FIPS PUB 49

FEDERAL INFORMATION
PROCESSING STANDARDS PUBLICATION

JANUARY/1974

1977 May 1

Guideline

ON
COMPUTER PERFORMANCE
MANAGEMENT:
AN INTRODUCTION

CATEGORY: ADP OPERATIONS
SUBCATEGORY: COMPUTER PERFORMANCE
MANAGEMENT

U.S. DEPARTMENT OF COMMERCE, Juanita M. Kreps, Secretary

NATIONAL BUREAU OF STANDARDS, Ernest Ambler, Acting Director

Foreword

The Federal Information Processing Standards Publication Series of the National Bureau of Standards is the official publication relating to standards adopted and promulgated under the provisions of Public Law 89-306 (Brooks Act) and under Part 6 of Title 15, Code of Federal Regulations. Under P.L. 89-306 the Secretary of Commerce has important responsibilities for improving the utilization and effectiveness of computer systems in the Federal Government. To carry out the Secretary's responsibilities, the NBS, through its Institute for Computer Sciences and Technology, provides leadership, technical guidance, and coordination of Government efforts in the development of technical guidelines and standards in these areas.

The complexity of managing today's ADP computer facility is compounded by the growing technological complexity and interaction of the resources being managed. This technological complexity demands that highly specialized tools and techniques be available to the ADP manager so that he may more effectively and efficiently manage his installation. The objective of a Computer Performance Management program is the application of this contemporary, specialized technology in support of good management. This document introduces the Federal ADP manager to Computer Performance Management and recommends the establishment of such a program at all Federal ADP facilities.

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RUTH M. DAVIS, *Director*
Institute for Computer Sciences
and Technology

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Abstract

A Computer Performance Management (CPM) program is any structured effort to measure and evaluate the performance of installed computer systems in support of established management goals and objectives. The purpose of this publication is to introduce the Federal ADP manager to the subject of CPM, to provide general assistance to Federal ADP managers in planning and organizing a CPM program, and to recommend the establishment of CPM programs at all Federal ADP facilities. Guidance is presented on the use of performance measures in four major areas of management responsibility. The role of the ADP manager and the expected resources required in instituting a CPM program are discussed.

Key words: Computer performance evaluation; computer performance management; Federal Information Processing Standards; performance measures.

Federal Information Processing Standards Publication 49

1977 May 1

Announcing the

GUIDELINE ON COMPUTER PERFORMANCE MANAGEMENT: AN INTRODUCTION

Name of Guideline. Guideline on Computer Performance Management: An Introduction

Category of Guideline. ADP Operations, Computer Performance Management

Explanation. This guideline provides general assistance to Federal ADP managers in planning and organizing a Computer Performance Management (CPM) program. The use of performance measures in four major areas of management responsibility is discussed. The role of the ADP manager and the expected resources required in instituting a CPM program are also presented.

Approving Authority. Department of Commerce, National Bureau of Standards (Institute for Computer Sciences and Technology).

Maintenance Agency. Department of Commerce, National Bureau of Standards (Institute for Computer Sciences and Technology).

Cross Index. None.

Applicability. This guideline is intended as a reference document of recommended practices for general use throughout the Federal Government in planning and organizing Computer Performance Management programs.

Implementation. Federal departments and agencies are responsible for issuing instructions for the use of this guideline by their operating units and for assuring that it is distributed or made available to appropriate organizations and individuals concerned. All comments and critiques are welcome and will be considered in future revisions. These should be addressed to the Systems and Software Division, Institute for Computer Sciences and Technology, National Bureau of Standards, Washington, D.C. 20234.

Qualifications. This guideline is based upon the judgment of a Task Group composed of members from the Federal Government, in addition to input received from other sources both within and without the Government.

This document is intended to serve as an introduction to Computer Performance Management. Because agencies have unique performance goals, no specific guidance can be prescribed as to recommended levels of "good" performance. As new insight into Computer Performance Management is gained, this guideline will be modified accordingly.

Where to Obtain Copies of the Guideline.

Copies of this publication are for sale by the National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia 22161. When ordering, refer to Federal Information Processing Standards Publication 49 (NBS-FIPS-PUB-49), title, and Accession Number. When microfiche is desired, this should be specified. Payment may be made by check, money order, or deposit account.

