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LEAN PROJECT PLANNING: USING LEAN PRINCIPLES IN PROJECT PLANNING

Jan Emblemsvåg, PhD
Vard Group AS/Ålesund University College*
Ålesund, Norway

ABSTRACT

Planning should be a crucial element of all types of projects, and its importance can hardly be overstated. Yet, planning is often not performed well. In this paper it is argued that this is due to a fundamentally erroneous approach to planning which is based on a division of the process between planners, who plan, and doers that use the plans which inhibits effective communication. By applying lean principles – principles that have produced excellent results in a number of settings – we propose to change this approach radically. Borrowing from the Last Planner System and combining it with Earned Value Project Management, we get a new approach called Lean Project Planning.

Keywords: Earned value, last planner, lean construction, CONWIP, engineering planning

1. FRAME OF REFERENCE

> Plans are nothing; planning is everything.
> Dwight D. Eisenhower

Project planning is an integral part of project management, see (PMI 2008). The origin of project management can be traced back to the post World War II era in which new efficient developments started taking place across the US, Europe and Japan (Davidson 2002). Despite this fact, many projects fail to meet their objectives and targets. Statistics vary by industry and topicality.

The United States Government Accountability Office performed a study of 778 major IT projects performed in fiscal year 2008 by the 24 major agencies of the US Government. The findings were quite typical of many IT projects – (Powner 2008) found that 53% of these projects (413 projects) totaling 25.2 billion USD in fiscal year 2008 where either poorly planned (79%), poorly performed (15%) or both (6%). Another large study was conducted by

* Please note that the views presented in this paper are solely those of the author and do not necessarily represent any of the affiliations whatsoever.

IBM, see (Jørgensen, Owen et al. 2008), covering more than 1,500 practitioners worldwide. Their findings were better but still far from good enough. They found that:

- 15% of the projects were either stopped or missed all goals,
- 44% of the projects did not meet time, budget or quality goals, and only
- 41% of the projects met all goals.

Thus, there is obviously room for improvement. What was perhaps more interesting about IBM study was that they found a huge difference in the best practitioners, which had an 80% success rate, compared to the worst practitioners, which had a meager success rate of only 8%.

What is due to poor planning and not is not easy to quantify as most problems have rarely a single root cause. Nonetheless, studies of project failures and problems indicate that planning is one out of ten problem areas, see (Oehmen 2012), whereas (Laufer and Tucker 1987, 1988) find that improvement in planning is beneficial. Thus, planning is an important topic to study to improve project management in general.

The most recognized and possibly one of the most useful and meaningful tools to report status and to analyze project cost, schedule and performance is the Earned Value Management (EVM) method (Sumara and Goodpasture 1997). It has some good performance metrics such as the Cost Performance Index (CPI), projects using it has a consistent and predictable performance history and after just 15% - 20% completion of the project, we can predict cost at completion within a finite range of values – see (Fleming and Koppelman 2005) for an excellent overview. Despite these advantages, which makes EVM a good point of departure for further development, (Yong-Woo and Ballard 2000) have shown that the approach suffers from the limiting assumption that activities and cost accounts are independent and by "making BCWP (earned-value) a priority in releasing assignments to the field which prevents quality assignments, which in turn results in unreliability of work flow". It is also recognized that EVM can be too complicated for many to master, see (Fleming and Koppelman 2005).

The Last Planner System (LPS) is another project planning approach found in the literature. It was developed by H. Glenn Ballard and Gregory A. Howell – the motivation for developing this approach was a key finding from (Ballard and Howell 1998) that only about half of the assignments made to construction crews at the beginning of a week were completed when planned. To improve this dire situation, they developed the LPS. How it works is explained more detailed in Section 2. For here, it is sufficient to recognize that it has solved many problems found in other planning systems but there is still improvement potential – particularly to progress planning, which will be explained more detailed later in Section 2.

However, we must also realize that in many projects they use no well-documented project planning approaches at all – it is all based on gut feeling, experience and other non-documentable sources – but since they are not documented we cannot discuss them here any further.

The question then becomes – is it possible to develop a better approach? One way can be to improve the EVM approach as (Sumara and Goodpasture 1997) propose. They note, probably correctly, that EVM has a cost-centric approach due to its roots in cost-reimbursable

contract environments whereas time-to-market can in many instances be more important in itself and also a major cost driver. They therefore devise a time-centric and simpler version of EVM where the focus is on "earn" task starts and finishes.

However, based on experience from industry, it makes more sense to focus on flow instead of tweaking the focus of EVM. Therefore, a marriage of the EVM and the LPS seems to give a better point of departure for a new approach, and this is presented in Section 3. Before that, however the Last Planner is presented in Section 2 to provide an overview of the theoretical background. It is assumed that the reader is familiar with EVM due to its long history and wide area of application. A closure is provided in Section 4.

2. REVIEW OF LAST PLANNER SYSTEM

The critique of EVM and Last Planner System (LPS) relies on sources in the literature and to some extent also experiences of this author where sources in the literature are either missing or too vague. Since EVM is well known we proceed to LPS.

The background for LPS can be traced to the seminal work of (Sanvido 1984) on systems, (Koskela 1992) on flow and (Laufer and Howell 1993) on construction project planning which has resulted in a new construction management approach called Lean Construction, see (Ballard and Howell 2004). The research on LPS started in 1992 during consulting project and culminated in Ballard's Ph.D. dissertation, see (Ballard 2000). Since then, there has been further development, as well.

Conceptually, LPS tries to bring the benefits of lean manufacturing into project related work like construction. Here, it suffices to focus on those areas that results in a number of important conceptual differences compared to EVM. A very good overview of LPS is provided by (Ballard 2000) in his PhD dissertation. There, he recognizes Lauri Koskela as the foremost production theorist in construction, and from (Koskela 1992) he obtains several important notions:

- The definition of "project" provided by (PMI 2008) is misleading because it focuses only on outputs and on an untested assumption of uniqueness that has discouraged learning from other industries. This in turn, has left production in Architectural, Engineering and Construction (AEC) industries focusing solely on conversion activities while ignoring the importance of flow- and value activities. Conversion activities refer to activities in which input is converted to output distinctly different from the input, flow activities refer to a number of activities including activities related to information flow and resources whereas value generating activities focus on how to meet customer requirements. The heart of the conversion model is that work can be divided into parts and executed independently, which is typical for EVM and similar approaches. The problem with this is that it leads to a contracting mentality which facilitates the management of contracts rather than the management of production or flow.
- There are also consequences for how projects are controlled (Koskela and Huovila 1997). Traditionally, the objective is to detect negative variances from target and then deploy corrective actions, which is quite different from the active concept of

production planning and –control found in manufacturing where the purpose is to conform to plan.

