



**EFFECTS OF SCHEDULED OVERTIME
ON LABOR PRODUCTIVITY:
A LITERATURE REVIEW AND ANALYSIS**

by

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**A Report to
The Construction Industry Institute
The University of Texas at Austin**

**Under the Guidance of
Overtime Task Force**

**from
Pennsylvania State University
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1. INTRODUCTION

Construction overtime has been frequently used as an inducement to attract labor and to accelerate schedule performance. While there may be positive short-term benefits to working an overtime schedule, the long-term consequences are typically viewed as detrimental. Understanding the effects of overtime scheduling is quite difficult because the factors affecting productivity in the overtime situation are numerous.

Given that an overtime schedule cannot be avoided, there is little, if any, information available to aid in deciding which type of schedule to follow. Reliable data in this area are nonexistent.

OBJECTIVE

The objective of this report is to critique the literature describing the effects of an overtime schedule on construction labor productivity. The need for such a summary arises because, relative to the published literature, little is known about the origin of the overtime data, type of project, surrounding circumstances, and amount of data. Yet widespread assumptions have been made that the data and conclusions are reliable. This report clarifies the above aspects for each data set.

SCOPE

This report focuses on scheduled or extended overtime, that is, an overtime schedule that lasts longer than several weeks. Spot overtime, which is intermittent and is generally not scheduled, is not covered, as the negative aspects are minor relative to the job as a whole.

The focus of the report is on labor productivity in terms of the workhours per unit of output. The influence of the premium time costs associated with overtime are only treated superficially.

The literature was collected from published and unpublished sources. In most instances, the way the data were collected is unknown. In some cases, the origin of the data is also unknown. The graphs are presented to illustrate the flaws in the data and should not be interpreted as validating or invalidating the effects of scheduled overtime on labor productivity.

BACKGROUND

OVERTIME ENVIRONMENT

Reliable studies of the effects of extended overtime on labor productivity are very difficult because there are many factors that can affect productivity, some of which have nothing to do with the overtime situation. Figure 1 shows the process of converting inputs (labor hours) to outputs (units of work) and illustrates its complexity. While intuitively obvious, it is often forgotten that manpower is not the only resource or component that is consumed at an accelerated pace in an overtime situation. Materials are installed at a faster rate; consumables, tools, and construction equipment are in greater demand; and engineering questions and information demands must be processed at a faster rate. Absenteeism, accidents, and fatigue may become a growing problem, and the quality of workmanship may decline. Thus, if a project is behind schedule, working overtime may simply exacerbate the problem. Therefore, whenever overtime is discussed, the surrounding circumstances must be clearly understood.

REASONS FOR OVERTIME

Scheduled overtime is initiated for a variety of reasons as summarized by Jones (1971). Although this material is dated, the reasons still seem applicable in the 1990's. Scheduled overtime may be used to:

- Attract additional manpower
- Maintain or improve completion schedule
- Take advantage of favorable weather
- Attract manpower to remote locations

