragraph page 2:**

Category: **Resources**

The **Resources** category relates to the management of AD/M resources with full emphasis on the **people** resource and functional **excellence. Work-effort** tracking and **accomplishment** tracking are covered as two separate concepts, both of which must be understood to provide the full status of a project or activity. Combining the data of work-effort tracking and accomplishment tracking also is the key to rational **estimating** and productivity **measurement.** But, the key concept to management of AD/M resources is professional **job satisfaction.** Job satisfaction tests the balance between reasonable challenge and undue pressure. It is the key differentiator between **"working smarter"** and **only "working harder".**

AD/M MATURITY GRID

07-01-83

Category: **Resources**

Subcategory: **Effort Tracking** - an accurate and appropriately detailed **record** of where **work-effort** has been **used**, to provide a base for **productivity** and **quality** measurement and **estimating**.

Grid Level Descriptions:

0	**No consistent** knowledge of where work-effort is being used (which tasks). Work-effort may be tracked by headcount only.
1	**Recognize need** for tracking work-effort on projects (development and period support), tasks, and phases. Require work-effort tracking on major projects. Initial measurement and data gathering system in place.
2	Major projects **track work-effort** by task and phase. Improved knowledge of the work-effort applied to specific tasks allows effort to be better directed.
3	Much of AD/M work-effort is used in controlled projects and period support with documented objectives and records of results. New development and enhancement is clearly differentiated from support and fixing. Work-effort information is **consistently used** to plan new efforts, and understand "cost of quality" (e.g., prevention, testing, and rework).
4	Virtually all AD/M effort is spent on development and period support projects. Management knows specifically where all work-effort is being used. Work-effort information is used as a **natural management tool** in preparing/changing AD/M plans and demonstrating AD/M trends.
5	

Note: **For grid position determination see last paragraph page 2:**

07-01-83

Category: **Resources**

Subcategory: **Accomplishment Tracking** - an accurate and appropriately detailed **record** of the **completion** of **tasks** and objectives, to provide a base for productivity measurement and estimating.

Grid Level Descriptions:

0	Consistent, quantitative **measures** of technical progress are **lacking** or are ineffective, leading to unacceptable surprises at the expected completion or major milestones of projects and assignments.
1	**Recognize need** for planning and tracking capability for tasks, assignments, and projects. Task planning and tracking procedure is selected and provided for major projects. Its use is still inconsistent and does not cover all projects.
2	Major projects **plan, track**, and **report technical status** by tasks planned and tasks completed. Deviations from plan are used to recognize, diagnose, and fix problems.
3	For most tasks, assignments, and projects, **quantitative tracking results** are used to develop and update estimating guidance. Most projects and period support activities track and report project status by tasks, and use measured deviations from plan to detect, diagnose, and fix problems.
4	Task tracking information is used as a **natural management tool** in preparing/changing/achieving AD/M plans and demonstrating AD/M trends at all levels and throughout the whole AD/M organization.
5	

Note: **For grid position determination see last paragraph page 2:**

Category: **Resources**

Subcategory: **Productivity Measurement** - a **relative** measurement that relates the **work** completed to the resource or **effort** expended, used to **improve** the AD/M function, to **estimate** future work more accurately, and to **measure** the effects of specific programs, such as, "quality improvement".

Grid Level Descriptions:

0

No consistent measurement and analysis of the productivity of AD/M people. Definitions of work-product output and cost are lacking or are inconsistent.

1

Recognize need for measurement and analysis of productivity in AD/M. Initial definitions of work-product output and effort are established. Definitions tend to relate to current technology, language, and techniques, limiting long-term applicability.

2

Major **projects are measured** and results are used to determine initial productivity trends. Recognize weakness of work-product output definitions limited to current technologies or techniques. A more functional approach is adopted (e.g., function points, or some equally effective approach).

3

Productivity **trends can be demonstrated** by quantitative functional measurements. Positive influences can be identified and encouraged; negative influences can be identified and avoided.

4

Productivity measurement and analysis is **routinely used** to: demonstrate progress; identify factors to encourage/avoid; select technologies, techniques, and approaches; provide estimating and validating guidance; and justify business cases. Trend is positive. Site is recognized as a leader in new techniques.

