

The Business Roundtable

Report C-2
November 1980

**SCHEDULED OVERTIME
EFFECT ON
CONSTRUCTION PROJECTS**

November, 1980
A Construction Industry Cost Effectiveness Task Force Report

Executive Summary

This paper reviews an analysis of the impact of scheduled overtime operation on construction projects and the inflationary effects of such operations. The data and findings cited in the previous Business Roundtable report (1974) on this subject have been found still valid and support the following conclusions:

- Placing field construction operations on a project on a scheduled overtime basis disrupts the economy of the affected area, magnifies any apparent labor shortage, reduces labor productivity, and creates excessive inflation of construction labor costs without material benefit to the completion schedule.
- Where a work schedule of 60 or more hours per week is continued longer than about two months, the cumulative effect of decreased productivity will cause a delay in the completion date beyond that which could have been realized with the same crew size on a 40-hour week.
- Where overtime operations are deemed necessary despite productivity losses—for example, on remote construction projects where bachelor housing is provided at the job site and on maintenance turnarounds—proper management can minimize the inflationary effects. Management actions to be considered include use of an additional shift and periodic shutdown of the work for a Sunday or weekend.

General Background

In most manufacturing operations, the output of completed units per hour of labor input is fairly easy to document and provides a sound basis for establishing the productivity of labor. This is not the case in construction work. In the construction

industry generally, there is no fixed standard of comparison for documenting productivity.

The data used for the conclusions reached in this report are based on fixed standards of measuring work hours required to perform specific functions necessary to accomplish construction operations. For example, the fabrication of any section of pipe involves handling, cutting, bevelling, bending, and welding or threading. Standard work hour requirements for each function provide a base for comparison with actual work hour expenditures and provide good documentation of productivity.

Synopsis of Source Data

This paper relates only to operations where the total job is placed on an overtime basis for an extended period of time. Meaningful data to cover periodic overtime is not available.

There have only been a few studies made of the effect of labor hours on labor efficiency (which is defined as changes in output resulting solely from labor input). This is particularly true in the construction industry. Very little data beyond 70 hours per week is available for studying the effect of overtime on the unit cost of labor in the construction crafts.

From studies of morale and fatigue factors as affected by working hours,¹ the following conclusions have been reached:

- Whatever the reason, one fact stands out clearly: The longer the hours, the more scheduled work time is lost through absenteeism.

- Injuries increased as hours increased, not only in absolute numbers, but also in the rate of incidence.
- For hours above eight per day and 48 per week, it usually took three hours of work to produce two additional hours of output when the work was light. For heavy work, it took two hours to produce one hour of additional output.

HOURS OF WORK PER DAY

Comparative Studies

Most comparative studies regarding the variation of productive output under varying hours of work have been made on manufacturing operations where the manual functions are somewhat paced by automated processes. In construction work, automated operations seldom exist, and the harmful effects of overtime operations should be more severe.

Another study² concluded that four weeks of eight hours per day was found to be 16 percent more efficient than four weeks of nine hours per day. This study was based on the *total cost* of finished products manufactured by the identical process under the two different hours per day of work time.

A study of the productive output of labor in completed units resulted in the following statistics for carpenters:

8-hour day	Completed units	120 pieces per hour.
9-hour day	Completed units	100 pieces per hour.

This indicates a worker is 20 percent more productive for four weeks at an eight-hour day than for four weeks at a nine-hour day.

DAYS OF WORK PER WEEK

When operations are scheduled on a seven-day basis, management action can materially affect labor productivity. A study² made at one factory showed that a substantially higher output resulted during the week following an “off Sunday” than the week following a “work Sunday”

EFFECTS OF OVERTIME ON CONSTRUCTION WORKERS

The studies referenced above were based on observations for relatively short durations of four weeks or less. The construction studies discussed below are based on longer periods of time.

When a project in an area is placed on a scheduled overtime basis, the movement of workers from other projects in the area to the overtime job creates an "auction" atmosphere. Other jobs go to overtime to hold their labor, and a bidding process is established. The local labor supply is fairly constant, and the additional productive capacity of transient workers is offset by the reduced productivity of all workers on an overtime schedule. Usually, a major portion of the increase in numbers of workers in the affected area is a result of permit workers in the crafts who are less proficient or poorly qualified.

Disruptions created by unwilling or poorly qualified craft workers, longer working hours each week, increased absenteeism, and reduced effectiveness due to fatigue reduce the productive output of labor materially. On extended overtime, the reduced productivity of workers for a week's work is equal to or greater than the number of overtime hours worked.