**Federal Information
Processing Standards Publication 49**

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Specification for

GUIDELINE ON COMPUTER PERFORMANCE MANAGEMENT:
AN INTRODUCTION

Contents

I. Introduction

The purpose of this Guideline is to introduce Federal ADP management to the concept of Computer Performance Management (CPM), and to recommend the establishment of a CPM program at all Federal ADP facilities. For purposes of this Guideline, an "ADP facility" will be understood to mean the complete set of resources dedicated to meeting an agency's requirements for automated information processing. "Management" of such a facility may either converge at a single point in the organizational hierarchy, or it may be divided among several collateral points of functional responsibility. A "CPM program" is any structured effort, in-house or otherwise, to measure and evaluate the performance of a computer facility in support of established management goals and objectives.

The complexity of modern computer systems requires that the ADP facility manager have at hand a wide range of information to fulfill his responsibilities effectively. These responsibilities range from satisfying the requirements of his users to notifying upper management of problems and status. Each area of responsibility calls for its own set of specific, quantitative and often technical information. The application of measurement techniques and evaluation methodologies to obtain this information is central to any CPM program.

This Guideline begins with an explanation of the relationship between CPM and the functional responsibilities of the ADP facility manager. Specific responsibilities to be considered include: (1) service to users; (2) management of resources; (3) communication with upper management; and (4) vendor relations. A number of recommendations are then made to assist the ADP manager in initiating a CPM program at his own facility.

II. CPM and Management Responsibilities

The problems and responsibilities that the ADP manager must face are similar to those encountered by managers in other functional areas. The goal of maximizing productivity at minimum cost applies to the ADP manager as well as to the manager of a manufacturing plant. His need for timely and accurate information with which to plan for future expansion is as acute as the needs of the inventory-control manager of a large department store. But while the growth of computer technology has helped to ease the burden and increase the effectiveness of managers in nearly every other aspect of agency operations, it has turned the ADP

facility manager's job into a sometimes overwhelming challenge. He may be charged with the responsibility for managing a multi-million dollar resource that operates at electronic speed on hundreds of independent problems at a time. Today's largest computers can process thousands of different jobs from as many different sources each day. Except for sporadic messages on the operator's console, and the visible movement of tapes, disks, and printers, most of what determines how well a computer system does its work is concealed within the circuitry of the hardware itself. It cannot be observed, measured or evaluated without the application of specialized technology. Yet many of the important decisions that a manager must make about the ADP resource depend upon a detailed and precise understanding of these invisible events and what they signify.

Consider a few of the decisions that the ADP facility manager faces nearly every day of his working life. Are user complaints about poor service justified? If so, what is the most economical and feasible way to remove or minimize the cause? If not, what kind of human factors may have led to user dissatisfaction and how should the facts about service levels be communicated to them? What kinds of economies or broad service improvements could be realized by minor modifications to user requirements? How are user requirements expected to change in the next one to five years, and with what effect on present resources? As for the facility itself, how many operator shifts are needed to handle the existing workload? How should the computer room be laid out to optimize operator efficiency? What kind of background should be required of support personnel, and what kind of training should they receive after they arrive? Is the amount of downtime the system suffers reasonable, given the state of contemporary hardware electronics and software engineering? Is the apparent slowdown in throughput at peak load hours acceptable to users? To management? Is there anything that can be done with the present configuration to enhance its performance at peak hours? If so, will the benefits justify the cost of the enhancement? If not, where is the bottleneck in the system and what is the most cost-effective way to alleviate it?

Questions like these could fill many pages. The point is that having reasoned, quantitative, well-documented answers to these questions largely determines the effectiveness with which a manager *manages* an ADP facility, instead of merely supervising it. Sometimes the answers may provide the Federal Government with substantial dollar savings, or significantly enhance an agency's ability to carry out its mission. The more immediate objective of CPM, however, is to regain control of a complex, costly and criti-

cal resource through a quantitative understanding of how that resource performs and of the alternatives that are available to make it perform more effectively and efficiently. In particular, the ADP manager must be effective and therefore well-informed in at least four major areas: (1) user requirements; (2) management of and planning for ADP resources; (3) communicating with upper management; and (4) vendor relations.

