PRODUCTIVE FOREMEN IN INDUSTRIAL CONSTRUCTION

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ABSTRACT: This paper attempts to identify characteristics which differentiate productive industrial construction foremen from less productive industrial construction foremen. The first section, data collection methodology, explains how the data for this paper were gathered. The next section, statistical analysis, briefly describes why certain methods of statistical analysis were performed on the data. The following section, data analysis methodology, explains both how the data were grouped for analysis and how highly productive foremen were identified. The fourth section, criteria for identifying differentiating items among foremen, is appropriately titled. The results of the research project are then presented, followed by a conclusions section which summarizes the findings of the study.

INTRODUCTION

Purpose of Study.—This paper attempts to identify the ways in which highly productive industrial construction foremen perceive or perform their jobs differently than do less productive industrial construction foremen. This information can be of great use to the construction industry, as it may be incorporated into current foremen training programs to make these existing programs more effective.

Methodology of Study.—The methodology used to accomplish the study's purpose was broken into three distinct parts. First, data pertaining to how foremen perform and perceive their jobs were gathered. This data was obtained when foremen answered questions which dealt with the following topics: (1) Planning of work; (2) assignment of tasks to crew members; (3) ordering and delivery of materials, tools, and equipment; (4) layout of work; (5) communication with craftsmen; (6) showing appreciation to crew; (7) knowledge of craft; (8) innovation; (9) attitude towards safety; (10) daily time analysis; and (11) personal background. Construction related questions of a subjective nature were also asked of the foremen. These questions dealt with the following subjects: (12) Factors having the most positive effect on crew productivity; (13) factors having the most adverse effect on crew productivity; (14) factors having a positive impact on foremen productivity; (15) areas of responsibility in construction; and (16) factors of job satisfaction for foremen.

After gathering the data, the highly productive foremen were identified so that their data could be separated from the rest of the foremen's data. Finally, statistical analysis was used to identify the areas in which highly productive foremen perceive or perform their jobs differently than

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do other foremen. In this way, the study attempted to identify characteristics which differentiate highly productive foremen from less productive foremen.

Source of Data.—The data for the study were collected at a major refinery in the southwestern United States. The construction, performed by an open shop contractor, consisted of a large addition (>$500,000,000) to an existing petroleum refinery. Data used in this study was collected near the employment peak of the job when construction was between 50% and 70% complete. The major parties involved felt that the refinery addition was on schedule and within budget.

Data Collection Methodology

Questionnaires.—The data for this study were collected using questionnaires. Optically scanned computer answer sheets, marked by each participant, were used in conjunction with each questionnaire.

Three different questionnaires were used during this study, these being foreman, general foreman, and craftsman questionnaires. The foremen questionnaire, given to 245 foremen, consisted of 57 questions. The first 32 questions covered the 16 topics previously mentioned. The remaining 25 questions were mainly of interest to the construction contractor. The questionnaire sessions ranged in attendance from 15–25 foremen/session.

The craftsman questionnaire, given to 77 craftsmen, consisted of 12 questions. These questions, which were intended to get craftsmen's view of their foremen, were practically identical to questions in the foremen questionnaire. These questionnaire sessions ranged in attendance from 15–20 craftsmen/session.

The general foreman questionnaire, given to 60 general foremen, consisted of 36 questions. These questions were intended to get the general foremen's perspective of their foremen and were, once again, very similar to those asked on the foremen questionnaire. The questionnaire sessions ranged in size from 15–25 general foremen/session.

Statistical Analysis

The type of statistical analysis which can be performed on data is a function of its distribution, magnitude, and level of measurement. Ranking, which was used extensively throughout this study, is considered an ordinal level of measurement. Ordinal measurement recognizes an order among the categories, but does not recognize an interval among the order.

M. G. Kendall developed a correlation analysis to be used specifically with nonparametric data, i.e., data that is ordinal, numeric, and may or may not be normally distributed (1). The data gathered in this study satisfies those conditions quite well; thus, Kendall correlation analysis was used exclusively throughout this study.

Data Analysis Methodology

Foremen Groupings.—Appendix I shows the craft breakdown of the

foremen who participated in this study. The foremen data were analyzed in three different groups, these being: all foremen, electrical foremen, and aboveground pipefitting foremen. According to Roscoe, behavioral research should be avoided on samples smaller than 30 in size (2). Since the electrical and aboveground pipefitting foremen groups contained 34 and 36 foremen, respectively, their responses could be analyzed separately.