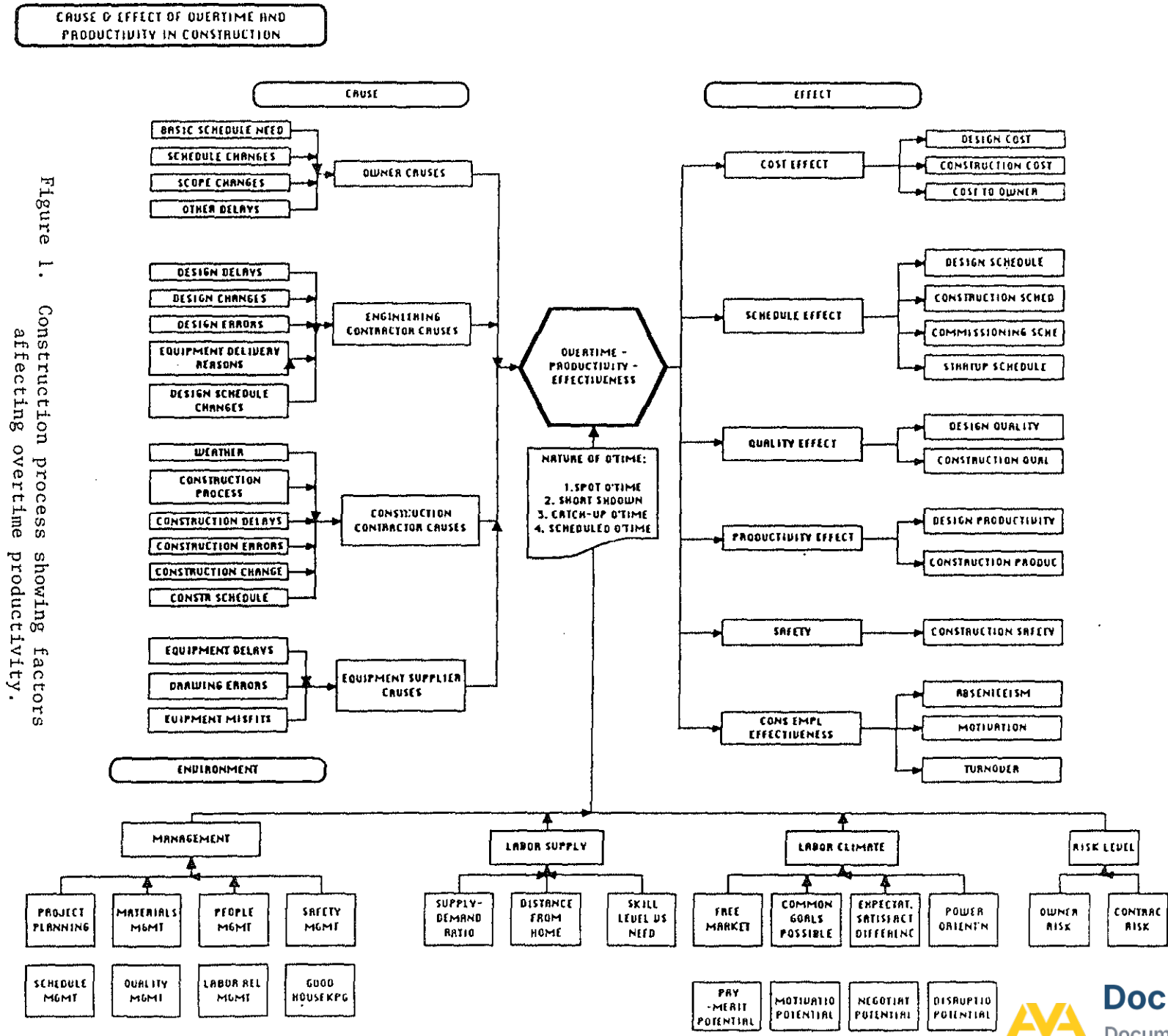


Figure 1. Construction process showing factors affecting overtime productivity.

- Make maximum use of equipment, especially earthmoving equipment
- Maintain schedules in limited work space
- Avoid contract penalties or win incentive awards
- Complete emergency construction
- Avoid strike deadlines
- Avoid higher wage rates

However, Jones stated that many overtime programs fail to achieve the end results desired.

NEGATIVE ASPECTS OF OVERTIME

Overtime is not without its negative aspects, especially if the schedule is applied for an extended period of time. The most serious consequences of scheduled overtime include:

- Premium wages
- Lower labor efficiency
- Increased absenteeism
- Increased accidents
- Higher incidence of faulty workmanship
- Labor unrest
- Greater competition for labor pool
- Attraction of less proficient workers

DEFINITIONS

In this report, the following definitions are used:

EXTENDED OVERTIME

Extended overtime is involved in a work schedule that extends over more than 40 hours of work per week. The schedule is planned in advance and lasts for at least 3 consecutive weeks, and typically longer. The term overtime is used interchangeably with extended overtime.

POINT OF NO RETURN

Point-of-no-return pertains to the point in time when the cumulative output or productivity realized on the overtime schedule equals the output that would have been achieved had the regular 40 hour schedule been maintained. This determination can be based on labor hours or on the cost of labor in dollars.

PRODUCTIVITY

Productivity is represented by the ratio of the input in terms of labor hours to the output in terms of units of work.

SPOT OVERTIME

Spot overtime is involved if a work schedule includes more than 40 hours in a given week, but excess hours are unplanned in advance; the schedule is short, typically one week, and is applied to a small portion of the work force.

