ELECTRICAL CONSTRUCTION FOREMAN TASK SCHEDULING

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ABSTRACT: The short-term task scheduling of electrical foremen working in commercial and institutional construction projects was evaluated using a combination of interviews, questionnaires, and field observations. The planning environment was evaluated qualitatively, including the project and firm size, availability of resources, planning horizon, and issuing of directives. The quantitative analysis of factors presumed to affect the scheduling was emphasized in the investigation. These factors included task duration, criticality, likelihood of problems during execution, actual problems, and offset in planned start. This investigation found that foremen had almost complete authority over their daily crew task assignments. The favored planning span to articulate an explicit schedule was the workweek. Labor availability was more constraining than material supply in the formulation of the schedule. Directives were verbally issued in all observed cases. Analysis of scheduling parameters showed that dependence on other subcontractors' progress was the most common source of problems, and that problems acted as uniform background noise in the scheduling accuracy. Short and near tasks were the easiest to schedule. Some tasks were categorized as "fillers," used to achieve continuity in labor utilization.

INTRODUCTION

Construction foremen are the "last planners" (Ballard 1994) who ultimately decide and carry out the directives to complete a project. The importance of foremen in motivating workers, assuring safety and quality, and efficiently conducting work has been recognized in several studies. Borcherding (1977) performed in-depth interviews with foreman in several specialties to examine the scope of work, span of control, and motivation. Hinze and Kuechenmeister (1981) investigated the characteristics and actions of productive foremen that lead to better productivity. Chang and Borcherding (1985) analyzed the validity of self-administered questionnaires in estimating productivity. Lemna et al. (1986) studied the characteristics of highly productive foremen in industrial construction. Mahoney and McFillen (1987) directed a survey analyzing foremen's perceptions of their contractors' role. Shohet and Laufer (1991) used interviews and questionnaires to analyze the percentage of time devoted by foremen to different activities and the effects of those activities on productivity. Howell and Ballard (1995) found that a detailed foreman-planning analysis is fundamental to the understanding and improvement of overall project productivity.

From these studies, a defining pattern emerges. The efficient foreman: communicates with craftsman and with the contractor; devotes a substantial proportion of time to planning the job; works for a supportive contractor; and can clearly define the day's work objectives. Efficient foremen traits thus fall into two major categories: leadership and planning. Despite the importance of planning evidenced by these studies, the majority have identified and/or quantified planning parameters at a general level and have not analyzed these parameters in detail.

This paper presents the results of an investigation sponsored by the Albuquerque, N.M. branch of the National Electrical Contractors Association (NECA). The general objective of this study was to analyze the planning behavior of electrical foremen under the uncertain environment typical of electrical construction. Specifically, it examined the weekly task scheduling of efficient electrical foremen in commercial/institutional construction and the environment in which their planning takes place. In the detailed study of this subset of foreman duties, this research sought to answer several significant questions: What factors affect the planning of tasks? Is there a correlation among those factors? How does actual performance correlate with the weekly task schedule? These questions were suggested by the researchers to NECA members, and later refined in scope as explained in the methodology section.

Although this information was originally intended for use by electrical contractors interested in improving their job planning by having a more realistic depiction of their foremen's planning performance, it has significant value for other stakeholders in the construction process. This study is of interest to:

- Other contracting specialities such as masonry, metal, and mechanical, which follow a similar field organization and work in similar environments.
- Construction education and research, by providing original field data about the scope, accuracy, and potential problems of electrical foremen planning.
- Software developers, especially those providing planning tools with nondeterministic duration and link capabilities. This research provides confidence intervals for planning variables that could be used as default values in their programs.

Electrical contracting provides an excellent framework for the analysis of planning at the lower echelons of construction management. The electrical contractor normally has a constrained set of feasible tasks, which are highly dependent on the performance of other subcontractors. The foremen's scheduling efficiency is therefore crucial to their ability to carry out their duties, and affects other crews in the flow of construction tasks.

