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Is construction project planning really doing its job? A critical examination of focus, role and process

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There is growing concern over the failure of construction planning to achieve its goals in spite of the considerable resources allocated to it. Deficient planning techniques are commonly blamed for this state. This view is challenged here following analyses of observations and studies by researchers and practitioners. The paper discusses normative planning vis à vis a deficient reality, and its probable causes. Planning effectiveness can be expected only after management modifies planning policy and prevailing practices are fundamentally changed. Future research should address planning from a wider, holistic perspective to include organizational, human and information-handling aspects, in addition to planning techniques as such.

Keywords: Construction control, information handling, planning deficiencies, planning techniques, purpose of planning.

Introduction

Planning occupies a central position in the functions of the manager. His responsibilities may vary with organizational philosophy and contingency but planning invariably remains an essential ingredient of his duties. (Steiner, 1979). Much Research and Development effort has been made during the last three decades but progress with techniques has not removed the dissatisfaction with the application and results of construction planning (Choudhury 1981, Mason 1984, Morton 1983). A Business Roundtable Report on Planning and Scheduling summarizes the situation thus: '. . . the systems have not yet lived up to their promise' (BRT, 1983).

Yet the potential for progress remains. In two studies conducted at the Illinois Institute of Technology that rated the importance of factors of productivity improvement in construction at company headquarters, planning received the highest score (Arditi, 1985). Efforts to improve planning have traditionally stressed the technical side of the process, i.e. planning models, tools, hardware and software (Birrel, 1980; BRT, 1983; Fondahl, 1982; Jaafari, 1984; Peer, 1974). The few researchers who went beyond the technical aspects singled out specific planning roles; e.g. Gilbert (1983) focused on project control, and Lichtenberg (1981) emphasized project forecasting.

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This paper reviews the planning processes for construction projects; examines critically the involved parties, their assigned roles, and the functions of planning; and describes the causes of planning failures. The paper aims at stimulating a questioning attitude toward planning as it is performed today and at setting into motion a drive for fundamental changes rather than propose solutions for specific problems. It furthermore intends to spur researchers and practitioners to develop and implement genuinely effective methods to replace present practices. The scope is limited to planning performed within the construction company.

The paper is based on the study of construction planning over several years along three avenues:

(i) Observation, structured and unstructured, of construction project planning, its processes and product. The authors did this in capacities as managers, consultants, and researchers in the construction industry

(ii) Review, analysis and synthesis of related studies conducted by others and selves (Laufer 1985; Laufer and Tenah, 1985; O'Connor and Tucker, 1986; Tucker, 1986). Particular reference is made to a recent study (Laufer and Cohenca, 1986) that introduced a quantitative assessment of the effort and effectiveness of construction planning. Though results are undergoing further evaluation, research methodology and some preliminary findings have been published

(iii) Major deficiencies identified by direct observation and the study of literature were summarized and presented to six groups of senior managers and planners at head-offices of large US companies. A one-hour presentation was followed by a two-hour discussion. The participants reinforced most of the conclusions, suggested some changes of emphasis, and refined several of the issues.

Planning of construction projects is examined in this paper by looking for answers to three questions: What is planning? Why plan? and How to plan?

Each question comprises three components which are discussed under separate headings:

– Normative – how should planning be done and what should it include?

– State of deficiency – a description of the common symptoms including some adverse ramifications.

– Diagnosis – an attempt to explain the underlying causes of the planning deficiencies.

What is planning?

Definitions of planning

What the term planning connotes is still subject to a lively debate (Mintzberg, 1981; Snyder, 1982), and this semantic controversy complicates the understanding of planning (Steiner, 1977). In this article we accept the definition that planning is a decision-making process performed in advance of action which endeavors to design a desired future and effective ways of bringing it about (Ackoff, 1970). More specifically planning answers the following questions:

– *What* should be done? (activities)

– *How* should activities be performed? (methods)

- *Who* should perform each activity and with what means? (resources)
- *When* should activities be performed? (sequence and timing)

Planning literature addresses three audiences: corporate management, project management on behalf of the owner (client), and project management on behalf of the construction company. Planning for corporate management can be described as 'predict and prepare' (Ackoff, 1983). It includes: (a) forecasting the company's future environment – identifying opportunities and threats, (b) deciding what to do (goals) to best cope with the environment, and (c) determining how these goals may be attained (means). Owner's project management concentrates on limited specific targets within strategic goals and on means through which they can be accomplished. Construction project management deals with a more detailed and complete planning of those means. For simplicity's sake we adhere to this classification even though owners have become increasingly more involved in construction, making the true-life situation somewhat less clear-cut.

Planning is a multi-stage, multi-level process. Some describe it as a top–down, systematic, complete and hierarchical process (e.g. Emery, 1969). Others hold that people plan opportunistically in a multi-directional, incremental, heterarchical mode (e.g. Hayes-Roth and Hayes-Roth, 1979).

Following the systematic hierarchical-refinement model the planning process can be subdivided into specific stages where each stage not only narrows down the options but deals with a different component of planning. The first stage defines the scope of the project and its goals, then the means (resources) and their limitations are enumerated, and finally the course of action (solution) is selected (Eilon, 1971).

The evolution of planning should be compatible with the roles of the various levels of management as projected in Fig. 1. Typically, the owner and top construction management are involved in setting the project goals (e.g. quality, cost, and time). Middle management, steered by top management is more involved in selecting the means (resources), while lower echelons assist middle management in selecting and devising the solutions.

Maintaining consistency in hierarchical plans represents a major difficulty of planning. This is especially true in construction where fast 'decay' of plans demand frequent modification (Laufer and Cohenca, 1986). Distance between site and home office further aggravates the situation.

The normative focus of planning

As stated, the planning process is expected to answer several 'to do' questions: *what?* is generally the owner's prerogative and *how? who?* and *when?* are predominantly in the contractor's domain. The answer to *how?* would be provided in the methods statement with reference to: (a) site layout, (b) production means, and (c) production processes (Hollins, 1971). Though emphasis would be on the more complex and novel activities, the methods statement should nevertheless encompass the entire scope.

Planning of methods should proceed concurrently with decision-making concerning resources and timing of their use. At times construction cost may also be the focus of planning, but normally it serves as a constraint or a goal.