5

Note: **For grid position determination see last paragraph page 2:**

Category: **Resources**

Subcategory: **Estimating - analysis and planning** that relates productivity **measurement** and **plans** to **predict** the **resources and schedule** required to accomplish an objective, on time, within budget, and meeting requirements.

Grid Level Descriptions:

0

Work may be started without estimates, or no estimates may ever be provided. Where provided, estimates may be based only on personal experience. Criteria and guidelines for estimating are **inconsistent** or **don't exist.**

1

Recognized need for estimating guidance distilled from the experience of successful estimators and project managers. Development of estimating documentation and guidelines started, including: objectives, plans, changes, tracking, tasks, results, feedback and, models.

2

Major projects have a rational validated estimate, project plan, and change control. The outcome is analyzed and the deviations from the estimate are determined and **analyzed consistently.**

3

Most projects are consistently being completed within **10%** of the initial estimate plus approved changes, and **measured results** prove it. Results from completed projects are consistently used to update estimating guidance. The guidance is distributed to everyone in the AD/M organization.

4

All projects are consistently within **10%** of the original estimate plus approved changes. A broad spectrum of estimating and validating guidance, based on completed projects, is **regularly provided** for all levels in the organization (department, function, site).

5

Note: **For grid position determination see last paragraph page 2:**

Category: **Resources**

Subcategory: **Job Satisfaction** - a **relative measure** that can demonstrate the trend in **professional satisfaction** of AD/M people with **their** job.

Grid Level Descriptions:

0

Little, or no, attention is paid to job satisfaction trends. The job satisfaction section of the Employee Opinion Survey may be discussed in department feedback meetings, but there are few systematic attempts by management to analyze the trends and relate them to improvements, or need for improvements, in the AD/M processes.

1

Trends in the job satisfaction section of the Employee Opinion Survey, for example, **begin** to be systematically analyzed by management, to establish the correlation between job satisfaction and improvement, or need for improvement, in the AD/M processes.

2

Trends in job satisfaction **can be correlated** by management with the demonstrated needs and accomplishments of the AD/M organization. Positive factors are encouraged. Negative factors are fixed.

3

Trends in job satisfaction are **regularly analyzed** and used by management to improve the AD/M processes, as naturally as other measures of accomplishment are used.

4

Morale is consistently excellent. Feeling of confidence, professionalism, excellence, accomplishment, and job satisfaction are **all at high levels**.

5

Note: **For grid position determination see last paragraph page 2:**

Category: **Processes**

The **Processes** category relates to the management of the processes by which the **AD/M work is accomplished.** Key concepts are: the **Fundamental Approach** of a structured management process continuously improved by analysis of data fed back from previously completed projects and efforts; and management of AD/M efforts by **Project Management** with specific objectives, controls, and expected results. Direct delivery of data and function to the user by information center concepts, and broader reuse of "available code" are emphasized as growing alternatives to new development in **AD/M methodologies.** Development center concepts and **AD/M Architecture** provide a more effective way to accomplish new development. Risk Assessment and Independent Review explore the value of **Objective Outside Review** as a help to the project team and user in successfully completing their assigned projects.

AD/M MATURITY GRID

07-01-83

Category: **Processes**

Subcategory: **Fundamental Approaches** - the **structured** management **processes** used to accomplish the AD/M function.

Grid Level Descriptions:

0

No step-by-approved-step **AD/M process** is documented, consistently followed, or encouraged. Individual managers follow individual processes. Lack of consistency causes most efforts to be treated as unique happenings. Quality is addressed by rework after installation.

1

Recognize need for a documented AD/M process. A rudimentary process is applied to general phases but there are no consistent, agreed-to definitions of each phase, activity, or management procedure to be used. Control of quality is achieved by testing at the end of the process. Mostly applied to major projects.

2

A step-by-approved-step AD/M process is selected, documented and **installed.** It is based on: user and AD/M understanding; planning, tracking, and reporting to results based on meeting commitments: schedule, cost, and specifications (quality). Control of quality achieved by preventive measures, such as, inspections or walkthroughs.

3

AD/M and user people **see the value** to their organizations in the documented AD/M process, and use it effectively to solve problems, get and hold agreement, and complete AD/M efforts successfully. The process is designed to provide guidance for efforts varying in size, scope, and type of activity. AD/M management consistently balances the trade-offs between prevention, testing and rework.