RESEARCH METHODOLOGY

This study included field observations, interviews, and questionnaires. NECA solicited volunteer contractors to select their most efficient foremen to participate in this research. The 12 contractors who responded to the request used their own criteria to qualify as "efficient" their selected foremen. Several contractors pointed out that planning efficiency is usually a part of the overall work pattern of a "good" foreman. In their opinion, if a foreman was cost efficient, planning efficiency would be present as well. The 15 foremen selected by their contractors then participated in a preliminary session to explain the investigation and tentatively identify the parameters to be observed. From this initial meeting, 10 foremen on different projects were chosen to participate during the next four months, with weekly visits to their projects by the researchers.

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J. Constr. Eng. Manage., 1996, 122(4): 363-369

The University of New Mexico

Research on Foreman Job Planning in Construction

Planned/Actual Progress

From:________ to ________ Project:________

By:________ Foreman:________

#	Work Item	Description	Location								(1)	(2)
1	TITLES	(Enlarged for typographic purposes)										
2												
3	(1)	Chances of task slipping from schedule										
4		(1 to 10)										
5												
6	(2)	Likely / actual problems (see notes)										
7												
8	(3)	Notes:										
9		1. Materials not available										
10		2. Manpower not available										
11		3. Contractor behind schedule										
12		4. Other subs behind schedule										
13		5. Weather										
14		6. Other										
15												
Weather		F = Fair; R = Rain; Describe others									(3)	
Manpowe		Expected / Actual										

Comments

FIG. 1. Planned versus Actual Bar Chart Form

During each visit, the foreman was asked to fill out a bar chart of the activities planned for the following week, indicating on a scale from 1 to 10 (1 meaning that no problems were anticipated) the likelihood of problems for each task, and trying to identify potential problems. The following week, the foreman indicated on an ''as-built'' bar chart the actual tasks performed, including unforeseen tasks and the actual problems encountered. These weekly interviews explored the priorities for the execution of tasks, the reasons for the postponement of some planned tasks and the inclusion of unplanned ones, and in general, attempted to investigate the reasons behind the scheduling process performed by foremen. The form used for this bar chart is presented in Fig. 1.

The initial pool of 10 foremen was reduced to the five judged to be more responsive after the first month of field observation. Of the five foremen discarded, two expressed their desire to step out of the investigation, two did not appear cooperative during the interviews, and one had a project in a security area which made very difficult the collection of data. Each of the remaining five foremen had one (and only one) project assigned, which was visited for three additional months, for a total of four months of observations from April to August of 1994. Numerical data were computed using only these more reliable foremen. The corresponding final pool of five projects were located in New Mexico, and consisted of three separate large new-building projects on Kirtland Air Force Base, a hospital expansion in Albuquerque, and a school in Santa Fe. Table 1 shows the cost of each project and its approximate stage of construction during the data-collection phase.

After the field observations were completed, a questionnaire and a final interview were administered to the participants, their employers, and three additional external contractors and foremen in Albuquerque and Gallup, N.M., and Las Vegas, Nev. This questionnaire served as a control for the locally collected data, and explored the different perceptions that upper management and foremen have of various scheduling issues, particularly those variables monitored during the field data-collection phase. A final brainstorming session brought together most participating foremen and contractors to discuss the results presented in this paper. The exit questionnaire is presented in Appendix I. Its results were consistent with field observations, and it is only referred here in those aspects that showed contradictions between perceived (as answered in the questionnaire) and recorded (from field visits) statistics.

This investigation was conducted in the middle of a construction bonanza in Albuquerque that stretched the supply of resources (primarily labor and materials). The study was limited to electrical contracts and did not analyze long-term scheduling strategies.

TABLE 1. Characteristics of Sampled Projects

Project description (1)	Stage at start of study (2)	Approx. cost of electrical contract[a] (3)
Hospital expansion	Final tasks	$293,000
Elementary school	Starting	$60,000
Office building	Early tasks	$2,600,000
Office building	Starting	$1,200,000
Office building	Middle of contract	$2,667,000

[a]Data provided by the electrical contractors. As a rule of thumb, the electrical contract is about 10% of the total project cost in commercial construction.