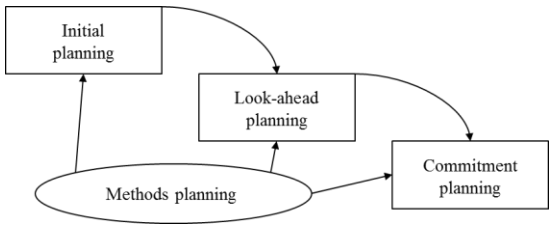
- The five design criteria from (Koskela 1999) are also true for LPS:

  - ✓ The assignment shall not start until all the items required for completion of a job are available (a sound job). An assignment is defined by (Ballard 2000) as the plan of what physical, specific work is to be done tomorrow. The person or group that produces such assignments is called by (Ballard and Howell 1994) the "Last Planner".
  - ✓ The realization of assignments is measured and monitored using Percent Planned Complete (PPC), which is the ratio (in percentage) between the number of planned activities completed divided by the total number of activities committed/promised.
  - ✓ Causes for non-realization are investigated and countermeasures deployed. This represents continuous improvement.
  - ✓ Maintain a buffer of executable assignments – it is important to avoid lost production due to starvation or reduced productivity due to suboptimal conditions.
  - ✓ Prerequisites for upcoming assignments must be actively made ready. This is essentially a pull mechanism preventing too great material buffers from emerging on site.

Conceptually, LPS has three hierarchical levels as shown in Figure 1 (Ballard and Howell 1998):

- From the *initial planning* we get the project budget and schedule, and it pushes completions and deliveries onto the project.
- The *look-ahead planning* is pulling resources into play and in so doing further adjusts and details budget and schedules.
- *Commitment planning* is based on an evaluation of what can be done, taking the actual situation into account, compared what should be done (as outlines in the higher planning levels). Based on this evaluation people commit themselves to the plan. This is the starting point for production control.

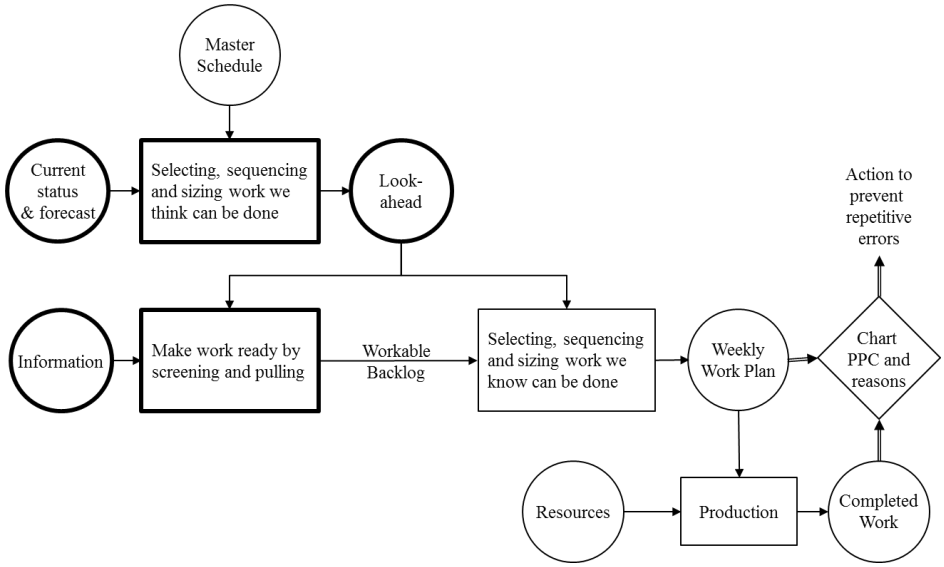
"Methods planning" is generic planning that outlines how work is to be executed with progressively more details from the top to the bottom in the planning levels.



Source: Ballard and Howell 1998.

Figure 1. The Planning system levels.

In Figure 2, the same process is depicted in more details. “Initial planning” in Figure 1 is the same as the “Master Schedule” in Figure 2. The “Look-ahead planning” in Figure 1 comprises of all the boxes in Figure 2 that are highlighted whereas most of the rest in Figure 2 is the “Commitment planning” in Figure 1.



Source: Ballard 2000.

Figure 2. Last Planner System with Look-ahead Processes Highlighted.

There are a number of important remarks to make about the look-ahead planning:

- The “Look-ahead plan” is more detailed than the “Master Schedule” and this is achieved by decomposing the activities in the “Master Schedule” into defined work packages and operations. In turn, sequence and rate from the Master Schedule can be improved and adjusted to realities.
- More detailed methods for executing work are found in the “Look-ahead Planning” and once this is known, work flow and capacities can be matched.
- The potential assignments in the look-ahead process are to be identified 3 – 12 weeks in advance depending on project characteristics such as reliability in the planning system, lead times for acquiring information, materials, labor and equipment (Ballard 2000). The purpose is to make sure that only activities that can be completed on schedule are to advance from one week to the next and finally into production. This will create a backlog of executable activities.
- For the aforementioned item to work, constraints must be analyzed and removed.

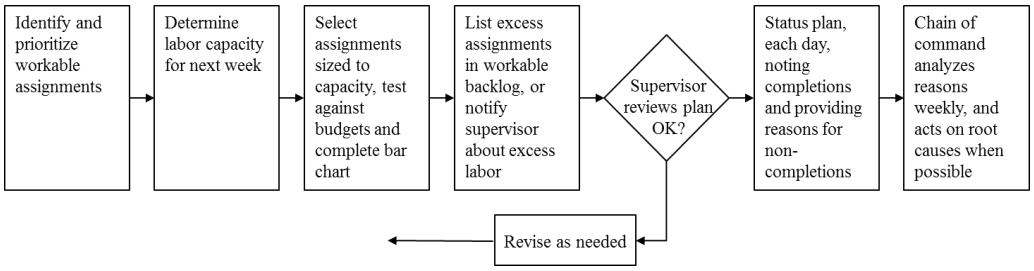
There are also many important remarks to make concerning the “Commitment Planning” in which the weekly work plans are made, see (Ballard and Howell 1998):

- The assignment must be specific enough so that it will be clear at the end of the week whether the assignment is completed or not.

- The assignments must be executable – nothing must be missing. This is to ensure flow, and (Koskela 2000) identified seven preconditions that must be satisfied in order for an activity to be sound/executable; 1) construction design (information), 2) components and materials, 3) workers, 4) equipment, 5) space, 6) connecting works – previous work and 7) external conditions such as weather, government rules and licenses.
- The assignments must be defined in the correct order of sequence to avoid rework.
- The assignments and the capacity available must match.
- The assignments that are not completed according to plan must become vehicles for learning to prevent similar mistakes to occur in the future.