Identifying Highly Productive Foremen.—In order to distinguish highly productive foremen from other foremen, a measurement criteria had to be developed. Ideally, the criteria should be quantitative in nature and free from bias. A unit rate, such as work completed per man-hour, would be an appropriate criterion; unfortunately, this information was not available for each individual foreman. Thus, an alternate form of measurement was needed. We chose, for this measurement, an index which attempted to measure the foreman's knowledge of productivity and cost-control related ideas.

To test the validity of the index, all general foremen and foremen on the job site were asked five questions. Since general foremen are promoted from the foremen level largely based on their expertise as foremen, it was hoped that the general foremen would score higher on the test questions that would the foremen. If indeed this did occur, it would largely validate the use of the index as a differentiating device among foremen. The five questions shown in Appendix II were used to make up the index.

Based on a scoring system of 1 and 0 for correct and incorrect answers, respectively, Appendix III shows the average score for the foremen and general foremen in the three foremen groupings analyzed. Since general foremen scored significantly higher than did the foremen on the test, the use of the index as a differentiating device among foremen was validated.

Criteria for Identifying Differentiating Items among Foremen

All Foremen.—This group was made up of all 245 foremen who answered the foremen questionnaire. For each question, the Kendall correlation coefficient and the corresponding level of significance were computed using bivariate analysis. A question which had a coefficient ≥ 0.15 and a significance level ≤ 0.01 was identified as being a differentiating characteristic among all foremen.

The seemingly low value of 0.15 was chosen as the correlation coefficient cutoff for the following reasons. First, most of the foremen on this construction project were average or above average foremen. The construction contractor simply demoted or fired foremen who were not doing a satisfactory job. Therefore, the group was rather homogeneous with respect to their foreman skills, thus the low correlation coefficients. Secondly, the group contained 26 different crafts, each with its particular work demands. Therefore, a highly productive foreman in one craft might answer a question differently than would a highly productive foreman in another craft. This potential disparity of "correct" answers among highly productive foremen also helped justify the low correlation coefficient cutoff. The level of significance was chosen to be < 0.01 due to

the large data base (245 cases) and the fact that the research is rather behavioral in nature.

Electrical Foremen.—This group was made up exclusively of electrical foremen, 34 in all, who answered the foremen questionnaire. A Kendall correlation coefficient ≥ 0.20 and a level of significance ≤ 0.10 were used for this group's cutoff criteria. The cutoff correlation coefficient increased 0.05 from the "all foremen" level due to the fact that only one craft was being analyzed, thus decreasing the disparity of "correct" answers among highly productive foremen. As stated previously, a group of 30 is needed in order to validate the statistical results. Since the number of electrical foremen participating in this study barely exceeded 30, it was appropriate to raise the cutoff level of significance to 0.10.

Aboveground Pipefitting Foremen.—The criteria used to identify items which are differentiators among aboveground pipefitting foremen are identical to the ones used for electrical foremen; thus, the reasoning behind, and the explanation for, each criteria will not be repeated here (refer to previous section on electrical foremen).

Results

Appendices IV–XIII present the major rather than the complete results of this research project. Each appendix is broken into three parts. The first part contains the question and possible answers as they appeared in the questionnaire and are found at the top of each appendix. This section is then followed by a Results section which lists the results for the all foremen, electrical foremen, and aboveground pipefitting foremen groups (and general foremen and craftsmen groups where applicable). The last section, Differentiating Items, identifies the differentiating items for the question and offers a brief explanation of each differentiating item for the all foremen, electrical foremen, and aboveground pipefitting foremen groups. The Kendall correlation coefficient and the level of significance are identified in parentheses after each of the differentiating items.

The appendices are meant to be self-explanatory; however, readers may have a few questions concerning their format. Thus, the following example will be explained to the reader in a step-by-step manner.

How many days ahead do you plan work in your head?

1	2	3	4	5
I don't	Less than 1	1–2	2–4	More than 4

In this case the question is, "How many days ahead do you plan work in your head?" The accompanying answers are 1, 2, 3, 4, and 5 corresponding to "I don't," "Less than 1," "1–2," "2–4," and "More than 4," respectively. Thus a foreman who plans work in his head less than one day in advance would circle 2.

The next section, "Results," lists the mean values for each of the three groups analyzed, these being all foremen, electrical foremen, and aboveground pipefitting foremen. The following is the results section to the example:

********** Results **********

FOREMEN		
All	Electrical	Aboveground Pipefitting
3.6	4.1	3.9

The mean value for all foremen is 3.6. Since a value of 4 was marked by foremen who plan their work in their heads 2–4 days in advance and a value of 3 was marked by foremen who plan their work in their heads 1–2 days in advance, the value of 3.6 means that "all foremen" plan their work in their heads between 1–2 and 2–4 days in advance. To assign a more specific translation of the mean value into the amount of time a foreman plans work in his head is to ignore the accuracy of the answers that make up the mean value. This argument is analogous to the idea of significant digits.