OUTLINE OF REPORT

Chapter 2 summarizes overtime effects as they relate to the hours worked per week, the hours worked per day, and the duration of the overtime schedule. The chapter is divided into four parts. The first describes those studies reported in the literature that are based on original data from construction projects. The second part covers other reports describing overtime effects in construction that are based on opinion surveys or unknown sources. These include publications from contractor trade associations designed to aid in the preparation of claims and changes. The third part of Chapter 2 describes several studies of overtime in the manufacturing and retail sectors. The last part of Chapter 2 summarizes what the literature has stated relative to the number of hours worked per day. Chapter 3 describes the various writings on the number of days worked per week and the effects of various schedule alternatives. The four 10-hour workday schedule (4/10) is also discussed. Chapter 4 describes the point-of-no-return concept. Chapter 5 provides a summary and conclusions.

2. EFFECT OF SCHEDULED OVERTIME: HOURS PER WEEK AND HOURS PER DAY

This chapter describes what various studies have reported regarding the effects of scheduled overtime on labor productivity. Two aspects are covered: the number of hours worked per week, and the length of the overtime period. The chapter is divided into four parts. The first covers construction studies in which the conclusions are based on project records, such as unit cost reports, or other recognized data. The second part covers other studies that were based on survey or opinion data, or for which the data source is unknown. The third section covers studies in the manufacturing sector, and the last part states what the literature has said relative to the number of hours worked per day.

EFFECTS ON CONSTRUCTION PRODUCTIVITY BASED ON PROJECT RECORDS

An extensive review of the published literature and other sources has yielded three studies of the effects of construction overtime. Table 1 summarizes pertinent data about each study.

Table 1. Summary data on overtime studies
based on project records.

Source	Time Frame	Number of Projects	Location of Projects	Project Type	Craft
Proctor & Gamble	1960's	1	Green Bay, Wisconsin	Process Plant	Unknown
Foster Wheeler	1963-68	5	Ohio Valley	Fossil Boilers	Boilermakers
Construction Industry Institute	1984-88	7	Louisiana Missouri Texas Wyoming	Process and Power Plant	Carpenters Electricians Insulators Ironworkers Laborers Pipefitters

The most publicized study of construction overtime is based on studies made by Proctor & Gamble at their Green Bay, Wisconsin operation. The study was first published as a Business Roundtable (BRT) report (1974) and was reissued in 1980 as part of the Construction Industry Cost Effectiveness Project (BRT 1980). Figure 2 shows the reported effect on productivity of extended overtime for a period of 12 weeks. As stated in both reports, the figure

represents the reduction in productivity normally experienced on projects operated on a basis of 50 hours per week and 60 hours per week....These observations are on a weekly basis with all completed work recorded from physical count or measurement and the work hours expended obtained from actual payroll hours. The curves reflect the averages of many observations. (1980, p.10)

The data in figure 2 are based on a comparison of actual workhours expended to a fixed standard base called a "bogey." The 1974 and 1980 reports contain the following warning with respect to comparisons of various data sets:

Direct comparisons of various data are difficult since all measurement of productive effort is not referenced to a Fixed Standard. The Industrial firm's data on productivity is based on Fixed Standards and a performance of 1.0 may not be the same as a performance of 1.0 referenced to some other standard of comparison. As a result, a 30% reduction of productivity in one set of data could compare with a 15% reduction reflected in another set of data due to this difference. (1980, p. 15)

The data are a comparison to the "bogey" standard based on a straight time schedule, rather than a comparison of actual productivity on straight time to overtime productivity.