A. User Requirements

ADP management's greatest responsibility is to its users. They, after all, are the reason the ADP facility exists. Although specific user needs are often not clearly stated, several categories of user requirements do appear to be applicable across vendor lines and across ADP installations.

1. User Service

(a) Timeliness

Most ADP users have deadlines to meet, and rely on the computer to meet them. This is as true during the project development phase as in the production phase, and is often reflected in the user's need for rapid turnaround time. In order to fulfill his own responsibilities, the ADP manager must know first what these turnaround time requirements are, and, second, whether his center is meeting them. Surveying users may not be a practical approach to defining such requirements, and waiting for users to pound on the ADP manager's door is no solution to monitoring levels of service. A better approach would be to obtain detailed information for each job class (e.g., the number of jobs submitted, the percent of jobs meeting published turnaround times) from system accounting log files. This information is invaluable for resolving questions about batch job turnaround time, at least for the job's life in the system. If a critical delay is suspected *outside* the system, a time-stamping procedure may be instituted to record actual batch job submission and pick-up times, or other manual operations such as reading in cards, bursting output, etc.

Although degradation of turnaround time by a few seconds is not noticeable to the batch user, an equivalent delay in response time can be very irritating to the interactive user. The development of remote terminal emulators (RTE's) and of intelligent hardware monitors has made it possible to accurately measure interactive response time at a large number of terminals. From the manager's point of view, RTE-like monitors can provide him with an accurate record of user interactions, which tell him and his interactive users exactly what level of service they are actually receiving.

(b) Accessibility

The location and quantity of remote batch and interactive terminals can do much to affect a user's attitude toward an ADP center. If the user has difficulty in finding an unused terminal, he will have little regard for the ADP manager's desire to satisfy his immediate requirements. Measurement techniques can be used to record port numbers and sign-on ID's of every remote access to the center. This data can then be analyzed to provide a clear picture of terminal demand which may suggest a more balanced placement of available terminals.

(c) Reliability

A brief system crash may have little impact on the total turnaround time of a batch user's job, but it may be unnerving to an interactive user sitting at a terminal wondering when the system will come up again and how much of his work may have been lost in the process. Without sufficient information as to the frequency and duration of system crashes, the ADP manager has no real feel for the quality of service he is providing his users. Simple measures such as mean-time-between-failures (MTBF) and mean-time-to-repair (MTTR) can provide this information.

(d) Availability

System availability is usually defined as the percent of scheduled time during which the computer system is operational. There is another aspect of availability, however, which concerns the nature of scheduled time itself. For example, heavy user demand during weekend or after-hours periods may necessitate the assignment of additional personnel or even the establishment of an additional shift. Information concerning the magnitude and type of demands across several weeks can be used to determine the appropriate hours of scheduled time for each major subsystem.

2. User Support

Support functions such as training seminars, user consultation, manuals, and regular center news bulletins are perhaps the most elusive user requirements to determine and evaluate. However, analysis of the type and frequency of user errors, use of existing vendor products, and user inquiries to support personnel usually provides the ADP manager with enough information to make intelligent and timely training and staffing decisions. In addition, the diligent logging and analysis of user-reported problems and complaints may indicate possible system-wide hardware or software problems.

3. User Chargeback

Many facility managers have found that the key to quantifying and controlling user requirements is the introduction of a system for "charging" users on the basis of equipment or services they require. The "charges" may only be for accounting purposes and not involve an actual transfer of funds. A chargeback system must meet at least two minimal design criteria: (1) charges should have some clear-cut relationship to actual resource utilization which users can easily understand; (2) charges should be approximately repeatable for a given job operating on the same data on a given system. Once accountability for computer resource utilization is established, users are frequently encouraged to cut down on wasteful uses of computer time. Others may restructure their legitimate workload to minimize "costs," and if the charging formula has been carefully designed, the effect will be a reduction in user demand on critical system resources. In addition to modifying user behavior, a chargeback scheme facilitates user planning and budgeting for future computer service needs. This, in turn, helps the facility manager to forecast overall workload growth patterns and to anticipate the need for new equipment, space, personnel, or procedures.