J. Constr. Eng. Manage., 1996, 122(4): 363-369

SCHEDULING ENVIRONMENT

Task scheduling responds to the environment in which it takes place. The context of this environment was qualitatively probed by means of questionnaires and interviews with the initial pool of foremen and contractors. This screening served to validate the more quantitative task scheduling parameters studied in depth during jobsite visits. The environmental factors analyzed were:

1. Project and company size
2. Labor supply
3. Availability of materials
4. Central office support
5. Scheduling horizon
6. Means for issuing directives

Project and Company Size

Project size defines the amount of resources to be managed, and frequently results in more complex technical and management issues for large projects than for small projects. However, the size of the project did not appear to result in major changes in the planning philosophies articulated by foremen in this study. The company's size and level of activity were by far more relevant, due to the type of support provided to field personnel. Larger firms had better-structured delivery systems for materials and personnel. While foremen in small firms had to report in person to the main office to request and pick up tools and supplies, larger firms had formal requisition processes that required more lead time. The formal requisition processes forced all participants to articulate their requirements, and were considered beneficial by all management levels, despite the longer turnaround time involved.

Labor Supply

Labor constraints constituted an important environmental factor. Union rules regulating the hiring of personnel prevent the requesting of a particular individual from the union hall, unless that person is hired at the foreman level or above. Because of this rule, if an individual is laid off after completing a project, chances are that he or she will not be hired again by the same company. In order to retain good labor, it was imperative for foremen to maintain a base level of activity throughout project execution. Contractors and foremen on large projects estimated that around 75% of their personnel is retained from one project to the next, and that around half of the labor at any given time has worked with their company continuously for one year or more. Foremen on smaller projects reported that only around 25% of their workers had been with the company for a month or more. Foreman retention was high for both small and large projects, at more than 90%. These figures were apparently affected by the high volume of construction in Albuquerque at the time of this study.

Availability of Materials

The availability of materials has been found to be a minor source of task delays in previous studies. For example, Ballard et al. (1994) found that only 3% of the foreman-planned tasks were affected by materials in industrial pipefitting projects. This figure is consistent with the findings of this study. In their responses, foremen estimated that they had on hand the materials to perform nearly 90% of the possible tasks at any given moment. Electrical contractors were also relatively comfortable with materials supply, but less so than their foremen; contractors consistently estimated at around 75% the proportion of tasks that could be started at any point and for which enough materials were on hand. Exploring this difference, it appeared that contractors were more aware of long-term tasks that could potentially be performed if materials were present, whereas foremen tended to consider only immediate tasks, for which their major components (e.g., switchboards, transformers) were already on the job.

Central Office Support

Even in well-managed firms, it was clear that foremen had the responsibility for determining the daily tasks to be performed on the jobsite. Even though all contractors or a senior superintendent visited their respective project sites several times per week, foremen retained the initiative to start or to stop individual tasks. In one case, the contractor indicated the weekly sequence of physical locations to work, but even in this instance the foreman was entrusted with most of the daily work planning. All the contractors participating in the study had multiple projects ongoing at the time, and therefore the scenario of a small contractor with a single ongoing project was not probed here.

Scheduling Horizon

Without exception, the foremen observed during this study used the workweek as their scheduling horizon. There are several reasons for this limited scheduling span. The supply of minor materials and of personnel required only one week's advance notice, a lead time corroborated by contractors. Reporting, in the form of hours worked for payroll purposes, was performed weekly. Foremen felt less concerned with long-term scheduling than did upper management. The initial task-scheduling form used for this research covered two weeks. However, it was reduced to one week after several foremen voiced their discomfort with the long initial span; some even refused to fill out the second week on the form.

Issuing Directives

Directives were verbally issued to the crews in all observed cases. However, most foremen kept some form of written record of the state of the project, and in many instances they used this record to complete the planned-tasks form utilized for this study. These records were kept in various ingenious ways, such as coloring the blueprints according to the area worked in each day.