4

All AD/M efforts follow the AD/M process keyed to continued AD/M and user involvement based on agreement, change control, and review and approval until the effort meets commitments or the commitments are changed. The AD/M process is updated regularly keeping it **current with the best** project experience.

5

Note: **For grid position determination see last paragraph page 2:**

AD/M MATURITY GRID

07-01-83

Category: **Processes**

Subcategory: **Project Management-** accomplishing the AD/M function by **organizing work into projects,** and **period support,** with **objectives, plans,** and **criteria** for judging **completion.**

Grid Level Descriptions:

0

AD/M work is **not consistently** managed as projects, or period support. A majority of it is managed as activity oriented support with undefined completion criteria. Managers receive no consistent training as managers of projects.

1

User, Executive, and I/S management **recognize** that **the need** to set and achieve specification, cost, schedule, and benefit objectives in their business requires an organized approach to manage AD/M.

2

Specific appropriate training in managing projects is given to all AD/M managers and affected users and executives. Documented objectives approved by User, Executive, and I/S management are **required** for major AD/M efforts. Most correction and enhancement activity is organized into releases.

3

The majority of AD/M work efforts are managed as projects or period support. Feedback from completed projects is consistently applied to improvement of the project management guidance and training. User, Executive, and I/S management **understand the value** of the approach. Predictability of results (cost, schedule, meets specs) is improving.

4

All AD/M efforts can be traced to an authorization, which covers specification, cost, schedule, and benefits. Delegation of the authorization authority keeps control, cost, and responsiveness in balance. **Predictability** of results is **high**.

5

Note: **For grid position determination see last paragraph page 2:**

AD/M MATURITY GRID

07-01-83

Category: **Processes**

Subcategory: **AD/M Methodologies** - the **alternative** technical approaches for delivering applications more effectively, such as, **information center concepts**, use of **available code**, new development with a **development center concepts**.

Grid Level Descriptions:

0

The AD/M technical approaches are **inconsistent** from project-to-project, and depend on the fortuitous skills and experience of the individual teams.

1

Recognized need for consistent methodologies, such as: standard design, development, implementation, and support tasks, inspections and walkthroughs, and use of standard software products. Consistent methodologies begin to be used to produce applications of more consistent quality.

2

Consistent methodologies are used on major projects. Information center concepts begin to be used to deliver data more directly to the user. Designers begin to seek out and use available code. Development center concepts beginning to provide more productive environment for AD/M professionals.

3

Consistent methodologies are used on all projects. Designers consistently seek to deliver more function directly to user through information center concepts. Standard operations environments and consistent methodologies are used to promote more development and use of available code. Development center concepts in full operation with education, hardware, and people.

4

Each application development project is **consistently** viewed and managed as a potential combination of: Information center concepts **(help)**; use of available code **(buy)**; new development with consistent methodologies using development center concepts **(make)**.

5

Note: **For grid position determination see last paragraph page 2:**

Category: **Processes**

Subcategory: **AD/M Architecture** - the **long range** view of application **architecture, data** as a valuable **asset**, and **consideration** of data **and** processing.

Grid Level Descriptions:

0

No consistent consideration, of the architectural structure, of the applications under development. Applications tend to be one-of-a-kind with no consistent thought for long life and more general use.

1

Recognize need for structure to provide greater potential for general use, and higher probability of longer useful life. Structured design, structured programming and data base design are initially emphasized.

2

Consistent view of application architecture begins to be applied to major projects. Consideration of data and processing is seen as a way to provide longer useful life and more general usefulness of applications.

3

Data administered as a resource, is considered key to more general usefulness and long life for all applications. **Consistent long range view** of application architecture forms strong base for all applications.

4

AD/M methodologies and AD/M architecture are **fully integrated** to provide the most effective solutions to site application needs. New applications are consistently developed with a long range view to achieve more general use and long life.

5

Note: **For grid position determination see last paragraph page 2:**

Category: **Processes**

Subcategory: **Objective Outside Review** - covers the **review** provided by **systems assurance, independent review,** and **structured risk assessment.**

Grid Level Descriptions:

0

No consistent systems assurance, independent review, or risk assessment is performed on projects or period support activities. Project team members fear reviews. They see them as disruptive and at worst destructive.

1

AD/M management **recognizes** that regular and routine systems assurance, independent review, and risk assessment, are an opportunity to help the users and project teams achieve their goals. Outside reviews and risk assessments begin to be applied to major projects.