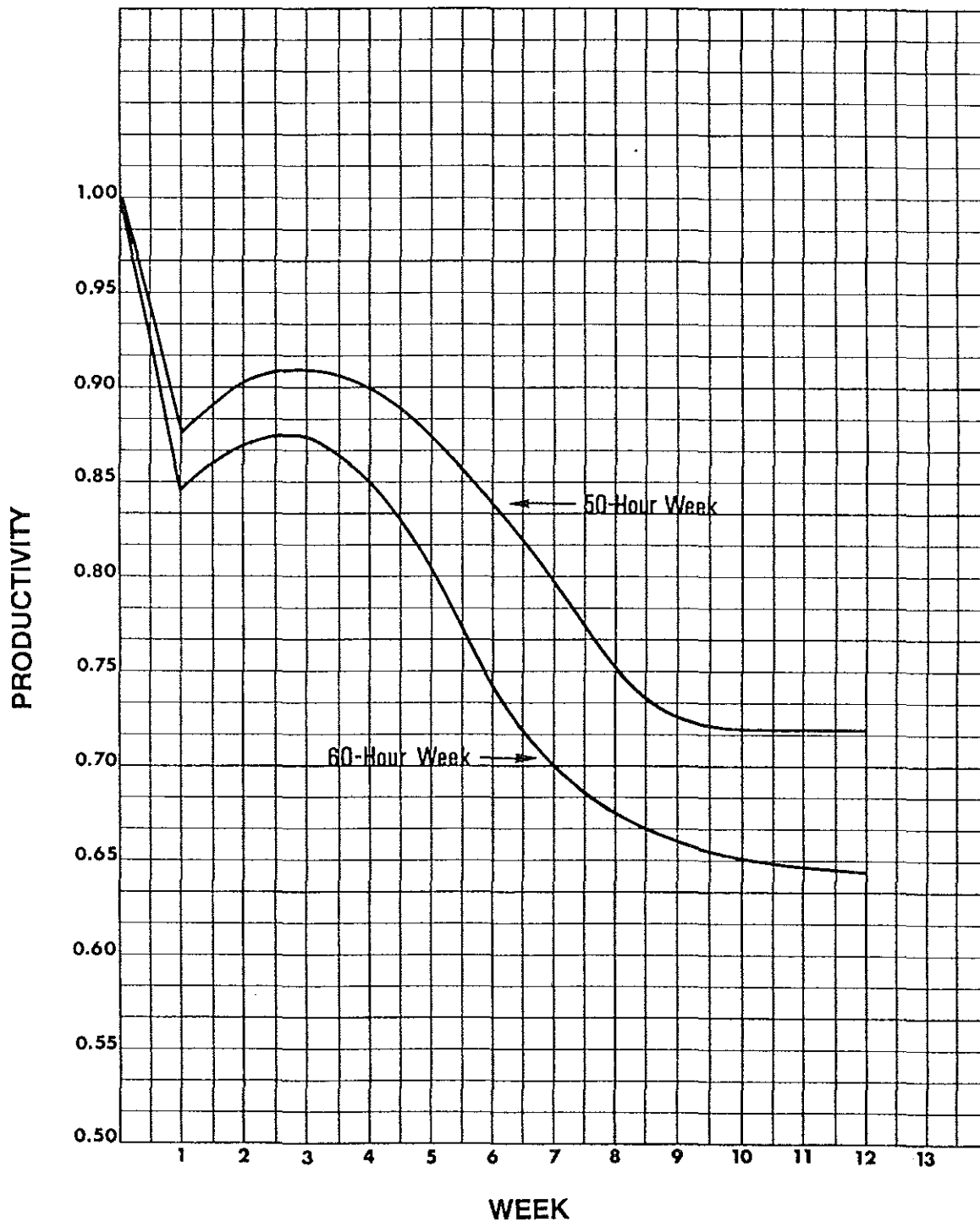


Figure 2. Cumulative effect of overtime on productivity, 50- and 60-hour workweeks (BRT 1974).

What is little known about the Business Roundtable reports is that the data all originated from a single project (i.e., the Proctor & Gamble Green Bay operation). The curves are a composite view of a series of comparably short jobs on scheduled overtime covering a 10-year period. The project operations were carried out in a tranquil labor climate and the field management was reported to be excellent.

The nature of the Green Bay construction activities is not known; however, some insight may be gained from a review of figure 3 (BRT 1974). The figure is a graph of actual records for 7 weeks on a 70-hour-per-week schedule on an emergency "turn around" operation. The seventh week involved commissioning and start-up operations. Prior to the 7-week overtime period, 14,000 workhours had been expended on a regular 40-hour-per-week schedule. The solid line marked "normal expectancy" represents field management's prediction of expected performance for the overtime operation, and has little or no relevance to the interpretation of overtime effects. The management action indicated at the end of Week 9/18 was a decision to shut down all construction operations on Sunday.

FOSTER WHEELER

A technical paper by L. V. O'Connor described the experiences of Foster Wheeler in constructing five large fossil boilers in the Ohio Valley between 1963 and 1968 (O'Connor 1969). The paper reported an average productivity decline of 7.9 percent per year during the period because of a variety of factors, including overtime, overmanning, and labor walkouts. Figure 4 shows their experiences relative to overtime inefficiencies. Although it is not explicitly stated, the reader is left with the impression that figure 4 is based on the boilermaker craft. No other information is given, and it is not known how the overall trend of productivity losses was factored into the figure. The percentage loss of efficiency is consistent with the BRT report if the scheduled overtime period is about 5 to 6 weeks.

