PREBID AND PRECONSTRUCTION PLANNING PROCESS

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ABSTRACT: Construction planning systems have been the subject of research, development, and implementation for the last several decades. Most studies have focused on planning tools and techniques, and not on the planning process itself. This paper presents the results of a research project that examined how construction planning is actually done at the prebid and preconstruction planning stages. The data were gathered through personal in-depth interviews conducted with experienced, competent project managers and other functionaries in leading, progressive United States construction companies. Construction planning was examined by four principal measures: the degree of involvement in the planning process; the proportion of plan issuance; the relative planning effort in various functional plans; and the formats used for issuing plans. The findings suggest that the practice of construction planning differs from what is commonly accepted and supported by the existing literature.

INTRODUCTION

Construction planning systems have been the subject of research, development, and implementation for the last several decades. Yet the essence of the planning process remains to be learned and refined, and its implementation improved ("Report" 1983; Mason 1984; Laufer and Tucker 1987; Laufer et al. 1992a). Most relevant studies have focused on tools and techniques, while very few have tried to describe the planning process itself (Erskine-Murray 1972; Birrel 1980; "Closing" 1984; Cormican 1985).

Central to understanding the planning process is the distinction between "planning" and "plan." Adopting Mintzberg's (1981) definition, we say that planning is a process of deciding what to do and how to do it before action is required. Planning includes the integration of a set of interdependent decisions. The plan is the formulation of the results of this process.

This paper presents the results of a recent research program that studied how construction planning is actually done, describing the planning process in detail and in practical terms. The description addresses both planning and plans. More specifically, it purports to answer the following questions:

- What is the involvement of the participating parties in planning?
- What is the effort invested in planning?
- How many types of plans are issued?
- Which formats are used for plans?

In the present study, these issues were examined at and above the level of site management.

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Cormican (1985) and others found that, throughout the life of a project, the construction planning process can be divided into three identifiable stages: prebid planning, preconstruction planning, and during-construction planning. The present paper addresses the first two of these, while all three are the concern of a complete report on this research (Laufer et al. 1992b).

RESEARCH METHODOLOGY

The research project presented in this paper followed two earlier studies (Laufer 1989, 1990), which examined the construction-planning process performed by the owner; the present study focuses on the construction company.

The data were gathered through personal interviews conducted in eight leading construction companies in the Western United States. Selection criteria included their progressive planning culture, procedures, and tools, and (due to time and budget constraints) their relatively convenient locations (in California, Washington, and Colorado). A total of 22 interviews were held, of which 18 were found to be usable. According to self-grading of projects by interviewees, all projects demonstrated moderate to high complexity and levels of innovation.

Participating companies, which selected their own representative interviewees, were asked to choose experienced, competent functionaries. Usable interviews came from two project executives, 11 project managers, two general superintendents, and three project engineers. The in-depth interviews lasted about three hours each, up to half a day. They included open discussions and specific questions, as well as prevalidation of the form and orientation of some sensitive questions. The interviews addressed a broad range of topics, all of which are covered in the complete report on the present study (Laufer et al. 1992b). The profile of the participating projects is presented in Table 1. Actual construction durations, shown in Table 1, were in most cases the same as that planned.

The interviews and the structured guide on which they were based constituted the third and concluding phase in the development of the research methodology. Two preceding phases served as a pilot study. The first of these included five profound interviews with project managers in Israel. Each interview lasted four hours and provided the basic input for the generation of a questionnaire, the main research tool. The questionnaire was then further tested through extensive discussions held with eight project managers on the East Coast of the United States. Excerpts from the final interview guide appear in Appendix I. The questions referred to a specific, recent project selected by the interviewee.

Research Variables

The interview focused on three major research variables: (1) Project stages; (2) functional plans; and (3) planning parties.

Project Stages

The prebid planning (PBP) stage takes place prior to submission of a bid. The duration of prebid planning varies widely, from several weeks to several months and more, depending mainly on type of contract.

The preconstruction planning (PCP) stage lasts up to three months. It expands from bid-award, which is typically not more than one month prior to mobilization, to a certain point in the construction process (normally not more than two additional months beyond mobilization).

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TABLE 1. Characteristics of Projects

Size of project (1)	Project Cost (millions of dollars)		Construction Duration (months)		NUMBER OF PROJECTS					
					By Type of Contract		By Type of Facility			
	Range (2)	Median (3)	Range (4)	Median (5)	Lump sum (6)	Cost reimbursable (7)	Commercial and public (8)	Industrial (9)	R&D (10)	Total (11)
Small/medium	10–49	31	10–24	14	1	7	2	4	2	8
Large	58–195	84	7–50	24	6	4	7	2	1	10
[Total]	10–195	58	7–50	23	7	11	9	6	3	18

Prior to addressing specific questions, the respondents unanimously agreed that this breakdown of construction planning into stages indeed reflected the reality of their projects.

