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BEATING THE USE OF HEURISTICS IN CONSTRUCTION PROCESS: CAN INFORMATION TECHNOLOGY DO IT?

Tayyab Maqsood
Department of Building and Construction, City University of Hong Kong, Hong Kong

Chotchai Charoenngam
School of Civil Engineering, Asian Institute of Technology, Thailand

Terry Clayton
Center for Language and Educational Technology, Asian Institute of Technology, Thailand

Salman Azhar
Department of Civil and Environmental Engineering, Florida International University, Miami, Florida,USA

ABSTRACT

The fast pace of on site construction processes demands site mangers of early recognition of the problems and instant decision making for the solutions to exercise effective onsite monitoring and control. Various tools both in the form of informal or formal exist for the purpose. Enormous efforts have been undertaken in construction industry world wide for the formal tools development for several decades to improve construction process utilizing various modernized equipment and technology including information technology. The promised benefits still have not been perceived in construction industry as were expected. The paper argues that IT related applications or tools cannot beat the use of heuristics unless they achieve a level of swiftness, ease of use and sophistication far better than a human mind can do. It is further argued that in the absence of such formal tools it may be possible to fix the attentions on developing and refining the tools that are natural and inevitable to use, the informal intuitive tools. The research demonstrates that cognitive guidance may be regarded as one of the means of improving the utilization of intuitive formal tools for site monitoring and control. A three level task was presented to 99 civil engineers, involving an on site construction problem coupled with three different level of cognitive guidance from none to extreme. The effect of guidance observed was in the form of an increase in the number of engineers responding to the task. The research, therefore, argues to focus efforts to utilize IT in improving natural and informal tools resulting in an appropriate use of intuition and heuristics.

KEYWORDS

Information Technology, Heuristics, Cognitive Guidance, Bias, De-biasing

1. INTRODUCTION

On construction projects the world over, site managers are expected to quickly identify actual and potential problems and take appropriate action to either prevent or minimize negative consequences (Belassi and Tukel, 1996). The methods site managers use to achieve this can be roughly categorized as 'informal' or 'formal' tools (Oglesby et al., 1989). Informal tools are visual observations or face-to-face simple talk with workers and recognizing a problem by 'gut feeling' or intuition. This method may be misleading as it depends upon human judgment. At the same time, it is quick, often correct and saves cognitive effort of managers (Skitmore et al., 1989).

‘Formal’ covers a wide range of graphical and mathematical methods, techniques and tools from simple paper-based bar charts, timetables, schedules, site maps and inventory lists to more sophisticated techniques that include CPM, influence diagrams and expert systems, any of which require the use of increasing complex information technology (IT). Formal assessment methods are used to check ‘slippage’ in schedule and cost overruns. Slippage alerts managers that something is wrong with work face operations. Formal methods do not directly indicate the cause of the problem but give only an indication of the problem when an important operation takes considerably longer than scheduled or if the reported unit costs overrun the budgeted amounts substantially (Oglesby et al., 1989). One of the drawbacks to these methods is that they are not proactive and are merely reactive approaches.

Engineers have, of course, been applying IT tools to various phases of the construction process for many decades: CAD/CAM in design, expert systems in procurement and estimation, fuzzy logic in planning and scheduling and so on. In recent years, ‘integration’ has attracted much interest and numerous computer-based systems have been proposed, simulated, modeled and tested for integrating the flow of information and improving coordination among and between designers, owners, contractors and material supplies. Advocates of IT applications tend to be enthusiastic in their claims of what can be achieved. In extolling the virtues of a relatively simple software program designed to gather site data, Russell (1993) predicts, “development of a coherent picture of the current status of a project and how it got there; faster response time in dealing with problems because multiple views of the project can be generated right at the site; integration of the site-reporting, project-planning and project-scheduling functions, thus enhancing communications between site and office; an increased likelihood of schedule updating and speedier updating, leading to increased schedule credibility; help in dealing with claims; and documentation of experience in a form useful for future projects.”

Despite the enormous effort invested in the line of research, " industry specific systems have failed to make the impact their vendors had hoped they would (O'Brien, 1997)." One of main reasons for the nonuse of information systems is that they cannot provide up to date information in a timely manner or format that is understandable to site personnel or compatible with their cognitive styles or limitations (Wilson, 1995). Davenport (1994) also found that managers don’t use the information that comes out of machines but prefer to obtain information that comes verbally thorough mutual coordination and cooperation. Ahmed and Minkarah (1990, cited in Moselhi et al., 1991) indicated that construction personnel prefer techniques that use less mathematics and will adopt these more easily rather than other techniques.