Although resource utilization information on which to base user charges is often provided by vendor-supplied accounting logs, it may be necessary to supplement this data with "homebrew" modifications or additional system instrumentation. Such modifications are frequently motivated by a need for more accurate and repeatable job charges, or by the desire to have actual dollar costs printed at the end of each job. A particularly effective example of this latter service is the projected job charge that informs the user of what his charges would have been had he allocated only as many system resources as his job actually used.

B. Resource Management

The most obvious responsibility of the ADP facility manager is the direct control of resources (equipment, space, personnel, etc.) placed under his authority. He must continually balance his resource costs against the dynamic requirements of his users. Having established a charging algorithm upon which job billings are based, for example, the ADP manager may find over time that his costs increase to the point that they exceed revenues. This may be due to increased personnel costs, decreased demand, inflationary increases in the cost of equipment and supplies, or procurement of additional hardware or software.

For facilities with chargeback systems, one solution to increased costs is relatively straightforward: raise the price of ADP services. A more acceptable solution is to reduce costs of processing a given workload through the application of measurement techniques and the use of fairly simple time-motion studies. Elimination of underutilized peripheral equipment, reduction in overtime, and elimination of unneeded operator shifts are examples of direct cost savings resulting from computer performance evaluation efforts.

Resource management also involves planning for the future. This implies that the ADP manager must have detailed information concerning the current workload: its history of growth, its present resource demands, its likely growth in the future. Number of jobs completed per month, percent utilization of major system resources, hours of system availability are several measures applicable to this problem. Performance data is thus valuable not only for enhancing the present system, but also for constructing models of future resource requirements.

C. Communicating With Upper Management

The ADP manager has a responsibility to report to his upper management on the status, performance and requirements of his facility. His reports should include, at a minimum, summary information concerning the previously discussed areas of responsibility. Although the form of such reports is a matter of taste and a function of the reporting requirements of upper management, some general guidance can be given:

1. Status reports should be regular, concise, and preferably graphical in nature.
2. The amount of information reported should not exceed management requirements. "Too much, too often" is a problem common to many performance reporting schemes.
3. Information should be at a level of abstraction which upper management can easily digest and understand, but sufficient to support the decision-making process.
4. The reports should compare the center's current level of performance against a set of predefined performance goals.

Performance measures are thus not only a basis for satisfying the informational needs of the ADP manager, but also an effective means of communication between different levels of management responsibility within the organization.

D. Vendor Relations

Most ADP managers interface regularly with vendor marketing and technical support personnel. The relationship with technical personnel becomes especially important in the areas of hardware and software reliability and mainte-

nance. A joint review of hardware and software performance data on a regular basis by ADP personnel and vendor representatives will help foster mutual respect and understanding. Tracking the frequency of tape and disk parity errors, the cause and duration of system crashes, and variations in other system performance measures will do much to raise the facility manager's concerns from the level of intuition to a demonstration of hard fact with which the vendor must deal. The ability to identify the source as well as the existence of errors becomes especially important in a multi-vendor ADP environment.

Proposed hardware and software modifications must be evaluated to project: (1) utility; (2) cost effectiveness; and (3) impact on total system performance. Major on-site modifications to a card punch in order to remedy an off-punch problem may require the unit to be down for a significant period of time. Hence, a complete replacement might be more desirable. A modification to the system scheduler which is intended to increase batch throughput but which inadvertently degrades interactive response time fails to consider *total* system performance. Measurement tools and techniques can be used not only to detect performance problems, but also to anticipate them and to prevent their occurrence.

III. Instituting the CPM Program

Although measurement and evaluation techniques are available to support the efficient and effective management of an ADP center, the question facing today's ADP manager is how to introduce this new technology into his own facility. How often should the information obtained from performance data be reported to the ADP manager, for example? In what form should it be reported? What is the ADP manager's role in instituting CPM procedures? The following paragraphs present a number of such issues that should be considered in inaugurating a performance management program.

