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THE APPLICATION OF A PILOT PULL PLANNING SYSTEM TO CONSTRUCTION PROJECTS

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A new planning system was introduced as a pilot within a large UK construction company. The system, which attempts to address some of the problems of construction "front end" planning, is investigated relative to Lean Construction and specifically the Last Planner system. The purpose is to see if it can be used as the basis for applying a lean planning model which the company intends to introduce and test through a research project. The existing system is seen to have strengths in terms of goodwill and commitment from the participants but is still fundamentally linked to the schedule pushed traditional approach to planning which is seen to be unsuccessful. An attempt to use "first run studies" to produce high quality planning and performance information was partly successful and indicated possibilities for future implementation. Further work is needed to fully develop the application model and training in the fundamentals of the system will be needed to improve performance.

Keywords: Lean Planning, Last Planner, Pull Planning.

INTRODUCTION

The use of planning methods on construction projects is an area that demands urgent attention, due to the unreliability of current methods in the face of the inherent uncertainties in the construction process. Uncertainty in construction is high and plan reliability is low (Johansen and Greenwood 1999). Research work in the field of Lean Construction suggests that much of the failure of planning is at the "sharp end" i.e. at the point on projects at which the work is carried out and with the inputs that ensure that the work is completed to plan (Ballard 2000). One of the larger construction companies in the UK, in association with University of Northumbria, has begun a research project to test whether some of the theories arising from recent research into Lean Construction can be applied to their projects to address the problems of planning reliability. Pilot attempts to improve front end planning are considered here and related to these theories to inform the design of the research application model.

Background

One of the UK's large construction companies, in benchmarking their performance in 1998, found that there were significant gains to be made in improving their planning functions. Their initial proposals to improve were based on consolidating existing best practice within the company based on traditional planning theories. This process was begun in one Division in 1999 and a new planning based Project Control Mechanism [PCM] was developed and disseminated to projects over the next 2 years. University of Northumbria worked in partnership with the company in developing the PCM and in facilitating its dissemination.

During development of the PCM the issue of more recent innovations in planning were discussed. The report "Rethinking Construction" (Egan 1998), in discussing improving the construction process, recommended consideration of "Lean Thinking" and this was a current issue at the time of development of the PCM. Since the early 1990's research has been undertaken to transfer Lean Thinking theories to construction under the banner of "Lean Construction". The majority of work in this area has been undertaken outside the UK. In particular, the US based Lean Construction Institute, and the International Group for Lean Construction have been at the forefront of research in this area.

The discussions about developing the PCM considered some of this work and particularly applications based around the theory of the Last Planner (Ballard 1994, 2000[1&2]). However, at the time it was felt that a more traditional approach should be taken and the PCM was developed on the basis of traditional theory and existing best practice within the division. The intention of disseminating the PCM around the whole division quickly was felt to preclude the introduction of "newer" methods. The issue of further improvements based around Last Planner was postponed and a longer term strategy was introduced based around testing the theory and its application on a small number of projects after the dissemination of PCM was completed in July 2001.

The introduction of the PCM had empowered managers to consider how planning might be further improved and on one project a simple "front end" planning system was introduced during the period that the research project was being set up. This system was felt to address some of the problems which the company were aware of and which have been highlighted by researchers as lean planning issues. As such it could form the basis for the proposed research involving the introduction and testing of a practical lean planning system for the company.

LEAN CONSTRUCTION

According to Howell (1999) *"Lean construction results from the application of a new form of production management to construction."* Howell is a founder member of the Lean Construction Institute which has developed the "Lean Project Delivery System" [LPDS] which seeks to improve construction and specifically to produce *"a better way to design and build capital facilities"* (Ballard 2000[1&2]). A major part of this process is the "Last Planner" system of production control that addresses the planning problems endemic in construction (Ballard 1994, Lean Construction Institute 2001). These endemic problems are considered to be those that produce the current failures of planning. Specifically construction does not manage the *"combined effects of dependency and variation"* (Howell 1999). However, the Last Planner cannot be considered in isolation, it is part of the LPDS; a holistic system for the management of production in construction. The LPDS is based upon research carried out by the Institute since its formation in 1997 and by its members and others in the years before this. They sought to consider whether theories and applications developed in manufacturing industry could be applied within construction.

