IMPLEMENTING LEAN: UK CULTURE AND SYSTEM CHANGE

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ABSTRACT

For the IGLC 11 Conference the authors reported the results of implementing Last Planner™ methods with a large UK contracting company. The projects studied demonstrated some success but also some cultural, organizational and systemic barriers to its effective implementation. Alarcon and Conte's White Paper for the IGLC11 conference discussed these issues and invited researchers to consider them. In response, the authors have reflected upon and critically re-analysed the research as a means to re-focus their future work in implementing Lean Construction methods in UK construction. Based on a review of the literature on *construction culture* we have identified theoretical factors that, together with Alarcon and Conte's list of *critical organizational elements*, provide a framework against which the results of the research have been considered. We conclude that the implementation of Last Planner was hindered by not fully considering cultural, organizational and systemic problems and by failing to recognize how deep-seated these problems could be. We intend, in future projects, to take a more considered, and wider approach to Lean Construction (possibly using the LCI's Lean Project Delivery System) and to focus our attention upon construction ventures where efforts at culture change have already started - in particular, where strategic partnering arrangements are in place.

KEY WORDS

Last Planner, construction culture, cultural barriers, implementation

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INTRODUCTION

For the IGLC 11 conference Alarcon and Conte produced a White paper focused on the area of "Implementation" (2003). In it they raised questions about the cultural, organizational and systemic issues that make the implementation of improvements difficult, and they invited papers on these issues. It is considered that these issues refer to the formal and informal relationships that exist in construction. This and the paper will use the shorthand phrase "cultural barriers" to refer to these issues from this point. At the same conference, we presented a paper reporting the results of a project that attempted to implement the Last Planner[TM] system on UK projects. This work was carried out with a large UK main contracting company; the construction arm of this company being assumed to being reasonably representative of UK contracting firms (Johansen & Porter 2003).

The project aimed to improve the existing planning system within the company and to test *Last Planner* as a formal way of achieving this. The research project is now complete, and the *ex ante* analysis indicates fairly clearly that the many of the issues raised by Alarcon and Conte were indeed critical to the implementation of Last Planner. In the present paper, we consider construction cultural issues and critically analyze the research project in the light of Alarcon and Conte's White Paper. By doing so, we consider what changes might be necessary for the successful implementation of Last Planner and the improvement of the planning process.

BACKGROUND

In June 2003 the authors presented their final report of a research project to implement the Last Planner[TM] system on two projects for one of the UK's large main contractors. The report indicated some positive outcomes but also, to assist the company in implementing the system in future, suggested improvements to the methodology used. We discussed the implementation on one of the projects [Project A] and, as well as indicating some of the technical problems encountered, also mentioned some of the cultural barriers to effective use of the techniques(Johansen & Porter 2003).

The results on Project A were favourably received by the participating main contractor's staff and by the client. The project however, was delivered late. This may be considered to be a failure of Last Planner, though most of the reasons for this failure were considered to be cultural barriers to its implementation. The other project used for the study [Project B] was substantially late. Last Planner was not implemented in such a systematic manner as in the first project: there were however, similarities between the two projects in the cultural problems that were encountered.

In considering the next step in developing this research the authors considered the comments of Green (2001) that *"It is especially important that critical researchers are self critical."*. While not intending to take Green's Critical Management Studies approach to the work, the authors were aware that they should consider whether their enthusiasm for Lean Construction methodologies and particularly Last Planner had produced a non-critical approach to the research task which ignored cultural problems. It is important to acknowledge that for researchers with experience in the problems associated with managing

construction projects Last Planner and the Lean Construction revolution can be seductive. People who have searched for many years for improvements in construction planning and organization in an industry with a reputation for not learning and repeating its faults are attracted by a system that promises both improvement and a learning-based system. Notwithstanding this, it is important to consider what the existence of these issues means for the next steps in the authors' attempts to research the implementation of Lean and Last Planner in construction.

CULTURE CHANGE

Construction – a dysfunctional industry?

Ballard alludes to the problems with existing organization and culture in construction when he says that [about production control and the Last Planner] *"there was no place for it in traditional project management thinking"* (Ballard 2003).

There has been much written about the number and range of ineffective reports into the performance of construction in the UK previous to 1994. Perhaps these are best summed up by Sir Michael Latham (1993) *"it has been a depressing experience to re-read previous reports to the Government including those of Sir Harold Emmerson (1962) and the Banwell Committee (1964). Many of the problems which they tackled still persist"*.