2. FAILURE OF IT SYSTEMS UTILIZATION IN CONSTRUCTION INDUSTRY

2.1 Reactive Approach

Using formal tools is a reactive approach to the problem solving. In a construction process, daily data is collected about various construction processes for a certain period of time and processed depending upon the updating interval. The results are measured against the variances allowed in the schedule and cost (Barrie and Paulson, 1992). In case they are out of the limits, problem is noticed and solution is sought. By the time a solution is furnished, the problem in actual has grown by many folds and consumes more resources for a fix. A long delay between problem occurrence, recognition and proper action for resolution in the use of formal tools is one of the reasons that use of formal tools is not highly successful on a construction site. The computer technology has been employed to overcome the limitations of manual system in the form of increased processing speed and decreasing the reaction time but the technology also has its deficiencies. Information technology has facilitated the process of filtering and disseminating information and the development of related softwares has decreased the time required in preparing reports and making information quickly available but they have not had much success in terms of actual use (Charoenngam and Kazi, 1997; Brandon et al., 1998). Most of the systems developed have not met with the success their creators have expected (O’ Brien 1997). Systems which were expected to revolutionize procedures have met with spectacular failure. These failures may be attributed partly to the fragmented nature of the construction industry which involves diverse participants from different disciplines each working for their own benefit (O’ Brien, 1997) and inherent deficiencies in the systems themselves, their nonuser friendly nature and their inability to provide all the pertinent information in a simple, straight-forward manner. These systems are too technology centered, user unfriendly and often unable to provide all the required information in one single package in a timely manner. Though they have made the process faster, they still are not fast enough to be able to work in synchronism with construction process. They are also expensive to purchase and maintain.

2.2 Neglecting Cognitive Aspects Consideration

Information Overload

Another problem in using formal tools is that the information is available in bulk and to find meaningful information can be very tedious (Tenah, 1986). Information overload occurs when the amount of information assimilated starts reducing and this happens when the amount of information presented increases. Umanath and Vessey (1994) observed that humans are always presented with an increasing volume of diverse information and this fact has been ignored always that humans are limited information processor. Information is absorbed by a user depending upon his cognitive capacity to translate information into knowledge. There is a limit to a user's cognitive capacity. The absorption process is carried up to a certain point beyond which more information becomes "overload" and hence of no use. This draws attention to the process of information acquisition, which is purely mental in character. The information received is not a function of the number of pages read but of the mental process of understanding and integrating the data into personal knowledge structures (Wilson, 1995). As information load increases, information digestion rate decreases. If a decision maker attempts to use all of the information available, cognitive effort increases drastically and the result is lower accuracy, increased effort and lower performance (Umanath and Vessey 1994).

Cognitive Modeling of Information Seeker

The quality of the information and way it is provided to the user is critical. Davenport (1994) mentioned that information overload would not occur if the information is really useful- the appetite for it would be insatiable. It has been observed that text based information is not as effective cognitively as information presented in graphical format. This leads to the idea that visual dissemination of information will eliminate the information overload and appetite or information digestion rate of the user will remain at significant level. This has given rise to the development of multimedia and visual system environments that provide information in visual formats. Visual environments can be generated by integration of graphical tools with existing project management applications (Cherneff et al., 1991; Parfitt et al., 1993; Navon, 1995; Froese et al., 1997; Kenneth et al., 1991). But graphical tools and project management applications alone may not be sufficient to create a stimulating or friendly environment for users. There is little actual evidence that such integrated visual environments enhance the capacity of users and increase their capacity to use information. The problem remains as long as the cognitive limitations of users are not taken into account in the design of such systems. To increase the capacity for information, a cognitive model of an information seeker or user has to be constructed and compatible information systems are to be developed (Wilson, 1995).