These five items may seem commonsensical, but according to (Ballard and Howell 1998),"… it is by far the exception rather than the rule to find construction contractors that make quality assignments, and even rarer to find engineering firms or departments to do so. Many more or less, pursue a strategy of flexibility, attempting to be prepared for whatever work may become available". Flexibility becomes a poor excuse for failing to plan, coordinate and execute properly. Instead, as (Ballard 1989) states; "Firefighters get the laurels".

Seen from the perspective of the foreman, his weekly work planning procedure will become as shown in Figure 3 (taking all the aforementioned remarks into account).



Source: Ballard and Howell 1998.

Figure 3. Foreman Weekly Work Planning Procedure.

Finally, we should notice that the PPC on non-lean processes are typically in the 35% - 65% range, whereas after LPS is implemented performance typically rise to 75% - above 90%, see (Ballard 2000). In fact, better than 70% was very rare prior to LPS (Ballard and Howell 1998). It was data like these that convinced these two that there were too many performance anomalies in the traditional project management paradigm to accept it, and the subsequent research resulted in the Lean Construction paradigm, see (Ballard and Howell 2004). With this in mind, we can investigate some crucial differences between EVM and LPS:

- In lean methods, pull techniques are used to govern the flow of materials and information through networks of cooperating specialists (Ballard 2000); in contrast, approaches employed by PMI are push-oriented techniques for releasing the information and materials.

- In LPS project control is obtained via execution (Ballard 2000); whereas, control in EVM relies on variance detection after-the-fact.
- Capacity and inventory buffers are used to absorb variation (*mura*). Feedback loops are included at every level in LPS to make rapid system adjustments, (Ballard 2000); in comparison, EVM doesn't include adjustments.
- LPS tries to mitigate variation in every aspect (product quality, rate of work) and manage the remaining variation, while in EVM variation mitigation and management is not considered (Ballard 2000).
- In LPS, decision making is distributed in design production control systems (Ballard 2000); by comparison, in EVM decision making is centered to one manager some times.
- In LPS a buffer of sound assignments is maintained for each crew or production unit (Ballard 2000); in contrast, the EVM method doesn't consider a backlog for crews.
- LPS production system design resists the tendency toward local sub-optimization (Ballard 2000); however, EVM promote optimization of each activity.
- The PMI-driven approach only considers managing a project at the macro-level. This is necessary but insufficient for the success of projects. LPS encompasses project- and production management, and formally recognizes that any successful project undertaking will inevitably involve the interaction between project- and production management (Abdelhamid, El-Gafy *et al.* 2008).

Thus, there are a number of important differences between the EVM and LPS frameworks. The overall impression so far is that EVM is good at handling the big issues in project planning relevant for the project manager and hers closest reports, but fails at a number of important issues concerning improving project performance relevant to supervisors. LPS, however, is good at what EVM fails at, but suffers from not handling the bigger issues as well as EVM. Both approaches fail to handle advanced engineering design work due to the fact that they have not managed to identify ways of measuring physical progress in engineering – this is discussed further in Section 4.

Next, we will look at how we can take the best from both and create a new, improved approach to project planning called Lean Project Planning (LPP).

3. INTRODUCING LEAN PROJECT PLANNING

Lean Project Planning (LPP) is in many ways a marriage between EVM and LPS. Based on experience of using both planning systems during the last 3 years at Vard Group AS, we concluded that both systems had their merit. However, due to a culturally ingrained skepticism towards bureaucracy we never really employed any of the systems to their full conclusion. We eliminated some of the formalism in both approaches and rather focused on planning as a process of communication and added some ideas of our own.

LPP is depicted in Figure 4. First, we notice that the planning system distinguished between the system part and the planning process part. The system part we implement in Primavera P6 or similar whereas the planning process part follows the LPS thinking and some EVM elements. On top we have the project plan, which is essentially the entire database

found in the IT tool. This is only the planner that sees – and as such does not really constitute a plan from a communication point of view.

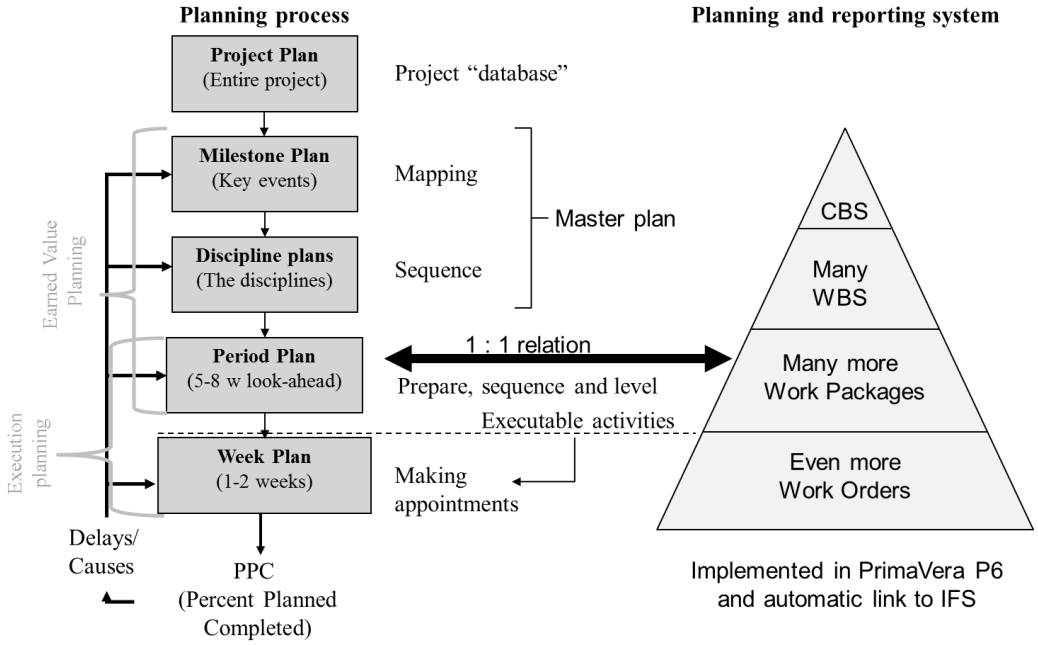


Figure 4. Lean Project Planning Overview.

The first plan is the Milestone plan that maps out key events of the entire project. This is defined early, but the number of milestones is less than 25. Then, we have plans for the major disciplines in which we sequence the activities to work effectively and to prevent rework and other non-value-added work. Together, the Milestone plan and the Sequence plans constitute a Master plan. These plans sees the whole project execution horizon, but in the next step – the Period plan – we have also incorporated the entire project scope of work but its usage and execution focus on looking ahead 5 – 8 weeks continuously.