The last section of the example identifies the differentiating items associated with the question and is presented below.

********** Differentiating Items **********

All Foremen

Diff. Item: Planning of work in foremen's heads (Corr. = 0.26, Sig. = 0.01)

Explanation: Highly productive foreman plan their work in their heads farther in advance than do other foremen.

Electrical Foremen

Diff. Item: Planning of work in foremen's heads (Corr. = 0.31, Sig. = 0.03)

Explanation: Highly productive electrical foremen plan their work in their heads farther in advance than do other electrical foremen.

Aboveground Pipefitting Foremen

Diff. Item: Planning of work in foremen's heads (Corr. = 0.35, Sig. = 0.01)

Explanation: Highly productive aboveground pipefitting foremen plan their work in their heads farther in advance than do other aboveground pipefitting foremen.

In this question, the highly productive foremen from all three groups had as a differentiating item, "Planning of work in foremen's heads." The numbers in parentheses after each differentiating item are the Kendall correlation coefficient and the level of significance. An explanation of the meaning of the relationship between the differentiating item and the correlation coefficient is offered immediately below each "Differentiating Item" so that the reader is relieved from the burden of interpreting statistics. In this particular question, the statistical analysis performed on the results indicated that the more productive foremen from all three groups planned their work in their heads farther in advance than did the other foremen in their groups as stated in the explanation offered under each "Diff. Item."

Appendices IV–XIII are similar in format to the example table; thus,

they should be interpreted in a similar manner.

Readers interested in obtaining the complete results of this research project are encouraged to contact the Construction Industry Institute, University of Texas at Austin, Department of Civil Engineering, E.C.J. 5.402, Austin, Texas 78712.

CONCLUSIONS

"Conclusions" is divided into two parts. The first part, "Common Differentiating Items," discusses the results based on the 16 subjects identified in "Methodology of Study." Differentiating items in each subject which are common to all three foremen groups (all foremen, electrical foremen, aboveground pipefitting foremen) are identified and commented on. The second part, "Craft Specific Differentiating Items," identifies and comments on the differentiating items for each foremen group. For example, the items which differentiate highly productive electrical foremen from less productive electrical foremen are identified in this section, regardless of whether or not these items are productivity differentiators for the all foremen and aboveground pipefitting foremen groups.

Common Differentiating Items.—The following section identifies the differentiating items which are similar among the three foremen groups for each of the 16 subjects.

Subject 1: Planning of Work.—It is obvious, based on the results shown in Appendices IV and V, that highly productive foremen plan their work farther in advance than do less productive foremen. This planning seems to take place in the foremen's heads rather than on paper; however, mental planning seems to be effective as highly productive foremen are more certain of what their crew members will be doing today than are less productive foremen.

Subject 3: Ordering and Delivery of Materials, Tools, Equipment, and Scaffold.—No items were identified as always being ordered early by all three groups of productive foremen. Rather, one group of productive foremen order one item early while another group of productive foremen order a different item early. Nevertheless, although the association may be weak, based on results shown in Appendix VIII, it appears as if highly productive foremen generally order their items sooner than do less productive foremen.

Subject 5: Communication with Craftsmen.—Based on the results as shown in Appendix IX, it appears as if highly productive foremen are more honest with their crews with respect to schedule than are less productive foremen. It should be mentioned that the results are not unanimous; rather, this conclusion is a generalization.

Subjects 2, 4, 6–16.—There appears to be no consistent differentiating items among the three groups of highly productive foremen based on the results to the questions pertaining to Subjects 2, 4, 6–16.

Craft Specific Differentiating Items.—The following general conclusions concerning each group of highly productive foremen have been developed based on the explanation of the differentiating items as seen in the appendices.

All Foremen.—The results of this research indicates that planning, either

on paper or in the head, is the major differentiator between highly productive and less productive foremen. Appendices IV and V have differentiating items for the all foremen group which plainly indicate that highly productive foremen do more planning than do less productive foremen. Appendix VIII, dealing with lead times for ordering materials, tools, etc., indicates that highly productive foremen tend to allow more lead time when ordering materials than do other foremen. This implies that the highly productive foremen tend to plan farther in advance when ordering materials than do less productive foremen. Thus, it seems in the best interest of construction managers to emphasize the importance of planning and to offer a training program in crew level planning to all foremen on the job site. Perhaps some type of incentive scheme could be developed whereby foremen who fill out weekly planning forms would qualify for a reward. Merely emphasizing to the foremen the importance of planning will do little to change the planning habits; however, an incentive plan related to planning is likely to persuade some foremen to change their planning habits.