Functional Plans

Nine functional construction plans (areas of planning) were defined in the present study and validated in the first two research phases. They are categorized under four families:

1. Base plan: engineering and method (e.g. main construction technology, systems, and components); and organization and contract (e.g. organizational structure, staffing, contractual strategies, selecting subcontractors).
2. Forecast and control: schedule (both short-term action plan and long-term forecasting); and cost and cash flow.
3. Technology: major equipment; site layout and logistics; and work methods.
4. Resources: manpower allocation; and materials allocation.

Planning Parties

Participating construction planning parties consisted of the following:

1. The site group: the project manager, general superintendent, project engineer, and scheduling engineer.
2. Home office (planning and control, procurement and contracts, plus operations and engineering).
3. Externals: the client, designers, and subcontractors.

Planning Measures

Construction planning was examined in the present study by four principal measures: (1) The degree of involvement in the planning process; (2) the proportion of plan issuance; (3) the relative planning effort; and (4) the format used for issuing plans.

Degree of Involvement

The interviewees were asked to evaluate the degree of involvement of each party in the preparation of the various functional plans. The involvement was rated on a six-level scale from "not at all" to "very high." This rating was determined twice, once in each of the two planning stages. The variable used for analyzing involvement in planning was the proportion of projects with extensive involvement, as measured by two tests detailed later in the present paper.

Proportion of Plan Issuance

The interviewees were asked to state which plans were issued. Answers were given in the form of yes or no to each of the functional plans, at each planning stage, and the percentages of the positive answers were straightforwardly obtained for analysis.

Relative Planning Effort

The interviewees were asked to assess the relative time invested in the preparation of each plan. The evaluation process identified the most time-invested plan as 100%, and then related all other plans to it. The process repeated itself for the prebid and preconstruction planning stages. No distinction was made among functionaries, and the reported percentages pertained to the accumulative effort of all involved parties.

Format of Plans

The interviewees were questioned about the format used for the issuance of each plan, in each planning stage. A list of various formats, established in the two preceding phases of the study, was put forward (e.g. checklists, diagrams, Gantt, CPM), but answers were not restricted to the suggested list. The results were analyzed by multiple variables (described and explained later).

INVOLVEMENT

The degree of involvement reported for all parties participating in the planning process is depicted in two matrices, one for each of the two planning stages: prebid and preconstruction (Fig. 1). Rows of matrices were assigned for the nine functional construction plans, and columns for the eight participants.

Significant results are those pertaining to functional plans in which a considerable number of respondents reported medium or higher degree of involvement (henceforth referred to as exhibiting strong involvement). Thus strong involvement was identified for each plan and party by combining reports for medium (3), high (4), and very high (5) degrees of involvement. The percentage of reporting strong involvement is illustrated by the intensity of shading in corresponding squares as follows: very dark (81–100%); dark (61–80%); semidark (41–60%); light (21–40%); and very light (0–20%). For example, in analysis of involvement at the prebid planning stage, strong involvement of home office in preparation of cost-and-cash-flow plans was found in 77% of examined projects. That falls within the 61–80% limit, thus the corresponding matrix square [Fig. 1(*a*), fourth row from top, fifth column from left] received a dark shade. Of special interest are cases in which the degree of involvement was rated high (4) or above (called very strong involvement), hence an additional analysis variable was used, by combining reports for high and very high involvement. When more than 60% of respondents indicated these two higher levels of involvement, an asterisk was placed in the appropriate square on the matrix. Referring to the preceding example, results of very strong involvement for the same party and plan were 69%, prompting the addition of an asterisk to the same square.

Prebid Planning

The nine (plans) by eight (parties) matrix in Fig. 1(*a*) shows analyzed results for the prebid stage of planning. By participating parties, the project manager's degree of involvement is paramount among all others. More than 80% of project managers demonstrated a strong (medium to very high) degree of involvement in organization and contract, and 61–80% of them in three other plans: cost and cash flow, schedule, and major equipment. When conducting the stricter test for very strong (high or very high) involvement, more than 60% of project managers were found to be involved in two plans: organization and contract, and cost and cash flow. Second in perceived involvement, and far behind the project manager, is the home office, with 77% of respondents reporting strong (and 69% very strong) involvement in cost-and-cash-flow planning, and 60% in organization and contract.