Wild (2004) in a study which seeks to re-interpret the research done by the Tavistock Institute of Human Relations from the 1960's suggests that the difficulties of UK construction are recurring and institutional, and that the industry is confused and uncertain: although new pressures for change now exist historical data suggest a slow response. He quotes Andrews and Derbyshire (1993) regarding unification of the UK industry as a method for improving it. They say *"If so many have preached unification of the UK construction industry for so long with so little effect how could we succeed? Is it indeed a lost cause? Have we been barking up the wrong tree all these years? Is it our destiny to build a fragmented future on a fragmented past and make the best of it?"*.

Considering the construction industry from a sociological viewpoint Wild (2002) says that historical research shows that construction is *"unmanageable"*: it is self-fragmenting and its projects are *temporary multi organizations* (after Stringer 1967) involving players that assemble to carry out tasks but keep their own organizations' interests. This results in discrepancies in values and power-differentials that result in both instability as well as problems in balancing the ends and means of a project. There are differences in people's expectation of one another and of their roles: Project roles are weak compared with core organization roles. This is made more complicated when many interfaces exist, as is the case in projects: individuals have to cross multiple boundaries involving cultural diversity as well as dealing with organizational versus project pressures. These are further affected by power/prestige issues and people may revert to the stability of their domestic roles if they cannot handle the uncertainties of the temporary multi-organization. Wild concludes that *"Finally different organizations have different stakes in and commitments to a project and therefore uncertainties configure differently for them, as do motives to override these uncertainties"* (Wild, 2002).

Attitudes

In his paper of 1998 Seymour reports on the issues that arose in a case study of an evaluation report of a project in which he tries to *"give some sense of the UK cultural context"* related to the useful dissemination of Lean. While the context is mainly concerned with the design rather than production end of the construction process he does point out that a key issue is the altering of mindsets.

Seymour's case study also provides evidence of what Ballard and Howell call the *"product mentality"* where a contractor is more concerned with his own work (and how he perceives the cost/value equation) than how the client might see it. This contractor still cares about his customer in terms of not wanting to "overcharge" for his work (this is not the case of trying to "rip off" a client) but appears to be unable to see that the clients concerns are with the whole of the facility being delivered and that the contractor's concern only for his own part of it is not providing the customer with true value. Seymour wonders whether these people should be ignored or have their attitudes changed.

Melles (1997) is reflecting on similar issues when he proposes that the most important goal of a lean system is to change peoples' attitudes and produce a common company philosophy.

Worker involvement

Green's work has consistently criticized the construction management research community's interest in what he calls the *"dark side of lean"* (2000). He believes that lean construction research is one sided and has ignored work which equates lean methods to instrumentalist, control based systems which exploit workers and are rooted in "hard" Human Resources Management (Green, 2001). While the authors would not agree wholeheartedly with his premise about the research community, anecdotal evidence from their experience would support the idea that there are certainly managers within construction who see Lean as being about command and control and forcing efficiency. However, the authors interpretation of Last Planner, in particular, has always been that it is about empowerment and transfer of commitment - at least to the foreman level and preferably beyond. Green may be correct though, when he suggests that there is a lack of strategic support for the development of improvements at the team level. Last Planner is offered as a solution to team level problems and perhaps efforts are directed at this level without fully thinking through the need for strategic support to provide the correct context, environment, training and support to allow it to be applied properly.

The Supply Chain

Forbes et al (2000) mention that *"It is critical to break away from the* tradition of treating project design and production as separate functions.". This re-iterates one of the key theoretical issues. It is evinced by examples from the work of the UK-based Construction Productivity Network, which is one of the bodies supported by the government to disseminate best practice and support changes in construction culture. The CPN Members report E3151 (2003) points out the necessity to have the supply chain (and site personnel) work together collaboratively and also says that unless these groups are prepared to buy into Last Planner it will not work. Another report (E4102, 2004) discusses the ways to create a

collaborative culture and calls Last Planner "a collaborative method" a description that is at odds with Green's views.