Electrical Foremen.—Three major conclusions become evident when comparing the items which were found to be productivity differentiators among electrical foremen. First, highly productive foremen plan farther in advance than do less productive electrical foremen (see "Electrical Foremen" differentiating items in Appendixes IV and V). Recommendations concerning planning are contained in the immediately preceding "All Foremen" section and will not be repeated here.

Secondly, highly productive electrical foremen readily share construction schedule status with their crews while less productive electrical foremen are not so likely to do so. The differentiating items from Appendix IX indicate that highly productive electrical foremen are much more likely to share good news concerning their crew's construction progress with their crew than are less productive electrical foremen. The sharing of good news serves as a form of positive reinforcement; workers are likely to feel a sense of personal and group satisfaction knowing that they have done a job in less time than the "experts in the home office" thought they would. Workers should be told when they are behind, on, or ahead of schedule so that they can set goals based on the schedule. Foremen should not use the schedule merely as a whipping tool, telling the crew when they are behind schedule but neglecting to tell the crew when they are on or ahead of schedule. Schedule information used in this way will, in the long run, not increase crew productivity.

Finally, highly productive electrical foremen also indicate that they take the personal preferences of their workers into account when assigning work tasks more often than do less productive electrical foremen. Appendix VII identifies this item as being a differentiator for electrical foremen. The item "I try to take into account the personal preferences of craftsmen" was nearly identified in Appendix VI as a differentiating item, as it had a correlation coefficient of -0.19 and a level of significance of 0.14. Therefore, the idea that workers perform better working at jobs they enjoy seems to be valid, at least for electrical craftsmen. Thus, electrical foremen should be encouraged to assign tasks based, at least partly, on the personal preferences of the men in their crews.

Aboveground Pipefitting Foremen.—After examining the items found to be differentiators among aboveground pipefitting foremen, the following conclusions can be made. Aboveground pipefitting foremen are similar to electrical foremen, in that highly productive aboveground pipefitting foremen are more likely to take into account the personal preferences of their workers than are less productive aboveground pipefitting foremen (see "Aboveground Pipefitting Foremen" differentiating items in Appendixes X and XIII). The recommendations made concerning this item, as found in the preceding "Electrical Foremen" section, still hold true and thus are not repeated here.

Secondly, planning is found to be a differentiator among aboveground pipefitting foremen; i.e., highly productive aboveground pipefitting foremen plan farther in advance than do other aboveground pipefitting foremen (see "Aboveground Pipefitting Foremen" differentiating items in Appendixes IV, V, and VIII). This differentiating item is discussed in the "All Foremen" section of "Conclusions" and will not be repeated at this time.

While planning and taking into account the personal preferences of workers seem to be somewhat common differentiators among foremen, aboveground pipefitting foremen have a differentiator which seems to be exclusively theirs. When compared to the average aboveground pipefitting foremen, the more productive aboveground pipefitting foremen place more responsibility on their crews. This may be a direct result of the aboveground pipefitting foremen's large crew size (see Appendix XII). With a large crew a foreman has less time to train each new worker than does a foreman with a smaller crew; thus, the more productive aboveground pipefitting foremen depend upon, to a greater extent than do other aboveground pipefitting foremen, experienced craftsmen to train inexperienced workers. (See "Aboveground Pipefitting Foremen" differentiating item in Appendix VI.)

Similarly, highly productive aboveground pipefitting foremen tend to pass the responsibility for solving problems concerning construction methods on to others, as they solve these problems less often than do other aboveground pipefitting foremen (see "Aboveground Pipefitting Foremen" differentiating items from Appendix XI). Thus, crew members working for highly productive aboveground pipefitting foremen are likely to become more involved in the problem solving area; however, along with the involvement comes a certain amount of responsibility, responsibility most other crews do not have. From Appendix IX it is seen that highly productive aboveground pipefitting foremen are more likely to tell their crews that they are behind schedule when they are, in fact, behind schedule than are other aboveground pipefitting foremen. Undoubtedly, at least some of the responsibility for being behind schedule is put on the crews. Furthermore, from Appendix XIII it is seen that highly productive aboveground pipefitting foremen are less willing to accept responsibility for work than are other aboveground pipefitting foremen. Thus, highly productive aboveground pipefitting foremen are more likely to put the responsibility for work on their craftsmen than are less productive aboveground pipefitting foremen.