Subcontractors and general superintendents are the next parties extensively involved in most plans, with a proportion around 40% for these two

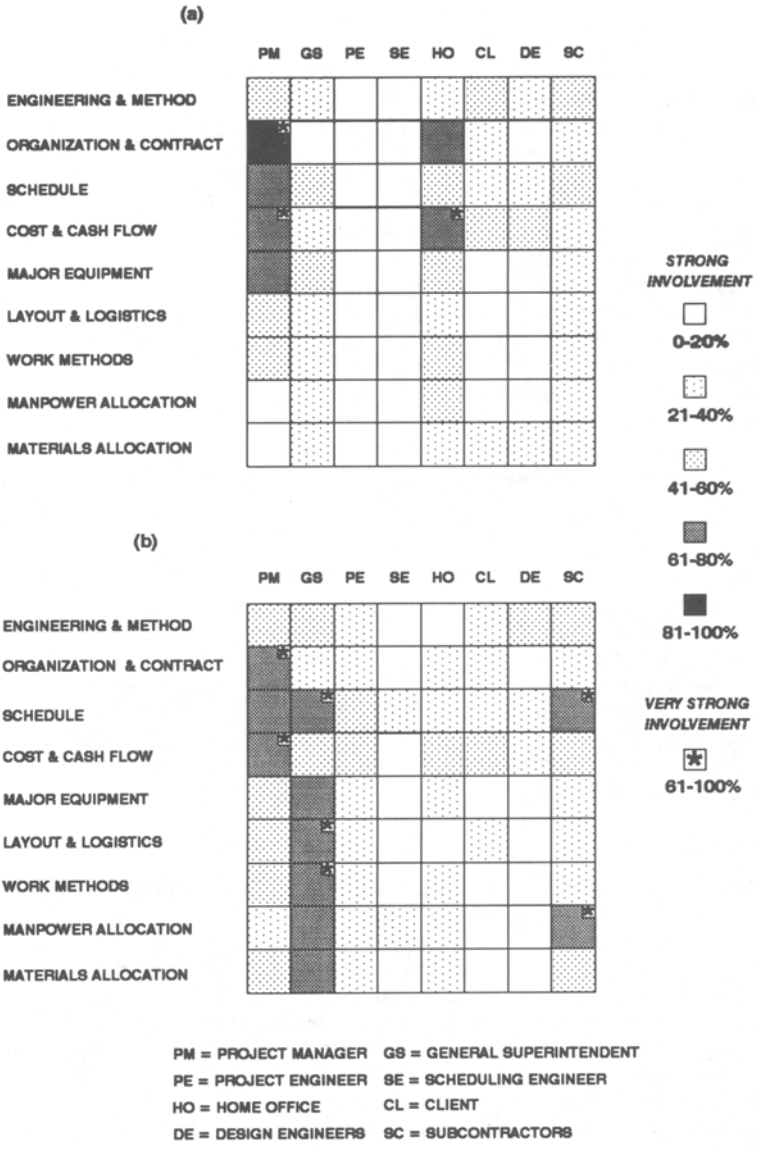

FIG. 1. Proportion of Projects with Strong or Very Strong Involvement: (a) Prebid Planning; (b) Preconstruction Planning

groups. One can clearly see that with no more than 20% of project engineers and scheduling engineers substantially involved in any plan, these two parties were almost out of the prebid planning picture.

By type of the various functional plans, schedule as well as cost and cash flow stand out at the PBP stage. Four of the eight participants displayed strong involvement, at a rate of more than 40%. Cost and cash flow is even more eminent, with very strong degree of involvement of more than 60%

of project managers and home office. Next in level of involvement are engineering and method, and organization and contract.

Preconstruction Planning

The matrix for the preconstruction planning stage, Fig. 1(*b*) reveals that more parties are intensively involved in more functional plans than at the prebid stage. The project manager retains about the same high level of involvement in most plans, but his involvement is second to that of the general superintendent. Out of nine functional plans, general superintendents evidenced strong involvement in six plans (and very strong in half of these) in more than 60% of projects.

Within this obvious focus-shifting to on-site planning, the home office is less involved. After the general superintendent and project manager, the subcontractors are the third-most-involved party, with more than 60% showing strong and very strong involvement in engineering and method and in manpower allocation.

No participating party was distinctly involved in all plans in less than 20% of the projects, as was the case with two parties at the PBP stage. Moreover, one of these two parties—the project engineer—moved up to hold the fourth place of highly demonstrated involvement at the PCP stage, though yet clearly smaller in magnitude than his two other strong on-site partners.

By type of plan, as was the case at the PBP stage, cost and cash flow is again the clearly leading plan, with more parties strongly involved than any other plan. Schedule too shows intensive involvement of four parties at the high proportion level (more than 50%). Schedule is now the only plan with three parties demonstrating strong involvement, and two out of these very strong, at a rate of more than 60%. The center of gravity has apparently shifted from the home office to the site, with the rising role of the project manager, general superintendent, and project engineer, probably at the expense of a decreasing home office.

EFFORT

The two bar charts in Fig. 2 illustrate the relative planning effort invested during the prebid and preconstruction planning stages. Results were obtained as follows: for each functional plan, at each planning stage, mean percentage of relative time input of all projects was computed. The resulting figures were then used to create a common denominator for the two planning stages. The highest score at each stage was defined as 100%, and then all other scores were multiplied by the same ratio. The normalized percentages obtained from this calculation—the mean relative planning effort for each plan—appear in Fig. 2. For example, at the PBP stage [Fig. 2(*a*)], cost and cash flow scored the highest mean percentage (88.5%) among all other plans, and was transformed to be 100%. Engineering and method, which received 36.5% at the same stage, was normalized by a factor of 100/88.5 to become 41%.