EFFECTS ON COSTS

The premium cost for overtime hours, plus the loss in productivity for the total hours worked, results in an unreasonable inflation of the unit labor cost. The charts included in this study illustrate the effect of scheduled overtime on unit labor cost and labor productivity. There is no precise conclusion regarding the cost of overtime that is universally applicable. Time, local labor climate, management actions, and job location are all factors which affect the cost of overtime operations.

OVERTIME VS. PRODUCTIVITY

Within narrow limits, workmen expend energy at an accepted pace established by long periods of adaptation. When the hours of work per day or per week are changed, there is an adjustment period. Studies reveal that scheduled overtime operations result in a sharp drop in productivity initially, followed by a fairly substantial recovery by the end of the first week. The recovery level of productivity may then hold fairly steady for a period of two to three weeks but show a steady decline for the following two to three weeks. After five to six weeks of operations, there is a further drop in productivity which levels out at a low point after nine to twelve weeks of sustained overtime operation. It should be understood that this condition results from normal reactions and does not reflect the effect of other adverse factors such as labor, climate, and poor management

SURVEY RESULTS: NATIONAL CONSTRUCTORS ASSOCIATION

A survey in the late 1960's by members of the National Constructors' Association for the scheduled overtime Task Force covered 60 percent of their total membership and showed that 23 percent of their contracts worked on a scheduled overtime basis. They also reported that 20 percent of their dollar volume of construction was on an overtime basis. This indicated that 20 percent of a \$2.8 billion labor cost was expended on an overtime schedule representing \$560,000,000 of labor payroll.

The survey showed that 66 percent of the overtime schedules were established for the purpose of attracting labor; the remaining 34 percent were to maintain or accelerate construction schedules.

The number of hours per week varied from job to job, but 50 hours represented a conservative average. At 50 hours per week, the inflationary effect on construction labor cost was 60 percent of the cost on a normal 40-hour week. This indicated that the same volume of industrial construction could have been accomplished for \$340,000,000 of labor cost if there had been no overtime involved. The added \$220,000,000 represented inflation of construction labor cost for only this segment of construction.

While the amount of work performed on overtime schedules has not been surveyed recently, it is estimated that the 20 percent figure has been reduced by about half. This is largely a result of increased awareness of the detrimental effects. However, there still is considerable potential for improvement.

CIRCUMSTANCES WHERE OVERTIME SCHEDULES ARE SOMETIMES EMPLOYED

As stated earlier, the analysis of productivity and cost effects of overtime operations in this paper are based on construction projects where full overtime schedules are employed for an extended period of time. It is further assumed that the construction workers commute to work daily.

Construction work is sometimes performed in special circumstances in which owners and contractors have felt that overtime schedules are justified despite the detrimental effects on productivity and cost.

Work in Remote Areas

Some construction job sites are located such that daily commuting of the construction worker is impractical, and he must obtain, or be provided, temporary quarters away from his family, at or near the job site. The higher weekly earnings resulting from an overtime schedule are sometimes employed to attract workers in these circumstances.

Some observers feel that the absence of a daily commute (where workers are housed and fed near the work) decreases the fatigue factor and the resulting productivity decline on an overtime schedule.

Work Requiring Shutdown of Production Facilities

In other circumstances, extended hours work schedules may be employed because operation of existing production facilities must be discontinued during the construction. This may involve emergency rebuilding following storm or fire damage, or construction/renovation work which must be done in conjunction with a maintenance turnaround or other outage. Owners in such circumstances may conclude that the high cost of downtime justifies the inefficiencies of overtime scheduling.

MANAGEMENT ACTIONS TO DECREASE PRODUCTIVITY LOSSES

Where work in excess of 40 hours per week is necessary, there are a variety of alternative or remedial actions which should be considered by management, depending on the circumstances:

- Use of travel or subsistence payments as an alternative to additional hours of work to provide sufficient total compensation to attract workers to remote sites.
- Employment of additional shifts—two or three shifts are often more productive than extended overtime.
- Use of an additional crew to provide scheduled time off without work interruption (e.g., each man works 14 days, then off seven days, as is common on offshore platform work).

- Where work is scheduled seven days/week, periodic shutdown of the work over a Sunday or weekend—productivity benefits may more than offset the lost working time. (Figure 8 illustrates the effect of this on a project on a 70 hours/week schedule.)
- An innovative approach is being applied to achieve seven days/week, 10 hours/day work on a nuclear power plant project. Premium pay is minimized by use of two alternating crews, each working four 10-hour days followed by four days off. The impact of costs and productivity will be analyzed when the project is completed and all data has been received.