So, when compared to other aboveground pipefitting foremen, it seems

clear that highly productive aboveground pipefitting foremen place more responsibility on their crews.

Appendix I.—Foremen Craft Breakdown

Boilermakers	3	Pipefitters	
Carpenters	14	Aboveground	36
Concrete	5	Hangers	15
Electricians	34	Testing	5
Excavation	6	Underground	4
Field Engineers	8	Precommissioning	1
Instrumentation	19	Reinforcing Iron Workers	3
Insulation	9	Riggers	9
Laborers	10	Scaffold Builders	7
Masonry	1	Structural Iron Workers	10
Mechanics	5	Transportation	7
Millwright	10	Warehouse	1
Painters	9	Welders	11
		Inaccurately Coded	3

Appendix II.—Index Questions

1. What is the purpose of the Code of Accounts?
   a. A baseline for estimating projects at a detailed level of activity.
   b. To accumulate actual job data.
   c. To analyze progress and productivity at a detailed level of activity.
   d. All of the above.*
2. What effect does "sandbagging" have on an activity?
   a. Overstates progress.
   b. Understates progress.*
   c. Has no effect on progress.
   d. None of the above.
3. What does crew mix mean?
   a. The ratio of helper to craftsman man-hours.*
   b. The ratio of direct supervisor to craftsman and helper man-hours.*
   c. None of the above.
   d. All of the above.
4. What are the primary results of a "high" crew mix?
   a. Excessive labor dollars spent.*
   b. Not enough labor dollars spent.
   c. Bad productivity.
   d. Understates progress.
5. Define a variance.
   a. Increased from the original budget.
   b. Decreased from the original budget.
   c. Any deviation from the original budget.
   d. All of the above.*

*correct answer(s)

Appendix III.—Index Scores

All Foremen	3.1

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All General Foremen 3.4

Electrical Foremen 3.6
Electrical General Foremen 4.1

Aboveground Pipefitting Foremen 3.7
Aboveground Pipefitting General Foremen 4.0

Appendix IV.—Mental Planning by Foremen

Section 1: Planning of Work

How many days ahead do you plan work in your head?

1	2	3	4	5
I don't	Less than 1	1–2	2–4	More than 4

********** Results **********

FOREMEN		
All	Electrical	Aboveground Pipefitting
3.6*	4.1	3.9

*Values in table are mean values for each group. For example, the value of 3.6 for "all foremen" means that foremen plan work in their heads between 1–2 and 2–4 days in advance.

********** Differentiating Items **********

All Foremen

Diff. Item: Planning of work in foremen's heads (Corr. = 0.26, Sig. = 0.01)

Explanation: Highly productive foremen plan their work in their heads farther in advance than do other foremen.

Electrical Foremen

Diff. Item: Planning of work in foremen's heads (Corr. = 0.31, Sig. = 0.03)

Explanation: Highly productive electrical foremen plan their work in their heads farther in advance than do other electrical foremen.

Aboveground Pipefitting Foremen

Diff. Item: Planning of work in foremen's heads (Corr. = 0.35, Sig. = 0.01)

Explanation: Highly productive aboveground pipefitting foremen plan their work in their heads farther in advance than do other aboveground pipefitting foremen.

Appendix V.—Knowledge of Future Crew Activities

Subject 1: Planning of Work

How well do you (foremen) know what every member of your crew will

be doing today, tomorrow, 2 days from now, 3 days from now, and more than 3 days from now

1 Certain 2 Pretty sure 3 Not sure at all

	FOREMEN				
	All	Electrical	Aboveground Pipefitting	General Foremen	Crafts-men
Today	1.1	1.1	1.1	1.1	1.2
Tomorrow	1.5	1.3	1.2	1.5	1.8
2 days from now	1.9	1.7	1.8	2.0	2.4
3 days from now	2.1	2.0*	2.1	2.2	2.6
More than 3 days from now	2.3	2.2	2.3	2.5	2.8

*Values in table are mean values for each group. For example, the value of 2.0 for "electrical foremen" means that electrical foremen are pretty sure of what their crews will be doing 3 days from now.

********** Differentiating Items **********

All Foremen

Diff. Item: Today (Corr. = −0.20, Sig. = 0.01)
Explanation: Highly productive foremen are more certain about knowing today's work assignments than are other foremen.

Electrical Foremen

Diff. Item: Today (Corr. = −0.33, Sig. = 0.06)
Explanation: Highly productive electrical foremen are more certain about knowing today's work assignments than are other electrical foremen.