3. ENHANCING INTUITIVE INFORMAL TOOLS UTILIZATION

The ultimate goal of much of the research on computer-based control and monitoring applications seems to be to reduce uncertainty to a point where it becomes virtually impossible for anything to go wrong. While this direction of research has produced many useful applications with certain weaknesses that need to be addressed, we should not neglect the potential of low-tech solutions. In their introduction to Decision Analysis with Supertree, McNamee and Celona (1990) begin with the premise that, "Uncertainty is a consequence of our incomplete knowledge of the world." While the influence diagram technique is highly mathematical and falls clearly into the 'formal' category of tool, the authors suggest that, "An influence diagram or decision tree is used to divide uncertainty into subfactors until the level has been reached at which intuition functions most effectively". They further remind us that, "probabilities are statements derived from a person's state of knowledge." What this means in practice is that a site manager's estimate of the probability of materials being delivered on time is based not necessarily on how many times this event has actually occurred but on how many times that site manager can recall instances of on-time delivery. McNamee and Celona (1990) are among the few designers of formal tools who seem to acknowledge this fundamental role of human intuition.

In contrast to the theoretical ideal of systematizing and automating much of the construction process is the actuality of practice. The literature on construction delay and its causes is particularly informative. In their study on construction delays in Thailand, Ogunlana and Jearkjerm (1996) observed that site managers: use simple bar charts for planning and monitoring but do not record sufficient detail or update information regularly; spend little time thinking about site organization; suffer material shortages often due to poor communication with the head office, and neglect the importance of coordination. The solutions recommended are often normative as in Mansfield et al. (1994) who advise that: contractors should establish an efficient materials management system; there is a continuing need for manpower development in the areas of project management, information and database management systems; construction programs should be seriously monitored and reviewed. The implicit solution is always the use of more sophisticated tools or systems or advanced training. In this paper, we are arguing that, given the conditions under which most site managers work and an enormous pace on which the construction processes moves, the problem is not the use of simple tools, rules of thumb and intuition per se. What we see lacking is industry recognition that behaviors like visual observation, chats with foremen and the use of individualistic rules of thumb are tools in the same sense we use to describe formal mathematical tools and that knowledge of them and how to use them more effectively can be improved.

3.1 What is Heuristic?

'Heuristic' is a term used by psychologists to denote general problem solving procedures that often work in solving everyday problems. It is a rule-of-thumb, a guideline for coming up with a solution (Best, 1989). The use of heuristics is very widespread in the industry (Flanagan and Norman, 1993). Skitmore et al. (1989) mentioned that cognitive heuristics or principles are systematic rules, which operate instead of a detailed analysis of the available information thus conserving mental effort. Such judgments provide cognitive shortcuts and perform trade off between psychological processing demands and the need for response accuracy. This intuitive decision mechanism enables persons to function on a day-to-day basis without having to analyze enormous amount of information. This mechanism is heavily dependent on experience. These cognitive short cuts vary from person to person and are usually developed after gaining enough experience or knowledge about certain phenomenon e.g. Site managers develop such rules of thumb after they have spent adequate time in the trade and acquired enough knowledge and experience.

3.2 De-biasing Strategies

De-biasing Strategies are required to for effective utilization of human intuition or heuristics. Lowe and Reckers (1994) have described various de-biasing strategies to minimize the effect of biases while making judgments. Zimbardo and Gerigg (1996) mentioned that awareness and recognition of biases could improve decision-making because a decision maker will keep himself away from these biases. Santamarina and Chameau (1989) also gave an idea of organizing the biases and limitations in a sort of flow chart that individuals could use to avoid the resulting pitfalls. Woodward et al. (1991) described human remembering as a process of reconstruction. An individual must reassemble or recreate the necessary structure and events, which must have happened rather than directly retrieving what actually did happen. The actual event with all salient factors is not stored in memory. Making judgments and choosing alternatives are complicated and complex process. In many cases humans complete these complex processes quickly with less than complete information and with little consideration. This way certain things may be overlooked. It is well known in the psychology literature that 'recognition is easier than recall'. Cognitive guidance makes this recognition process easy. In the context of on-site construction processes, cognitive guidance may be provided in the form of checklist of the problems which a site manager may take notice of, while having routine inspection. This aspect of cognitive guidance we have exploited in this paper to make utilization of informal tools effective and efficient.

4. METHODOLOGY

This research forms a part of the research project carried out to investigate formal and informal tools usage in the on site construction processes and to investigate the rules of thumb used by site managers with a view to enhance on site construction productivity. In this investigation, we used a hybrid task/questionnaire and focus group interviews to try and uncover some of the psychological processes behind site managers' reasoning and behavior. Qualitative method of research was adopted to carry out this research. Content analysis technique was used to analyze the data. Focus group sessions were executed to verify the findings. The details about the methodology and data analysis techniques have been described elsewhere (Charoenngam and Maqsood, 2001; Maqsood, 1999). A total of 110 civil engineers responded to a web-based task. Ninety-nine responses were used in the analysis. The respondents were categorized by their level of experience in terms of years. They came from construction management and related fields of engineering such as water resources management, structural and transportation engineering. All but nine of the respondents are currently enrolled in the masters' program at the School of Civil Engineering, Asian Institute of Technology. Thirty-seven have direct experience in construction. Direct Experience (DC) means they have worked on a construction site as a site supervisor or in a capacity in which they made frequent visits to a site. Twenty-one were inexperienced and forty have experience but in fields other than construction (OC).