2

Risk assessment guidance is provided appropriate to projects of all sizes. Reviewers are specifically assigned and are trained in review techniques. Outside reviews and risk assessments are **consistent**ly done for major projects.

3

The project teams, users, and site management view outside review and risk assessment as **very helpful**. They begin to use review and risk assessment as tools to improve their projects and the site guidelines and standards.

4

Outside reviews and risk assessments are a **natural, expected activity** on all projects. Results are used to: improve projects; improve knowledge between projects; and improve the guidance provided in site standards and guidelines.

5

Note: **For grid position determination see last paragraph page 2:**

Category: **Standards and Guidelines**

The **standards and guidelines** category relates to the **existence, coverage, use** and **quality** of the written standards and guidelines for the AD/M function. Unlike the previous categories, the maturity level **definitions are the same** for each **subcategory** in the standards and guidelines category. Each subcategory covers a different **subject area,** and the maturity level of the standards and guidelines for that subject area are evaluated. The subject areas are: **management, resources, processes, standards and guidelines,** and **tools and techniques.** These are the same subject areas with the same definitions as the categories in the Maturity Grid.

Consider how well the standards and guidelines **cover** the **needed standard** approaches, while **allowing** the use of **more effective** approaches. Consider how quickly and effectively the **better ways** are **encouraged, identified, and incorporated** in the guidelines. Consider whether the standards and guidelines are a **real asset** to training new people, and accomplishing the objectives of the site.

Category: **Standards and Guidelines**

Subcategory: **Management** - covers the standards and guidelines for the **businesslike management of the AD/M function.**

Grid Level Descriptions:

0

Standards and guidelines, for AD/M management, either **don't exist** or are **little used** because they are inflexible and not related to the real needs of the organization. They are generally seen as adding work without providing value.

1

Recognize that standards and guidelines, for AD/M management, must be developed to solve real organization **needs** They must solve real problems and must be flexible enough to cover all projects and period support activities, and support new approaches and technologies. Development is begun but it may be spotty and uncoordinated.

2

Standards and guidelines, for AD/M management, exist. They are **used effectively** on major projects. Management's review, approval, and actions support and reinforce their use.

3

Routine review, evaluation, and update of the standards and guidelines for AD/M management, **keeps them current** with the objectives of the organization and the most successful practices demonstrated. All projects and period support activities are covered.

4

Standards and guidelines, for AD/M management, are **completely integrated** with the AD/M processes, tools, and techniques. The management processes develop the standards and guidelines; the standards and guidelines guide the development or selection of the tools and techniques; and the use of the tools and techniques accomplish the processes.

5

Note: **For grid position determination see last paragraph page 2:**

Category: **Standards and Guidelines**

Subcategory: **Resources** - covers the standards and guidelines for the **management** of **AD/M resources** with emphasis on the **people** resource.

Grid Level Descriptions:

0

Standards and guidelines, for AD/M resource management, either **don't exist** or are **little used** because they are inflexible and not related to the real needs of the organization. They are generally seen as adding work without providing value.

1

Recognize that standards and guidelines, for AD/M resource management, must be developed to solve real organization **needs.** They must solve real problems and must be flexible enough to cover all projects and period support activities, and support new approaches and technologies. Development is begun but it may be spotty and uncoordinated.

2

Standards and guidelines, for AD/M resource management, exist. They are **used effectively** on major projects. Management's review, approval, and actions support and reinforce their use.

3

Routine review, evaluation, and update of the standards and guidelines, for AD/M resource management, **keeps them current** with the objectives of the organization and the most successful practices demonstrated. All projects and period support activities are covered.

4

Standards and guidelines, for AD/M resource management, are **completely integrated** with the AD/M processes, tools, and techniques. The management processes develop the standards and guidelines; the standards and guidelines guide the development or selection of the tools and techniques; and the use of the tools and techniques accomplish the processes.

5

Note: **For grid position determination see last paragraph page 2:**

Category: **Standards and Guidelines**

Subcategory: **Processes** - covers the standards and guidelines for the **management** of the **processes** by which **AD/M work** is accomplished.

Grid Level Descriptions:

0

Standards and guidelines, for AD/M processes, either **don't exist** or are **little used** because they are inflexible and not related to the real needs of the organization. They are generally seen as adding work without providing value.