Partnering and the role of subcontracting

Miller et al (2002) support a view that the relationship between main contractors and subcontractors is fundamentally a transactional one where all parties try to obtain additional value at lowest cost. They argue that most subcontractors are small and are essentially different to larger main contractors but that the traditional nature of the relationship has seen Main Contractors attempt to take advantage. They contend that many subcontractors have difficulty seeing how innovations can add value to their existing methods and that they are so far from the client that they are also unlikely to obtain any benefit themselves from applying such innovations. Small subcontractors are seen to be *"individual decision making entities"* - who can chose the level of their engagement with the process but who are remote from decision making and struggle for identity. The contract seeks to ensure project completion but does not motivate for improvement. This results in lack of trust and respect and poor communication and a consequent increase in self interest. They say *"it is therefore reasonable to conclude that all parties should be construed as being vital to the construction process"* and they suggest closer relationships are necessary. In their paper they consider two case studies based on transactional and relational approaches and contrast the levels of trust and willingness to engage between the two [in favour of relational]. They seem to suggest that there needs to be some form of harmonization [such as partnering] for lean construction innovations to succeed.

Forbes et al (2000) in their conclusions also believe that issues of trust and team building are important and that Partnering can support these by empowerment in decision making.

THE CHALLENGE

These messages, arising from the literature, indicate the following cultural barriers to be significant for the successful implementation of innovations:

- There are deep-rooted historic problems with the industry. The basis of commercial engagement results in barriers caused by power imbalances, diversity of allegiance, interests and commitment.

- The results of the industry fragmentation and discontinuity producing a lack of trust and a climate of uncertainty in which actors in the process may seek the comforts of a command and control approach. This may be in particular with the "lower" levels of the workforce which results in their withholding of commitment and in them taking comfort in rigid approaches to how they behave.

The literature also suggests that proposals to counter-effect these problems could be based on relational approaches such as Partnering.

In inviting further work on the human aspects of implementation Alarcon and Conte quote Alarcon and Diethelm's list of organizational elements that are critical for successful implementation (2001). These are:

- A clear methodology, with well defined and rigorous strategies;

- Clear signals and a high degree of commitment from upper management;

- Establishment of a special organization for implementation, with a clear and rigorous operation;

- Project managers or heads of department are key officers, both for leadership and commitment that they must exert as well as in removing barriers to the implementation of what is being promoted;

- Knowledge of both the "Lean" concepts and the implementation program is fundamental for the company's personnel. This requires effective communication;

- The definition of functions, responsibilities and levels of authority of the companies project managers and/or professionals.

The authors propose to use this list to critically analyse their Last Planner research with a view to improving the implementation in future.

THE ORIGINAL RESEARCH

Research development and Aims and Objectives

The research arose from the company's regional management seeking to improve its planning performance and engaging Northumbria University to assist in this by training company personnel. The issue of Lean Construction was introduced in course development and in training sessions. There followed further discussions over a period of approximately two years during which senior managers in the company were persuaded to support a trial of the Last Planner system. The overall aims were to test the system on two major projects and to engage the company's staff and subcontractors with the process. The process was based upon the following:

- Northumbria University would be involved in the training of company staff and subcontractors on two major construction projects, on the use of the Last Planner system.

- Subcontractors would be involved in the weekly planning process

- Look-ahead schedules would be employed to ensure work is made ready to facilitate the achievement of weekly plans

- Weekly targets would be chosen from the look-ahead schedule, and agreed with the subcontractors

- Percentage Plan Completion [PPC] of the weekly targets would be analysed and discussed with the subcontractors, as a means to drive improvements.

The key issues to be considered in the implementation of the Last Planner research methodology would be that:

- The research should be aimed at more complex projects, that are essentially non repetitive in nature as this is where the company seeks improvement

- The emphasis should be on practical application of the Last Planner methodology i.e. the site staff should be able to modify the system to suit the project situation

- The process would seek to engender ownership both of the plans and the method

- An attempt should be made to identify the barriers to implementation among the team

- The approach should reflect the opportunity to redefine larger problems into smaller achievable components, as a means to boost performance and reinforce culture change. (Small Wins).

- The approach should reflect the concept of the 'no-blame culture' as a basis for commitment planning and should consider whether this system will work as a means to engender mutual trust between the management team and the subcontractors (Promise Management).

Project A

An initial meeting was held with the project team in May 2002, and several meetings followed over the subsequent three months to develop and agree the Last Planner methodology. It was clear that both the PM and the Planner took an active interest in the idea of using Last Planner as one of a number of tools to deliver on a very tight construction schedule. The meetings involved the PM, Construction Manager, Planner and Site Engineers, so that a wide range of staff had an understanding and interest in the development and implementation of the Last Planner methodology.