The marriage between EVM and LPS takes place at the Period Plan level that is plans that are looking ahead 5-8 weeks, i.e. a given period. The introduction of period plans facilitates the look-ahead functionality of LPS and greatly improves the EVM reliability as well. The fact that these plans focus only 5 – 8 weeks ahead is just as important as the fact that they look ahead. Our strategy is that by start following up closely 5 – 8 weeks ahead, we can maneuver out of problems we have not identified. Long leading time items are, of course, followed up prior to the 8 week horizon. Such items typically include procurement of major components.

The marriage of EVM and LPS is achieved operationally by defining our work packages so that we get a 1:1 relation (in most cases) between activities in the Period plan and these work packages. This gives a very good way of tracking physical progress, the CPIs gives physical meaning to the supervisors and the EVM becomes difficult to manipulate, which is one of the worries voiced by (Kim and Ballard 2000). LPS also gains by being linked into the

EVM strengths. In a sense we have created a CONWIP system for project work given a certain manning. How this works in explained in Section 3.1.

We have also solved the problem of managers releasing work to get nice numbers in that unless all seven preconditions for execution, as discussed earlier and introduced by (Koskela 2000), the system blocks time registration on activities that do not have quality assignments, see Section 3.2. Thus, people who try to game the system will soon find themselves in problems and they are the ones that will end up looking like fools in the weekly lean meeting where the commitment planning takes place. In this way, we use a combination of IT systems and social cooperation from discipline in order to make sure the system is not gamed. The relation between socialization and discipline is important as (Niebuhr 1932) notes: "All social co-operation on a larger scale than the most intimate social group requires a measure of coercion". The coercive elements in the lean meetings are several including:

- Attendance is not voluntary in any fashion – attendance sheets are used.
- People have to come prepared – lack of preparation leads to disciplinary measures such as being returned to the desk to prepare while the meeting is halted and people waiting.
- Line management join the meetings at random.
- People have to explain to the other members of the team what they did in the last week, what are deviations from plan, how do they intend to solve handle this deviation and so on.
- People that cannot live according to this discipline have disciplinary cases on their hands.

The important part of this, however, is that this meeting discipline is communicated in advance so it is predictable. Then, people accept it as normal. Also, after a while, people understand why it has to be so and also promote it themselves. Equal treatment of people becomes the norm and people understand that this discipline is necessary to keep the meetings focused and highly effective.

The only way supervisors and others can game the system in the short run, is by including activities that are partially finished on the week plan, or reporting greater progress than what is the case. However, due to the fact that we limit duration of activities by 8 weeks, they can only get good numbers in the short run. In reality, the project team will normally reveal these people after a few weeks. Thus, we see that EVM and LPS can mutually reinforce each other, which is the main idea behind LPP.

The purpose of looking ahead in the Period plan is to prepare for execution, as already mentioned, but also to make more detailed sequencing and level the production. Production leveling is important to keep high productivity, but here we also use another well-known tactics; 1) maneuvering and 2) buffering.

Many companies and their planners make a lot of detailed plans in the belief that this will create effective execution. However, nothing could probably be further from the truth. A process that has a certain degree of inherent uncertainty – like planning and execution – will not perform better by squeezing it into too tight control limits (too detailed activities); this is a well-known fact from Quality Engineering, see for example (Taguchi, Chowdhury *et al.* 2005). In order to make more accurate planning useful, the processes themselves must be less

prone to random variation, first. Therefore, it is much more important to train the organization to live with this uncertainty and then rely on the expertise of supervisors and coordinators to maneuver to find the best solution for given circumstances. In this way planning is everything; the plan is nothing. In order to make this work, planning must primarily be a process of communication at the lower levels in the planning system/-process. Therefore, the week plans are defined only right before execution and the purpose is coordination for maneuvering and creating commitment for execution. This takes place in a so called "lean meeting", and this is the meeting where most committing coordination and communication takes place – the entire project team; once a week; one hour.

There is also another important reason for training the organization to live with uncertainty – this is important for maneuverability. This is expanded on in Section 3.2. However, regardless at how good supervisors are at maneuvering, there will be times when they either lack people or have too many people under their supervision – 100% correct manning is rare. In general, the cost of delaying projects and missing deadlines is very large, so trying to keep manning low in order to score high on the CPI is a dangerous tactic, albeit one that is employed by some, see (Kim and Ballard 2000). A far better approach is to man according to the needs in the Period plan, where we find all the execution critical activities, then add some more manning based on heuristics or statistics to handle activities that are not planned. These unplanned activities essentially become buffers both in time and manning. They are buffers in time because *when* they need to be executed is of little importance, and because of this we can easily move people in and out of such activities and thereby also serve as buffers in manning.

The lowest level in the planning system and planning processes is the week plan level. This is essentially a work list for every supervisor and his team(s) of foremen and workers coordinated across all disciplines. However, despite their simplicity, the week plans have several important functions:

- Week plans are tools of communication and coordination, which is discussed in greater depth in Section 3.3. It is here the communication part of planning is very important because in order to properly coordinate activities of this detail – can be whole work packages or parts of work packages depending on manning and progress requirements – communication is the only way forward. No amount of detailed activities in a planning system can replace the simple tool of talking to each other.
- This is what (Ballard and Howell 1998) refer to as commitment planning. In the weekly lean meeting, when project members are presenting and discussing these week plans, the make appointments as to what to do, when to do it and in what sequence. Possible sequencing problems are dealt with right there and then.
- The regular status review of these week plans, in the subsequent lean meeting, is also crucial for performance. Many companies – even Fortune 500 companies – are what (Jackson 2006) refers to as Plan-Do companies. The real secret of execution lies in "follow-up" (Check and Act) – thus, complete the whole sequence of Plan-Do-Check-Act.

Next, three crucial elements of LPP is explained in greater details in three separate sections.

3.1. From CONWIP in Manufacturing to CONWIP in Projects

Project planning and manufacturing planning has historically been two, disconnected camps. What we intend to do is to start adapting well-known production planning and –control approaches in manufacturing to project planning and -control. Then, we must first identify the best practice in manufacturing when it comes to flexible solutions in manufacturing.

Production planning and –control schemes can be roughly divided into push and pull (Krishnamurthy and Suri 2000). However, what the true difference between these two schemes in terms of production planning and –control has been somewhat unclear. The notion in much of the literature, and particularly among practitioners, has been that pull is *kanban* or Make To Order (MTO) (Hopp and Spearman 2004) meaning that a product is only made when the customer has requested that specific product. While this is true on the business level, it is incorrect on a tactical level. Thus, in a commissioned paper (Hopp and Spearman 2004) try to sort this out by distinguishing between strategic pull and tactical pull.