TASK SCHEDULING PARAMETERS

Several task attributes provided insight to foreman scheduling efficiency. These parameters were observed during the jobsite data collection for this study, and were quantified in different ways, some as Boolean yes/no (1/0), some numerical, and some multiple-choice answers. The parameters were tested at the start of the data collection, resulting in the inclusion of some initially unforeseen (e.g., fillers/critical) and the discarding of others (e.g., contractor input) that did not appear to be common or relevant. The observed parameters were:

1. Planned and actual duration
2. Proximity of start date
3. Critical versus filler activities
4. Forecasted and actual problems
5. Offset from planned start date
6. Unplanned tasks

Planned and Actual Duration

The average actual duration of recorded tasks was 2.3 days, with a 95% confidence interval between 2.1 and 2.6 days. The planned duration for the same tasks was 2.4 in average, with

J. Constr. Eng. Manage., 1996, 122(4): 363-369

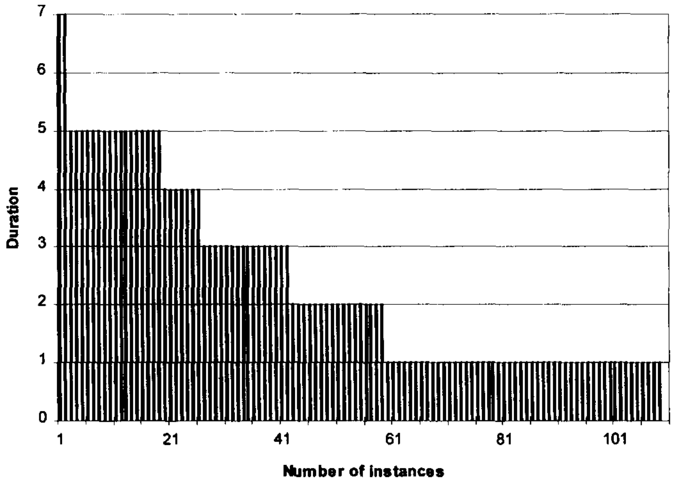

FIG. 2. Task Duration Distribution

a 95% confidence interval between 2.1 and 2.7 days. There is no significant difference between planned and actual task duration at a significance level of 5%. The frequency of each duration is shown in Fig. 2. The distribution approximates an exponential shape. Almost all activities were performed in the regular five-day workweek, and some were continuously performed over the seven-day calendar week.

To better visualize the relationship between task duration and other factors, activities were classified as either short (duration equal to or less than 2 days) or long (more than 2 days). Short tasks were typically performed in a well defined area and had a clear scope, for example "trim entrance canopy" and "connecting heating units." Long tasks were more encompassing and vague, with descriptions such as "install raceways in area A" and "fish small conduits." Sixty-five percent of the tasks were short and 35% were long.

There was a good balance between overestimating (19% of the activities) and underestimating (17% of the activities) the actual duration. In most cases (64%) the predicted duration corresponded exactly to the actual duration.

The long tasks constituted a special case: they were, in many cases, essential to the work progress; at the same time, they were easy to use as fillers (i.e., to achieve work continuity). This dual nature of long tasks helps to explain why foremen tried to combine long and short tasks at any point in time.

Proximity of Start Date

One of the task parameters explored whether foremen would be willing to commit to their schedule a uniform amount of tasks for each day of the week. To this effect, activities were classified as "near" if their start date was between 0 and 3 days from the moment it was scheduled, and "far" if their start date was more than 3 days away. Since the vast majority of activities were performed in a five-day workweek, it follows that 3/5 (60%) of the activities should have been near, and 2/5 (40%) should have been far. The results of this classification corroborated the observed tendency of foremen to schedule for the near future. Of 145 activities, 121 (83.5%, or 5 out of 6) were near and 24 (16.6%, or 1 out of 6) were far. The 95% confidence level for near activities is between 77% and 90% of the sample, still above the ideal percentage.