A 'gaming session', based on repetitive production control methods was held with the Management team, to illustrate the benefits of continuity and flow in a production system.

The University team's initial proposals were based on research papers on Last Planner and advice from seminars of the Lean Construction Institute. The project team, however, proposed to amend the system advocated by the researchers for application specifically to this project. They kept to the principles of Last Planner but developed their own forms, their own ideas of the correct timing and membership of meetings and used two "Lead Planners" to be the main drivers of *look-aheads* and to run the meetings. They used Last Planner for the finishing sections of the project, after the structure was erected. They also developed the University team's information into a specific presentation of Last Planner, for delivery to the subcontractors. This was produced on PowerPoint, and featured a series of highly visual images aimed at capturing the interest of the subcontractors. The Last Planner meetings and discussions were closely monitored by the researchers.

The results of the study were discussed in last year's paper (Johansen & Porter 2003) but essentially, while providing evidence of benefits in terms of the structure and discipline of the planning process and good support for the system from the company participants, the construction project finished behind programme, so it was difficult to argue that the use of Last Planner had been fully successful. The authors were able to identify where some of the

problems and barriers had been and it was clear that many of these were cultural and organizational. Notwithstanding this point, the researchers and the project team were of the opinion that the project had benefited substantially from using the Last Planner methodology, and that without its use the construction project might have suffered a larger time overrun.

Project B

The initial meeting with the Project Manager was held in April 2002 to discuss Last Planner concepts, and the nature of the project. Two sessions were held in May 2002 to introduce the project principles respectively to the company team and to a range of representatives from the subcontractors. This centred on a presentation of the Last Planner system, including discussions of the possible benefits and of commitment needed. The company site manager, works manager, section engineers, foremen and design assistant attended the first meeting and the second added the subcontractors.

No-one on the project had any prior knowledge of Last Planner methodology. The presentation was mainly text-based and involved an explanation of the perceived problems in planning, and why the company has committed time and money to the research. The presentation particularly mentioned the reactive nature of current planning and the fact that earlier research within the company (Johansen 2002) had suggested that staff and subcontractors:- rarely *"know"* they often have to *"assume or guess"* and that the company existed in a "maybe" or "do our best" culture, instead of a culture of commitment. The presentation included at its core a matrix showing typical *laissez faire* planning practice, as compared with Lean Planning culture and stressed the transformation of uncertainty from an uncontrollable external factor to a proactive *'we control it'* culture. The staff and subcontractors were asked to concentrate on moving from the need to carry out each work package at maximum speed, to reducing variation and following a more coherent and consistent speed between tasks. They were also asked to think in terms of mutual interest rather than dumping problems and risk on others.

The Project Manager decided to focus the Last Planner activities specifically upon the brick and block-work. Meetings were held two to three times per week, with a focus on the co-ordination of the scaffolding and brickwork. The planning meetings were 'chaired' by a main contractor foreman and attended by the onsite foremen from the brickwork and scaffolding subcontractors. A researcher attended the meetings on a regular basis. This project produced similar results to project Project A in that those who participated felt that there were benefits in terms of communication and co-ordination from the meetings. Although the planning meetings benefited from both the brick / block work and scaffolding subcontractors attending the same meeting (compared with separate meetings for Project A), the benefits of involving the floor slab contractors were not considered, and perhaps as a direct consequence of this failure, subsequent problems in the interface between the floor slab and the brick façade of the building began to mount up. However, the Project Manager took little interest in the work and after the initial meeting the feeling among the research team was that he had bypassed the research work so that he could concentrate on the major day to day problems he had with a complex, tightly priced and ambitiously timetabled project. The project missed its handover deadline by many months.

CRITICAL ANALYSIS
Methodology and Strategy

The authors discussed the research strategy in detail with the two Regional Directors who were sponsoring the work and three drafts of the aims, objectives and methodology were considered before the final proposal was put in place. The methodology appeared to be clear and well defined yet two clearly different approaches and levels of interest and commitment from the Project Managers on each project arose. It was felt that this could not be completely explained by their differing levels of knowledge of the technique before the research started. For Project A it appears that there were flaws which came from inconsistencies between some of the key issues from the methodology. In terms of the way the methodology was applied the researchers were conscious more of engendering ownership and they encouraged the site teams to take over the process and training as early as possible. Perhaps the researchers were too conscious that their own status as academics might produce a feeling among project personnel that the basic idea was not practically based. Certainly the development and encouragement of ownership down into the subcontractors was left in the main to the site team after the initial meetings. Perhaps this did not take enough account of the balance of power relationships between the parties.