1

Recognize that standards and guidelines, for AD/M processes, must be developed to solve real organization **needs.** They must solve real problems and must be flexible enough to cover all projects and period support activities, and support new approaches and technologies. Development is begun but it may be spotty and uncoordinated.

2

Standards and guidelines, for AD/M processes, exist. They are **used effectively** on major projects. Management's review, approval, and actions support and reinforce their use.

3

Routine review, evaluation, and update of the standards and guidelines, for AD/M processes, **keeps them current** with the objectives of the organization and the most successful practices demonstrated. All projects and period support activities are covered.

4

Standards and guidelines, for AD/M processes, are **completely integrated** with the AD/M processes, tools, and techniques. The management processes develop the standards and guidelines; the standards and guidelines guide the development or selection of the tools and techniques; and the use of the tools and techniques accomplish the processes.

5

Note: **For grid position determination see last paragraph page 2:**

Category: **Standards and Guidelines**

Subcategory: **Standards and Guidelines** - covers the **overall architecture** and **plan** for the **development, installation, use, and update** of **AD/M standards and guidelines.**

Grid Level Descriptions:

0

Overall architecture and plans, for AD/M standards and guidelines, either **don't exist** or are **little used** because they are inflexible and not related to the real needs of the organization. They are generally seen as adding work without providing value.

1

Recognize that overall architecture and plans, for AD/M standards and guidelines, must be developed to solve real organization **needs.** They must solve real problems and must be flexible enough to cover all projects and period support activities, and support new approaches and technologies. Development is begun but it may be spotty and uncoordinated.

2

Overall architecture and plans, for AD/M standards and guidelines, exist. They are **used effectively** on major projects. Management's review, approval, and actions support and reinforce their use.

3

Routine review, evaluation, and update of the overall architecture and plans, for AD/M standards and guidelines, **keeps them current** with the objectives of the organization and the most successful practices demonstrated. All projects and period support activities are covered.

4

Overall architecture and plans, for AD/M standards and guidelines, are **completely integrated** with the AD/M processes, tools, and techniques. The management processes develop the standards and guidelines; the standards and guidelines guide the development or selection of the tools and techniques; and the use of the tools and techniques accomplish the processes.

5

Note: **For grid position determination see last paragraph page 2:**

Category: **Standards and Guidelines**

Subcategory: **Tools and Techniques** - covers the standards and guidelines for the **identification, evaluation, selection, installation, and use of AD/M tools and techniques.**

Grid Level Descriptions:

0

Standards and guidelines, for AD/M tools and techniques, either **don't exist** or are **little used** because they are inflexible and not related to the real needs of the organization. They are generally seen as adding work without providing value.

1

Recognize that standards and guidelines, for AD/M tools and techniques, must be developed to solve real organization **needs.** They must solve real problems and must be flexible enough to cover all projects and period support activities, and support new approaches and technologies. Development is begun but it may be spotty and uncoordinated.

2

Standards and guidelines, for AD/M tools and techniques, exist. They are **used effectively** on major projects. Management's review, approval, and actions support and reinforce their use.

3

Routine review, evaluation, and update of the standards and guidelines, for AD/M tools and techniques, **keeps them current** with the objectives of the organization and the most successful practices demonstrated. All projects and period support activities are covered.

4

Standards and guidelines, for AD/M tools and techniques, are **completely integrated** with the AD/M processes, tools, and techniques. The management processes develop the standards and guidelines; the standards and guidelines guide the development or selection of the tools and techniques; and the use of the tools and techniques accomplish the processes.

5

Note: **For grid position determination see last paragraph page 2:**

Category: **Tools and Techniques**

The **tools and techniques** category relates to the **existence, coverage,** and **quality** of installed and used tools and techniques for the **AD/M function.** Like the standards and guidelines category, the maturity level **definitions are the same** for each **subcategory** in the tools and techniques category. Each subcategory covers a different **subject area,** and the maturity level of the tools and techniques for that subject area are evaluated. The subject areas are: **management, resources, processes, standards and guidelines,** and **tools and techniques.** These are the same subject areas with the same definitions as the categories covered in the Maturity Grid.

Consider how effectively the site **evaluates** available **tools and techniques** against the needs of the site. Consider how effectively the site **identifies and analyzes** the unfilled **needs,** to state and solve new requirements. Relative to the **general existence** of useful tools and techniques, for each subject area, consider how well those actually installed and used **meet the needs** of the site.