Aboveground Pipefitting Foremen

Diff. Item: Today (Corr. = −0.28, Sig. = 0.09)
Explanation: Highly productive aboveground pipefitting foremen are more certain about knowing today's work assignments than are other aboveground pipefitting foremen.
Diff. Item: 3 days from now (Corr. = −0.26, Sig. = 0.06)
Explanation: Highly productive aboveground pipefitting foremen are more certain about knowing what their crews will be doing 3 days from now than are other aboveground pipefitting foremen.

APPENDIX VI.—WAYS IN WHICH FOREMEN ASSIGN WORK

Subject 2: Assignment of Tasks to Crew Members

Based on the methods listed below, how do you assign tasks to your crew members? (This question was presented to the foremen as a rank-

ing question with 1 being the most common way to assign a task.)

	FOREMEN		
	All	Electrical	Aboveground Pipefitting
I try to assign the work so that it gets done as quickly as possible.	1*	1	1
I try to take into account the personal preferences of craftsmen.	3	3	3
I try to pair inexperienced craftsmen with experienced craftsmen.	2	2	2
I leave it up to the workers as to who does what.	5	5	5
I randomly pair workers to the job.	4	4	4

*Values in table are rank values for each group with 1 being the most common way to assign tasks to crew members and 5 being the least common way to assign tasks to crew members.

********** Differentiating Items **********

All Foremen

Diff. Item: None

Electrical Foremen

Diff. Item: None

Aboveground Pipefitting Foremen

Diff. Item: I try to pair inexperienced craftsmen with experienced craftsmen (Corr. = −0.21, Sig. = 0.09)

Explanation: Highly productive aboveground pipefitting foremen try to pair inexperienced and experienced craftsmen together when assigning work more often than do other aboveground pipefitting foremen.

Diff. Item: I randomly pair workers to the job (Corr. = 0.29, Sig. = 0.05)

Explanation: Highly productive aboveground pipefitting foremen randomly pair workers to the job less often than do other aboveground pipefitting foremen.

APPENDIX VII.—CONSIDERING CRAFTSMEN PREFERENCE

Subject 2: Assignment of Tasks to Crew Members

When assigning tasks to the craftsmen, how often do you take into account the craftsmen's personal preferences?

1	2	3	4	5
Less than 10% of the time	10–25% of the time	25–50% of the time	50–75% of the time	Over 75% of the time

********** Results **********

FOREMEN		
All	Electrical	Aboveground Pipefitting
2.6*	2.6	2.3

*Values in table are mean values for each group. For example, the value of 2.6 for "all foremen" means that foremen take into account the craftsmens' personal preferences between 10–25% and 25–50% of the time.

********** Differentiating Items **********

All Foremen

Diff. Item: None

Electrical Foremen

Diff. Item: Taking into account craftsmens' preferences when assigning work (Corr. = 0.22, Sig. = 0.08)

Explanation: Highly productive electrical foremen are more likely to take into account the preferences of their workers when assigning work than are other electrical foremen.

Aboveground Pipefitting Foremen

Diff. Item: None

APPENDIX VIII.—ORDERING LEAD TIME

Subject 3: Ordering and Delivery of Materials, Tools, Equipment, and Scaffold

On the average, when ordering materials, tools, equipment, and scaffold how much lead time do you figure is necessary so that you will have the ordered item when you need it?

1	2	3	4	5
0–2 hrs	2–5 hrs	5–10 hrs	1–3 days	More than 3 days

	FOREMEN		
	All	Electrical	Aboveground Pipefitting
Materials	3.7	4.3	4.4
Tools	2.2*	2.8	2.2
Equipment	3.1	3.3	3.5
Scaffold	3.8	3.8	3.8

*Values in table are mean values for each group. For example, the value of 2.2 for "all foremen" means that foremen order tools a little more than 2–5 hours in advance of when the tools are needed.

********** Differentiating Items **********

All Foremen

Diff. Item: Materials (Corr. = 0.21, Sig. = 0.01)

Explanation: Highly productive foremen tend to allow for more lead time when ordering materials than do other foremen.

Electrical Foremen

Diff. Item: None

Aboveground Pipefitting Foremen

Diff. Item: Tools (Corr. = 0.35, Sig. = 0.01)

Explanation: Highly productive aboveground pipefitting foremen tend to allow for more lead time when ordering tools than do other aboveground pipefitting foremen.

APPENDIX IX.—SHARING SCHEDULE INFORMATION WITH CREW

Subject 5: Communication with Craftsmen

In the four situations listed below, how honest are you with your crew? Use either always, normally, seldom, or never as your answer.