The strategy of pull (strategic pull) means that products are made according to demand and not according to forecasts and the like, which is push, whereas tactical pull is a system that places explicit limits on Work In Progress (WIP). It has nothing to do with eliminating waste – it is therefore not strange that Shingo once said (according to (Hopp and Spearman 2004)) that "'Eliminating waste' is a nonsensical slogan". The mistake often done is mixing the tactics of implementing lean (tactical pull) with pull as strategy (strategic pull) so that that lean and pull became synonymous irrespective of whether we talk about strategic level or tactical level.

In Figure 5 the common CONWIP system is shown. Here, a global pull is sent to the activity A_i which triggers a push of work through the subsequent activities. Unlike, in a *kanban* system the resting states of the buffers is empty except at the start and finish of the CONWIP cycle, see (Bonvik and Gershwin 1996), leading to a reduction in inventory, which is good because 'inventory is the flower of all evil and variability is its root' (Inman 1993). However, due to local push and hence lack of local feedback in CONWIP systems, a failure of a machine will lead to downstream starvation and upstream congestion – in *kanban* these problems will not occur. Yet, overall, (Bonvik and Gershwin 1996) concludes that CONWIP is a better approach than pure *kanban*.

There are studies indicating the CONWIP systems (either ordinary or Hybrid) can be applied in high-variety/low-volume environments with success, see for example (Slomp, Bokhorst *et al.* 2009). The level of WIP is not directly relevant in projects because many components are one off and even repetitive processes are mostly temporary in the sense that they are not continuous as in manufacturing – they can be carried out with several days in between and hence there is a natural limit to WIP for most WBSs. Therefore, in projects CONWIP is under all circumstances better than *kanban*. We therefore propose to base Lean Project Planning (LPP) on the CONWIP system. But how do we translate CONWIP into LPP?

The best is to start with a fundamental principle in manufacturing is – there are three types of variability buffers in manufacturing (Hopp and Spearman 2004): 1) inventory, 2) capacity and 3) time. Since lean is to accomplish whatever we want to accomplish with minimal buffering costs (Hopp and Spearman 2004), this means that we must find the project

equivalents to inventory, capacity and time in manufacturing and how to keep them at minimum costs in order to approach something that we can call lean.

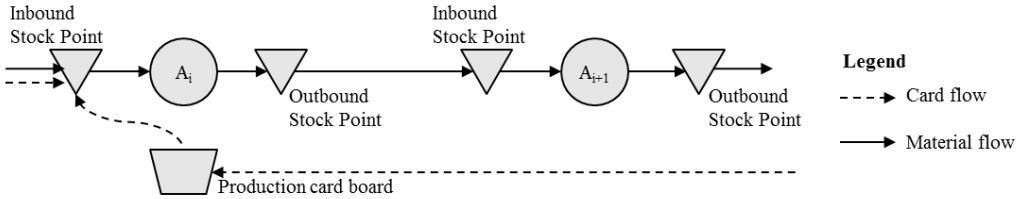


Figure 5. Common CONWIP.

Both inventory and time can be managed by the seven preconditions that must be satisfied in order for an activity to be sound (Koskela 1992); 1) construction design (information), 2) components and materials, 3) workers, 4) equipment, 5) space, 6) connecting works – previous work and 7) external conditions such as weather, government rules and licenses. The exact configuration of these seven preconditions in manufacturing will be different than in project work but the essentials remain the same.

Capacity, however, is different. In lean manufacturing, the production is takt paced as a result of the importance of leveling production in order to achieve strategic pull (Hopp and Spearman 2004). Without leveling the production, strategic pull will produce large inventories or disruptions in the supply chain. Furthermore, in manufacturing, the sequence of steps is predefined – particularly in assembly – and the production is on-going but with changes in product mix. In project work, however, there can be many different paths – some critical and others not – and some are truly unique which demands engineering and on-going problem solving. Therefore, there are a number of uncertainties in projects not encountered in manufacturing, which means that there must also be a buffer due to uncertainties.

In many projects, this is handled by increasing the level of detail in planning as if the level of detail has anything to do with predictability in the future. The fact is that the notion of accuracy in manufacturing is brought uncritically into project work, but this leads ironically to disruptions and problems. There is another solution, however, where we use capacity in a creative way – as an asset. By planning the activities critical for execution and then add a lump sum of people to the project to handle unplanned tasks and uncertainties, we have surplus capacity on the paper. In reality, however, this means that the capacity can be managed without interrupting project progress without any cost consequences. The lump sum of people is determined based on heuristics.

Now, we can proceed to the issue of CONWIP in project planning by finding ways of explicitly limiting WIP. The five design criteria discussed by (Koskela 1992) are useful for this. In short; executable assignments means that only assignments that are executable are to be started. This is essentially a blocking device that will lead to upstream congestion and downstream starvation if no countermeasures are swiftly in place. Therefore, by maintaining a buffer of executable assignments is crucial for avoiding this problem. Furthermore, to secure this buffer of executable assignments, there must be a steady focus on making the prerequisites for upcoming assignments ready. Essentially, this is a *pull* system.

What is missing in LPS is the push part. In LPP, the EVM secures a push by stressing the dates, using the performance measures to drive behavior which leads to executing activities

that in LPS would have been stopped because they are not fully executable, i.e., sound, (for example – pump is missing in the pump package). Such activities are being focused on and *do* become executable during the execution because others are working on the prerequisites for execution/soundness during. This takes place when there is a risk of starvation. If, we do end up having a positive buffer of executable assignments – the system will work as LPS. So, LPP is clearly a derivative of LPS. This explication is best noticeable when it comes to the next section, which is only superficially discussed in the Lean Construction community, and the content of Section 3.3 is not even mentioned.

3.2. Planning As Communication

Communicate is derived from the Latin word *commun* and a suffix 'ie', derived from 'fie', which means 'to make' or 'to do'. Thus, to communicate is 'to make something common' (Bohm 2004), and the purpose is to coordinate actions by the means of reaching an agreement communicatively, without reservation (Habermas 2003). Habermas uses the theory of speech acts developed by (Austin 1975) as his point of departure to develop his theory of communication. Speech acts are actions involving speaking, and we understand a speech act when we know what makes it acceptable. Of course, this is a matter of objective conditions of validity that the hearer cannot infer directly but only indirectly through the acceptability of four validity claims. Whereas a grammatical *sentence* must fulfill only the claim of *comprehensibility*, a successful speech act (a communicative action) must satisfy three additional validity claims (four in total);

- It must count as *true* for the participants insofar as it represents something in the world.
- It must count as *truthful* insofar as it expresses something intended by the speaker.
- It must count as *right* insofar as it conforms to socially recognized expectations.