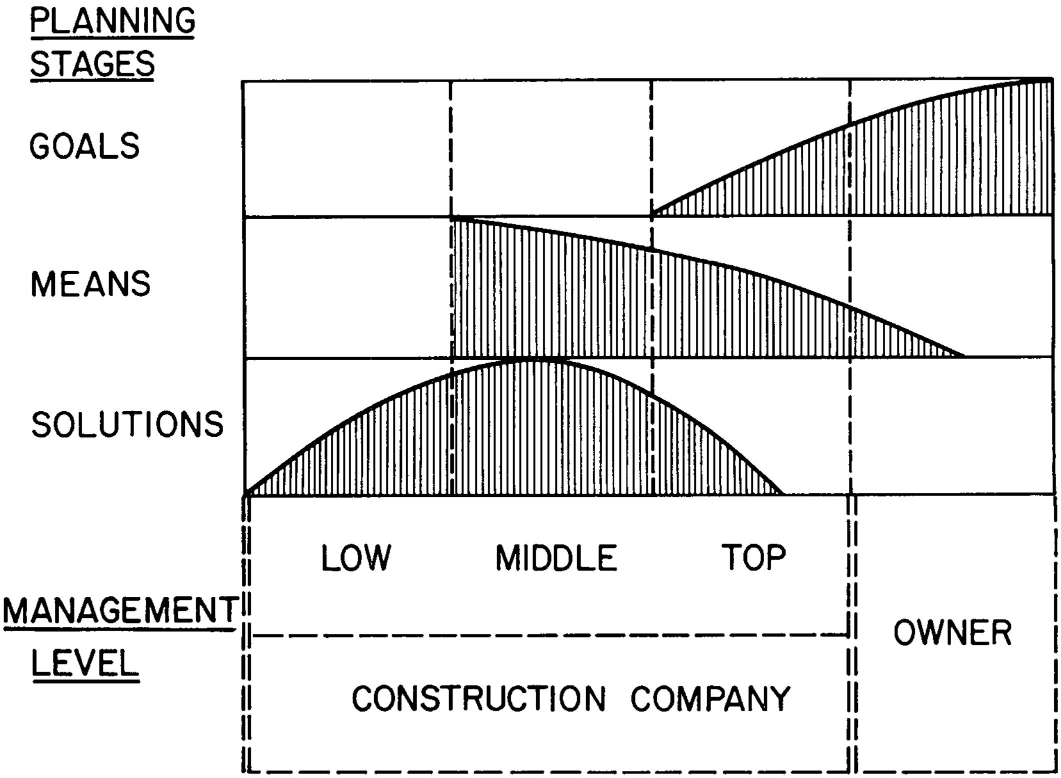


Fig. 1. Planning evolution and management involvement.

The focus of planning in practice

In most construction companies doing formal planning, the primary focus is on time planning, and to a lesser extent on resource allocation and its cash-flow implications. They key issue of how to carry out the work (i.e. the method statement) does not receive due attention.

The over-emphasis given to scheduling finds its expression in a fundamental confusion of concepts between planning and scheduling or programming (Clough, 1972). Mason (1984) demonstrates in numerous examples the improper and inconsistent use of the terms planning and scheduling in construction management circles. Worse still, scheduling techniques are sometimes perceived as synonymous with project management as a whole (Baker *et al.*, 1979).

No schedule is prepared without some implicit knowledge of the methods, but a norm that does not yield explicit plans of methods is inadequate. As stated by Steiner (1979) and Hussey (1982), two prominent researchers in the field; 'Planning without a plan (e.g. of methods) is a waste of time'. In a comprehensive review of construction planning, Erskine-Murray (1972) came to the conclusion that it is vital to increase the effort devoted to methods planning at the expense of resources and attention given to scheduling.

The fact that detailed planning of methods (termed 'Solutions' in Fig. 1) is performed later on site by lower level management, does not preclude the need for an early general plan of methods explicitly drawn up that integrates the entire project. It forms the basis for the detail methods plans of the individual components. Lower level management will follow through with systematic, continuous and coordinated planning only if an early overall plan exists.

Causes of the present state

Why scheduling gets excessive emphasis at the expense of methods planning can be explained by two dominant factors – the goals of construction projects, and the training of construction planners.

Of the three major goals of a construction project: cost, time and quality, the last usually receives least attention. This is generally true also outside construction due to the fact that while cost and time are tangible, demonstrable, and economically measurable, quality is vague and poorly defined (Mintzberg, 1982). While cost is more important for the commercial success of the company, time is often perceived to be more influenced by management's involvement (Ireland, 1985; Sidwell, 1984). This stems, *inter alia,* from the additive nature of construction costs, where a cost change of one item will not significantly affect the cost of most others, particularly of material that comprises more than 50% of construction costs. This contrasts with the high degree of interdependence between the timing and duration of construction activities, where a delay of one activity can trigger a chain of delays and disruptions in many others. Management's perceived ability to affect the time goal more than the cost or quality goals is reflected in the greater attention given to the planning of the schedule, and to the lesser attention given to construction resources and a methods statement. Clearly, cost-plus projects, frequently awarded to the large and more developed construction companies, also promote greater emphasis on scheduling.

The typical construction project planner is a graduate of a civil engineering programme with minimal formal training in construction methods. Regretfully, most construction management and engineering programs emphasize production management and neglect the construction process (Laufer, 1987). These same engineers, however, are thoroughly indoctrinated in quantitative techniques and scheduling. The association of these techniques with computers has added to the obsessive preoccupation with scheduling. Progress made in computers has created a misconception that scheduling techniques have progressed likewise. Every few years a 'latest scheduling technique' is introduced into construction companies giving a specious impression of progress and which diverts more resources to scheduling (Mason, 1984).

Why plan?

The normative role of planning

Beyond a general consensus that planning is the most important function of the construction manager, there is little in the pertinent literature to define, classify or analyse the more specific objectives of planning. To identify planning deficiencies it is necessary to dissect the planning objectives into their constituent components which in practice are pursued *en block*.

Generally speaking, the purpose of planning is to assist the manager to fulfil his primary function, namely, direction and control. Direction can be subdivided into execution (or action planning) and coordination. Execution concerns the directing of the parties under the supervision of the construction company in the implementation of the project components. Le Breton and Henning (1961) assign to execution an important role in strategic planning: 'a plan must involve action'. Hussey (1982) goes further by asserting that 'the real product (of planning) is action'. The role of execution is even more decisive where it concerns tactical/operational planning (e.g. planning construction projects). Execution should be understood to mean that early decisions – the plans – become either direct assignments, or at least guide-lines for site management to make operational decisions later on. The essential elements of how, when, and who are thus prepared for the execution of the construction project.