As Fig. 2 shows, more relative effort was invested in the cost-and-cash-flow plan at the prebid planning stage than in any other functional plan, while schedule was found to be the dominant plan in terms of invested effort at the preconstruction stage. Note that at the PBP stage schedule is not the leading plan; it is, however, second with 82% as much time as spent on cost and cash flow. At the PCP stage, schedule leads all other plans in terms of time invested. Layout and logistics consumed 61% as much time, and cost and cash flow about half as much.

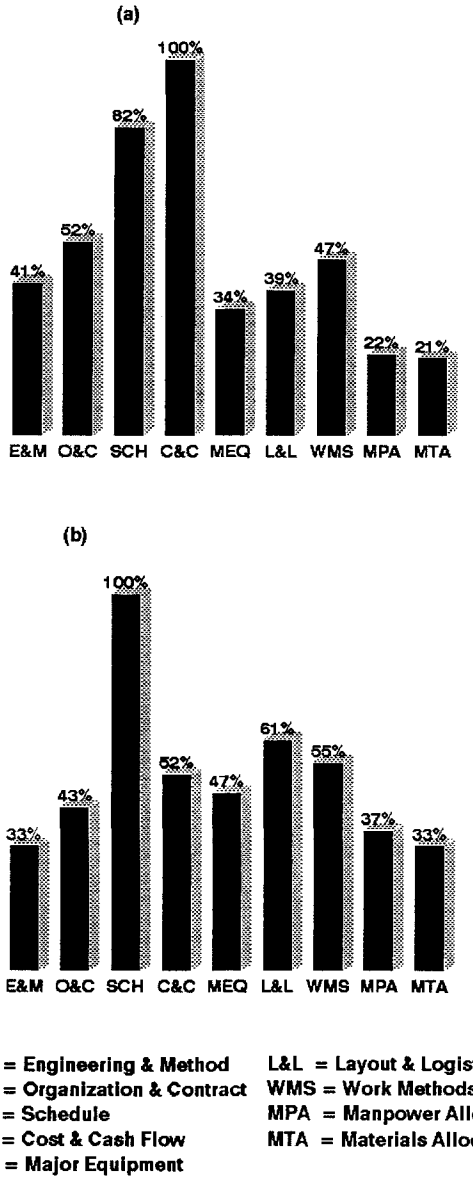

FIG. 2. Relative Planning Effort: (a) Prebid Planning; (b) Preconstruction Planning

Organization and contract was the third in terms of time invested at the PBP stage, but sixth in PCP. Work methods was fourth in PBP and third in PCP. Materials allocation, at the other end of the scoring scale, was last in PBP, and shared the last position in PCP with engineering and method.

It is generally accepted that no other functional plan matches schedule in terms of invested planning effort throughout project life. The results of this study do not suggest otherwise. (The observed lead of schedule over

all other plans during construction in terms of relative planning effort, reported in the full report, is even more sweeping than at the PCP stage.) It is, however, important to realize that the combined planning effort invested in all other plans is substantially large, when compared to schedule. Summing up the relative planning efforts for all plans in Fig. 2(*a* and *b*), and then dividing each total by its corresponding relative planning effort of schedule, yields a factor of 5.34 for PBP, and 4.61 for PCP. In other words, the overall planning time of the various plans, observed in this study, was on average about five times as long as that invested in preparation of schedule. If this finding may seem somewhat surprising, it should be borne in mind that in the industry schedule quite commonly includes part of the other functional plans to which respondents were asked to refer separately in this study.

PLAN ISSUANCE

While the two planning measures discussed thus far— involvement and effort—pertained to the planning process, the next two are concerned mainly with the planning product.

Table 2 provides results of the proportion of plan issuance, i.e. the percentage of projects in which parties not only were involved and/or invested effort in planning, but actually prepared and issued plans, in the form of a document. Separate results are given for each of the two stages. At the PCP

TABLE 2. Proportion of Plan Issuance

Plan (1)	Family of plans (2)	Prebid Planning		Preconstruction Planning	
		Proportion for plan (%) (3)	Mean proportion for family (%) (4)	Proportion for plan (%) (5)	Mean proportion for family (%) (6)
Engineering and Method	—	53	—	56	—
Organization and Contract	—	93	—	67	—
—	Base Plan	—	73	—	61
Schedule	—	100	—	94	—
Cost and Cash Flow	—	100	—	78	—
—	Forecast and Control	—	100	—	86
Major Equipment	—	63	—	72	—
Layout and Logistics	—	88	—	89	—
Work Methods	—	69	—	89	—
—	Technology	—	73	—	83
Manpower Allocation	—	56	—	83	—
Materials Allocation	—	63	—	78	—
—	Resources	—	60	—	81

stage, "plan issuance" means a major revision or a new plan (though not necessarily one document per plan, or vice versa). A number of functional plans not issued at all in some of the projects at either prebid or preconstruction stages might be prepared later, during construction. In addition to the nine given plans, respondents were encouraged to add any other plan they prepared (e.g. safety, quality control, value engineering, labor relations). In most cases, these additional areas were reported to have been covered by one of the nine already-listed plans.