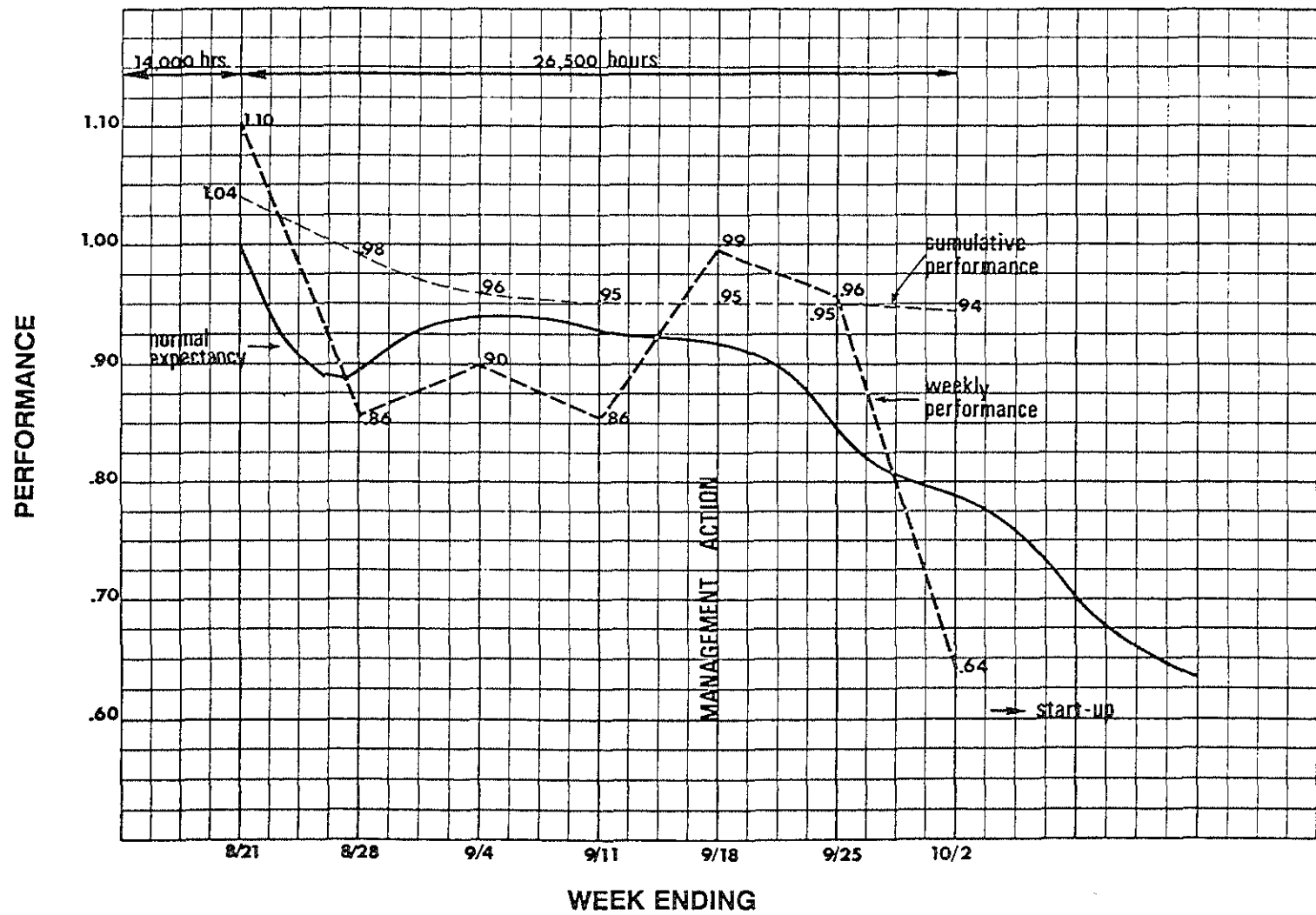


Figure 3. Performance curve #4: Shutdown (BRT 1974).