The second planning function is to coordinate and communicate with the many parties involved in the realization of a construction project, i.e. the owner, designers, licensing authorities, subcontractors and suppliers, and numerous specialists and functionaries on site and in the home office. Planning, here, concentrates on harmonizing and facilitating clusters of construction activities which are characterized by a high degree of interdependence. The construction technology being inherently interdependent provides few or no 'buffers', and requires many diverse parties to work in close liaison with each other in terms of time and/or space. Maintaining coordinated production becomes thus a key function of construction management (Emery, 1969).

The third function of planning is to facilitate project control which encompasses control proper and forecasting. If planning establishes targets and the course to reach them, control is the process that ensures the course of action is maintained and desired targets are reached. Control involves measuring and evaluating performance, and the taking of corrective action when performance diverges from plans. To be effective, a control system must be modelled closely after the planning system. In reality, planning and control are usually inextricably intertwined, forming a continuous planning and control cycle (Dermer, 1977; Harrison, 1981). To achieve this objective, the scope and focus of planning, the format of the plans, the level of detail, and many additional factors are determined with the facilitation of control in mind.

Control is needed to hold in check three elements of risk:

– Conceptual risk – resulting from imperfect formulation of the problem, such as using an incorrect model, making wrong assumptions, or choosing incorrect decision criteria.

– Administrative risk – resulting from management's failure to implement the solution.

– Environmental risk – resulting from unanticipated environmental changes which may spoil even a well conceived and implemented plan.

The amount of control required depends mainly on the conceptual, administrative and environmental risks the organization faces (Dermer, 1977). Many construction projects, in particular the large and complex ones, must make allowance for all three risks.

In the recent study mentioned above (Laufer and Cohenca, 1986), it was found that for a 20 million dollar construction project lasting 18 months, three man-months are invested in planning prior to the onset of construction, while control (including replanning), during the course of construction, consumes 15 man-months. The results also indicate that in an uncertain environment, resources required for control increase significantly, at times even double.

Forecasting entails the calculation of project performance at specified future milestones.

Mathematically and statistically sophisticated models, derived from a large data base to produce a specific result (e.g. a completion date, a bid price, a cash-flow projection), may be employed extensively in forecasting. In essence, forecasting is an operation of processing collected information primarily of past performance, the result of which defines the future, but which serves as a decision-making instrument for now or soon.

Studies reported by Ahuja and Nandakumar (1985) reveal that early recognition of future events, such as a potential delay, can be significantly helpful to the contractor and the owner in reducing their adverse effects.

The aforementioned four planning objectives: execution, coordination, control and forecasting are characteristically performed to a 'satisfactory' level. 'Well enough' but not necessarily 'as well as possible' standards are considered the norm (Ackoff, 1970). Other objectives like constructability, efficiency and contingency planning are, by contrast, approached with an aim at optimization. In this group the preparatory planning activities (i.e. the gathering and processing of data) are stressed at the expense of the information exploitation stage (i.e. the dissemination and use of the plans proper).

Constructability planning pursues the optimum integration of construction knowledge and experience with the engineering design to achieve the overall project objectives (Griffith, 1984; O'Connor and Tucker, 1986). Companies adopting this philosophy employ experienced construction experts at an early engineering stage to ensure that design features are incorporated that will hold down cost and time. This type of planning forestalls future states that would otherwise occur. Execution and control planning, on the other hand, produces future states that otherwise would not occur. This is achieved by limiting the freedom in the selection of design solutions. In essence, this process trades off some of the construction constraints against tighter design constraints to yield an integrated, optimized project.

Efficiency planning concentrates on the construction phase, where it purports to minimize the resources required to obtain a specified level of performance, or to maximize performance with available resources. Stressed is an indepth, sophisticated and extensive analysis in which many alternative plans are reviewed. Sub-optimized construction processes are eliminated to produce a plan which promises the best future results.

Contingency planning, the last element in this family, is most common in the military. The planner provides for the most likely future environments by preparing numerous alternative plans in advance (Ackoff, 1970). The method involves extensive data gathering and processing for a review of hypothetical future environments. Several plans are prepared for the likely contingency to minimize response time when the plan is needed. Adverse results predicted by forecasting can sometimes prompt immediate preventive measures. Contingency planning should not be confused with forecasting, however. Forecasting focuses on a limited number of project goals for one probable future environment. Contingency planning deals with the entire project in many possible environments.

Emphasis on evaluation of alternatives is common to all three optimizing approaches: in the first, they concern detailed design and broad construction alternatives, in the second, alternative construction process, and in the last, alternative environmental conditions. The characteristics of the optimizing planning approaches are summarized in Table 1.

The benefits of the types of planning mentioned so far stem from the products of planning, i.e. decisions in the form of plans. Planning has, however, an additional significant objective, namely, of enhancing the development of management through the engagement in the process (Ramanujam *et al.*, 1986). This is expressed in the popular management cliche: 'After you completed the planning you could lock up the plans in a desk drawer, and still derive 90 percent of the benefits of the activity' (Dermer, 1977). The undoubtedly valid claim put forward by some students of strategic planning, that this objective often outweighs all others, will not be broached here, as we confine the discussion in this article to tactical/operational planning and to tangible aims.

Formal planning yields many indirect benefits such as in litigation, where plans (in particular CPM) can be useful in establishing the facts and the intentions of the parties (O'Brien, 1976). Some go as far as to claim that for this reason CPM has been increasingly used as an administrative and legal tool rather than as a planning instrument (Royer, 1986).

The role of planning in practice

What objectives are actually pursued during the planning of construction projects? There are many indications that control casts a dominating shadow over all other objectives (Baker *et al.*, 1979; Fondahl, 1982; Royer, 1986). This is expressed in several ways: (i) most documents produced by the planning system are geared towards control, both in format and content; (ii) while 'project plans (execution) are not viewed by management as living documents' (BRT, 1983), management usually goes out of its way to obtain forecasting and control reports; (iii) semantically, the planning and scheduling departments in many construction companies are termed 'control groups'.

It is quite common to find the formal plans prepared at the firm/project level decorating the project management office walls on site. Execution proper is governed by informal short-term planning performed by site/work management, at times totally disallowing the formal plans (Docherty, 1972). To mention a few reasons for the inadequacy of this method: (a) resources requiring long lead time cannot be on hand when due; (b) integrating the various project components becomes extremely difficult; (c) maintaining consistency between multi-level decisions is not feasible, and (d) optimization planning is completely ruled out.