As Table 2 shows, schedule and cost-and-cash-flow plans were observed as having the highest proportion of plan issuance at the prebid planning stage; they were issued in all examined projects. A slight decrease in schedule, and a larger one in cost and cash flow, were reported at the PCP stage, although schedule maintained its highest position with 94% of respondents. Organization and contract was prepared and issued in 93% of projects at the PBP stage (occupying the second highest place after schedule and cost and cash flow), but dropped significantly, to 67%, at the PCP stage. Two plans—work methods and manpower allocation—exhibited an opposite trend, as they considerably increased their proportion of plan issuance from PBP (69% and 56%) to PCP (89% and 83%). Layout and logistics, along with work methods, attained the second best position in PCP. Last in both stages was engineering and method (with 53% in PBP, and 56% in PCP). The low level of engineering-and-method plan issuance can be attributed to the fact that in lump-sum contracts (seven out of 18 in this study), main construction technology is normally determined, in an earlier stage, outside the construction firm.

Respondents recommended that, in future, organization and contract should appropriately be addressed by two separate plans, instead of one: organizational structure (which, in most cases, focuses mainly on staffing), and contractual strategies.

An overall picture is obtained when observed proportions of plan issuance are studied by families of functional plans. The concluding number given in Table 2 for each family of plans is the mean proportion of plan issuance for that family. The forecast and control plans are leading at both prebid and preconstruction planning stages, but a distinct decline is apparent from PBP to PCP. A similar decrease can be noted in the base plan, with an average of a relatively low PBP rating of 73% that declines in PCP to 61%. Both of these families are typically concerned with fundamental, global, and comprehensive planning, hence their decline between the prebid and preconstruction stages. On the other hand the technology and resource plans, characteristically more involved in detailed planning, display an expected increase in proportion of plan issuance, with resource plan issuance increasing an impressive 21%, from 60% to 81%.

FORMAT

Following the findings of plan issuance, it is now of interest to look into the various formats used for the articulation of plans. For example, to what extent were CPM, Gantt and time/resource diagrams employed for scheduling (e.g. Cullen and Nankervis 1985)? The following questions are specifically answered: (1) What was the rate of employment of any type of format for each plan? (2) How many different types of formats were used for any plan? (3) What was the accumulative number of formats for each plan (total of answers for the first question across all formats)? (4) What

was the overall employment extent of any format (total of answers for the first question across all plans)?

Answers to all these questions, and a few more, are given in Table 3. Columns 2–12 provide the answer to question 1 for each of the nine plans listed in column 1. Columns 13–14, worked out directly from columns 2–12, display the answers to questions 2 and 3, respectively, and the numbers that answer question 4 appear at the bottom row of each of the two parts of Table 3, in columns 2–12. Table 3(*a*) displays results for the PBP stage, and Table 3(*b*) for PCP. Of interest are the findings in each of the two stages as well as the trend of change—if there is one —from prebid to preconstruction planning.

Variety and Total Number of Formats

In both planning stages, the highest rate (eight projects and more) of any format employment was observed in three plans and three formats: Cost and cash flow was issued mainly in standard forms or tables; layout and logistics in drawings; and schedule in CPM at both stages and in a Gantt chart at the PBP stage. Organization and contract, issued mainly in an organizational structure format, also belongs to this range, but only at the PBP stage. The accepted notion about the most-commonly used formats for the most-commonly issued plans is reaffirmed.

What was less expected—and is more enlightening—is the variety of different formats used for some of the plans. Although CPM (probably associated with construction plans more than any other format) indeed scored the highest rate reported for one single plan (14 projects, in schedule, at the PCP stage), schedule was still reported to have been issued in five other formats as well (at both PBP and PCP stages). But it is another plan—work methods—which is probably more eye-catching than all others in terms of the number of formats.

Nine different types of formats were used for the representation of work methods, at both construction planning stages. Work methods, then, may be perceived as the all-encompassing, ultimate work plan, certainly at the local detailed level. Its richness calls for employment of a variety of representation mediums. This plan is so process- and action-oriented that expressing it through one single medium or document is extremely difficult; therefore it requires the use of many types of formats. This observation is strengthened when another variable—the total number of formats used for each plan—is considered. At the PBP stage, only schedule exceeded work methods (and then just barely) in the total number of formats. Work methods surpassed schedule in PCP and showed the highest total of number of formats (26) at either planning stage.