ILLUSTRATIONS

Figures 1 through 8 illustrate the effects of overtime in the construction industry on costs and productivity.

FIGURE 1.
Effect of Premium Pay for Overtime on Cost of Labor

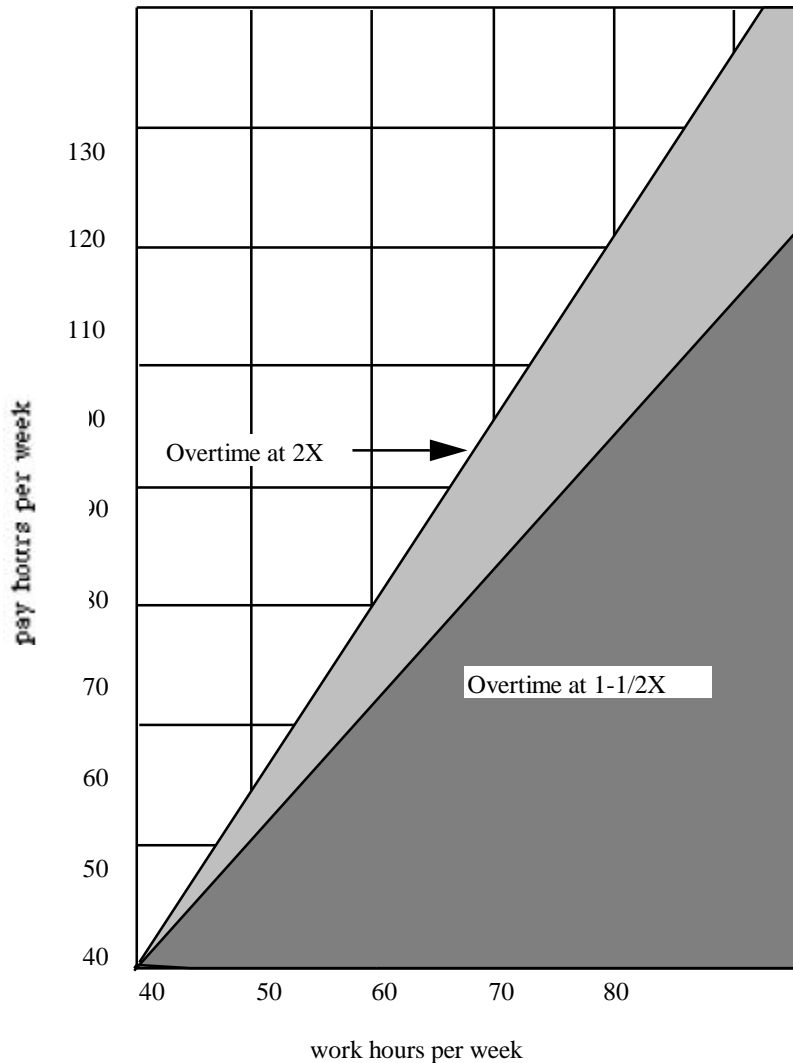


Figure 1 illustrates the effect on payroll cost when construction projects are operated on an overtime basis. The upper line applies where the craft working agreements stipulate double time pay for all overtime. For 60 hours of scheduled work, the worker will be paid for 80 hours. The additional 20 hours of pay is a premium only and represents a 33-¹/₃ percent inflation of construction wages per hour of scheduled work time.

Many labor agreements now provide for Mon.—Fri. overtime (or a portion of it) @ 1-¹/₂x. In such cases, the pay effect lies between the two lines.