Excessive emphasis on control at the expense of execution is apt to be disfunctional. The perception of being continually controlled irritates site managers (Arditi and Koseoglu, 1983). A more direct damage is that first-line supervisors are distracted from today's and tomorrow's tasks in order to produce an historical record of yesterday's problems. They often find it more advantageous to use their mental energy preparing a justification of what happened last week than trying to improve the plans for next week (Barnes, 1981; Gilbert, 1983). This reversed emphasis on control instead of execution leads to a virtual elimination of what Ackoff (1970) terms 'prospective' planning, namely, planning that is directed toward creating a desired future. Instead, efforts are devoted to 'retrospective' planning, planning directed toward removing deficiencies produced by past decisions, which in construction constitutes a vital part of control.

Ironically, the habit of site management of ignoring the formal plans makes control, which is primarily conveyed through the formal plans, ineffective. Top management's inability to produce changes at site often leads to a reversal of the role of control; instead of taking concrete steps to correct performance variances, most variances are 'remedied' by adjusting the plans to actual performance (Mazzini, 1986). The main role of planning may be seen as undergoing a transformation in three stages, from (i) the normative role in which it is supposed to initiate and direct action *before* it takes place, to (ii) the intended role in practice in which it is to influence and regulate operations *while* in progress, to (iii) the existing role where it is relegated to follow-up and *post-factum* status reporting for the record and forecasting.

Causes of the present state

How does one explain the fact, that with the exception of control and forecasting, so little of the original purpose of planning is being pursued? Planning for optimization is, of course, an arduous task. Decision-making is very difficult due to the interdependence between the elements which imposes a heavy burden on planners. Under these circumstances, executing the planning process consumes vast resources (Galbraith, 1972). Each component in optimization planning poses its own set of obstacles.

Constructability is unpopular because the traditional contract system stymies an early admittance of the contractor's representative to the design team. Where early design participation is possible it becomes very problematical and costly, particularly in large, highly specialized design terms (Gray, 1983; O'Connor, 1985).

Efficiency is infrequently aspired to because an administrator tends to satisfy rather than maximize (Simon, 1961). In the uncertain environments that are so common in construction (Lawrence, 1981) it can also be the wrong approach.

Contingency planning is rarely done because uncertainty is often conceived either as the owner's responsibility, e.g. incomplete design, in which case the contractor lacks the incentive to shorten response time, or as so unpredictable that contingency planning would be irrational (Ackoff, 1970).

Why execution planning, which is, after all, the *raison d'etre* for any planning, receives such low priority is less excusable. A partial explanation lies in its difficult nature. Execution planning must be done in 'real time' to match the pace of work. The unavoidable, frequent planning revisions (Laufer and Cohenca, 1986), and the time needed to update the plans make 'real time' planning tough indeed. Sophisticated hardware is not of much help because most updating requires not only time adjustment but also change in the network logic (Mason, 1982).

There may be a more central, less apparent cause for the insufficiency observed of the various planning objectives. Planning is mandatory rather than voluntary (Ramanujam *et al.*, 1986), and when imposed without constant political power backing, it can enjoy at best only sporadic successes (Ewing, 1969; Laufer and Tenah, 1985). The extent of internal political backing given to the clients of planning probably has considerable influence on the degree of pursuit and achievement of the planning activity in construction companies.

The most powerful among planning consumers is the owner. Many construction companies introduced systematic planning utilizing network techniques primarily because of owner's demands (Arditi, 1981; Arditi and Koseoglu, 1983). Other typical sources of political power within the construction company are: top management, middle management (e.g. the project manager), the planner, and lastly work management (e.g. the superintendent). Sub-contractors as external powers sources typically rank in importance before the superintendent. The owner and the subcontractors are viewed here as consumers of plans performed by the general contractor.

Table 2 gives a schematic view of the relative political power of the various users of planning *vis à vis* their respective needs for planning, classified by objectives. The stronger bodies are heavily engaged in forecasting and control while execution and optimization is the role of the weaker parties. The hierarchy in Table 2 is not representative of all situations (quite often the planner may be at the bottom of the ladder), but it portrays a fairly typical relationship of power between the parties and their pursuit of planning objectives.

Naturally, control based on measurement and catering to top management will tend to focus on output measures (i.e. time and cost) and less on process measures (i.e. construction methods). This may also explain the meagre attention devoted to the formal planning of production methods.

How to plan?

The normative process of planning

The normative process of planning comprises five phases (Fig. 2) to which we turn our attention in the ensuing section:

- Planning the planning process
- Information gathering
- Preparation of plans
- Information diffusion
- Planning process evaluation

In developed construction companies where planning is standard procedure, a procedure manual spells out the detailed planning steps of who does what, when and how. Each project ought to be analysed beforehand and throughout its duration in respect of the features that make it unique environmentally, technologically and organizationally (Lindsay and Rue, 1980; Harrison, 1981; Steiner, 1979). The results become the basis for laying out the planning process.

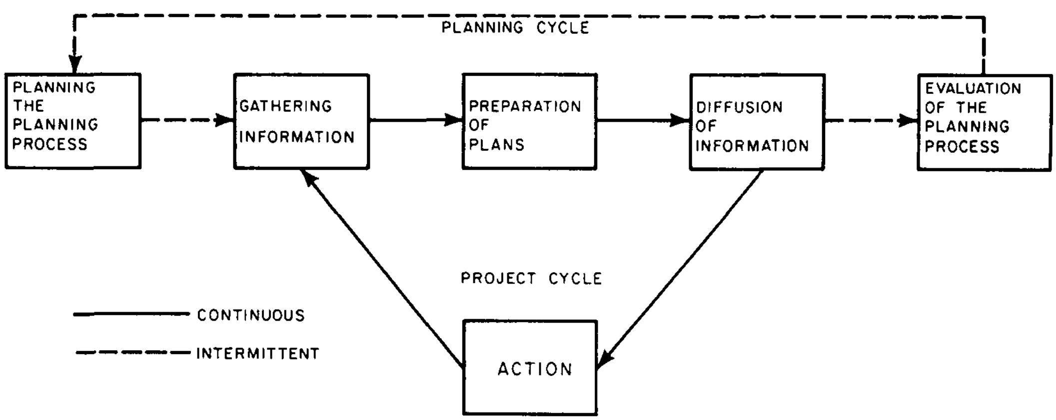


Fig. 2. The planning process. ——continuous; - - - - - intermittent.