Second in number of types of formats in PBP are the two resource plans, manpower and materials allocation, but they lag far behind work methods when total number of formats is considered. This picture more or less repeats itself at the PCP stage. Cost and cash flow shows the lowest number of types of formats at both stages, another reaffirmation of the plain, control-oriented nature of this plan, which does not require rich mediums of representation. The fact that engineering-and-method plans at both stages are represented primarily by textual formats and time charts, rather than by technical diagrams, indicates that the constructor's main role in this planning area is analyzing and evaluating the implications of various design alternatives.

When summarized, no meaningful changes in types and total number of

formats for each plan can be identified between the two planning stages. Differences are noted, however, between PBP and PCP when the total number of uses for specific formats are compared (columns 2–12). The two most noticeable shifts appear in protocols of meetings (column 3), which rose from 18 to 32, and CPM (column 10), which more than doubled its overall use from PBP (14) to PCP (31). CPM was also found to be the only format exhibiting a change in the number of functional plans that employed it, from PBP (5) to PCP (8). All other formats were generally used by the same plans at both stages. The only format employed by all plans at both planning stages was meeting protocols (column 3). The increased use of meeting protocols from PBP to PCP shows the importance of this informal medium of plan issuance and underscores the central role of meetings in all construction planning processes. Nahapiet and Nahapiet (1985) reached a similar conclusion based on an extensive case study research in the United Kingdom and the United States. This conclusion is further supported by the frequent use of the textual medium lists and checklists (column 2), which was employed in eight of nine plans at both planning stages and was the most-frequently used format in PBP. It must be stressed that these conclusions are not drawn from leading questions. Referring to their projects, all respondents preaffirmed that, for instance, meetings were indeed planning sessions, and meeting protocols were plans.

The total number of formats issued was 156 in PBP and 174 in PCP. This 12% increase appears to be of no relevant significance, considering that it did not result from a similar rise in the number of format types employed. It should also be noted that these figures of 156 and 174 do not imply the issuance of the same numbers of separate documents, since some documents commonly incorporated more than one plan. Quite often, the document referred to as schedule also accommodated other functional plans (e.g. manpower allocation, materials allocation).

Average Number of Formats per Plan

Although the total number of formats used for each plan (column 14 in Table 3) enables us to distinguish those plans in which high format employment rate was reported, from those that exhibited a low one, it does not take into account the number of issued plans, i.e. proportion of plan issuance expressed in number of responses. This latter variable (column 15) must be considered if a consistent basis is to be set for measuring format use across all plans and at both planning stages. When the number in column 14 is divided by the one in column 15, for each plan, the average number of formats used by each plan is obtained (column 16). The resulting numbers range from a low of 1.10 to a high of 2.09. The primary finding is that on the average more than one medium of representation is employed by each plan, with an overall average of 1.49 mediums per plan in PBP, and 1.36 in PCP. Work methods again leads at both planning stages, with an average of more than two formats in PBP and 1.63 in PCP. This is not surprising, given the importance of this plan in the previously examined parameters; it further stresses the notion that work methods is indeed, at least in the more progressive construction companies, an aggregation of many plans that includes additional verbal explanations and drawings of the construction method. Work methods plans must be issued in a concrete and instructional fashion, at once compressed and detailed. They must be expressed in a variety of formats.

The textual formats (columns 2–4), one of five format classes identified

TABLE 3. Format of Plans

Functional plan (1)	NUMBER OF FORMATS: Textual: Lists, check-lists (2)	Textual: Meeting proto-cols (3)	Textual: Verbal instructions (4)	Technical Diagrams: Dia-grams (5)	Technical Diagrams: Draw-ings (6)	Organizational Diagrams: Organiza-tional structure (7)	Organizational Diagrams: W.B.S (8)	Time Charts: Gantt (9)	Time Charts: C.P.M (10)	Time Charts: Time/ resource diagrams (11)	Tables: Standard forms/tables (12)	Number of types of formats (13)	Total number of formats (14)	Number of issued plans (15)	Average number of formats (16)
(*a*) Prebid Planning															
Engineering and method	—	4	2	2	—	—	—	1	1	—	—	5	10	8	1.25
Organization and contract	3	2	2	1	—	8	1	—	—	—	1	7	18	14	1.29
Schedule	1	1	—	4	—	—	2	9	8	—	—	6	25	16	1.56
Cost and cash flow	3	3	—	—	—	—	—	—	—	5	8	4	19	13	1.46
Major equip-ment	3	1	—	2	2	—	—	2	—	—	2	6	12	10	1.20
Layout and lo-gistics	4	2	1	3	9	—	—	—	—	—	—	5	19	14	1.36
Work methods	5	3	4	4	3	—	1	1	1	—	1	9	23	11	2.09
Manpower al-location	3	1	—	1	—	—	1	1	3	4	2	8	16	9	1.78
Materials allo-cation	2	1	2	1	—	—	—	1	1	2	4	8	14	10	1.40
[Total]	24	18	11	18	14	8	5	15	14	11	18	—	156	—	—