FIGURE 2
Cumulative Effect of Overtime on Productivity 50 and 60 Hour Workweeks

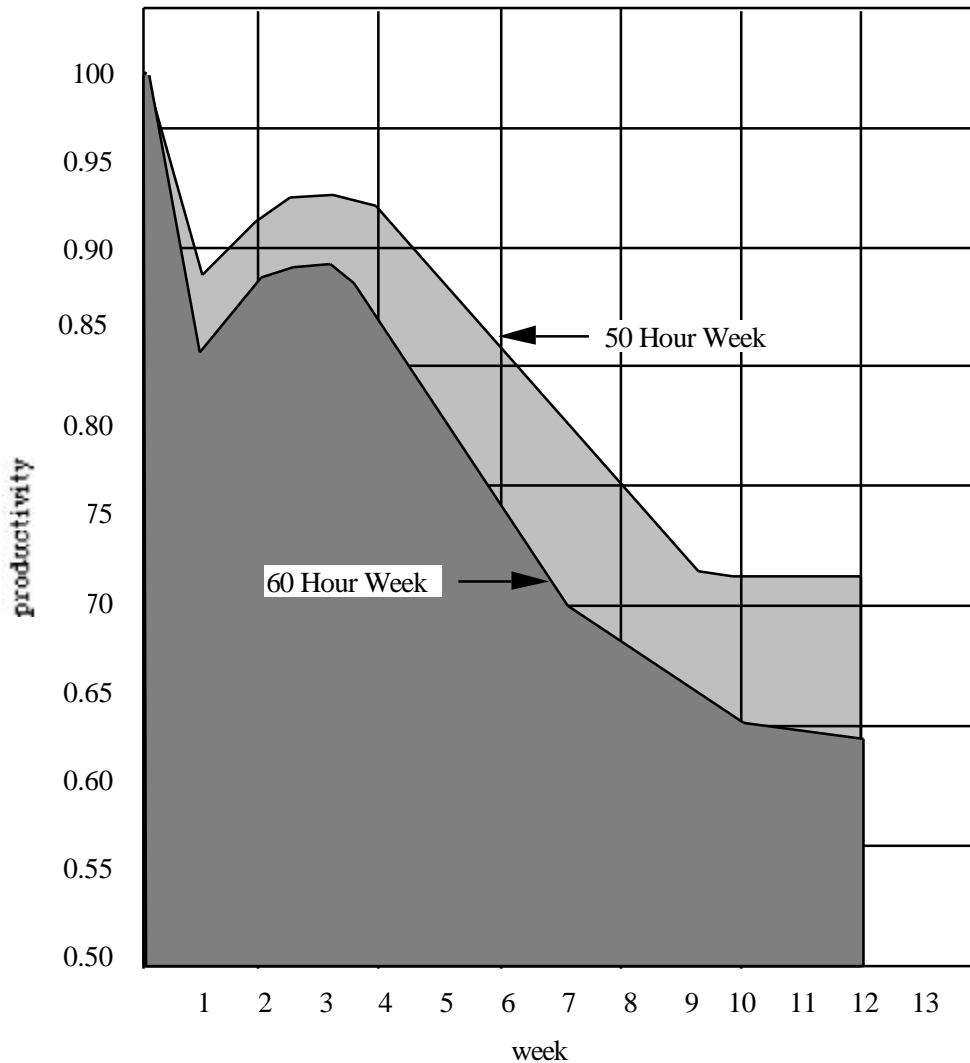


Figure 2 represents the reduction in productivity normally experienced on projects operated on a basis of 50 hours per week and 60 hours per week. The data for these curves is from project operations in an area of tranquil labor relations and with excellent field management direction. The measure of productivity is a comparison of actual work hours expended for preplanned operations with a fixed standard base of calculated work hour requirements called a "bogey." 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.

FIGURE 3 Cumulative Cost of Overtime—Successive Weeks Productivity Loss Plus Overtime Premiums