Already here we understand why a plan is less useful than planning – a plan only has to be comprehensible whereas planning as a communicative process must also be true, truthful and right to gain acceptance.

To develop the notion of planning as communication further, it makes sense to base it on (Habermas 2003) theory of universal pragmatics because this is a theory that focuses on doing things with words, to borrow from (Austin 1975). Habermas starts out by making a clear distinction between sensory experience or *observation* and communicative experience or *understanding*. Observation is directed at perceptible things and events (or states); understanding is directed toward the meaning of speech acts, see Figure 6. The difference in level between the perceptible and symbolically prestructured reality is reflected in the gap between direct access through observation of reality and communicatively mediated access through understanding a speech act concerning reality. This will inevitably induce distortion which is why direct observation is always preferable over communicatively mediated access – a finding highlighted in lean manufacturing environments as well, see for example (Jackson 2006). With the finding from other research that about 85% of leaders and managers can be called relatively closed-minded, see (Nutt 1998), we understand that separating the planners

and the doers as in traditional planning environments is potentially disastrous, as (Sussland 2002) also points out.

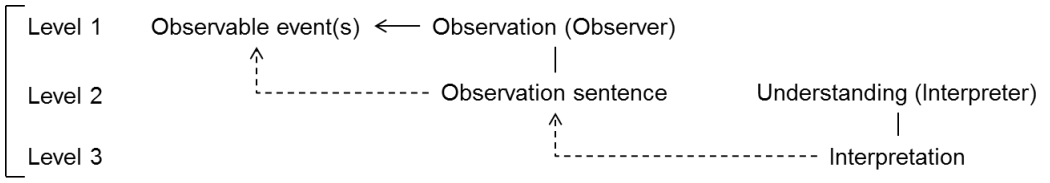


Figure 6. From Observation to Interpretation via Communication (Habermas 2003).

Furthermore, without good relations, communication will fail because communicative actions may fall prey to so called strategic actions, or communication primarily aimed at furthering ones self-interest by means of influence at the expense of reaching an understanding (Habermas 2003). From this discussion, we again understand the importance of communication in planning. Plans by themselves are almost without value.

Regardless of the efforts made at satisfying these validity claims, there will inevitably be miscommunication. According to (Baldoni 2004), there are two kinds of miscommunication; inadvertent and purposeful. Luckily, there are ways of dealing with purposeful miscommunication, such as:

- Exhibit good will – try to speak clearly and try to listen well. The fact is that speaking completely clearly is impossible. Thus, people who want to trip others will always succeed if they want and if they are reasonably intelligent. Therefore, stop trying to trip other person. Nobody can fool everybody all the time.
- Set clear objectives – people need to know what is expected to perform well and communicate clearly. This is also useful to avoid inadvertent miscommunication. Clear objectives, which are regularly followed up, can be a very useful tool to rut out fiefdoms within the corporation.
- Ask for feedback – feedback provides an opportunity to correct the communication to reduce the gap between what we believe we communicate and what others perceive we communicate.

The purpose is to help the people in the planning process identify hidden assumptions and make them explicit so that they can engage in communicative action. The work of (Habermas 2003) and (Bohm 2004) is essential here and only dialogue constitutes communicative actions. With reference to Figure 7, persuasion and discussion are strategic usage of language whereas dissemination is merely the spreading of information more according to the traditional transmission-oriented approach to communication and planning. While Figure 7 is not an exhaustive overview, it includes some of the most important usages of language that are likely to take place in projects, which we can break further down as:

- Ordering (special case of dissemination) – a person tells another what to do. This is the classic old-style of management, and it is quite common today as well on many shop-floors. This should really be the last resort of communication as it, for example,

is ineffective for the overall system over time, not to mentions what happens if the personnel that provide the orders are missing.

- Teaching/presenting (special case of dissemination or dialogue depending on the approach) – a person presents subject matters for an audience. This can vary from the almost classic one-way monologue to a highly interactive two-way dialogue. Teaching is nonetheless one of the least effective ways to communicate knowledge as John Holt points out, as quoted by (De Geus 1988). At best, 40% of what is taught is received, in most situations it only about 25%.
- Persuasions and discussion (argumentation) – some persons try to convince others about their points of view. This is also known as rhetoric – the art of making speeches, which originated in ancient Greece. It was quintessential for anybody who wanted high office. However, rhetoric degraded, to the dismay of Plato, into concerning itself with the means of persuasion and not with the ends, see (Honderich 1995). Persuasion thus understood is mostly a one-way affair. Argumentation, however, is much more two-way. Both can be intensive and frequent, and both concern the same objective – influence and convince others. However, there is a major difference –discussions are more confrontational and therefore more susceptible to our defensive routines because assumptions are not in the open and up for discussion. In fact, (Bohm 1993) points out that its linguistic roots are 'percussion' and 'concussion' and that "Discussion really means to break things up. It emphasizes the idea of analysis, where there may be many points of view" (Bohm 1993). However, the only extent where assumptions are fully exposed are dialogue.
- Dialogues – persons engage in "… a stream of meaning flowing among us and through us and between us – a flow of meaning in the whole group, out of which will emerge some new understanding, something creative" (Bohm 1993). Dialogues therefore are multi-directional, synchronous and very intensive. Assumptions are fully exposed and shared. They may, however, stretch over years. It is important to note that what most people call dialogues are essentially conversations and not dialogues.

From this discussion we understand that planning must primarily be a dialogue and secondary a discussion when needed. Unfortunately, the way many centralized planning approaches work is more of the dissemination and persuasion approach because the planners and those executing the work are separated not in time and space but in person. Therefore, the LPS approach where those that execute the work are also those who plan the work is fundamentally correct and consequently adopted in LPP.

There are also nonlinguistic means to improve communication and commitment planning. Research shows that once people commit to what they think is right, orally or in writing, they are more likely to honor that commitment, even if the original incentive or motivation is subsequently removed (Cialdini 2001).

Lean meetings therefore become highly fundamental parts of the planning system for coordination, socialization/discipline, establishing commitment, knowledge transfer and learning. The lean meeting is also an important learning arena, which can be easily shown by using the SECI process originated from the work of (Nonaka and Takeuchi 1995), see Figure 8.