1 Always 2 Normally 3 Seldom 4 Never

	FOREMEN			
	All	Electrical	Aboveground Pipefitting	Crafts-men
I tell my crew that they are behind schedule when they are, in fact, behind schedule.	1.6	1.6	1.8	2.3
I tell my crew that they are on schedule when they are, in fact, on schedule.	1.9*	2.1	2.1	2.5
I tell my crew that they are ahead of schedule when they are, in fact, ahead of schedule.	2.2	2.5	2.1	2.8
I tell my crew that they are behind schedule when they are, in fact, either on schedule or ahead of schedule.	3.6	3.5	3.7	3.1

*Values in table are mean values for each group. For example, the value of 1.9 for "all foremen" means that foremen normally tell their crews that they are on schedule when they are, in fact, on schedule.

********** Differentiating Items **********

All Foremen

Diff. Item: None

Electrical Foremen

Diff. Item: I tell my crew that they are on schedule when they are, in fact, on schedule. (Corr. = −0.25, Sig. = 0.07)

Explanation: Highly productive electrical foremen are more likely to tell their crews that they are on schedule when they are, in fact, on schedule than are other electrical foremen.

Diff. Item: I tell my crew that they are ahead of schedule when they are, in fact, ahead of schedule. (Corr. = −0.22, Sig. = 0.10)

Explanation: Highly productive electrical foremen are more likely to tell their crews that they are ahead of schedule when they are, in fact, ahead of schedule than are other electrical foremen.

Aboveground Pipefitting Foremen

Diff. Item: I tell my crew that they are behind schedule when they are, in fact, behind schedule. (Corr. = −0.22, Sig. = 0.08)

Explanation: Highly productive aboveground pipefitting foremen are more likely to tell their crews that they are behind schedule when they are, in fact, behind schedule than are other aboveground pipefitting foremen.

APPENDIX X.—METHODS OF SHOWING APPRECIATION

Subject 6: Showing Appreciation to Crew

How do you usually show appreciation to individuals in your crew for a job well done? (This question was presented to the foremen as a ranking question with 1 being the most common way to show appreciation.)

	FOREMEN		
	All	Electrical	Aboveground Pipefitting
Compliments, praise	1*	1	1
Tolerance of breaks	5	5	5
Receptive to suggestions	3	2	3
Recommend for rate increase or promotion	2	3	2
Tolerance to early quits or late starts	7	6	7
Selective job assignment	4	4	4
Other	6	6	6

*Values in table are rank values for each group with 1 being the most common way to show appreciation to individuals in a crew and 7 being the least common way to show appreciation to individuals in a crew.

********** Differentiating Items **********

All Foremen

Diff. Item: None

Electrical Foremen

Diff. Item: None

Aboveground Pipefitting Foremen

Diff. Item: Compliments, praise (Corr. = −0.25, Sig. = 0.08)
Explanation: Highly productive aboveground pipefitting foremen are more likely to use praise to show appreciation to members of their crews for work well done than are other aboveground pipefitting foremen.
Diff. Item: Receptive to suggestions (Corr. = 0.27, Sig. = 0.04)
Explanation: Highly productive aboveground pipefitting foremen are less likely to be receptive to suggestions to show appreciation to members of their crews for work well done than are other aboveground pipefitting foremen.
Diff. Item: Selective job assignment (Corr. = −0.29, Sig. = 0.04)
Explanation: Highly productive aboveground pipefitting foremen are more likely to use selective job assignment to show appreciation to members of their crews for work well done than are other aboveground pipefitting foremen.

Appendix XI.—Construction Methods Problem Solving

Subject 8: Innovation

Estimate, on the average, how you solve problems relating to construction methods on the job site?

1	2	3	4	5
0–20% of the time	20–40% of the time	40–60% of the time	60–80% of the time	80–100% of the time

	FOREMEN		
	All	Electrical	Aboveground Pipefitting
Someone within my crew comes up with a good solution.	2.1*	2.2	2.0
I come up with a good solution.	3.5	3.5	3.7
I ask someone outside my crew for advice and they come up with a good solution	1.7	1.6	1.7

*Values in table are mean values for each group. For example, the value of 2.1 for "all foremen" means that someone within a foremen's crew comes up with a good solution to a problem related to construction methods a little more than 20–40% of the time.

********** Differentiating Items **********

All Foremen

Diff. Item: None

Electrical Foremen

Diff. Item: None

Aboveground Pipefitting Foremen

Diff. Item: I come up with a good solution (Corr. = −0.38, Sig. = 0.01)

Explanation: Highly productive aboveground pipefitting foremen do not come up with good solutions to construction methods problems as often as do other aboveground pipefitting foremen.