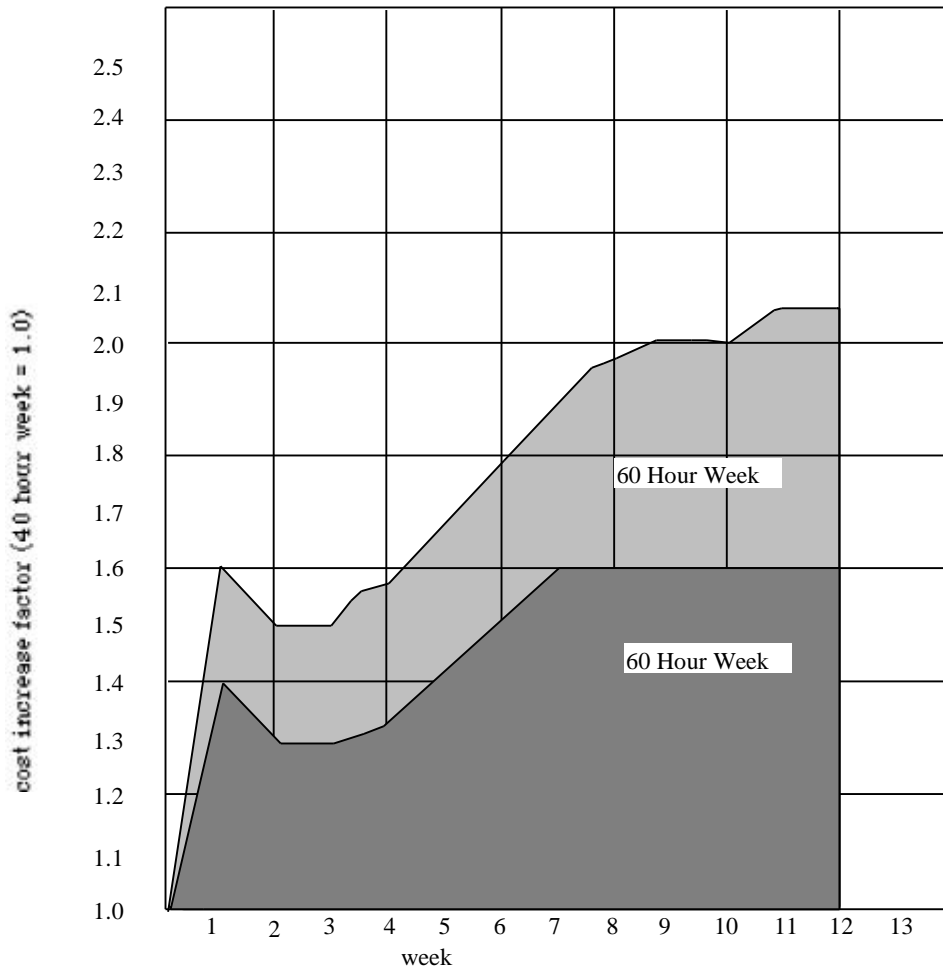


Figure 3 shows the cumulative effect of scheduled overtime operation on the unit labor cost of construction for 50 and 60 hours per week. This data includes the effects of both reduced productivity and double-time pay for overtime hours. The cost increase factor is the ratio of pay hours to work hours divided by the productivity factor (shown in Fig. 2). For 50 hours per week of scheduled operations, the unit labor cost of construction will increase by approximately 60 percent after about seven weeks of operation. For a scheduled operation of 60 hours per week, the unit labor cost will increase by 100 percent to 105 percent after approximately eight weeks of operation.

If all overtime were at $1\frac{1}{2}x$ instead of $2x$, the unit labor cost would still increase by over 80 percent after eight weeks at a 60 hours per week operation.

FIGURE 4. Relationships of Hours Worked, Productivity and Costs (40 Hours vs. 50 Hours)

1 50 Hour Overtime Work Weeks	2 3 Productivity Rate		4 Actual Hour Output for 50 hr. Week	5 Hour Gain Over 40 hr. Week	6 Hour Loss Due to Productivity Drop	7 Premium Hours	8 Hour Cost of Overtime Operation (at 2X)
	40 Hr. Week	50 Hr. Week					
0-1-2	1.00	.926	46.3	6.3	3.7	10.0	13.7
2-3-4		.90	45.0	5.0	5.0	10.0	15.0
4-5-6		.87	43.5	3.5	6.5	10.0	16.5
6-7-8		.80	40.0	0.0	10.0	10.0	20.0
8-9-10		.752	37.6	-2.4	12.4	10.0	22.4
>10		.750	37.5	-2.5	12.5	10.0	22.5

Figure 4 shows the effect of reduced efficiency of a 50 hour week and the premium cost of overtime. When a job is scheduled for 50 hours per week, there is a reduction in productivity for the total 50 hours—not just for the 10 hours of overtime. Column 3 reflects an interpretation of the productivity rate from Figure 2 for the periods shown in Column 1. Column 4 reflects the return in productive work for 50 hours of scheduled operations, due to the reduction in productivity. Column 5 shows the productive effort gained for the week over 40 hours due to the overtime hours worked. Column 8 shows the cost of this gain. It is interesting to note that after working overtime for six to eight weeks, labor cost is inflated by 50 percent with the productive returns no greater than would be accomplished on a 40-hour week. Records indicate that continuous overtime operations beyond eight weeks results in an actual productive return of less work accomplishment than a regular 40-hour week Figure 5 shows the same data for a job scheduled for 60 hours per week.