High Level Commitment

There was clear commitment from the two most senior managers in the regions. The way this was expressed to the site teams may have introduced another problem. Again the researchers were conscious of trying to generate ownership of something that they all felt would be beneficial to the team and did not want the problems of a prescriptive top down "order" from above getting in the way of the message that Last Planner was worth trying. What they ended up doing was relying on their ability to "sell" the message and allowing Project Manager B to say in part "I am not buying". Once it became clear that the pressure of work on Project Manager B meant that he saw the research as an additional burden which could be isolated and managed by a subordinate, the researchers did not feel comfortable in going back to the sponsor and asking for an intervention. In fact the researchers did, unsuccessfully, try further persuasion and particularly tried to sell the idea of a first run study for a repetitive section of the project which it was believed would have had benefits [the project had significant problems later with this part of the work]. Project A was a complete contrast but it is important to note that both the Project Manager and Planner on this job had heard of Last Planner and did not need anything more than an invitation to become involved.

Organisation and definition of responsibilities

This aspect of implementing the research methodology could be considered an area of weakness. Despite engaging a wide range of 'stakeholders' at an early stage, there was never a sufficiently rigorous control over the level of individual responsibilities and levels of authority, nor were expectations really discussed with the site team and then extended to the subcontractors. The team was allowed to decide how to implement the system in many ways. One example, on Project A, was that they had separate weekly meetings with each of the subcontractors involved in the finishings. In reviewing the original paper (Johansen and

Porter, 2003) Ballard pointed this out as a problem, as individual LP meetings failed to realize the benefits of co-ordination between the subcontractors. What is interesting here is that the decision to hold separate meetings was made in an attempt to overcome cultural problems. In many cases the power in the subcontractor was vested with the visiting supervisor and by meeting one supervisor at a time, the Lead Planner could take a flexible approach to meetings. If one supervisor could not make a particular meeting then the Lead Planner could meet another supervisor, or re-arrange the meeting. However the real Last Planners were perhaps the site foremen. The foremen had much better knowledge of activities on the ground, and could consequently make more realistic commitments regarding their targets for the next week's work, but they did not have the power, for example, to alter the labour resource without authority from the visiting supervisor. On those few occasions when both the travelling supervisor and the site foreman attended an LP meeting, it was clear that more progress was made. Is it possible that this sort of model for LP meetings could be more suited to cultural and organizational features of the UK construction industry? Or do we need to further explore the practicality of holding a single weekly LP meeting?

Project Managers' role

As mentioned above, there was a major contrast between the two Project Managers' attitudes and commitment. Within the limitations of the work that was carried out on Project B, however, this did not appear to be the major reason for the problems encountered in implementing the Last Planner system. It is true to say that a more direct intervention by the Project Manager in the brickwork package by encouraging more involvement from other key subcontractors would have assisted but the implementation problems noted were similar to those encountered on Project A where the Project Manager gave his full support and encouragement to the initiative.

Lean Knowledge and Communication

The method of developing Lean knowledge and the implementation programme among the site team was through the University providing initial training and for the site team to take over this role. It has already been mentioned that this transfer possibly took place too early. Project A is a better example of the original research proposal being put into practice and on this project many subcontractors were involved and communication was relatively effective [and considered to be better than on most projects]. The bespoke system of training and of implementing Last Planner on Project A has much merit and in our final report to the company we recommended that it be developed further. The problems identified on Project A are not felt to be associated with the level of knowledge or basic communication about Lean but more to do with the behaviour of the participants and their difficulty in changing from their traditional roles. There is be a greater need for the subcontractors to buy into the LP system and its merits.

Culture, Organisation and Systems

This is where the major criticisms of the research project can be made. The researchers assumed that a good idea executed by a committed team could overcome years of deep-rooted problems and that Last Planner could, by itself, become a driver of change.

The reality is that the problems encountered are so deep-seated that they cannot be solved by attempting to use one tool in isolation. Neither of the two projects was able to deliver a Last Planner system through their own direct labour because all work was subcontracted. The literature referenced above gives us a clear idea of the problems which subcontracting produces and which were clearly seen in both our projects. While there was a range of positive and negative behaviour there was a prevalence of issues associated with lack of trust and commitment, diverse allegiance and reliance on traditional, comfortable "norms".