Critical versus Filler Activities

Activities were classified as critical if they were essential to the performance of the immediately following tasks either by the electrical or another contractor. This parameter required a degree of subjective judgment, since all production tasks eventually become critical. The defining criterion was whether the activity was essential at the time it was scheduled.

From this classification, it was apparent that some of the tasks were not critical at the time they were scheduled. When asked to explain the reason for including these activities, foremen agreed that these "filler" activities served to achieve work continuity on the job; that is, to keep a constant manpower level. One hundred and twenty-one (83%) of the observed tasks were critical, and 24 (17%) were fillers. When asked "What proportion of your tasks are started to keep workers busy?" in the final questionnaire, foremen conceded that only around 5% could be classified as such, while contractors estimated the figure at around 10%. These differences in percentages, particularly when compared to the higher computed statistics, probably indicate foremen's reluctance to be perceived as playing with their workers' paid time. However, the honest combining of critical and filler activities could be one important ability of efficient foremen and thus should be encouraged instead of stifled.

Forecasted and Actual Problems

A list of six causes of problems in completing planned tasks was developed with the foremen and contractors. The major causes identified were lack of materials, lack of workers, contractor behind schedule, other subcontractors behind schedule, and weather. Using this list, about one-third (44/145, or 30%) of the observed tasks were forecasted by foremen to have some problem during their performance. Thirty-six percent of tasks turned out to have some problem during their completion. The ability of foremen to detect problematic tasks was better than their ability to pinpoint the particular problem. In 55% of the cases, the actual problem was not the one predicted.

Fig. 3 shows a breakdown by cause of forecasted and actual problems for tasks that experienced some execution problem. The main cause of problems was other subcontractors lagging behind schedule, followed by lack of manpower, lack of materials, and the main contractor being behind schedule. While the interviewed foremen predicted that more than two-thirds (68%) of problems would arise from other subcontractors' lack of progress, only slightly less than half (49%) of the time did other subcontractors actually obstruct the performance of electrical work. Causes that were more within the control of the electrical contractor were underestimated: lack of manpower (14% forecasted to 26% actual), lack of materials (2% forecasted to 8% actual), and general contractor behind schedule (2% forecasted to 8% actual). These results should be viewed with caution, however, due to the small sample size of tasks with execution problems.

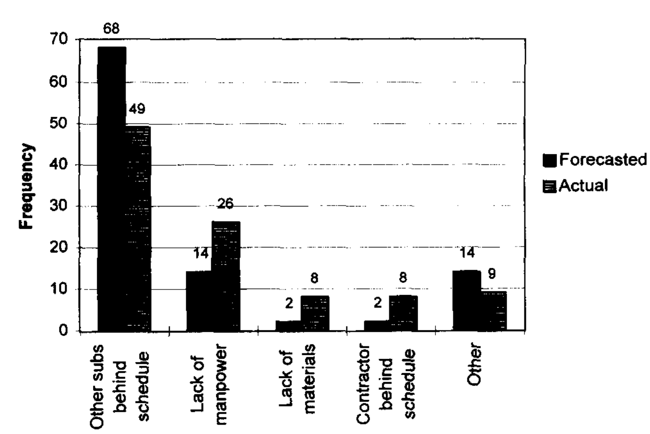

FIG. 3. Forecasted and Actual Problems

J. Constr. Eng. Manage., 1996, 122(4): 363-369

Offset from Planned Start Date

The offset in tasks' actual start dates compared to their planned starts was considered a good indicator of the level of scheduling accuracy. In the week immediately following the scheduling, each planned task was compared to the corresponding actual performed task. This was done with the help of the foreman, who explained the reasons for deviations in the schedule and who built the bar chart with actual dates. Initially, foremen were requested to keep a journal (furnished by the researchers) of performed project activities. This approach was quickly abandoned, however, since it created an impression of second-guessing the foremen's judgment. Instead, foremen were asked to keep this record in any format they felt suitable. By allowing them to control what they perceived as their internal affairs, foremen's openness and the quality of their reporting improved significantly.