A. CPM Reporting

Figure 1 depicts the life-cycle of a typical computer system, progressing from an analysis of requirements to the final installation, operation, and enhancement of the selected system. In each phase of the computer life-cycle, measurement and evaluation play a major role in satisfying the informational needs of the ADP manager. As noted earlier, performance data is as useful during the requirements analysis phase as it is during the system enhancement phase. Every installation, regardless of size, should have some form of reporting during each phase of its system's life-cycle.

The types of data to be collected and reported should be determined not by their mere availability, but by the informational requirements of the ADP manager. These informational requirements are in turn determined by the ADP manager's scope of responsibility. Each report should provide a historical trend of the center's performance which is updated on a regular basis (depending upon the nature and importance of the information), and should contain specified performance criteria. These criteria may be translated into control limits on the performance charts. A control limit is a value chosen to represent the boundaries of acceptable performance for a given system variable. Some of these variables and their associated control limits may be "objective-directed"—that is, they indicate the center's ability to meet certain specified objectives (e.g., one-hour average batch turnaround time). Others are "process-directed," indicating the level of performance of internal system resources (e.g., the CPU, disks, memory). When control limits are exceeded, an exception report is generated and, when appropriate, an in-depth study may be recommended to determine the specific cause(s) for the exception and appropriate remedies for its correction. Sample reports consistent with the ADP manager's responsibility to his users in the areas of turnaround time, reliability, and user support (see Section II.A) appear in the Appendix.

Determining control limit values is highly dependent on the constraints and resources of the ADP center, and indeed on the goals of the organization. Frequently, past performance has been used as a standard against which current performance is evaluated. Although past performance does not necessarily mean *good* performance, it is a reliable indicator of the baseline system's natural reaction to various workload demands.

Finally, the performance reports generated by an ADP center should always remain highly visible, especially to its user community. Publication of "performance charts" in the center's regular newsletter is an excellent vehicle for accomplishing this.

B. Management's Role

The ADP facility manager should play a central role in instituting and overseeing a CPM program. The scope and objectives of the program should be clearly established from the beginning so as to preclude any misconceptions and unnecessary data collection. Perhaps most importantly, subsequent control and review by the ADP manager is needed to guarantee that the program is continually meeting the organization's informational needs, in addition to insuring that the morale of the program personnel is maintained.
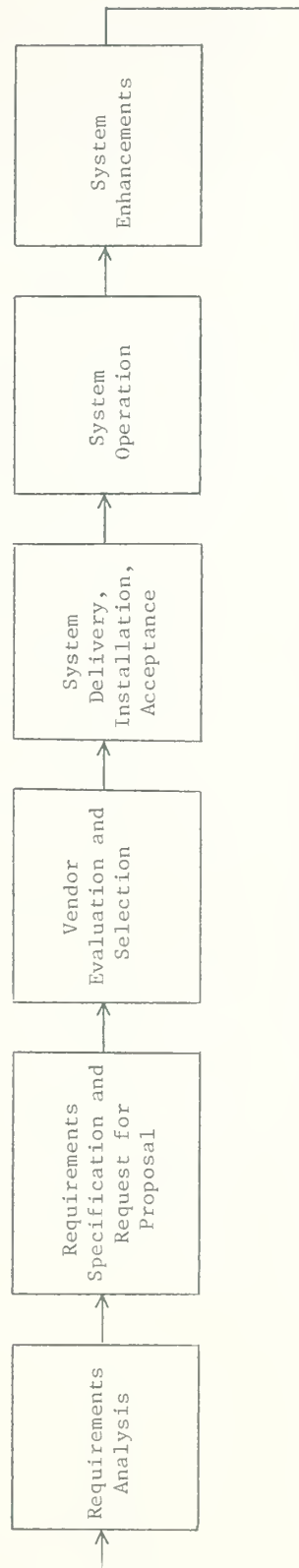
FIGURE 1. The Computer System Life Cycle

1. Define Scope and Objectives

Prior to instituting any CPM reporting procedures, the ADP manager should first have a clear understanding and definition of the scope of his responsibilities. Next, the objectives of the proposed CPM program should be established and the information requirements should be defined in order to insure that only pertinent data will be collected during the later phases of the program. Finally, the nature of the actual reports to be produced, the frequency with which they should be produced, and the performance criteria related to each should be determined. Once again, the reports should reflect enough, and only enough, information for the recipients to function effectively within the scope of their responsibility.