4.1 The Task

A web-based task was developed to elicit and capture people's reactions to a typical site situation. Respondents were asked to look at a photograph was originally taken to illustrate 'overcrowding' and is used in a course on construction productivity improvement taught by one of the faculty in the School of Civil Engineering's Construction Engineering Management Program. The task is divided into three stages. In the first (unguided) stage, the respondents were given the following instruction: Imagine that you are at this site as the site manager. What comes to your mind when you see this? The second stage offered guidance in the form of a simple question: Do you see a problem here? The third stage provided more specific guidance in terms of a checklist of possible problems. Respondents were asked to pick one or more from the list and prioritize them. In each case, a dialogue box was provided for respondents to enter their comments.

4.2 Focus Group Sessions

A series of three focus group meetings were held and each ran for about two and half-hours. A total of 11 participants with more than 8 years direct experience in construction work participated in all three sessions. Two of the three authors acted as focus group leaders. The sessions were tape-recorded and extensive notes were taken during the sessions by one of the authors who is an experienced interviewer. An interview schedule was prepared that included questions on rules-of-thumb, the relationship between decision-making and experience, beliefs about site practice and recommendations for improvement. Following each session, the authors met to review and categorize the data. As the complete data is rather extensive, in this paper we have summarized the related findings.

5. RESULTS

5.1 Effect of Cognitive Guidance

The first stage of this task 'Visual 1' was without any cognitive guidance. Participants were simply asked to, "Imagine yourself at a site and think "What would I do?" with a further instruction to respond with their "first thoughts". This stage is an attempt to simulate or replicate the site situations where site managers go out to visit the site without anything specific in their minds. This is true in case of routine site visits where site managers don't have anything specific to look for. Using a content analysis approach (Patton, 1990) the framework in Table 1 was devised to categorize the responses. Comments that explicitly or implicitly referred to the management of labor, material and equipment or factors influencing their use were categorized as ' management' problems (e.g. "There are too many laborers standing at one place."). Comments like, "Foundation is not being placed correctly." were categorized as 'technical'. The 'None' category included comments like, "Some foundation work is going on."

Table 1: Visual 1 With No Guidance

Nature of Experience	Experience in years	Total no of participants	Event (over Crowding)												
			Problem Solving Process Parameters in First Thinking												
			Management						Technical						None
			Identification		Causation		Action		Identification		Causation		Action		
			one	more than one	One	more than one	one	More than one	one	more than one	one	more than one	one	more than one	
Inexperienced	0	20	4	2	0	0	0	2	1	0	0	0	0	0	14
Other Than Construction (years)	1-2	21	5	0	1	0	1	0	6	0	0	0	0	0	10
	3-5	9	3	1	0	0	1	0	1	0	0	0	0	0	5
	6 or more	10	5	0	3	0	3	0	2	0	0	0	0	0	3
	Total	*40*	*13*	*1*	*4*	*0*	*5*	*0*	*9*	*0*	*0*	*0*	*0*	*0*	*18*
Direct Construction (years)	1-2	17	9	5	1	1	4	0	1	0	0	0	0	0	3
	3-5	11	2	5	3	0	0	0	1	1	0	0	0	0	2
	6 or more	11	2	3	3	0	1	0	2	0	0	0	1	0	3
	Total	*39*	*13*	*13*	*7*	*1*	*5*	*0*	*4*	*1*	*0*	*0*	*1*	*0*	*8*
	All	99	30	16	11	1	10	2	14	1	0	0	1	0	40

Nearly half the participants declined to indicate a problem of any kind. Of the remainder, the majority of the comments fall in the Management category. In both the Management and Technical categories, respondents identified a problem more frequently than they indicated cause or action to solve the problem indicated. Within the three levels of experience, participants with Other Then and Direct Construction experience identified one or more problems much more frequently than the Inexperienced groups. In the context of the task situation; the first task presented in a laboratory simulation/experiment; a 'safe' strategy would be little or no commitment pending further information. This 'watch and wait' strategy also emerged as a rule-of-thumb in the focus group discussions with experienced site managers. However, in this early stage, the effect of experience is evident in that those with direct construction experience were, by far, more inclined to risk identifying a problem. Within the Direct experience group, the effect of experience has an interesting 'inverse' affect; i.e. those with more experience seem more reluctant to identify a problem than their less experienced colleagues. Perhaps, with more years on the job, site managers come to understand that problems are never as simple as they first appear and, whenever possible, a watch-and wait strategy may be the best course of action.