Table 1. Characteristics of optimizing planning approaches

Planning approach	Type of optimization	Alternatives reviewed	Reference to future state	Assumptions concerning environment			Uniqueness of planning process	Number of action plans produced
				Certain	Uncertain	Unknown		
Constructability	Integration of design and construction	Detailed design and broad construction solutions	Avoiding undesirable future states				Early timing, organizational arrangements	None
Efficiency	Fastest-most economical construction phase	Construction processes	Producing the best future state				Sophisticated, in depth, and extensive analysis	One, very detailed
Contingency	Shortest response time for future changes	Possible future environments	Preparing for all probable future states				Extensive data gathering and processing	Many, somewhat general

Table 2. Actual pursuit of planning objectives as affected by the user's planning needs and their relative political power

User	Owner	Construction home office			Construction site		Actual Pursuit
Objective		Top mgmt	Middle mgmt	Planner	Sub-contractors	Work mgmt	
Forecasting	Very high	Very high	Very high	Moderate	Moderate	Low	
Controlling	Very high	Very high	Very high	Moderate	Very low	Low	
Coordinating	High	Moderate	Very high	Moderate	Very high	High	
Executing	Very low	Very low	Moderate	Very low	Very low	Very high	
Optimizing	Very low	Very low	Low	Very high	Very low	Very low	
User's Power							

Decisions made at this stage include: effort and timing for each planning stage, updating frequency, planning horizons and level of detail, and degree of planning and control centralization. The planner further decides on the selection of the information to be gathered and the method of distribution (Tuman 1981), and on the scheduling techniques to be used (Cori, 1985). Some advance information gathering may be needed at this point but that occurs infrequently and requires relatively modest resources.

The next phase, information gathering, may require considerable resources. The source material required for planning a typical construction project includes:

- Contract documents
- Blueprints and specifications
- Site and environmental conditions
- Construction technology
- Internal and external production resources (e.g. availability and cost)
- Productivity of labour and equipment
- Goals and constraints dictated by top management, the client, and various external authorities regarding quality control, finance, and law.

After onset of construction, information regarding progress on site is also collected, with emphasis on resources consumed and goals achieved.

In the third stage, working out the plans, decisions are made based on the evaluation of the collected information using techniques adapted to resource planning and scheduling (e.g. site lay-out, temporary facilities, flow diagrams and process charts, Gantt, LOB, CPM, PERT and GERT) and their respective cost implications (e.g. cash flow, break-even and risk analysis).

The preparation of the plans is followed by information dissemination according to users' needs. A surfeit of data can be as harmful as a shortage. The planner must make a realistic, and to a certain degree psychological assessment, of what information is required by whom (Tuman, 1981) and in what format (Cullen and Nankervis, 1985); what knowledge content is optimally/minimally required (Mason, 1984); and what accompanying activities will offset anti-planning forces and ensure implementation according to plans (Laufer and Tenah, 1985). After each planning iteration during the project's cycle, needs must be reassessed to adjust to the constant changes in the staffing of key recipients of information and particularly in consequent changes in the plans. If a drastic change in the execution of the project is called for, or if the response time must be very short, the medium and format of the information distribution must be adapted accordingly. Under these circumstances, the planner not only makes the decisions concerning information distribution but often has to take an active role in its assimilation (Laufer and Tenah, 1985; Morton, 1983).

The evaluation of factors made during this phase include:

- Functionaries receiving information (e.g. project manager, purchasing agent)
- Scope of information (e.g. by entire project or by area, comprehensive or selective)
- Subjects (e.g. cost, procurement status)
- Content (e.g. guidelines and goals, results and status, variances and reasons, analysis and calculations, assumptions and explanations, and remedy suggestions)
- Level of detail (e.g. broad brush, very detailed)

– Distribution frequency (e.g. weekly, monthly)
– Format (e.g. textual, tabular, symbolic, graphical, pictorial)
– Medium (e.g. visual-paper, screen; auditory-tape, telephone, direct meeting)
– Accompanying activities (e.g. consulting, advising, training, negotiating, involving, and promoting)

The true believer in the value of planning will not forego the inclusion of executional control and of the planning process itself. This is the instrument that enables him to make periodic evaluations during the lifetime of the project and that also becomes the basis for improving the planning process for future projects. As in other performance measurements, the control must include output measures (e.g. adherence to schedule) and process measures (e.g. extent of plan usage). The measures are based on factual data and users' perceptions such as satisfaction with the plans (Arditi and Koseoglu, 1983; Ramanujam *et al.*, 1986; Steiner, 1979).

The process of planning in practice

Of the five planning phases depicted in Fig. 2, the first and last are neglected to the point of non-existence and the other three suffer from major deficiencies in the way they are carried out. This is manifest in the relative attention each phase receives and in the techniques selected to accomplish them.

The phase that receives the most and sometimes only attention is the preparation of plans. As already mentioned, the focus here is on the planning of time and resources, utilizing primarily CPM/PERT networks. Even though these tools have been used for over three decades, their success has been limited. One survey in large construction companies has shown that only 15% of CPM/PERT users deem them very successful (Davis, 1974). Another study in large companies found that only 43% used CPM effectively, (BRT, 1983). In small construction companies the situation is even less encouraging, as one study indicates, that only 10% attempt to use CPM (Waddill and Mayes, 1986).

As the reasons for the limited effectiveness of CPM/PERT have been discussed extensively in the literature (Birrell, 1980; Erskin-Murray, 1972; Fondahl, 1982; Jaafari, 1984; Mason, 1982; Mason, 1984; Parsons, 1983; Peer, 1974; White, 1985), only the major shortcomings are given a brief recap here. Generally, it is argued that the CPM concept was created for national projects and cannot satisfy the contractor's needs for whom an efficient utilization of resources and their cost control is more important than construction time. Specifically, the following weaknesses are advanced:

(i) The CPM model refers mainly to technological constraints while the limitations of resources are barely considered. It does not ensure full continuity for the construction crew which is the backbone of operational planning in construction.

(ii) Even for technological relationships the model does not always provide satisfactory solutions. CPM is suitable for 'sequential' operations which characterize an erection type of work. It is not suitable for 'bulk' operations which is typical of an installation type of work, where detailed sequencing of activities is often irrelevant or unimportant.

(iii) When technological relationships are well defined and the model may be theoretically satisfactory we find that in many instances CPM is difficult to apply in practice. The majority of activities on a construction site are overlapping, not only with the immediately preceding and succeeding items but possibly with a score of preceding and following activities. This fact has always been obvious on a bar chart but is difficult and tedious to express accurately in an activity network.

(iv) The model only processes planning data that have been fed to it. Other input data – duration of activities, relationships, resources – have to be prepared by the planner using mainly heuristic decision-making concepts which entail giving attention to each activity and making many activities critical. This contrasts with the model algorithm which determines an incidental critical path related to activity duration.