Overall, 53 of 145 observed tasks (37%) experienced some kind of offset from their planned start, ranging from 3 days ahead of schedule to a 15-day delay. A significant proportion of tasks with offset in their start missed the planned start date by only one day (20 of 53, or 38%). Using absolute values, the median offset was 3 days and the average was 3.64 days. The 95% confidence interval was 2.44 to 4.71 days. Each observed foreman was equally prone to having tasks delayed. The significance of offsets in correlation to other parameters is explored in the next section.

Unplanned Tasks

In their exit questionnaires, foremen consistently estimated that the start date of 5% of their tasks was not known the day before they were performed, and that between 5% and 15% of the tasks had start dates that could not be anticipated the week before. These estimates agreed with the observed unplanned tasks, which amounted to 11% of the sample. While some of these unplanned tasks were totally fortuitous (e.g., fixing a severed power line), the majority of the cases corresponded to tasks whose start depended on external factors, such as the completion of work by some other trade.

To account for tasks that could not be scheduled with certainty, a likelihood scale from 1 to 10 was established. Activities that could be considered "certain" received a 1, while completely unpredictable tasks were given a 10. Thirty-nine activities, or 27% of the sample, received a rating greater than 1, including 6 (4%) which were assigned a 10.

CORRELATING PARAMETERS

Comparisons between some closely related parameters (planned versus actual duration and forecasted versus actual problems) were presented in the previous section. It is also revealing to compare the correlation among other significant parameters.

Filler Activities

Since filler activities were highly discretionary, they exhibited a greater degree of uncertainty and less-accurate predictability than their critical counterparts. Fifty-eight percent of fillers showed some offset in planned duration, against 32% overall. The severity of these offsets was greater than for the general sample, with an average of 4.48 days and a 95% confidence interval ranging from 2.63 days to 6.32 days. Forty-six percent of fillers had a likelihood rating greater than 1, compared to 27% for all activities. Fifty percent had some problem during execution, while only 36% of the total sample experienced problems.

Other comparative statistics show that fillers had the same proportion of long tasks as the total sample, and that they followed the ideal near/far proportion of 60% much more closely than did the total sample, with 58% being near versus 83% of the total sample.

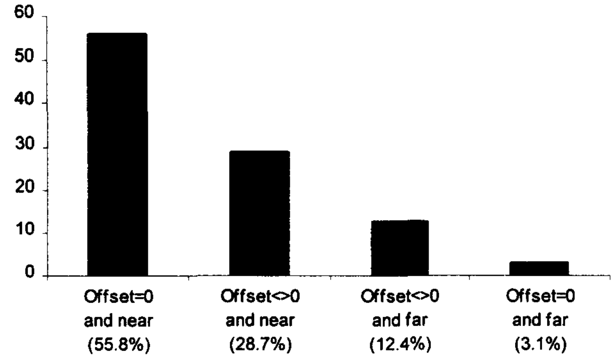

FIG. 4. Near and Far Tasks Ranked by Offset

Proximity

The better predictability of near tasks was evident in comparative statistics. Fig. 4 shows a breakdown of sampled tasks by offset and proximity. Most activities were near with no offset, followed by near tasks with some offset, then far activities with offset not equal to zero, and finally, far activities with offset equal to zero.

Ninety-one percent of tasks with a likelihood rating of 1 were near, compared to 73% overall, Actual execution problems, however, did not show a statistically significant difference between far and near tasks. This was not unexpected since, while the foremen's ability to forecast offsets and possible problems was better for near activities, the external factors resulting in problems occurred uniformly during the week. Thus, 41% of far tasks had actual problems and the ratio for near activities was 35%. The total sample had a proportion of 36%.