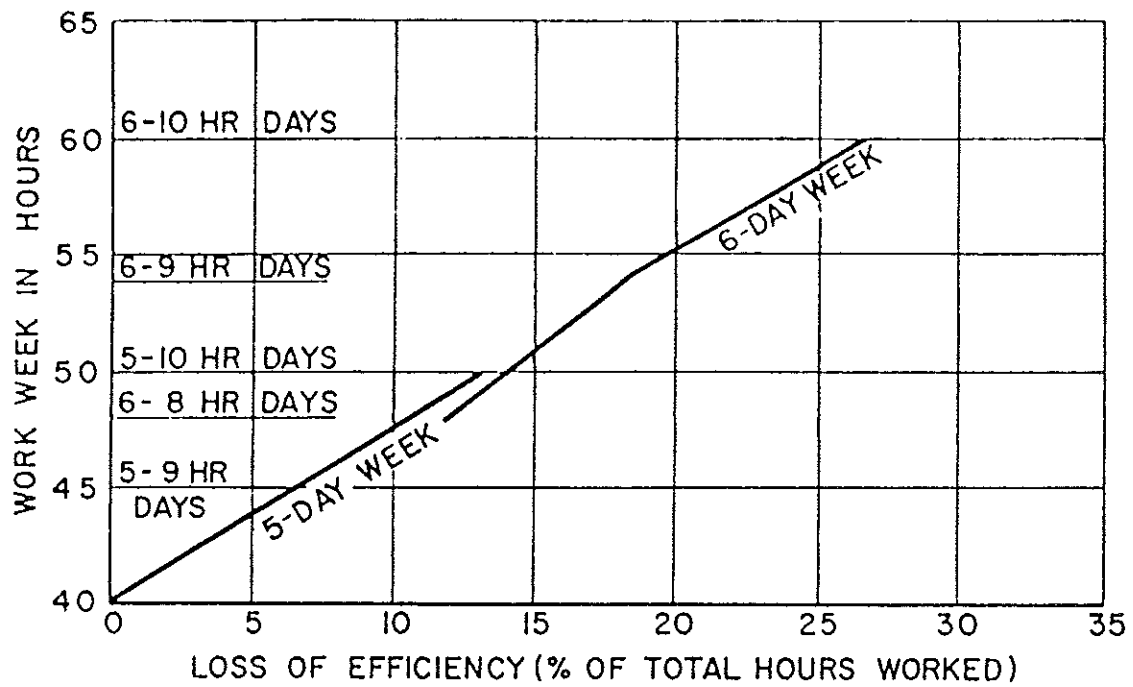


Figure 4. Overtime inefficiency (O'Connor 1968).

In 1984, the Construction Industry Institute (CII) sponsored a 3-year study of construction overtime (CII 1988). This study represents the only source of original data since the 1960's. The study also differs from the other two studies in several respects. The data base includes multiple projects, and the data were collected by direct observation rather than from project records. The focus is on the work of a single crew as opposed to an entire craft, and the study reported results for a number of crafts. The analyses are independent of the project estimate.

The study included seven projects. As shown in table 2, the two natural gas recovery projects were in the early stages of completion and the refinery expansion project was nearing completion. One was a shutdown project, and another (Project 4) was experiencing considerable productivity problems aside from the overtime situation. Project 5 was on a rolling 4/10 schedule. Only on Projects 3 and 4 were data collected on straight time and overtime schedules.

The limitations of the study included the inability to compare overtime productivity to straight time productivity, incomplete data collection procedures, the use of moving average calculations, and the inability to correlate changes in productivity to other factors and job site conditions. The problems caused by these limitations are illustrated in figures 5 through 8, which show the overtime and straight time productivity of electricians and pipefitters on Project 4. No discernible patterns can be identified. Figures 9 and 10 show the electrician productivity on Project 3. In both instances, the productivity was better on a 6-day, 10-hour schedule than on straight time. The baseline period is at the end of the overtime period and probably reflects a period of productivity letdown.

The study could not develop defensible conclusions relative to the effects of an overtime schedule because the productivity trends for the same crews were not consistent. The report also concluded that productivity does not necessarily decrease on an overtime schedule. At best, fatigue did not seem to be a factor.

Table 2. Project characteristics in the CII overtime study.

Project Number	Project Type	Weekly Work Schedule (Days/Hours per day)	Percent Complete	Number Crafts	Number of Crews
1	Refurbishment of distillation unit at a refinery	6/10 7/10	U ^a	Insulator	U
2	Refinery expansion, including some punch list work	5/10+1/8 7/10	85-90	Insulator Pipefitter	4 9
3	Oil refinery shutdown	6/8 6/10 5/8	U	Electrician	2
4	Fossil power plant	4/9+1/8 5/10+1/8	U	Electrician Pipefitter	U
5	Chemical processing plant	4/10 ^b	U	Electrician Pipefitter	U
6	Natural gas recovery plant	5/10	15	Carpenter Ironworker Laborer Pipefitter	U
7	Natural gas recovery plant	5/10	18	Laborer	U

^aU = Unknown.

^bRolling 4/10 schedule.