Appendix XII.—Average Crew Size

Subject 11: Personal Background

What is your average crew size?

1	2	3	4	5
1–7 workers	8–10 workers	11–14 workers	14–19 workers	More than 19 workers

********** Results **********

FOREMEN		
All	Electrical	Aboveground Pipefitting
3.0*	2.9	3.4

*Values in table are mean values for each group. For example, the value of 3.0 for "all foremen" means that foremen direct an average crew size of 11–14 workers.

********** Differentiating Items **********

All Foremen

Diff. Item: None

Electrical Foremen

Diff. Item: Average size of crew (Corr. = 0.32, Sig. = 0.03)

Explanation: Highly productive electrical foremen tend to be in charge of crews which are larger than other electrical foremen's crews

Aboveground Pipefitting Foremen

Diff. Item: None

Appendix XIII.—Factors Having a Positive Impact on Foremen Productivity

Subject 14: Factors Having a Positive Impact on Foremen Productivity

Which of these factors have the most positive impact on whether a foreman is productive or not? (This question was presented to the foremen as a ranking question with 1 having the most positive impact on foremen productivity.)

	FOREMEN				
	All	Electrical	Aboveground Pipefitting	General Foremen	Craftsmen
Gives clear directions	2*	2	2	2	1
Plays no favorites among workers	8	9	9	9	8
Has work well planned out	1	1	1	1	2
Even tempered	14	12	14	14	14
Is creative when it comes to problem solving	10	10	10	10	7
Takes into account preferences of workers when assigning work	12	11	12	13	13
Willing to accept suggestions	5	5	5	6	4
Accept responsibility for work	7	7	8	6	9
Lays out work quickly	13	13	13	12	10
Makes decisions quickly	11	14	10	11	11
Has a lot of self-confidence	9	8	7	8	12
Is proud of his work and crew	6	6	6	5	6
Is good at motivating his crew	4	3	4	4	3
Stresses safety	3	4	3	3	5

*Values in table are rank values for each group with 1 having the most positive impact on foreman productivity and 14 having the least positive impact on foreman productivity.

********** Differentiating Items **********

All Foremen

Diff. Item: None

Electrical Foremen

Diff. Item: None

Aboveground Pipefitting Foremen

Diff. Item: Even tempered (Corr. = −0.26, Sig. = 0.08)

Explanation: Highly productive aboveground pipefitting foremen feel that being even tempered has a more positive effect on foremen productivity than do other aboveground pipefitting foremen.

Diff. Item: Is creative when it comes to problem solving (Corr. = 0.28, Sig. = 0.06)

Explanation: Highly productive aboveground pipefitting foremen feel that creative problem solving is less of a positive factor on

foremen productivity than do other aboveground pipefitting foremen.

Diff. Item: Takes into account preferences of workers when assigning work (Corr. = −0.25, Sig. = 0.09)

Explanation: Highly productive aboveground pipefitting foremen feel that taking into account workers preferences when assigning work has a more positive impact on foremen productivity than do other aboveground pipefitting foremen.

Diff. Item: Willing to accept responsibility for work (Corr. = 0.43, Sig. = 0.01)

Explanation: Highly productive aboveground pipefitting foremen feel that accepting responsibility for work is less likely to have a positive impact on foremen productivity than do other aboveground pipefitting foremen.

Diff. Item: Has a lot of self-confidence (Corr. = −0.27, Sig. = 0.05)

Explanation: Highly productive aboveground pipefitting foremen feel that having a lot of self-confidence has a more positive impact on foremen productivity than do other aboveground pipefitting foremen.

Diff. Item: Is good at motivating his crew (Corr. = −0.37, Sig. = 0.01)

Explanation: Highly productive aboveground pipefitting foremen feel that expertise in crew motivation has a more positive impact on foremen productivity than do other aboveground pipefitting foremen.

Diff. Item: Stresses safety (Corr. = 0.26, Sig. = 0.04)

Explanation: Highly productive aboveground pipefitting foremen feel that stressing safety has less of a positive impact on foremen productivity than do other aboveground pipefitting foremen.

Appendix XIV.—References

1. Nie, N. H., et al., *Statistical Package for the Social Sciences*, 2nd ed., McGraw-Hill, New York, N.Y., 1975.
2. Roscoe, J. T., *Fundamental Research Statistics for the Behavioral Sciences*, Holt, Rinehart and Winston, Inc., New York, N.Y., 1969.