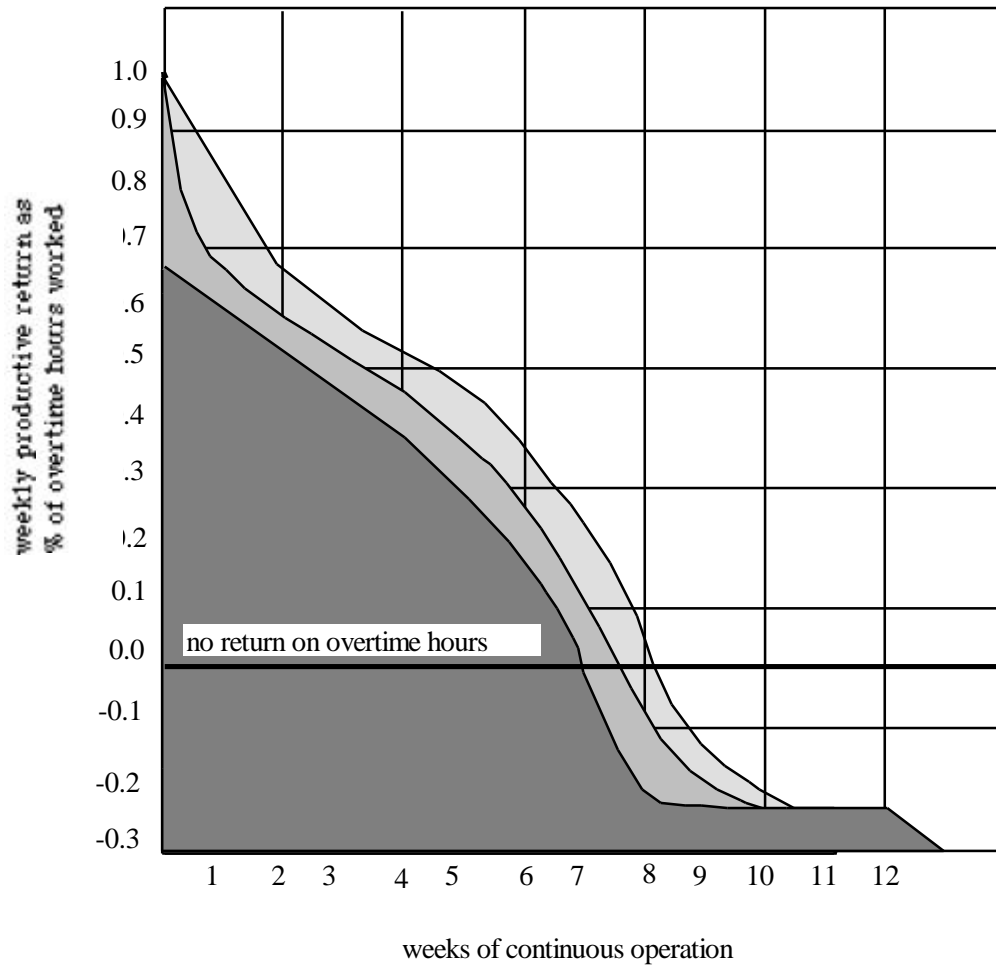
FIGURE 5
Relationships of Hours Worked, Productivity and Costs
(40 Hours vs. 60 Hours)

1 60 Hour Overtime Work Weeks	2 3 Productivity Rate		4 Actual Hour Output for 60 hr. Week	5 Hour Gain Over 40 hr. Week	6 Hour Loss Due to Productivity Drop	7 Premium Hours	8 Hour Cost of Overtime Operation (at 2X)
	40 Hr. Week	60 Hr. Week					
0-1-2	1.00	.90	54.0	14.0	6.0	20.0	26.0
2-3-4		.86	51.6	11.6	8.4	20.0	28.4
4-5-6		.80	48.0	8.0	12.0	20.0	32.0
6-7-8		.71	42.6	2.6	17.4	20.0	37.4
8-9-10		.66	39.6	-.04	20.4	20.0	40.4

Figure 5 is the same as Figure 4 except the data is for a 60 hour week.