2. Determine Approach

A successful CPM program requires skilled personnel who are intimately familiar with the computer resources being measured and the tools being used, and who have the ability to properly analyze and interpret the measurement data. Two possible sources thus exist for establishing CPM reporting procedures: in-house personnel and outside consultants.

For installations with qualified and available personnel, the in-house approach is preferred. This not only allows for better project control, but has the additional advantage that in-house personnel are more aware of the objectives and internal workings of the organization. When qualified in-house personnel are not available, an outside consultant should be used. Some advantages of the outside-consultant approach are its cost-effectiveness (for organizations with no available performance measurement resources—i.e., personnel, monitors, etc.), its objectivity, and the opportunity for knowledge-transfer from the consultants to in-house contacts. Possible disadvantages include the consultants' lack of familiarity with the internal operations of the organization, and the possible friction that may arise between the consultants and in-house personnel.

3. Control and Review

The failure of many performance improvement efforts has been traced to the lack of genuine management interest and support. Too often the ADP manager supports a performance measurement group during its initial phases, but then gradually loses interest. This decline in interest is usually a result of false hopes and unrealistic expectations for cost savings. Recognition of CPM as a valuable source of *information* and a necessary adjunct of ADP management, as well as a technology for reducing costs and increasing efficiency, will do much to sustain an ADP manager's active interest and support.

Finally, the total CPM program should undergo a periodic review. Changes in informational needs should be reflected in new CPM reports. Existing reports should be examined to determine their current relevancy. Too often reports continue to be generated when the need for them has long since passed.

C. Resource Requirements

Perhaps the most significant costs of any CPM program are those incurred during start-up. Such costs usually include: the program's initial planning, system modifications to acquire the necessary data, acquisition of commercial products and packages, and the development of report generation mechanisms. Once underway, continuous reporting demands other costs and resources: system overhead to collect performance data, processing time to analyze the data, and manpower to interpret the data and maintain the reporting system. In addition, in-depth studies prompted by exception reports may require the use of rather sophisticated tools—notably, hardware and software monitors. The cost of these tools varies with the type and accuracy of data to be obtained. The additional costs of personnel and training may, once again, make it more cost-effective to hire outside consultants for such one-time studies.