Category: **Tools and Techniques**

Subcategory: **Management** - covers the tools and techniques for the **businesslike management of the AD/M function.**

Grid Level Descriptions:

0

No consistent understanding of where tools and techniques, for AD/M management, are needed or available. If used, they are applied sporadically, with unknown results.

1

Knowledge and analysis of both the effort and the outcome of fundamental AD/M tasks, shows where tools and techniques, for AD/M management, can be most effective. **Recognize need** for consistent effort to identify, use, and measure effectiveness of tools and techniques. Measurements may be subjective and isolated.

2

Growing set of AD/M tools and techniques, for AD/M management, are used on major projects. Needed improvements are identified, developed, and installed, for future projects. There is a specific search for tools and techniques to fill gaps. The information center and development center concepts begin to focus attention on the integration and use of tools and techniques.

3

The coverage of AD/M tools and techniques, for AD/M management, is expanded to all projects and period support. Objective measurement and analysis of results provides for **easy and natural selection** of the best AD/M tools and techniques. Information center and development center concepts provide a broad complement of useful, integrated tools.

4

AD/M tools and techniques, for AD/M management, are **integrated completely.** The processes and standards and guidelines are applied almost automatically through use of the tools and techniques. The feedback on completed projects operates to improve the tools and techniques, as it does the processes, standards, and guidelines.

5

Note: **For grid position determination see last paragraph page 2:**

Category: **Tools and Techniques**

Subcategory: **Resources** - covers the tools and techniques for the **management of AD/M resources** with emphasis on the **people** resource.

Grid Level Descriptions:

0

No consistent understanding of where tools and techniques, for AD/M resource management, are needed or available. If used, they are applied sporadically, with unknown results.

1

Knowledge and analysis of both the effort and the outcome of fundamental AD/M tasks, shows where tools and techniques, for AD/M resource management, can be most effective. **Recognize need** for consistent effort to identify, use, and measure effectiveness of tools and techniques. Measurements may be subjective and isolated.

2

Growing set of AD/M tools and techniques, for AD/M resource management, are used on major projects. Needed improvements are identified, developed, and installed, for future projects. There is a specific search for tools and techniques to fill gaps. The development center and information center concepts begin to focus attention on the integration and use of tools and techniques.

3

The coverage of AD/M tools and techniques, for AD/M resource management, is expanded to all projects and period support. Objective measurement and analysis of results provides for **easy and natural selection** of the best AD/M tools and techniques. Development center and information center concepts provide a broad complement of useful, integrated tools.

4

AD/M tools and techniques, for AD/M resource management, are **integrated completely.** The processes and standards and guidelines are applied almost automatically through use of the tools and techniques. The feedback on completed projects operates to improve the tools and techniques, as it does the processes, standards, and guidelines.

5

Note: **For grid position determination see last paragraph page 2:**

AD/M MATURITY GRID

07-01-83

Category: **Tools and Techniques**

Subcategory: **Processes** - covers the tools and techniques for the **management** of the **processes** by which **AD/M work** is accomplished.

Grid Level Descriptions:

0

No consistent understanding of where tools and techniques, for AD/M processes, are needed or available. If used, they are applied sporadically, with unknown results.

1

Knowledge and analysis of both the effort and the outcome of fundamental AD/M tasks, shows where tools and techniques, for AD/M processes, can be most effective. **Recognize need** for consistent effort to identify, use, and measure effectiveness of tools and techniques. Measurements may be subjective and isolated.

2

Growing set of AD/M tools and techniques, for AD/M processes, are used on major projects. Needed improvements are identified, developed, and installed, for future projects. There is a specific search for tools and techniques to fill gaps. The development center and information center concepts begin to focus attention on the integration and use of tools and techniques.

3

The coverage of AD/M tools and techniques, for AD/M processes, is expanded to all projects and period support. Objective measurement and analysis of results provides for **easy and natural selection** of the best AD/M tools and techniques. Development center and information center concepts provide a broad complement of useful, integrated tools.

4

AD/M tools and techniques, for AD/M processes, are **integrated completely.** The processes and standards and guidelines are applied almost automatically through use of the tools and techniques. The feedback on completed projects operates to improve the tools and techniques, as it does the processes, standards, and guidelines.