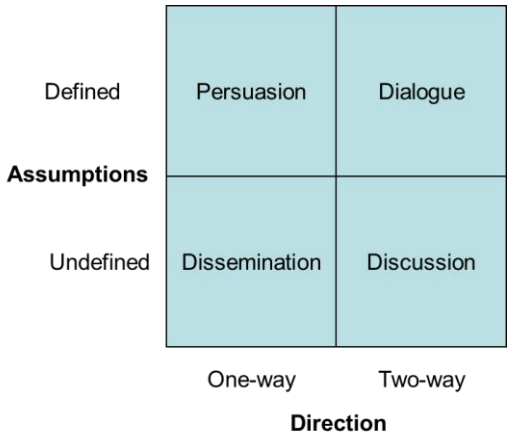


Figure 7. Use of Language in Corporations.

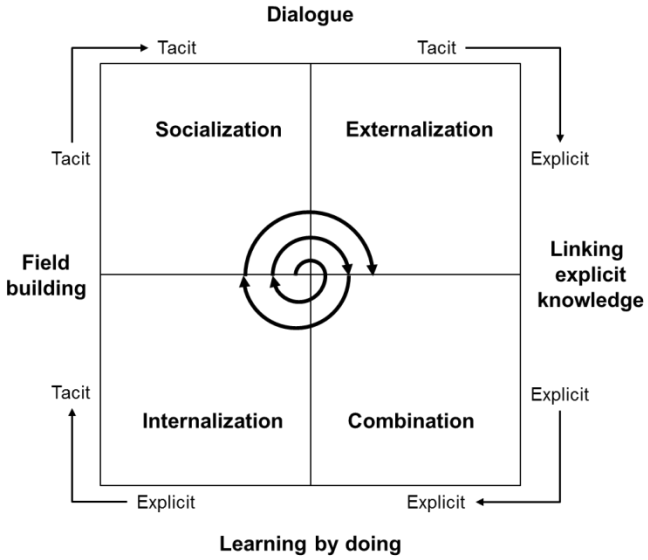


Figure 8. The SECI Process Derived from (Nonaka and Takeuchi 1995).

First of all, the acronym SECI consists of the first letters of the four modes of knowledge conversion – Socialization, Externalization, Combination and Internalization. These four knowledge conversions consist of four possible configurations of tacit- versus explicit knowledge. These terms were first proposed by (Polanyi 1966). He actually proposed a dichotomy in three; 1) explicit knowledge, 2) implicit knowledge and 3) tacit knowledge. While most agree on the definitions on the explicit type of knowledge, the definitions of tacit knowledge vary – also because some view implicit knowledge as a type of tacit knowledge. Explicit knowledge can be defined as 'knowledge that can be fully expressed and communicated clearly', which includes all codified knowledge, rules, procedures, methods and so on. Implicit knowledge is according to (Polanyi 1966) another form of expressive knowledge, but it is not expressed due to various settings such as cultural customs, organizational styles and so on. Tacit knowledge, on the other hand, is a type of elusive and

illusive ‘awareness’ of individual that cannot be expressed in words – a part of this type of knowledge is what (Johnson-Laird 1983) refers to as mental models which includes schemata, paradigms, perspectives, beliefs and viewpoints. From this (Polanyi 1966) has been credited with two much quoted sentences – “we can know more than we can tell” and “we know more than we realize”.

While the explicit and to some extent the implicit knowledge is quite straightforward to manage – and corporations have according to (Sveiby 1997) “…sunk billions of dollars…” in Knowledge Management (KM) solutions to capture knowledge without much results, the great irony is that tacit knowledge embodies the true competitive advantage for companies (Cavusgil, Calantone *et al.* 2003) because it is not easily transferable or decipherable for other corporations than where it was initially conceived. In the context of planning, this is of utmost importance – it means that a planning system must draw insight even from tacit knowledge of the project team to be truly effective, which is exactly why the SECI process is highly relevant here.

The SECI process starts with the Socialization mode, first. This is because knowledge resides in people – and *only* in people from an organizationally point of view. In terms of LPP, this means that the lean meeting is not just a necessary evils to coordinate, but they are absolutely crucial for learning. In fact, some of the most successful companies (Nonaka and Takeuchi 1995) discuss, applies brainstorming camps and parties to help this mode of knowledge conversion work effectively. This is what they refer to as building field where people can share mental models and experiences.

The knowledge spiral leads us from the socialization mode to the externalization mode where the tacit knowledge is converted from tacit knowledge to explicit knowledge and hence made available for the rest of the organization. The main vehicle for this is dialogues. Here, we can also find storytelling, models, metaphors, hypotheses, concepts and analogues useful. Due to the relative inaccessible nature of tacit knowledge, metaphors and analogues are the most common approaches.

Once the knowledge is made explicit, it can be linked with other explicit knowledge and yield new insights. This takes place in the combination mode. This is the typical focus for many in knowledge work, but we are only half-way. In terms of the LPP process, this is an important part of the lean meeting because the meeting is to focus on what was planned, handle deviations and what must be executed forward – explicit knowledge.

In the next step in the knowledge spiral we go to the final knowledge mode – internalization. This means to truly grasp the explicit knowledge and make it our own understanding and add to our current tacit knowledge. One of the most effective ways of doing for most people this is the learning by doing approach. This was an integral element of the extremely successful Training Within Industry (TWI) initiative in the US during World War II in which more than 1.75 million people were certified in more than 16,500 plants. In fact, according to (Dinero 2005), Toyota has more or less used the same system unchanged for more than 60 years with great results so it is an essential and integral part of the Toyota Production System.

From this discussion we understand that if we conceive of planning as an activity that is based on facts transmitted through utterances, then it follows that communication must be one of the primary vehicles of planning. Then, we can maneuver properly which is a central element of our strategy, and how planning and maneuverability is related is discussed next.

3.3. Improving Maneuverability by Project Planning

First of all, maneuverability is crucial in our strategy because without high degree of maneuverability, flexibility will degrade into an internal flexibility to save costs and keep control without offering any real value to the customers. Here, we can learn from the military and in particular from the work of John Boyd (1927 – 1997). Boyd discovered first hand that contrary to common belief, there were times when the less maneuverable of two, roughly comparable competing jetfighters won an air combat. Boyd explained this fact by an ability of the less maneuverable, but more agile, jetfighter to more rapidly change. For example, the more maneuverable jetfighter is capable of taking a tighter turn, but the more agile jetfighter can more rapidly change from one turn to another – although the turn is not as tight as the turn for the more maneuverable jetfighter. Boyd, then, concluded that "The ability to shift from one maneuver to another more rapidly than an adversary enables one to win in air-to-air combat"[1].