Ballard and Howell (1998) address some of the complaints that construction is not like manufacturing when they say *"Adopting a single-minded strategy of transforming construction into manufacturing would be precisely the wrong thing to do."* They specifically point out that the range of construction projects varies from *"simple and slow"* to *"complex and dynamic"* and they note that the manufacturing analogy cannot be successfully applied to the latter, which are inherently uncertain. Others

have also recognised that uncertainty is a key component of construction projects at all stages and that this has a major importance for planning (Laufer 1997). Ballard and

Howell define construction as a form of production which has two characteristics (1998). These are:

1. They involve assembly of parts but the whole is too large to move between work stations so the work stations themselves move.
2. They are rooted in place.

The nature of construction produces uncertainty in that the physical location of work is different from project to project and site conditions may vary. In addition there are other variables associated with the assembly of parts *"fixed in place".* These are that the product becomes [at least in part] unique and that the organisation that produces the product is temporary. Both of these add to uncertainty. They suggested in their 1998 paper that the challenge for Lean Construction was twofold. Firstly to reduce the number and size of the *"peculiarities"* of construction so that lean manufacturing techniques could be applied. An example of this would be moving towards more standardisation of components. Secondly, to concurrently develop lean techniques which addressed the problems associated with the dynamic nature of construction and which could not be solved by applying existing lean manufacturing techniques. They suggested that the correct analogy for construction was not with the manufacturing production process but with the product development process and that for new methods to develop construction needed more action in mapping its existing processes and understanding production.

Much of the LCI and IGLC work in this field can be seen to be rooted in the first attempts by Koskela to define a theory of construction (1992) and his subsequent proposals of a *"Task, Flow, Value generation model"* producing the emerging *"TFV theory of production"* (Koskela 2000, Koskela and Howell 2001). The theory proposes that construction is a combination of three historic conceptualisations. These are: that production transforms inputs to outputs and is managed by reduction of the work into smaller parts and efficiency; that production is a flow where, as well as being transformed, there are stages of waiting, inspection and movement and management is by reducing variability; and that production is the fulfilment of customer needs and that management translates these into products which achieve conformance to the need. This theory challenges existing project management models and suggests that some of the basic and recurring problems of construction are self inflicted because of a limited view of production in construction.

There is commonality between this and Ballad and Howell's approach given above and two of the authors came together later to develop these challenges to the way projects are managed (Howell and Koskela 2000, Koskela and Howell 2001). The authors use the Project Management Body of Knowledge (1996) as an example of mature best practice as perceived by the project management community and seek to ask questions of it. They point to a number of problems with the project management approach and say that project management theory is deficient. Project management is seen as clearly defining two separate processes, that of project management and that of producing the product. Yet, in practice, there is a vague interface between planning and execution with the planning role being poorly defined and short term planning done badly if at all. Execution is inefficiently managed and control is rooted in corrective action and not in learning for improvement. Project management assumes that uncertainty as to methods and scope are low. The planning techniques espoused

are effective mainly for small, simple slow projects and relationships assumed to be simple and sequential. Payment rules guide planning and suggest that boundaries between activities are rigid. Control focuses on individual activities without consideration of how they affect others. The authors put forward the premise that the reality for construction projects is that uncertainty is high and that project management has failed because of the lack of linkage between planning and execution and the ineffectiveness of execution management. They also propose that theory based in lean thinking applied to construction and particularly the use of production management and control can improve Project management.