5

Note: **For grid position determination see last paragraph page 2:**

AD/M MATURITY GRID

07-01-83

Category: **Tools and Techniques**

Subcategory: **Standards and Guidelines** - covers the tools and techniques for the **development, installation, use, and update** of **AD/M standards and guidelines.**

Grid Level Descriptions:

0

No consistent understanding of where tools and techniques, for AD/M standards and guidelines, are needed or available. If used, they are applied sporadically, with unknown results.

1

Knowledge and analysis of both the effort and the outcome of fundamental AD/M tasks, shows where tools and techniques, for AD/M standards and guidelines, can be most effective. **Recognize need** for consistent effort to identify, use, and measure effectiveness of tools and techniques. Measurements may be subjective and isolated.

2

Growing set of AD/M tools and techniques, for AD/M standards and guidelines, are used on major projects. Needed improvements are identified, developed, and installed, for future projects. There is a specific search for tools and techniques to fill gaps. The development center and information center concepts begin to focus attention on the integration and use of tools and techniques.

3

The coverage of AD/M tools and techniques, for AD/M standards and guidelines, is expanded to all projects and period support. Objective measurement and analysis of results provides for **easy and natural selection** of the best AD/M tools and techniques. Development center and information center concepts provide a broad complement of useful, integrated tools.

4

AD/M tools and techniques, for AD/M standards and guidelines, are **integrated completely.** The processes and standards and guidelines are applied almost automatically through use of the tools and techniques. The feedback on completed projects operates to improve the tools and techniques, as it does the processes, standards, and guidelines.

5

Note: **For grid position determination see last paragraph page 2:**

AD/M MATURITY GRID

07-01-83

Category: **Tools and Techniques**

Subcategory: **Tools and Techniques** - covers the **overall coordinating architecture** and **tools** for the identification, evaluation, selection, installation, and coordinated use of AD/M tools and techniques, such as the development center and information center concepts.

Grid Level Descriptions:

0

No consistent understanding of where overall coordinating architecture and tools, for AD/M tools and techniques, are needed or available. If used, they are applied sporadically, with unknown results.

1

Knowledge and analysis of both the effort and the outcome of fundamental AD/M tasks, shows where overall coordinating architecture and tools, for AD/M tools and techniques, can be most effective. **Recognize need** for consistent effort to identify, use, and measure effectiveness of tools and techniques. Measurements may be subjective and isolated.

2

Growing set of overall coordinating architecture and tools, for AD/M tools and techniques, are used on major projects. Needed improvements are identified, developed, and installed, for future projects. There is a specific search for tools and techniques to fill gaps. The development center and information center concepts begin to focus attention on the integration and use of tools and techniques.

3

The coverage of overall coordinating architecture and tools, for AD/M tools and techniques, is expanded to all projects and period support. Objective measurement and analysis of results provides for **easy and natural selection** of the best AD/M tools and techniques. Development center and information center concepts provide a broad complement of useful, integrated tools.

4

The overall coordinating architecture and tools, for AD/M tools and techniques, are **integrated completely**. The processes and standards and guidelines are applied almost automatically through use of the tools and techniques. The feedback on completed projects operates to improve the tools and techniques, as it does the processes, standards, and guidelines.

5

Note: **For grid position determination see last paragraph page 2:**

SESSION REPORT

SHARE

61	M802	Managing Understudies and Standins -- Experiences with Contractors and Consultants	75
SHARE NO.	SESSION NO.	SESSION TITLE	ATTENDANCE

Technical Support Management	Vicki Coronel	USF
PROJECT	SESSION CHAIRMAN	INST. CODE

U.S. Fidelity & Guaranty, 100 Light Street, Balto., MD 21202, 301-625-5528
SESSION CHAIRMAN'S COMPANY, ADDRESS, and PHONE NUMBER

ABSTRACT

As a result of the critical shortage of qualified systems programmers many installations have considered hiring contract systems programmers or consultants. Rich Schiesser of the Data Service Bureau for the City of Los Angeles and Charles Necker of the Bendix Corporation both have recent experience using systems programmer contractors and consultants. The following are copies of the talks given by both individuals describing these experiences.

EXPERIENCES WITH SYSTEMS PROGRAMMER CONTRACTORS & CONSULTANTS

Rich Schiesser (DSB)
Data Service Bureau
City of Los Angeles
200 North Main Street
Los Angeles, California 90012