(*b*) Preconstruction Planning

Engineering and method	—	5	1	1	—	—	—	2	2	—	—	5	11	10	1.10
Organization and contract	4	4	2	—	—	5	1	—	—	—	1	6	17	12	1.42
Schedule	1	1	—	3	—	—	3	2	14	—	—	6	24	17	1.41
Cost and cash flow	2	2	—	—	—	—	—	—	2	4	10	5	20	14	1.43
Major equipment	3	4	—	1	2	—	—	1	1	—	3	7	15	13	1.15
Layout and logistics	2	3	1	2	10	—	—	—	1	—	1	7	20	16	1.25
Work methods	3	7	3	3	4	—	1	1	3	—	1	9	26	16	1.63
Manpower allocation	2	2	1	1	—	—	2	3	5	3	2	9	21	15	1.40
Materials allocation	5	4	—	1	—	—	—	1	3	1	5	7	20	14	1.43
[Total]	22	32	8	12	16	5	7	10	31	8	23	—	174	—	—

in this study, play a major role (50%) in the high score recorded for work methods in column 16, at both planning stages. This can be attributed to the difficulty posed by this assignment-oriented plan, if standard, structured forms are to be used for its issuance (unlike the control-oriented plans, i.e. schedule and cost and cash flow).

The lowest values of average number of formats per plan in PBP were seen in major equipment, engineering and method, and organization and contract. In PCP, the lowest values were seen in major equipment, engineering and method, and layout and logistics. These four plans are basically design and configuration plans that address objects more than actions. They have a unidisciplinary scope and a limited use. They are completed just once, if at all, for each planning stage. Typically, these plans do not require the use of many formats. These design and configuration plans can be viewed as a static city road map while work methods, using the same metaphor, is the whole dynamic city transportation system. It should be also noted that, as reported in the complete research report (Laufer et al. 1992b), these four plans dropped significantly in terms of invested planning effort at the during-construction planning stage.

Classification of Formats

When the 11 formats presented in Table 3 are analyzed and classified by their main emphasis and by their formality (e.g., CPM is a typical formal mode, while protocols of meetings are inherently informal), three families of formats can be identified, as depicted in Table 4.

The textual formats are very informal, action- and planning process-oriented, and are seldom used for control. The technical and organizational diagrams serve mainly for the design and configuration of objects (rather than planning of processes), are semiformal, and are used partly for control. The main focus of the third family—charts and tables—is time and money. These formats, extensively used for control purposes, are also the most formal, well-defined, recognized standard mediums. They are mainly concerned with results and achievements, milestones, and deadlines. They are employed for the planning of outcomes more than for the planning of processes.

Table 4 shows the relative frequency of overall format employment in each family at each of the two planning stages. Results were obtained by summing up the numbers in the bottom row in Table 3 for the corresponding

TABLE 4. Families of Formats

Family (1)	Main emphasis (2)	Formality (3)	Use for control (4)	Relative Frequency of Formats (%)	
				Prebid planning (5)	Preconstruction planning (6)
Textual	Actions	Informal	Very low	34	36
Technical and organizational diagrams	Objects	Semiformal	Low to moderate	29	23
Time charts, tables	Results	Formal	High to very high	37	41

formats (e.g. columns 5–8 for technical and organizational diagrams), and then dividing by total number of formats. At the PBP stage, no significant difference can be noticed between families, as each one assumes about one-third of the total. The picture is somewhat changed in PCP, with a relative increase in the overall employment of charts and tables and a decrease in the use of technical and organizational diagrams, i.e. focus of planning shifts from objects to results, with wider utilization of formal representation mediums. The relative weight of textual, informal formats, though, has not diminished at all.

SUMMARY AND IMPLICATIONS

The present study has examined the construction planning process through four planning measures—involvement, effort, plan issuance, and formats—and focused on three independent planning variables—functional plans, participating parties, and stages.

Some common notions on the practice of construction planning, strongly supported by the existing literature, can be summarized as follows: (1) Scheduling is the essence of construction planning, and more time is invested in it than in all other plans; (2) CPM and Gantt charts are primary formats used for construction planning; and (3) construction planning is carried out by a line manager, assisted by a staff person (and even the other way around).

However, the findings of this study, based on a sample of competent and successful managers affiliated with advanced companies, suggest otherwise: (1) Scheduling, as important and central as it is, is only one of many construction planning areas. Our study found that the accumulative effort invested in the preparation of other functional plans was about five times greater than that invested in scheduling; (2) A variety of formats (11 identified in this study) are employed for the issuance of construction plans. Articulating a complex plan as a true model of reality requires numerous mediums of representation; (3) the planning process involves many parties, internal as well as external to the construction company, whose involvement varies according to planning area. Some parties, such as the project manager, participate in the planning process throughout most of project life, while others' participation changes with the evolution of planning. The general superintendent emerges as the leading party in preconstruction planning; the project manager, dominant in prebid planning, moves to a secondary position. The high level of involvement exhibited by the subcontractors in preconstruction planning should be acknowledged as well.