This can also be seen in the broader supply chain. One of the intentions of the study was to involve the designers and clients' representatives in planning. This did not occur because the company felt that the research started too late in the project Perhaps such a holistic approach was expecting too much, too soon?

Of course none of this is new. Glenn Ballard in reviewing the paper for IGLC11 said *"I don't see anything here that is peculiar to the U.K.. Development of subcontractor management capabilities is a frequent, problem also in the U.S., and I suspect, everywhere else as well. The opportunities appear to be in making effective use of the preferred supplier program, aligning incentives of all the players and implementing all-trade Last Planner meetings."*.

Partnering

The foregoing discussions lead to the issue of relational contracting and the use of preferred supply partners as a possible solution to cultural barriers. Unfortunately this is also a problem for the research. The limited number of subcontractors involved in the research in Project B indicates that it cannot necessarily be taken as a meaningful example. However, in Project A, all the finishing contractors on a £25 million project were involved and what is significant is that many of them were "preferred contractors" i.e. those with a special single or small multiple supplier arrangement with the main contractor. There was no consistency in behaviour. The preferred contractors were not always the most supportive and *vice versa*. There were references from site staff to the fact that the preferred contractors were appointed through high level contacts and that in many cases the site foremen and workers knew very little about what this meant. Certainly there was evidence of "mutterings" about deals going on behind the scenes, and these may have served to undermine the legitimacy and authority of the formal LP meetings and of the staff of the main contractor

The authors have some experience of partnering in both its 'project-specific' and 'strategic' forms having facilitated partnering development workshops and carried out research in this area. One of the things they have realized is that, to use the American expression, there are many groups who *"talk the talk"* but few who *"walk the walk"*. Those who truly engage with strategic partnering, in particular, have seen some spectacular success in terms of physical results and in culture change but successful ones also appear to believe that it is a long and hard road and believe that they are only starting the journey. Howell (1997) has said that *"Partnering can be a solution to the failure of central control to manage production in conditions of high uncertainty and complexity"*. This may be true but in the absence of an easy way to overcome the construction industry's traditional problems it may be the only way to begin to get Lean issues effectively into companies so that Lean can evolve and become the "new tradition".

CONCLUSIONS

The original research project was seriously affected by the cultural barriers indicated in the literature review. There were examples of the deep-rooted historic problems with the industry. Despite some successes with the Last Planner Methodology, analysis of the research notes indicates that the basis of commercial engagement did result in barriers caused by power imbalances, diversity of allegiance, interests and commitment. There was fragmentation and discontinuity, lack of trust and a climate of uncertainty and some actors did seek the comforts of a command and control approach, withheld their commitment and took rigid approaches to how they behaved.

The authors' attempts to improve implementation of Last Planner is rooted in a belief that they should be looking for research which benefits all levels of the UK construction industry. Throughout the last 50 years, when UK construction problems have been publicized and innovations suggested, there have always been progressive organizations that have sought improvement through innovative methods and have set examples for the industry. However, the industry has not essentially changed. There are currently companies that will argue that they are applying Lean innovations with some success and there are quasi-governmental bodies that are offering good support for disseminating the messages about these innovations. However, we are still searching for a method of implementation that will galvanize cultural change and see Lean Construction applied across the whole breadth of the industry – by, for example a small regional subcontractor as well as by organizations on nationally significant projects such as Terminal 5 at Heathrow.

To assist in achieving this goal, the authors, in this paper, have tried to be self-critical and look for better ways to implement Last Planner in the cultural context of the UK industry. The original methodology was partly flawed but possibly no more than many research projects: it involved people and that always produces problem of a sociological nature. Certainly we have produced more questions than answers. What has been learned is that Last Planner is not a stand-alone tool. It is part of the Lean Project Delivery System and needs to be considered as such. Furthermore, tools are ineffective without people who want to use them and therefore we believe that culture must change before the tools can be expected to work. The researchers intend to put this into practice by next working with maturing strategic partnering arrangements where culture change is already underway and by considering a broader approach to Lean, possibly by using the full LPDS or at least to take note of Ballard's point (2003) that Phase Scheduling has become a key part of Last Planner and broadening the application to include this.

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