(v) The network model usually presupposes that interferences and variability occur rarely. In fact, uncertainty is not a brief intrusion into a predictable sequence of operations. The oposite is true. Randomness and uncertainty exist in construction everywhere.

Progressive construction companies, aware of the impact of uncertainty, respond by adopting sophisticated planning models which incorporate probability analyses that relate either to the variable nature of the activity duration, or to the variations of the network logic itself (Ahuja and Nandakumar, 1985; Bennet and Ormerod, 1984). These simulation-techniques-based stochastic network models suffer from their own problems such as insufficient data of model parameters and inconclusive interpretation of results. But the main weakness is that these instruments are primarily intended for forecasting. Treating activities and their interrelationships as stochastic variables does nothing to further the understanding of the reasons for variability. It does not make the models useful for planning execution and cannot, therefore, influence short-term decisions and performance on site (Duff, 1980).

Nonetheless, so long as better methods are unavailable, CPM/PERT techniques cannot be supplanted. Their continued use must be conditioned by awareness of their limitations, which should serve as an incentive for the allocation of more attention to information gathering and diffusion.

The major deficiency in the information gathering phase is in the approach to uncertainty. Researchers are not in agreement over the definition and measurement of uncertainty, but in all suggested classifications construction would receive a high rating (Duncan, 1972; Lawrence, 1981).

Reducing uncertainty where decision-making (e.g. planning) is required can be approached in various ways. One may classify the strategies for reducing uncertainty according to the extent of involvement the decision-maker has with the decision situation. The strategy may attempt to:

(1) reduce decision-maker's perception of uncertainty, (2) devise a model of uncertainty, (3) reduce uncertainty by obtaining more complete information, or, (4) reduce uncertainty by changing the situation.

Labour availability is a good subject to illustrate various information gathering methods of planners facing uncertainty.

In the majority of cases the planner ignores the uncertainty. He makes little effort to seek additional information and continues to use the deterministic model for planning (Arditi, 1981). A more progressive planner occasionally injects a stochastic model but he refrains from pursuing new information sources, and blithely feeds the model with pure guesswork data. Less frequently will a planner utilize secondary data on past labour availability, such as is obtainable from the local commerce bureau, to run historical extrapolations. Quite rarely one encounters the enterprising planner who goes after primary information such as forecasts published by the local union. In all above cases the planner remains a passive recipient of information confined to his office.

Very rarely will a planner behave like an investigating journalist who visits the area of interest and examines the nature of uncertainty and its causes of source. Input of this type may provide richly rewarding information and insight that will improve his ability to cope with uncertainty by taking suitable counter measures under his control, e.g. in construction methods, (Howard, 1971).

Virtually non-existent is the planner willing to deploy all available methods to gather (yes, if necessary, spy out) information, and use it to influence future events, by introducing changes in factors *a priori* not under his control (e.g. in design solutions).

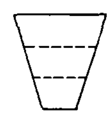
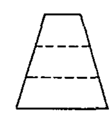
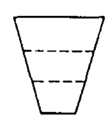
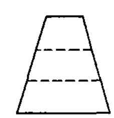
It is not suggested that the last method is the most desirable one – there is no single best way. Obviously, it can become uneconomical to accumulate information because at some point the cost of collecting exceeds expected returns. There are ways to calculate the desirable amount of information through techniques such as Bayes's theorem, or its later improved version (Edwards *et al.*, 1968), or by using 'the expected value of perfect information' method (Howard, 1966). In cases of very high uncertainty the investigative method is often unfeasible and not cost effective. In these situations, remaining deliberately oblivious of uncertainty coupled with a flexible and responsive mode of management may be more appropriate (Ackoff, 1970). The important point is that the good planner keeps an open mind to all information-gathering methods including his own active participation, and that he makes his choice according to the situation.

The currently practiced technique of extracting information from internal records falls equally short of the normative one. In most cases where information concerning construction progress on site is sought, the planner relies almost entirely on the formal MIS. The additional or verifying information that can completely alter the picture lies untapped in the existing communication system (e.g. memos, letters, telexes and minutes of meetings), or in routine documents like drawing transmittals, requisitions, purchase/work/mod/orders, expediting reports, and remains there. Valuable information is lost because people in the field and at the head office are not interviewed.

To demonstrate the implications of the various information gathering attitudes, a comparison between the common and an alternative approach is presented in Table 3. For each approach the underlying assumptions, the ensuing process of information gathering and the probable results are shown. The planner taking the common approach overlooks the distortion of upward communication. He also believes the extent of uncertainty is negligible to moderate, that pursuing information actively is not cost effective, and that his ability to influence future, external events is extremely limited. The planner's role is fashioned accordingly. He handles information which is primarily internal, formal, and related to current and historical events.

The planner who embraces the alternative approach recognizes that important information is filtered out in the upward communication process (Barndt, 1982). He also assumes that the uncertainty level is moderate to considerable, that pursuing information actively is often cost effective, and that future external events can be occasionally influenced by his activities. He

Table 3. Comparison of two information-gathering approaches

	Characteristics	Common approach	Alternative approach
Assumptions	Filtering of upward information	Limited	Considerable
	Extent of uncertainty	Negligible/Moderate	Moderate/considerable
	Aggressive pursuit of information	Often not cost effective	Often cost effective
	Ability to affect future external event	Limited	Occasionally feasible
The process	Role of planner	Receiving information	Trading and verifying information
	Mode of information gathering	Passive/static	Active/dynamic
	Type of information	Primarily formal	Formal and informal
	Source of information	Primarily internal	Internal and external
	Time of events studied	Historical and current	Historical, current and future
Probable results	Distribution of information concerning historical events:		
	Unreliable Partially reliable Reliable		
	Distribution of information concerning future events;		
	Unknown Uncertain Certain		

therefore actively trades and verifies information of a wider range which also includes external and future events.

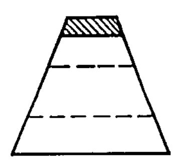
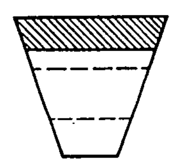
The table indicates that the probable results of the alternative approach are superior for historical events, where the proportion of reliable information will increase, and for future events, where the proportion of certain information will increase.

It must be stressed again that the alternative approach is not necessarily always the preferred one. The choice is contingent upon the situation.