Offset

To visualize the offset parameter correlated with other classifications, each was broken down according to its task offset from planned start. The classification, compared against their offsets, were:

1. Short tasks, defined as those with duration equal to or less than 2 days
2. Low likelihood, meaning tasks with likelihood ratings greater than 1
3. Actual problems, tasks with any actual problem recorded
4. Far, defined in the previous section as tasks scheduled to start 3 or more days in the future
5. Fillers, already defined as tasks that were noncritical at their time of execution

Offsets were grouped into:

1. Delays longer than 3 days ("offset > 3")
2. Delays between 1 and 3 days ("0 < offset ≦ 3")
3. Tasks performed as scheduled ("offset = 0")
4. Tasks performed ahead of schedule ("offset < 0")

Table 2(a) shows the observed offsets by category as absolute quantities; even more significantly, Table 2(b) shows the severity (impact) of each offset for each category, computed as the percentage of the total within the category. The same results are presented graphically in Fig. 5, which also includes the composition of offsets for the total sample.

The categories are affected by offsets in different propor-

J. Constr. Eng. Manage., 1996, 122(4): 363-369

TABLE 2. Breakdown of Offsets by Parameter

Parameter (1)	Short (2)	Low likelihood (3)	Actual problems (4)	Far (5)	Filler (6)	Total, offsets (7)
			(*a*) Absolute values			
Offset > 3	13	11	17	8	13	62
0 < Offset ≦ 3	20	10	15	4	1	50
Offset = 0	45	12	14	4	6	81
Offset < 0	6	4	5	4	1	20
Total, parameter	84	37	51	20	21	213
			(*b*) Severity			
Offset > 3	15.5	29.7	33.3	40.0	61.9	29.1
0 < Offset ≦ 3	23.8	27.1	29.4	20.0	4.8	23.5
Offset = 0	53.6	32.4	27.5	20.0	28.5	38.0
Offset < 0	7.1	10.8	9.8	20.0	4.8	9.4
Total, parameter	100.0	100.0	100.0	100.0	100.0	100.0

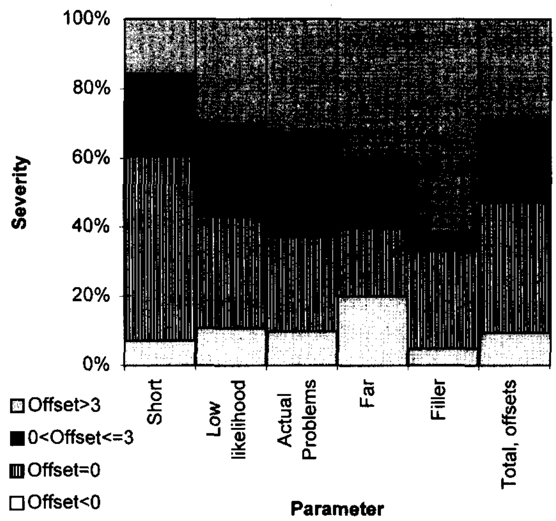

FIG. 5. Breakdown of Offset Severity by Parameter

tions. The "low likelihood" and "actual problems" classifications generally followed the proportions of the total sample, suggesting that they are not significant factors in predicting scheduling accuracy. The "short" classification had a high proportion of tasks on schedule and even performed ahead of schedule, pointing to a better predictability of short tasks. At the other end of the spectrum, "far" activities showed a lower accuracy than the total sample in the forecasting of their start dates with no offsets (20% against 38%)—an expectable result given that "far" activities were subject to greater uncertainty between the moment they were scheduled and their actual start.

The most significant difference in severity between the total sample and a single category was in "fillers." The majority of "fillers"—69%—had delays of more than 3 days against 29% for the total sample. This proportion reinforces the perception that fillers are indeed used by foremen at their discretion. A delay in a filler task has, by definition, little or no impact on the overall performance. It follows that these delays are not arbitrary, but correspond to a defined strategy. The low number of occurrences, especially in the "far" and "filler" categories, grant that the statistics discussed in this section be used only as guidelines.

SUMMARY AND RECOMMENDATIONS

This investigation has shown that electrical construction foremen can and do schedule their work efficiently in a complex environment that depends on factors mostly beyond their control, such as labor supply and other subcontractors' progress. Foremen were found to bear almost all the responsibility for the daily scheduling of their crews' work, which they handle in an informal, verbal manner.