IV. Recommendation

It is the conclusion of FIPS Task Group 10 that only through the effective use of specific and pertinent information about his system's performance can the Federal ADP manager properly fulfill his responsibilities. This information can be acquired through the application of existing measurement and evaluation technology in the form of a vigorous and effective CPM program. It is therefore recommended that a Computer Performance Management program be established at all Federal ADP facilities.
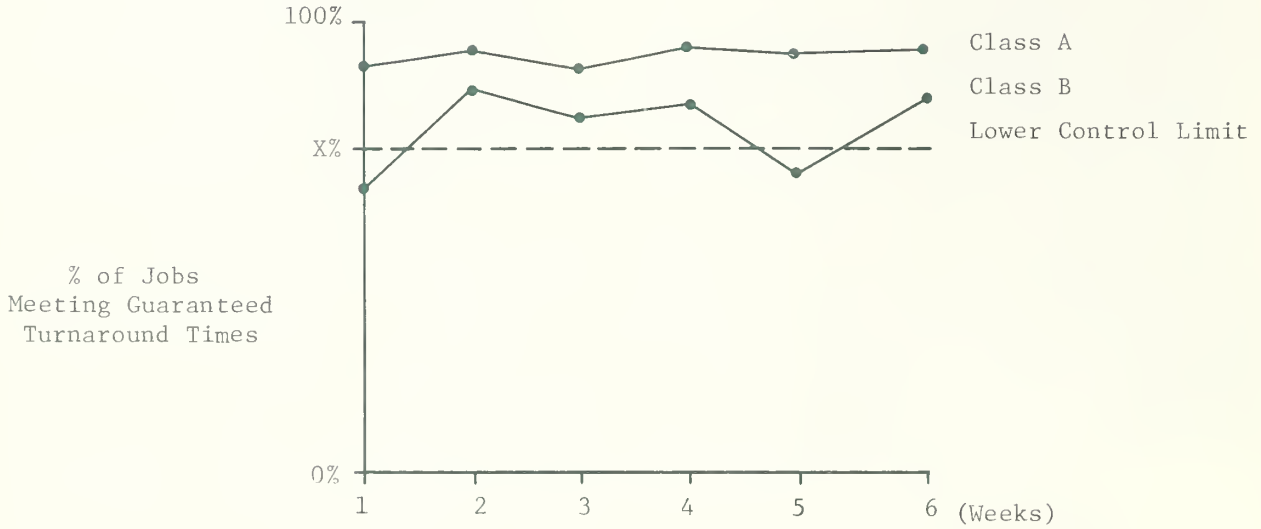
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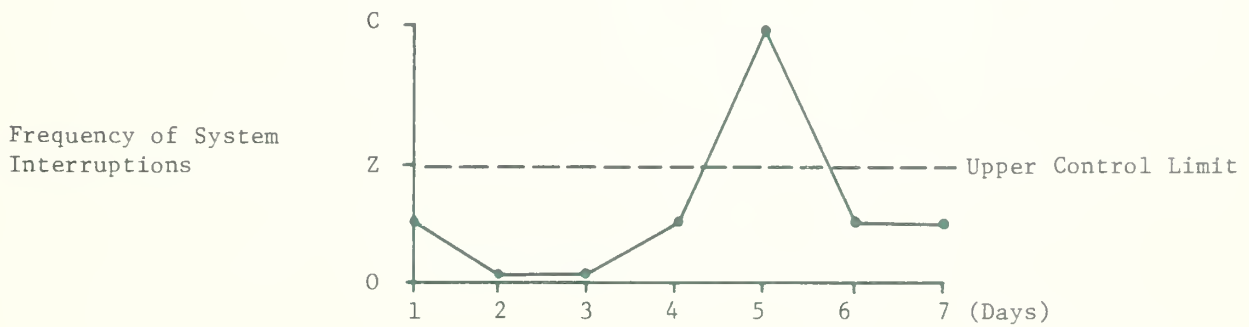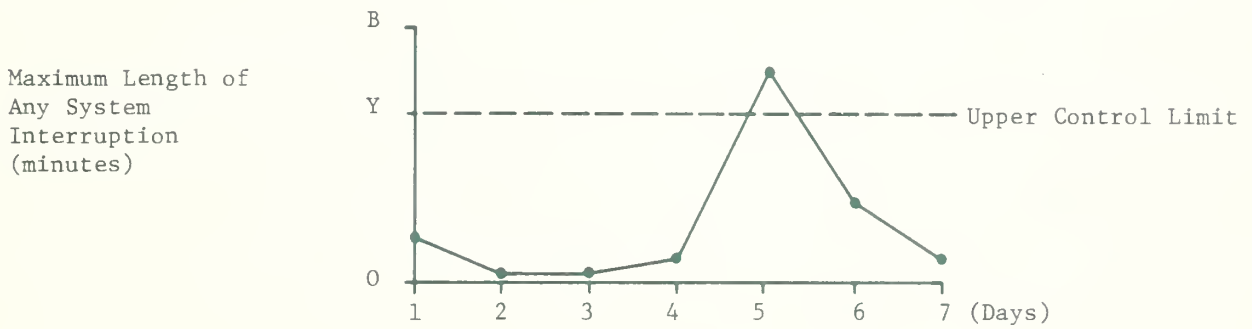
Appendix: Sample CPM Reports