LEAN PLANNING

The LPDS is a system which deals with the whole of the construction process and beyond. The development of the LCI's theories have considered many aspects of the production of construction projects and the particular area which concerns this paper is the provision of improved planning.

Ballard (1994) suggested that Joseph Juran's ideas of Control and Breakthrough were relevant to construction planning. The proposal was that, while construction was rooted in a "control" focus which made historic comparisons aimed at preventing "bad change", Ballard believed that Juran's idea of causing "good change" was more fitted to the problems of construction. Ballard (2000[1]) suggested a theory which has been refined since 1994 that sought to improve planning by essentially turning around the traditional way of planning and basing it more on a *"pull process".* He called this the *"Last Planner".*

Johansen and Greenwood (1999) produced a model of construction planning which was based upon existing theory as seen in the training and education available in the UK. It is a hierarchical model where planning is owned by managers and carried out by teams, including subcontractors. In it plans develop in detail from whole project to weekly and information gathering and accurate calculation of time and resources is the norm. Control is by means of regular, measurement based checking. However, this model was not matched by the reality of planning. The problems associated with uncertainty and lack of quality resources produced a lack of ownership, little information gathering, time based on guestimation with inaccurate durations and little input from subcontractors. Activity durations and overlaps were "fudged" with managers attempting to put float into everything. Control was inaccurate with achievement of planned progress limited. In fact, Koskela and Howell's concept of "show pipe" (2000), which is pipe erected incompletely to give an appearance of progress, is something that anecdotal evidence suggests is well recognised by managers in construction. There appears to be a lack of belief in the efficacy of planning because of the failure of the process which can be attributed to the "control" approach which is based around seeing the world as a fate not a problem. Ballard's theory addresses the failure of planning to "cause" a desired future and breaks planning down into three main components. These are *Front End Planning, Lookahead Planning and Commitment Planning".*

The corresponding outputs from these are the *Master Schedule, "Lookahead Schedule and Weekly Work Plan"*. The theory suggests that traditional control based planning produces a forecast of what SHOULD be done then does it and compares it to was done [DID]. It proposes that SHOULD needs adjusting to current reality and then, using lookahead and weekly planning, must be further adjusted to what CAN be done and what WILL be done. The lookahead schedule is a 6 week plan which seeks to

identify and eliminate the restraints on the activities in the plan. This allows the *"Last Planner"* i.e. the person who makes the final commitment to what is done in the weekly plan, to choose from achievable assignments. The final component of the theory is the use of Planned Percentage Completion [PPC] as a measure of the performance of the planning system and as a tool for learning from plan failures. (Ballard 1994, 2001).

Figs 1 and 2 are an attempt to clarify the differences between the traditional method [Schedule Pushed] and the Last Planner system [Plan Pulled].