Much of this study focused on the quantitative analysis of foreman scheduling. Its methodology proved to be fruitful in allowing a rapid and objective evaluation of scheduling data. The analysis of numerical data and subjective perceptions was also significant in picturing the foreman's planning reality. Although many of its findings corroborate basic planning and scheduling principles, this investigation was unique in showing that foremen experience the same uncertainties that upper management tackle at a more global level, and that foremen have developed specific strategies for their planning. Consequently, this study points to the wisdom of allowing flexibility in foreman's planning, as opposed to its micromanagement by upper levels within the firm.

Specifically, this study has shown that circumstances that lower uncertainty result in more accurate forecasts. For example, short and near tasks are easier to schedule than their long and far counterparts. The analysis of execution problems also led to logical conclusions: the dependence on the progress of other subcontractors is especially prone to problems, and those problems can arise uniformly on all days of the week. The detection of a deliberate pattern of using noncritical activities as fillers to achieve continuity in labor utilization was a significant finding of this research. This strategy was in line with the many clever ways in which efficient foremen were observed to manage their work, not limited to task scheduling. Examples of such fine abilities could be found in their crew management, in maintaining a steady supply of materials, and keeping good relations with the general contractor. These strategies, not covered in the present study, could constitute an important topic for further research.

Further research should also include the in-depth analysis of foreman and contractor attitudes toward scheduling. The methodology for new research on foreman planning could be based on this study, but to explore other planning dimensions, they should emphasize even more the in-depth interviewing component of this investigation.

Foremen were better at planning their work than they were willing to give themselves credit for. Was this simple modesty, or did it show disdain, fear of failure, or some other psychological idiosyncrasy? The foremen's medium- to long-term scheduling strategies should also be investigated and compared with the results from this study.

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J. Constr. Eng. Manage., 1996, 122(4): 363-369

APPENDIX I. INTERVIEW GUIDE

1. What percentage of production tasks typically slip from its planned start?
   If planned one week in advance:
   ____% slip by 1 day or less
   ____% slip by 3 days or less
   ____% slip by 1 week or less
   ____% slip by 1 week or more
   If planned two weeks in advance:
   ____% slip by 1 day or less
   ____% slip by 3 days or less
   ____% slip by 1 week or less
   ____% slip by 1 week or more
   If planned three weeks in advance:
   ____% slip by 1 day or less
   ____% slip by 3 days or less
   ____% slip by 1 week or less
   ____% slip by 1 week or more
2. What is the percentage that the duration of a production task typically varies with respect to its original intended value?
   If planned one week in advance ____%
   If planned two weeks in advance ____%
   If planned three weeks in advance ____%
3. What are the production tasks most likely to slip from their planned start?
4. What percentage of your production tasks' start is not known and have to be started:
   Next day ____%
   Next 3 days ____%
   Next week ____%
   Next month ____%
5. What percentage of your production tasks is devoted to:
   Repair own defective work ____%
   Perform work not originally contracted ____%
6. What percentage of production tasks have:
   Sufficient materials as soon as required ____%
   Sufficient tools as soon as required ____%
   Sufficient personnel as soon as required ____%
7. What percentage of production tasks get:
   Interrupted before finished to work elsewhere ____%
   Interrupted before finished for lack of resources ____%
   Started before optimum time to keep people busy ____%
8. What percentage of the personnel under your supervision is typically coming from:
   Previous jobs within your company ____%
   Union hiring halls ____%
   Other (explain) ____________ ____%
9. How many days in advance do you need to request additional personnel?
10. How many days in advance do you know you will need additional personnel?
11. What is your best guess of the percentage of foremen working for your company that have been retained after the completion of the job they have been working on? Consider the last two years.
12. What percentage of the typical work force under your responsibility has been working with the firm:
    A month or more ____%
    Three months or more ____%
    Six months ore more ____%
    A year or more ____%
13. How many days in advance of the actual required date do you order:
    Major components (e.g., switchgear) ____ days
    Minor components (e.g., conduits) ____ days

Comments:

APPENDIX II. REFERENCES AND BIBLIOGRAPHY

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