The second stage of the task provided more guidance in the form of more direct instructions; "Do you observe any problem in this scene? If yes, please identify one or two problems important to you", and two similar questions designed to elicit probable cause and possible corrective action. The intention of the question is to reduce observers' uncertainty as to the task requirement. This is the simulation of mind of site managers if they go out on site visits with some aim of pinpointing the problem. The stage involves the knowledge and skill of the site managers to pinpoint the problem. This change in the level of cognitive guidance required a corresponding change in the framework used to categorize the comments. In Table 2, a Primary problem is one, which, if addressed, will improve the process depicted in the picture. For example, if a respondent said, "There are too many laborers standing at one place", a solution that addressed this would, most likely, improve the process. A statement like "The workers are not wearing hard hats." was classified as a 'Secondary' problem because while this may be a general safety problem, issuing hard hats is not going to improve the work process.

Table 2: Visual 2 With Some Guidance

Nature of Experience	Experience in years	Total no of participants	Event (Overcrowding, Excess Labor)											
			Problem Identification				Causation				Action			
			Management		Technical	None	Management		Technical	None	Management		Technical	None
			Primary	Secondary			Primary	Secondary			General	Specific		
			Overcrowding	e.g. safety, unclean			e.g crew planning	e.g. Supervision			e.g. long term actions	e.g. at that moment		
Inexperienced	0	20	4	5	4	7	4	3	2	11	3	5	2	10
Other Than Construction (years)	1-2	21	4	3	6	8	2	1	4	14	0	4	3	14
	3-5	9	4	2	0	3	2	2	0	5	1	3	0	5
	6 or more	10	3	2	2	3	0	3	1	6	1	4	0	4
	Total	*40*	*11*	*7*	*8*	*14*	*4*	*6*	*5*	*25*	*2*	*11*	*3*	*23*
Direct Construction (years)	1-2	17	9	2	6	0	4	7	5	1	3	7	4	3
	3-5	11	6	2	1	2	4	3	2	2	2	5	2	2
	6 or more	11	5	2	3	1	4	2	2	4	1	4	1	5
	Total	*39*	*20*	*6*	*10*	*3*	*12*	*12*	*9*	*7*	*6*	*16*	*7*	*10*
	All	99	35	18	22	24	20	21	16	43	11	32	12	43

The pattern of responses in Table 2 is similar to unguided stage in that there were many more comments identifying a problem than indicating cause or action but the frequencies in all categories were much higher. The same holds true for levels of experience. Within the Direct Experience group, the questions seem to have the effect of reducing the reluctance of more experienced managers to indicate a problem. In this task, it was possible to quantify the number of comments indicating overcrowding. Experience does seem to play a role in site managers' ability to identify the problem depicted in the picture, although years of experience alone does not appear to be a significant factor. Those with only 1 or 2 years experience reveal a slight technical bias (6 of 17 comments) which might be a function of their recent technically oriented bachelor degree training and their lack of hands on management experience. For a new site manager, there may be much less personal risk in dealing with a technical as opposed to a management issue. A similar pattern is seen inn attribution of cause; those with more years of experience more frequently cited management rather than technical issues as causative factors. Specific action taken 'at that moment' was preferred in all cases.

The third stage provided highly structured guidance in the form of a checklist of possible problems. Respondents were asked, "Do you observe any problem in this scene? If yes, please identify one or two important problems. Check as many as you want and rate any two as 'first' and 'second' most important." The design of this stage is based on a psychological concept of 'recognition is easier than recall" and is main objective of the research to accomplish. This is to be noted that for this stage, only problem identification was investigated and solutions were not sought. Table 3 gives the comparison of Visual 2 (some guidance) and Visual 3 (extreme guidance) for problem identification. The most striking aspect of the data (Table 3) is that with this level of guidance, all of the respondents made choices; no one abstained from identifying a problem, as was the case in stage 1 and 2. The checklist seems to have a noticeable impact on the users' perception of 'overcrowding' as the main problem in the scene depicted. For an explanation, we turn to the psychology literature which tells us that recognition is easier than recall (Best, 1989).