Figure 1. Schedule Pushed Planning

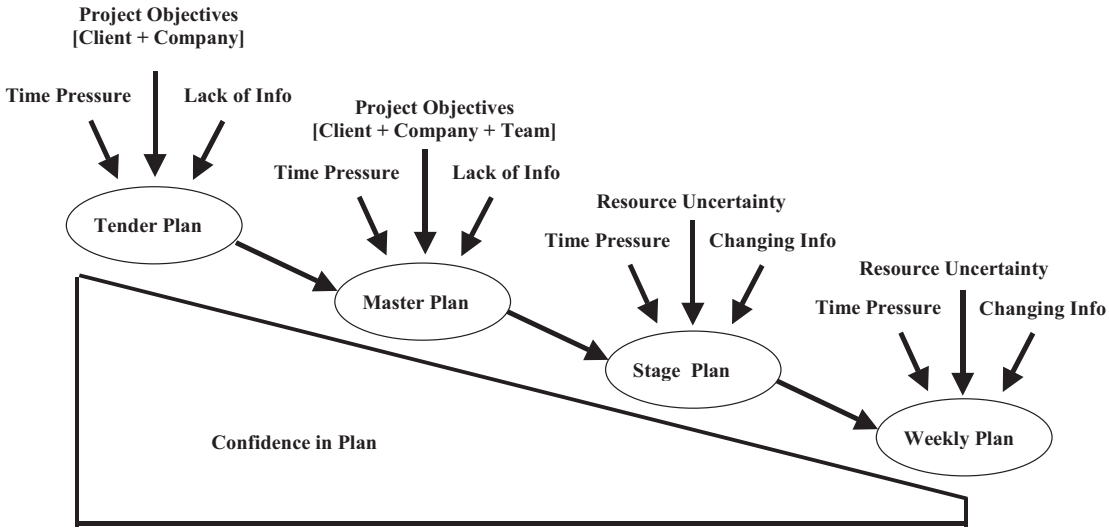
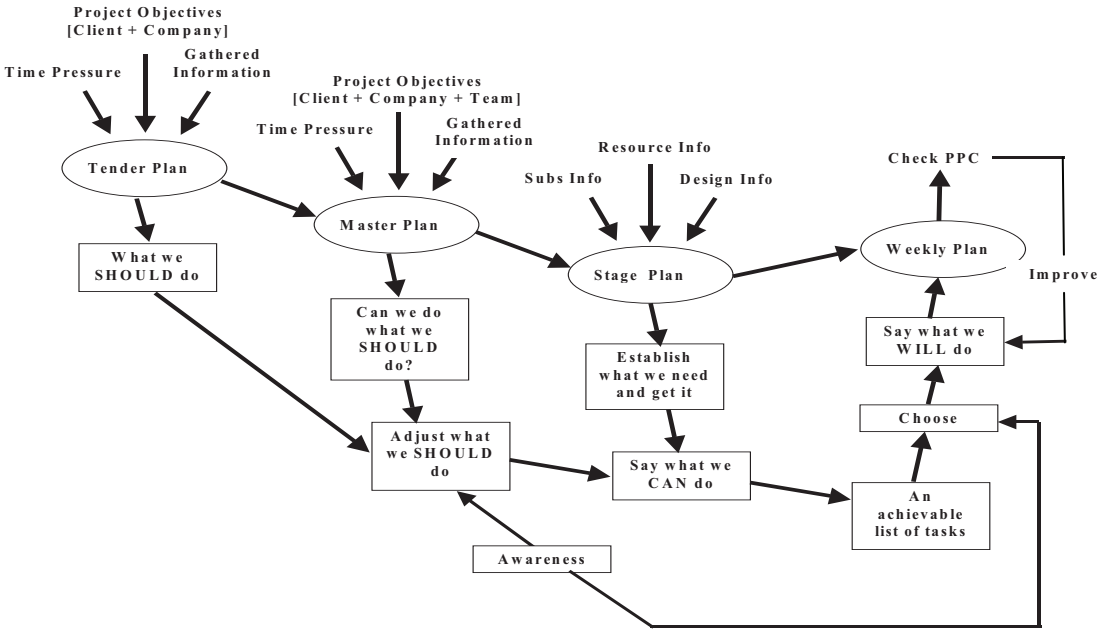


Figure 2. Plan Pulled Planning



THE PILOT PLANNING SYSTEM

The new planning system was based around improving a number of systemic problems. These were that a successful "front end" plan needed to be simple and easy to follow, to engender ownership and commitment at the supervisor level, to allow regular monitoring and review for improvement and to ensure overall project planning targets were met. The key components of the system put into place were that all supervisors [including subcontractors] would meet regularly to discuss, develop and review plans and that plans would be "visual". Supervisors would be expected to commit to work on a "yes or no" basis. No prevarication would be allowed. No minutes would be used as the plan itself would be the record of discussion. Improved co-ordination was expected as well as improved achievement of plans.

The project was a refurbishment of a listed building into accommodation units and the first method of visual planning used marked up A3 drawings.