Information diffusion as practiced today is also plagued by serious deficiencies. The underlying assumptions, the ensuing process and the probable outcome of the common practice, versus an alternative one, are shown in Table 4. Implied is the general attitude: 'The planner plans and the manager implements smoothly and at once'.

This contrasts visibly with findings outside construction that indicate there is a strong resistance to planning that must be overcome for the plans to be implemented (Bologna, 1980;

Table 4. Comparison of two information diffusion approaches

	Characteristics	Common approach	Alternative approach
Assumptions	Implementation of plans	The planner plans – the manager implements smoothly and at once	Diverse specific activities are required to facilitate implementation
The process	Role of planner	Diffusion of information according to the company's standardized procedure	Identification of information consumers and their attitudes, analysis of their current needs, diffusion of information adapted to thse needs, performace of activities that facilitate implementation
	Extent of utilization of computer capabilities	Exaggerated – voluminous detailed printout, frequent issues of major revisions attempted	Limited, matched to needs
	Medium and format of communication	Primarily paper, computer product, graphical symbols and numerical tables	Paper screen phone and meltings, employing texts tables graphs and pictures
Probable results	Relevancy and timely attainment of information by users Relevant and attained (portion utilized) Relevant but not attained Irrelevant but attained		

Ewing, 1969; Steiner, 1979). Studies in construction also point to the importance of solving the bias of users against planning, as asserted by O'Brien (1984) 'people problems are the most difficult obstacles to successfully applying CPM'. Laufer and Tenah (1985) demonstrated the need for many complementary activities adapted to the specific situation to avoid or overcome resistance to planning.

In the common approach, information is distributed according to standard instructions in the company's manual (Tenah, 1986). Though this procedure dictates a selective distribution of reports according to the users' functions, it does not cater for variations and assumes one best way. The medium and format of communication is dull and dry, as poignantly stated by Mason: 'CPM scheduling has been overdeveloped as a science and underdeveloped as a user-oriented tool. It is all too often forgotten that schedules are not produced for schedulers but for managers' (1984).

Computers often induce the creation of over-elaborate, unnecessary or irrelevant data. Managers find it impracticable, if not impossible to assimilate this over-abundant information and cull from it the important and relevant elements for effective use (Bennett, 1983; Gilbert, 1983; Harrison, 1981; Morton, 1983). The planner himself suffers from excessively detailed plans, which causes updating lags that deprive the plans of their 'real time' value. This in turn contributes to the fact that execution is not guided by planning, but vice versa. In some companies computerized update delays have become so extreme that formal planning is done manually during construction (Mason, 1982).

These difficulties are brushed aside by the seductive nature of computers that keep churning out frequent, voluminous revisions. Since the model and software were designed for the revisions and paper tolerates them, the planner proudly sees in them his primary purpose. But site-management in real-life situations finds them difficult to live with (Arditi, 1981). The probable result of the common approach is that users receive, in an unfriendly format, only part of the information really useful to them (Choudhury, 1981; Arditi, 1981).

The alternative includes activities described earlier under the normative method of information diffusion, with the probable result that more relevant information is acquired when due and that much of it will be used to guide on-site execution.

The actual role of planning discussed above and the common way information is handled both make implementation of formal plans unlikely. In the present situation two distinctly separate systems of information flow exist side by side, as shown in Fig. 3. At the company/project level the information system is formal and has a limited effect on on-site execution. It functions mainly to describe historical developments and the current status. At the site/work level there is a system of informal information and decision-making, mainly short-term that dictates execution on site.

Planning the planning phase is virtually non-existent. True, companies' planning manuals prescribe different procedures for different situations, such as lump sum project versus cost plus, or small versus large, but variations in many other important respects, such as percent of design completion at construction start, or users' attitudes to planning, are ignored. No mechanism, formal or informal, takes care of checking the peculiarity of the project and its possible effect on the planning process.

The last phase of the planning process – planning effectiveness assessment – is conspicuous by its absence. Admittedly, measuring planning effectiveness is difficult to accomplish, and has not been solved satisfactorily even outside the construction industy (Dyson and Foster, 1980; Greenly, 1984; Kudla, 1976). Output measures are problematic because the results depend not only on the quality of the planning but also on the quality of project management and various environmental factors. This has led to heavy reliance on process measure and to the establishment of a list of symptoms of ineffective planning, which includes, *inter alia:* (a) rare contact between planners and top management, (b) lack of iteration in planning process, and (c) excessive quantities of data with spurious accuracy. In construction the measurement of planning effectiveness is still in a primitive state where even empirical studies resort to substitutes such as self reported satisfaction (Arditi and Koseoglu, 1983), or to weak process

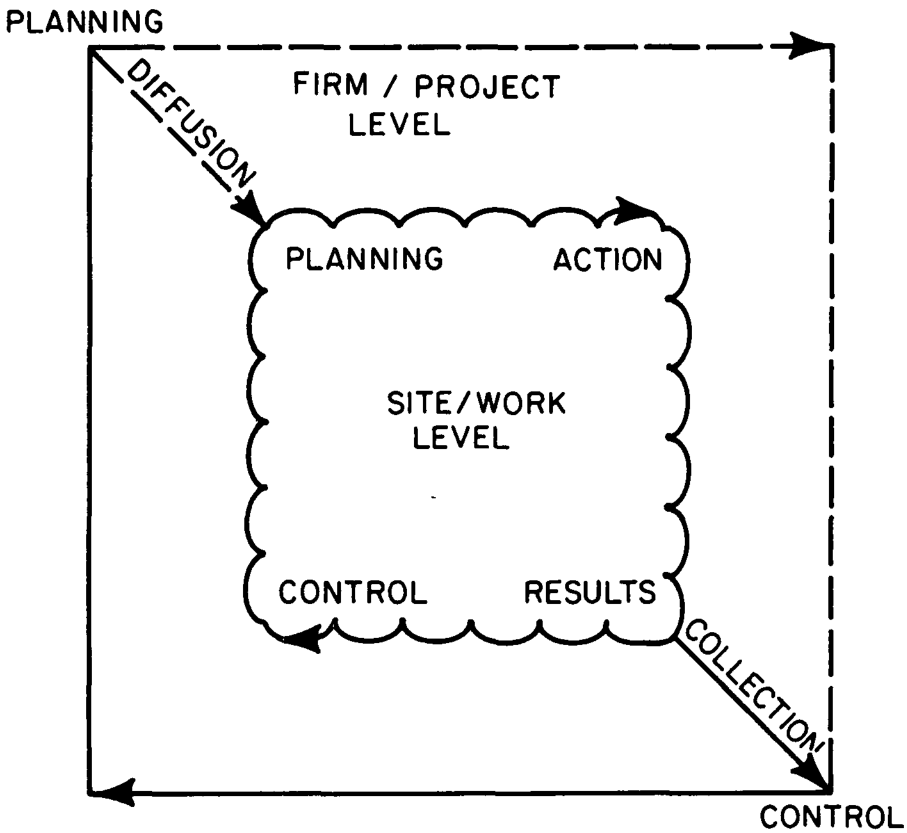


Fig. 3. The common mode of information flow. Information channels are represented as —— formal and influential; ----- formal and non-influential; ~~~ informal and influential.

measures such as 'percent of a firm's projects using bar charts or CPM' (Wong and Logcher, 1986).