Despite the widespread informal use of checklists on-the-job and in everyday life there is little, if any, treatment in the literature of this heuristic as an aid to problem solving. Oglesby et al. (1989) one of the standard texts in construction productivity management for example, make no mention of the use of checklists specifically as a means of improving the use of intuitive tools.

Table 3: Comparison of Visual 2 (Some Guidance) and Visual 3 (Extreme Guidance) for Problem Identification

Nature of Experience	Experience in years	Total no of participants	Visual II				Visual III			
			Problem Identification				Problem Identification			
			Management		Technical	None	Management		Technical	None
			Primary	Secondary			Primary	Secondary		
			Overcrowding	e.g. safety, unclean			Overcrowding	e.g. safety, unclean		
Inexperienced	0	20	4	5	4	7	7	6	7	0
Other Than Construction (years)	1-2	21	4	3	6	8	6	5	10	0
	3-5	9	4	2	0	3	5	2	2	0
	6 or more	10	3	2	2	3	5	3	2	0
	Total	*40*	*11*	*7*	*8*	*14*	*16*	*10*	*14*	*0*
Direct Construction (years)	1-2	17	9	2	6	0	10	3	4	0
	3-5	11	6	2	1	2	6	3	2	0
	6 or more	11	5	2	3	1	5	3	3	0
	Total	*39*	*20*	*6*	*10*	*3*	*21*	*9*	*9*	*0*
	All	99	35	18	22	24	44	25	30	0

5.2 Focus Group Interviews

Use of formal tools

Participants offered a number of possible reasons why formal tools remain under used. Most require special training or require information which may not be available when needed. It is very difficult to see short term gains in using new tools and long term gains are not evident. They must be simple and easy to understand at all levels. Resource scheduling/leveling, for example, is not commonly used even though we have sophisticated software to do it. In the words of one participant, “When work can be done by using simple bar charts, what is the benefit of using CPM or other sophisticated techniques?” He uses bar charts and apart from some minor problems, he has never suffered any serious problems so he has no motivation to use more complex tools.

Use of Informal tools

Some site managers make use of notes in the form of ‘todo’ lists (a form of checklist) before visiting a site. One participant said he always thinks of his function or reason for going to the site and this might determine, to a large extent, the content or a todo list. More than one site manager described how he makes a mental picture of a ‘smooth’ site in his mind and compares the actual situation with this mental image. Asking questions seems a simple enough form of information gathering but our site managers agreed that there is a certain 'art' to this. It is often insufficient to ask a foreman, "Did you check x?" and site managers seem to learn what many successful salespeople and negotiators are explicitly taught, i.e., to probe, "Did you check x yourself?”. Site managers all seem to have their own internal list of significant indicators they check for on site. For example, several participants described how they look at the layout, movement of material and labor and position and activity of the tower crane. These indicators are evaluated intuitively and 'felt' in terms of some degree of (dis) satisfaction.

6. CONCLUSIONS

Despite the enormous effort and cost invested in developing and implementing sophisticated formal tools, techniques and systems to improve the construction process, they are little used in practice. Simple site monitoring tools (informal chats, visual observation, bar charts etc.) are easy to learn and apply. More complex information technology based systems may not be popular or successful. While they reduce cognitive load by breaking a task down into component parts, they also increase cognitive load in terms of the specialized training and the high level of interpretative effort required. The pace of construction has always been intense and only with the most simple tools have site engineers been able to synchronize information needs with the pace of the construction process. Any weaknesses or limitations in the nature of the tools they use are overshadowed by the timeliness of the information they provide. This leads to the notion, of striving for efforts to improve the use of informal tools. The research exhibits based on this limited sample that there would seem to be some benefit in even rudimentary cognitive guidance (questions) as a means of giving structure to site people's casual observing behavior. The extreme guidance in the form of checklist of problems helped engineers to recognize the problem depicted. A tool such as a checklist has some obvious functions. It serves as a reminder to look for indicators of problems on site and provides a handy record of casual observations. Both functions serve to help reduce the cognitive load on the site manager and keep his thinking guided and aligned as he makes his rounds. This is recommended that in addition to execute efforts for formal tools improvement and development it may be feasible to make efforts for enhancing and improving the use of informal intuitive tools.

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