However, as the project moved into the more complex works within individual units it became clear that another system was needed. At this point the management team accelerated the production of a "show apartment" which acted, among other things, as a prototype for the sequence and methods for the remaining apartments. On completion a workshop was held involving all parties including client, design team, and subcontractors. This workshop produced a standard activity sequence for the apartments based on input from everyone. This allowed a new visual planning system to be used; referred to as the "triangle system" see *fig. 3*. At the weekly planning meetings each activity within each apartment was given a code based on a triangle and all the work on one floor could be shown on a single sheet with space at the bottom for recording key issues discussed. If the base of the triangle is drawn it means that the work is available. If the left side is drawn then work is in progress and the completion of the triangle signifies that work is complete. Blank spaces indicate that work is awaiting progression into the available category. Drawing in the base and completing the triangle was the responsibility of the subcontractor while drawing in the progress line was done by the main contractor. Discussions and monitoring were carried out daily, by the contractors Project Manager, and daily 7 a.m. meetings with all supervisors were introduced in addition to the weekly meetings. The senior managers wanted the supervisors to focus on their next work period [weekly] and also to ask *"why did we not achieve this?"* when they monitored this work.

Figure 3.

First Floor - Apartments	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Acoustic Floor	△	△	△	△	△	∠	—
Studs 1st side	△	△	∠	—	—	∠	∠
Noggins	—	—	—	—	∠	∠	
M&E 1st fix	—						

Many of the factors used within this process can be linked to issues within Ballard's Last Planner System (1994) and the LPDS (2000[2]). These include the idea of "First Run Studies" i.e. carrying out a sample of the work with the intention of improving

planning and production. This can be seen in the acceleration of the show apartment and the follow up workshop. Also the idea of involving supervisors in commitment planning through a Yes or No statement and the focus on measuring achievement and learning to drive improvement can be seen to be clearly related to the Can/Will and Planned Percentage Completion components of the Last Planner.

In order to test the efficacy of the system and how it related to Last Planner in practice interviews were carried out with some of the personnel involved. The Visiting Manager, Project Manager, site supervisors and the supervisor of the main subcontractor were interviewed as the project moved into the final stages. Data were analysed, compared and interpreted using content analysis based on comparative conceptual matrices.

EVALUATION

There were clearly some positive advantages seen in the system. Communication was felt to be improved. A lot of irrelevant discussion was cut out and a better focus on critical issues was seen. The presence of all parties in meetings provided insights into everyone's work and *"we all knew what needed doing"*. The single page per floor format was particularly beneficial with the space for notes on key issues being commented upon positively as being *"better than keeping it in the head"*. The ability to see and understand the state of progress of each floor very easily and clearly even by those not involved in the project regularly was considered to be one of the main advantages of the system and the term *"transparency"* was used by all interviewees.

The supervisors all thought that they benefited because it enhanced their ability to concentrate on *"high attention items"*. Most of those interviewed gave positive opinions about the transferability of the system to other projects. In particular the A3 sheets, although there were differing opinions about the triangles with some believing that they would only be useful for repetitive work but one supervisor in particular

saying that he had already developed the system for non-repetitive work within this project.

All the interviewees considered that the prime purpose of the system was monitoring and there was evidence to suggest that this in fact had negative connotations. There was much more emphasis from everyone on the measurement aspect rather than the generation of improved future plans. The Project Manager pointed out that the nature of the system meant that a quantification of the triangles allowed for a more accurate system of monitoring than the traditional *"few lines on a bar chart"* and most personnel mentioned the concept of *"projecting where you will be"* but other factors suggested that this was not the primary focus.

The Last Planner System (1994) is rooted in changing the traditional view of construction which emphasises top down hierarchical "pushing" of production to a production control philosophy which uses "pull" methods and shields "front end" planning from upstream uncertainties. It relies on forecasting what Can be done and stating what Will be done. It emphasises the need for the planning system to be in control. The evidence from the interviews suggests that the traditional approach is difficult to change even with committed personnel.