Boyd formulated his insight in what became known as the OODA loop, see Figure 9. It starts by observing what the current situation is. Given these observations, the decision-maker(s) have to orient themselves by setting the observations in context, hold it up against abilities and experiences, taking into account problems at hand (friction) and make a total analysis and synthesis of the situation. After orienting themselves, the decision-maker(s) must decide what to do. The decision is implemented and leads to action. From these four steps there is continuous feedback to observations – thinking (orientation), decisions and actions impact observations or our belief of what we observe. Note that there are no explicit targets. There is only implicit guidance and control. This includes the intent (what is to be accomplished), rules of engagement (procedures), policies and the like. It also includes what not to do, which is typically more important to give clear messages about than what to do because the very essence of maneuvering lies in local decision-making by those that face the situation on the ground.

There are a number of important consequences of maneuver-oriented thinking for planning:

- Detailed plans made early are meaningless – circumstances change and render detailed planning obsolete.
- Planning must be conducted by those closest to the action which implies that central planning on a number of issues is not only impossible but also harmful – they lack the necessary insight to make good decisions.
- Many important aspects of planning is impossible to succinctly put into plans which means that planning must focus on communication.
- Risk and uncertainty on a short-term and an operational level cannot be handled by advanced modeling of possible future scenarios because the richness of information makes it impossible on such short notice. Risk and uncertainty must be handled operationally by completing the OODA loop very quickly and thereby let maneuverability become the way to handle risk and uncertainty in the short, operational term.

[1] See his work 'Strategic Game of ? and ?'. Unfortunately, John Boyd never published his work officially.

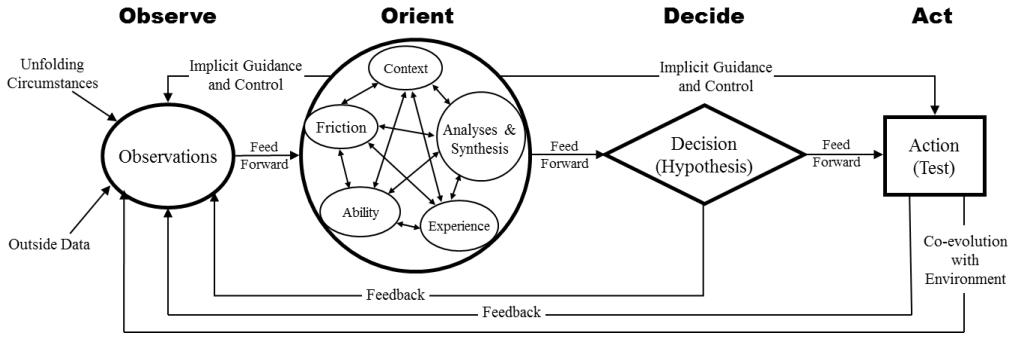


Figure 9. The OODA Loop for Maneuver Warfare. Adapted from John Boyd in (Richards 2003).

Note that "speed" is an oversimplification of agility and misses the point. As the greatest Japanese samurai in history – Musashi Miyamoto (1584 – 1645) – commented: "Speed, not being necessarily good, can only cause you to lose control". In a project this means that the quicker the planning loop is performed, the more successful will the project be in planning and execution. Although, technology can help – it can be a double-edged sword. In fact, John Boyd noted that "…complex hardware and systems tend to focus organizations inward, which can accelerate the trend towards confusion, disintegration, and collapse" (Richards 2003). It is the process of planning that count – not the plan; and this is essentially a process of communication.

4. CLOSURE

The Lean Project Planning (LPP) approach is a natural evolution from LPS – an explication of it and a streamlining of it towards the needs maneuverability needs of Vard rather than more generically towards construction as LPS or shipbuilding. The inclusion of EVM is an improvement as long as management is aware of the gaming problems in EVM. This being the case, LPP proves to be a useful synthesis of EVM and LPS at least as judged from the more than 10 projects that have applied it so far.

The explication is important in the next step where we will focus on engineering planning, see next section, because, this is where we see the greatest potential for methodological improvement. We have, however, identified some items to improve further also in the production part of LPP, such as:

- The importance of the role of project managers and -coordinators can hardly be overstated, and here we need to develop better training methodology and support. We have started by using the Training Within Industry (TWI) methodology, see (Dinero 2005), but there is still some way to go.
- The links we have today between the period plan and the week plan are not delineated explicitly – they are based on heuristics as opposed to structures. This makes the planning system somewhat unclear for outsiders and harder to train people in, but since we do not use freshmen as work leaders it may not be a disadvantage. However, it is something to consider and evaluate.

However, the single most important aspect to improve is how we conduct engineering planning. Engineering is increasingly entering the 3D domain so keeping track of hours consumed and use it statistically for future projects is close to irrelevant unless it is done on a very aggregate level which means we will have big problems measuring progress and hence calculate CPI. The fact is that making the drawing today takes 5 minutes whereas the engineering design process prior to the printout/plotting can take days, weeks or even months in some cases. On top of it, they are often iterative. So how do we measure the progress correctly so that we can judge whether we are ahead of schedule, on schedule or behind schedule and so on? This is partly the topic of a PhD study we have undertaken because it turns out that this is an unsolved problem at least in the literature. Even the state-of-the-art report recently published by The Joint MIT-PMI-INCOSE Community of Practice on Lean in Program Management, which has much insight to offer on a number of issues in engineering, fail to address the problem of measuring progress, see (Oehmen 2012). They are more concerned about communicating the progress to all in a project thereby implicitly assuming that the measurement of progress is correct.

Here, the insights of (Koskela 1992) can also be useful. Traditionally, also engineering planning has been suffering from the problem of focusing solely on conversion and has ignored flow. This means that a new approach may have to focus not only on the engineering design activities but also on other necessary activities for conducting the actual engineering design to make sure that the entire flow is captured. Another issue in engineering planning is that unlike in the production stage of the projects where activities take place on a single location, in the engineering design stage of the project we have geographically distributed activities with employees in Norway, Romania and Croatia and also in different legal units. How this network of activities can be planned and followed-up is a topic requiring further research.

Finally, but not the least, we foresee that research into how to recruit and train project people is necessary due to their pivotal role in the communication process both in the lean meetings but also outside. Furthermore, we believe that there is much to improve in the structuring and management of the lean meetings to prevent unnecessary human biases coming into play and hence distort the decisions-making process. Biases are well-known problems from the literature, see for example (Kahneman and Tversky 1982), yet it has to our knowledge not been properly addressed in planning and execution of projects. This is consequently also something we will work on in the future.

Based on the insight from implementations so far, it is clear that LPP actually works quite well – this is the verdict at least from our anecdotal evidence. Fundamentally, planning conceived as a process of communication seems to be a correct notion. Communication is difficult and the reality is that there is much to improve which is why we keep working on a number of issues mentioned earlier. This is, however, not a problem – it is a healthy sign because it shows that we able to constantly improve our approach which is crucial; in the wise words of Chan Master Jiantang Ji.

Who has no faults? Excellence is a matter of reforming them.

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