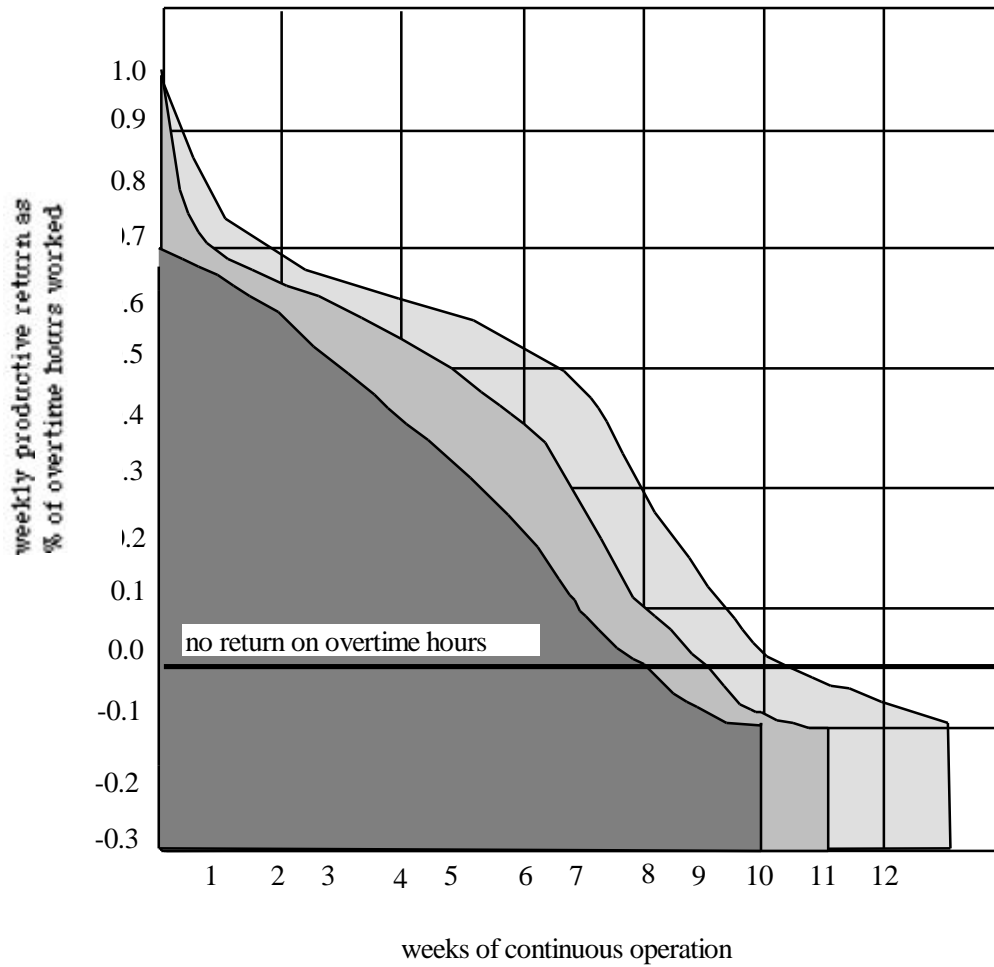
It is important to note that the effect of reduced labor productivity reaches the point of no productive returns on overtime hours earlier for a 50-hour schedule than for a 60-hour schedule. However, the inflated cost per hour of productive effort is greater for the 60-hour schedule. This results from the reduced productivity applying to a smaller base of overtime hours and indicates that a 45-hour job schedule very quickly becomes nothing more than wage inflation.

FIGURE 6
Ratio of Productive Return to Overtime hours for 50 Hour Job Schedule



Figures 6 and 7 are graphs reflecting the ratios of productive return to overtime hours for long-term job schedules of overtime operations. Obviously, one curve would not be representative of all jobs, but the three curves reflect the average and the range of expected performance.

FIGURE 7.
Ratio of Productive Return to Overtime Hours for 60 Hour Job Schedule



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 percent reduction of productivity in one set of data could compare with a 15 percent reduction reflected in another set of data due to this difference.