Causes of the present state

What explains the imbalance of attention given to the different phases of the planning process? If this state mirrors the attitude of top management it cannot justify the behaviour of the planners themselves. We point out that the proposed switch from the deficient to the normative process will not necessarily involve additional resources. On the contrary, the typical normative approach calls for an improved spread of the same resources at the planners' discretion (Fig. 4).

Many of the flaws in the current process of planning are attributable to the skills and attitudes of the professionals – researchers, developers, and planners.

Research and development of models and techniques of planning have traditionally originated in the academe which is, at least partially, motivated by what Simon (1969) calls the

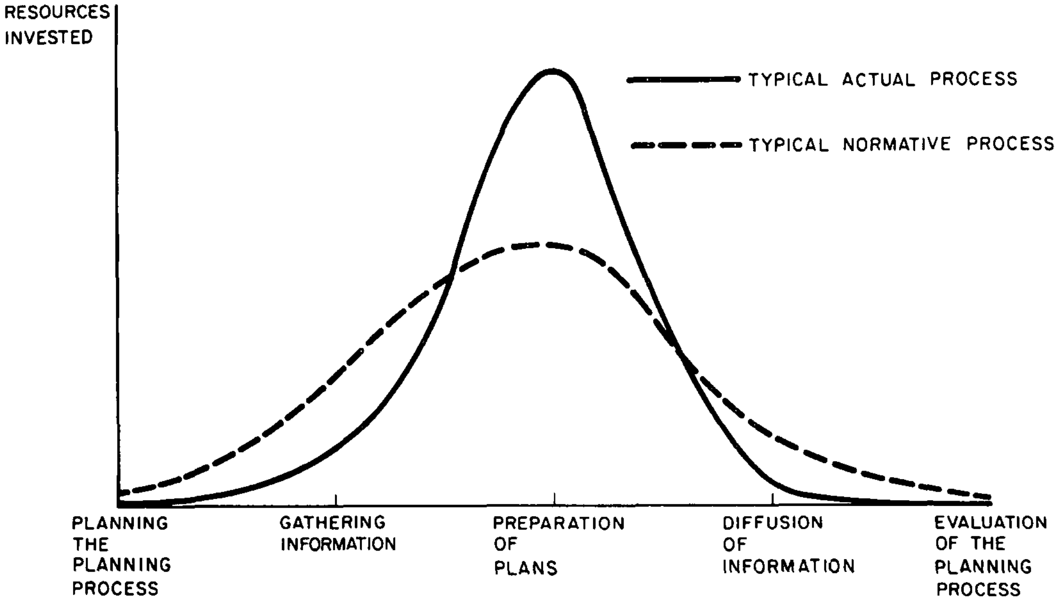


Fig. 4. Distribution of effort during the planning process. The typical actual process is represented as a solid line and the typical normative process as a broken line.

'desire of academic respectability'. It terms of prevailing norms, academic respectability turns its attention to subjects 'that are intellectually tough, analytic, formalizable, and teachable'. Organization, people, and information handling, though the central theme of project planning, is perceived as 'intellectually soft, intuitive, and informal' and is, therefore, largely ignored by researchers in the academe. Moreover, the preference for quantitative problems that have mathematical rigor has at times led researchers to fit spurious problems to available methodology rather than search for the relevant problems.

Programmers and engineers are accustomed to dealing with things. Therefore they tend to develop and apply tools rather than deal with people. For them, people usually assume a stable state from whom generalizations can be made. 'One best way' is thus a prevailing philosophy (Gilkeson, 1981; Harrison, 1981; Mintzberg, 1976; Morton, 1983). Engineers' training and acquired orientation predispose them to prefer impersonal, logical/deductive work that enables them to use sophisticated quantitative tools, over activities that require extensive personal contacts and involve informal, intuitive techniques. When faced with the ever-present dilemma where to invest their limited time – in information gathering or in information processing (Emery, 1969) – they tend to favour the latter.

Conclusions

There is growing recognition that in spite of the vast attention devoted to construction planning and with all the models, techniques, soft/hardware available and engaged, its achievements are wanting. On-site construction is usually performed without planning. While there is wide agreement on the existing situation, its interpretation is disputed. Most previous attempts to find a cure were limited to the technical aspects of planning. Analysing the same body of evidence but in a larger perspective, this article demonstrates that planning problems are *multiple and much more fundamental.*

The major flaws of planning identified in this article are:

- Focus – scheduling is overemphasized while methods planning is neglected;
- Role – control overshadows action planning;
- Process – decision-making proper gets almost all the attention, while the necessary steps prior to the following it are ignored.

As a result it becomes a case of the tail wagging the dog: instead of the advanced formal planning setting the course of action, it is execution that shapes the so called formal plan.

The problems stem primarily from inadequacies of the qualifications, orientation and motivation of the parties involved. This holds true throughout the life cycle of planning – beginning with research and development of planning techniques by academicians and programmers, next, to the application of these techniques by planning engineers, and finally, to the utilization of the plans by top managers.

The practical implication of this study is that for planning to become effective, methods should be changed (e.g. gathering and diffusing of information), policies should be modified (e.g. the role of planning and control), assumptions should be adjusted (e.g. attitude to uncertainty) and the overall philosophy of project management should be re-examined. Considering the existing deep-rooted beliefs and practices on the one hand, and the diversity of problems on the other, the proposed revamping will not take place overnight. It will demand a concerted and sustained effort by practitioners and researchers alike. This study is a step in this direction.

An important opportunity presents itself with the beginning of advanced computerized construction research (e.g. knowledge-based systems) now unfolding. Awareness of an counter-action against the tendency to repeat past mistakes are necessary to ensure the opportunity will not be missed. We recommend that the organizations funding construction research, and most importantly the users of the research products make certain that the research will be relevant, balanced, and will encompass the scope of all planning aspects.

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