It became clear in the interviews that the idea of the supervisors controlling their own planning was not, in fact, part of the system. The *"Yes No"* process was not actually about encouraging the supervisors to commit to achievable plans but was part of

monitoring and was based on not allowing supervisors to provide *"smokescreens"* but to give them *"no hiding place, and put them on the spot"* when discussing progress. There was a clear belief that if left to themselves supervisors would *"underestimate"* the work to be done. The plan belonged to the Project Manager and was produced by him although supervisors were, in theory, allowed some input within the weekly meetings. Before the weekly meetings he highlighted particular activities as requiring triangles completed within the next week. The initial success rate of the system used here was low [between 40 and 60%] which is not unusual within construction planning. However, the way that senior management decided to improve this was to double the targets and drive for a 50% achievement [of 200% = 100%]. There was a belief that the abilities of the supervisors were varied and that while some engaged with the process others did not. Some supervisors where seen to prefer *"living in the now"* and not to wish to think ahead. The companies own supervisors were not unhappy with this. They believed that the plans were over-ambitious but that this was necessary to drive achievement from the subcontractors. Interestingly, this appeared to be their own management's attitude to them. Their major concerns were with the daily meetings as they did not believe that measuring them daily allowed them to achieve anything as the emphasis on *"is it finished or not?"* did not allow for the timing of activities [some of which took more than one day]. A number of concerns were expressed at the lack of timing and dates in the system. One concern was that the daily meetings were *"less about solving problems than finger pointing"* and that they left the meetings *"demoralised"*. Additionally they were concerned over the language of the triangle system believing that it was not simple enough to translate to the subcontractors operatives and that it needed to be.

One of the biggest problems which the supervisors pointed out was that of commitment and ownership from the subcontractors. It was believed that they lacked interest in the system and often simply ignored the plans [leaving them behind or even putting them in the bin]. It was considered that the transfer between the A3 drawing system and the triangles had not been successful [in part because of the *"language"*

problem mentioned above] but also that there were problems with the way the system was monitored. There were suggestions that the completion of the triangles was not checked and that some subcontractors said they were finished when they were not. The nature of the system was that triangles were opened but, because there were no dates, the closure of them was not monitored properly and action to assure completion was limited. What became clear from the interviews was that there was still some uncertainty about how the system was meant to work.

Despite these negative comments all the interviewees were positive that the system was an improvement on existing methods.

CONCLUSION

The purpose of the research was to investigate the pilot “front end” planning system and to see if it could be used as the basis for a lean planning application model to be tested in a research project. As such there were a number of positive outcomes. There was much encouraging goodwill towards the system from the participants and evidence of a commitment to improvement. Some practical issues such as the use of the show apartment and follow up workshop have clear links to lean planning concepts. However there was also much evidence of the need for both a culture change and technical changes to the system before this model could be considered lean. The mapping of existing processes needs to include more detail particularly in

terms of performance data and timing. There is still a control focus with little linkage between planning and execution which makes the system closer to traditional "schedule pushed" than "pull" planning. The supervisors are not as involved as they should be and ownership of the plan has not really been devolved to them. The lack of a real lookahead schedule with restraints analysis reduces the ability of the supervisors to achieve the plans.

However, the managers who instigated the system and the supervisors involved have had no real introduction to lean concepts and have developed the system based on their own feeling for the inadequacies of existing planning systems. This bodes well for the introduction of a lean model. Training needs to take place regarding lean planning. The key issue would seem to be the culture change required in bringing management at all levels, and within the supply chain, to a common level of knowledge and ownership. In particular the issues of dependency and variability and concepts such as commitment planning could be introduced. Technical additions to the system such as a lookahead plan and more detailed process mapping are necessary to assist system success.

While there is potential to support the introduction of a new planning system based on lean theory and the Last Planner further work is needed to develop a model which can deliver the perceived benefits available from a lean approach.

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