FIGURE 8 Performance Curve — #4 shutdown

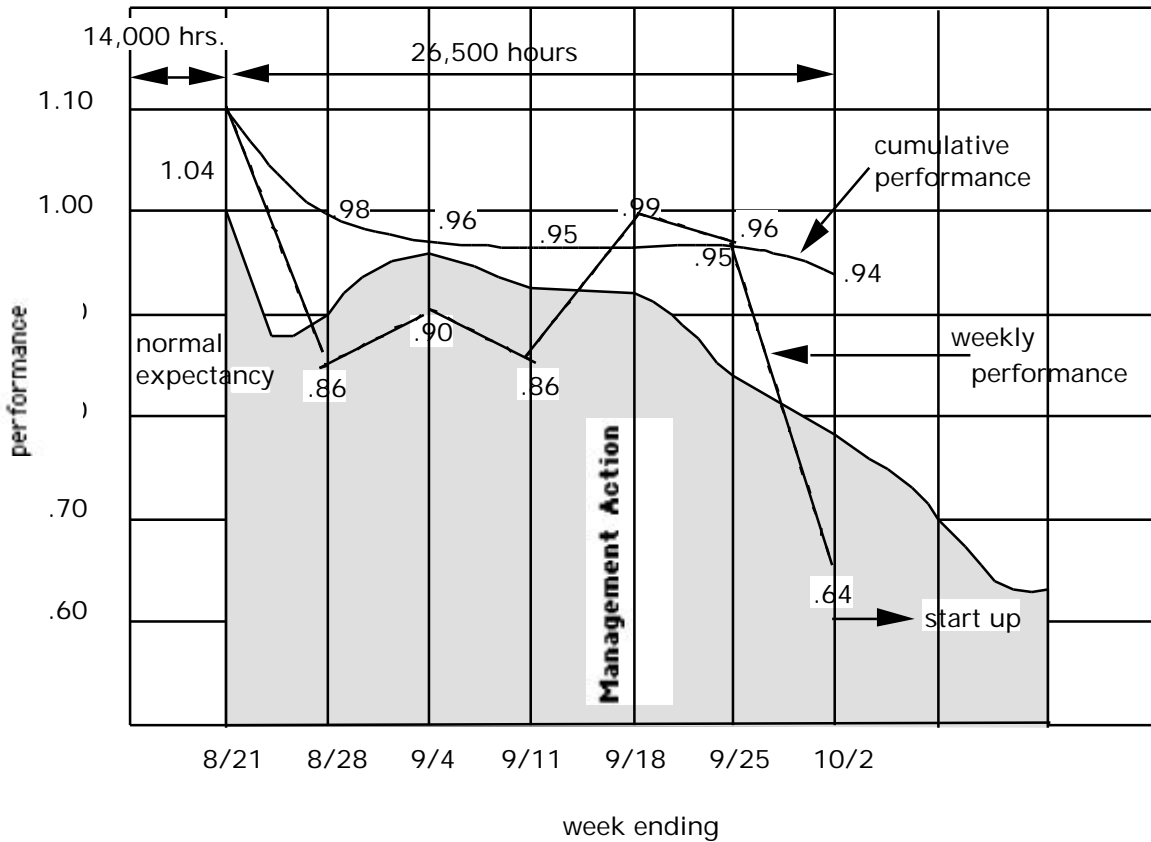


Figure 8 is a graph of actual records for a project operating on a 70-hour per week schedule for a period of seven weeks. The seventh week involved commissioning and start-up operations, and effective performance measurement was not practical.

Prior to the week ending 8/21, 14,000 hours of work had been accomplished on a regular schedule of 40 hours per week. The labor performance for the week ending 8/21 was 1.10, which is a performance 10 percent better than the bogey standard. The bogey standard is a tight target of work hour requirements for various functions and represents good performance. It is, however, an attainable target and is not an industrial engineering ideal.

The solid line marked "cumulative performance" is the cumulative labor performance for the total job to date and on 8/21 was 1.04. The dramatic improvement in weekly performance from 0.86 on 9/11 to 0.99 on 9/18 was the result of a management decision to shut down all construction operations on the Sunday preceding the 9/18 report.

The line marked normal expectancy represents the field management's prediction of expected performance for the overtime operation. It is significant to understand that this job of seven weeks' duration was an emergency turnaround type of operation of relatively short duration. The total construction activity of this job extended over several years and was never operated on an overtime basis for the total job.

Selected References of Studies Related to Overtime Costs

- 1 Bronha, Lucien: "Physiology in Industry," Pergammon Press, Toronto, 1960.
2. Dankert, Mann and Northrup: "Hours of Work," Harper and Row, New York, 1965.
3. Department of Labor Bulletin No. 917 (B.L.S.) GPO Washington, DC, May 1947.
4. Kossoris, Max: "Studies of the Effects of Long Working Hours," B.L.S. Bulletins 791 and 791 A, GPO Washington, DC, 1944.
5. Mechanical Contractors' Association of America, "How Much Does Overtime Really Cost?" Bulletin 18-A, 1969.
6. National Electrical Contractors' Association: "The Hidden Cost of Overtime," Detroit, 1969.
7. Northrup and Brinberg: "Economics of the Work Week," National Industrial Conference Board, New York, NY, 1950.
8. Princeton University Industrial Relations Digest XII "Fatigue and Productivity," Princeton, NJ, September, 1942.

¹¹ Dept. of Labor Bulletin No. 917: "Hours of Work & Output." Washington. D C 1947

²² "Use of Statistics In the Investigation of Industrial Fatigue", Phillip Sargent Florence, Columbia University,. 1918