Turnaround Time Report

100%

Class A

Class B

Lower Control Limit

X%

% of Jobs
Meeting Guaranteed
Turnaround Times

0%

1   2   3   4   5   6 (Weeks)
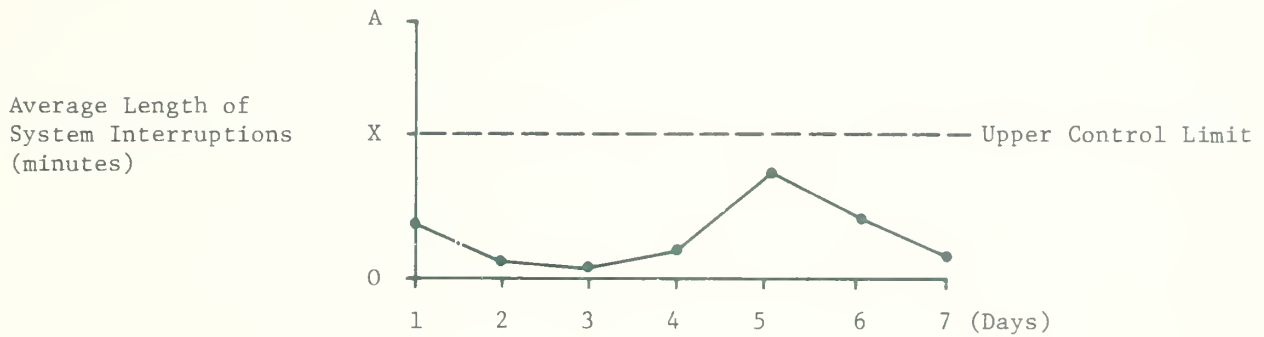
Frequency: Weekly

Performance Criterion:

1. X% of all jobs in each class
    shall satisfy the guaranteed
    turnaround time requirements
    of that class.

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System Reliability Report

Average Length of
System Interruptions
(minutes)

A

X — — — — — — — — — — — — — — — — Upper Control Limit

O

1   2   3   4   5   6   7 (Days)

Maximum Length of
Any System
Interruption
(minutes)

B

Y — — — — — — — — — — — — — — — — Upper Control Limit

O

1   2   3   4   5   6   7 (Days)

Frequency of System
Interruptions

C

Z — — — — — — — — — — — — — — — — Upper Control Limit

O

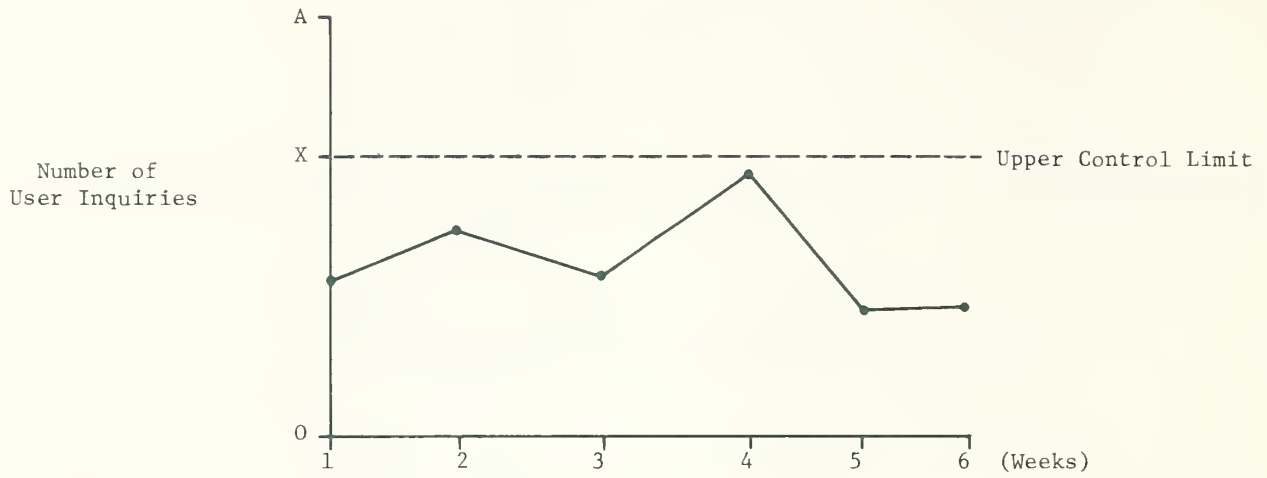1   2   3   4   5   6   7 (Days)

Frequency: Daily

Performance Criteria:

1. The average length of system
    interruptions shall be less
    than X minutes.
2. No interruption shall last
    longer than Y minutes.
3. There shall be no more than
    Z interruptions per day.

User Support Report

Frequency: Weekly

Performance Criterion:

1. The number of inquiries to the user
   support group shall not exceed X
   per week.

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