As presented, this study was in essence of a descriptive nature. Nevertheless, given the highly-demonstrated progressiveness of the sample companies and projects, the findings of this study can be regarded as normative, until further research yields the establishment of well-founded and accepted principles.

We hope to stimulate in this study further work of researchers and educators in the development of methods, procedures, and tools for: (1) Coordination of project planning among the various internal and external parties; (2) working with multiple formats—their selection, preparation, and distribution; and (3) using advanced information technology to facilitate the integration of parties and plans, e.g. groupware.

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APPENDIX I. INTERVIEW GUIDE

Introduction

The questions focus on several planning measures, which concern eight parties participating in the preparation of nine functional plans at the prebid planning stage and at the preconstruction planning stage. You are requested to refer to a specific project with which you are familiar.

Questions

Preparation of Plans

1. Which of the following functional plans (Fig. 3) were prepared (column 2), and in which manner (column 3)?
2. What was the percentage of time invested in the preparation of the following plans (Fig. 3)? Select a plan in which the amount of time invested in its preparation was the highest, assign it the highest value (100%), and

Plan (1)	Yes/No (2)	Format (3)	% (4)
Engineering & Method			
Organization & Contract			
Schedule			
Cost & Cash Flow			
Major Equipment			
Layout & Logistics			
Work Methods			
Manpower Allocation			
Materials Allocation			
Other			

Note: Format = Checklists, diagrams, protocols of meetings, standard forms, WBS, Gantt, CPM, etc.

FIG. 3. Preparation of Plans

Plan	Site				Home Office	Externals		
	Project Manager	General Superintendent	Project Engineer	Scheduling Engineer		Client	Design Engineers	Subcontractors
Engineering & Method								
Organization & Contract								
Schedule								
Cost & Cash Flow								
Major Equipment								
Layout & Logistics								
Work Methods								
Manpower Allocation								
Materials Allocation								
Other								

Note: Not at all = 0 Very Low = 1 Low = 2 Medium = 3 High = 4 Very High = 5

FIG. 4. Involvement

relate the responses for the other types of plans to the value assigned (column 4).

Involvement

3. Rate the degree of involvement of the following parties (Fig. 4) in each of the plans.

APPENDIX II. REFERENCES

Birrel, G. S. (1980). "Construction planning: beyond the critical path." *J. Constr. Engrg. Div.*, ASCE, 106(3), 389–407.

"Closing the gaps in project management systems." (1984). *Systems gap working party report*, Association of Project Managers, Butterworth, Surrey, U.K.

Cormican, D. (1985). *Construction management: planning and finance*. Construction Press, London, England.

Cullen, J. D., and Nankervis, C. W. (1985). "Overcoming the luddite factor: some behavioural aspects of the field supervisor's role in construction planning." *Int. J. Project Mgmt.*, 3(3), 133–140.

Erskine-Murray, P. E. (1972). "Construction planning—mainly a question of how." *Occasional Paper No. 2*, Institute of Building, Ascot, Berkshire, England.

Laufer, A. (1989). "Owner's project planning: the process approach." *Source Document 45*, Constr. Industry Inst., Univ. of Texas, Austin, Tex.

Laufer, A. (1990). "Decision-making roles in project planning." *J. Mgmt. Engrg.*, ASCE, 6(4), 416–430.

Laufer, A., Cohenca-Zall, D., and Howell, G. A. (1992a). "The planner-manager competence dilemma revisited." *Project Management without Boundaries, Proc., 11th INTERNET World Congress on Project Mgmt.*, 2, 61–73.

Laufer, A., Shapira, A., and Cohenca-Zall, D. (1992b). "The process of construction planning and its products: practice in mature companies." *Res. Rep.*, National Building Research Inst., Haifa, Israel.

Laufer, A., and Tucker, R. L. (1987). "Is construction project planning really doing its job? A critical examination of focus, role and process." *Constr. Mgmt. and Economics*, 5(3), 243–266.

Mason, D. (1984). "The CPM technique in construction: a critique." *AACE Trans.*, Montreal, Canada, E.2.1.–E.2.10.

Mintzberg, H. (1981). "Research notes and communications, what is planning anyway?" *Strategic Mgmt. J.*, 2, 319–324.

Nahapiet, J., and Nahapiet, H. (1985). *The management of construction projects: case studies from the USA and UK.* Chartered Institute of Building, Ascot, Berkshire, England.
"Report on planning and scheduling." (1983). *Modern Mgmt. Systems, Rep. A-6,* Business Roundtable, New York, N.Y. Appendix A-6.1.