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# **WORK SYSTEM INNOVATION: Designing improvement methods for generative capability**

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## **Abstract**

This paper explores how a work system's capability for improvement is influenced by its improvement methods. Based on explorative case study at a Lean manufacturing facility, the methods problem solving and Appreciative Inquiry were compared through in-depth qualitative studies over a 12-month period. The findings show how problem solving leads to solutions inside the existing improvement trajectory, whereas Appreciative Inquiry due to increased generative capability enables solutions outside the existing trajectory. The paper suggests how improvement methods can be designed for appropriate generative capability, which can be useful for practitioners who need to create systemic change.

**Keywords:** Continuous improvement, Lean, Appreciative inquiry

## **Introduction**

Operations management in industrial production has been focused on creating learning organizations for decades and has focused on engaging everyone in the organization in improvement activities (Delbridge *et al.*, 1998). This has led to new ways of organizing and managing work systems that go beyond those of scientific management from the industrial age. Liker (2004) argues that Lean, and the Toyota Production System as exemplar, is an exceptional work system for accomplishing the constant drive of organizational learning through continuous improvement. Lean has therefore been a role model for creating work systems and continuous improvement culture in manufacturing as well as by private and public service providers all over the world (Arlbjørn *et al.*, 2011). Despite its extensive popularity in research and practice there has not been developed consensus about how to implement Lean practices (Brännmark *et al.*, 2012) and there has been developed a divide between 1) Lean as a collection of tools for concrete problem solving and waste reduction (Hines *et al.*, 2004; Petterson, 2009), 2) Lean as a set of principles to follow (Womack and Jones, 2003), and 3) Lean as a philosophy of long-term excellence based on learning, focus on customer value, and waste reduction (Liker, 2004; Shah and Ward, 2007). One challenge is shared

across this divide: How to create a lasting continuous improvement culture (Lewis, 2000; Bateman, 2005; Liker 2011). That is, how to establish a work system with a high capability for continuous improvement over time and not just sporadic stand-alone initiatives (e.g. Kaye and Anderson, 1999; Savolainen, 1999). Recently, this challenge has attracted even more interest due to global competition and strategic choices of specializing within narrow parts of the engineering value chain which has increased the need for a high improvement capability (Zhang, 2011). It has therefore become increasingly important to answer how to develop continuous improvement capability. Bessant and Francis (1999) describe that a work system's improvement capability consist of its competence in structured problem solving, idea management, degree of experimentation, ability to connect to strategic goals, and to involve the entire system. The importance of the problem solving competence is stressed widely in the literature (e.g. Berger, 1997; Kerrin, 1999; Terziovski and Sohal, 2000; Delbridge and Barton, 2002; Jørgensen *et al.*, 2003; Liker, 2004; Shook, 2008).

Although this apparent importance of problem solving competence has been widely accepted in practice there does not seem to exist any research investigating the role of problem solving for creating improvement capability or whether alternative methods would be better suited for long-term development of improvement culture. The aim of this paper is therefore to investigate these questions.

Over the past years an alternative paradigm for developing organizations has emerged from a critique of problem solving as a change method, stating that while the problem-based paradigm certainly can be useful for creating specific improvements, it may inhibit the capability to create lasting improvement cultures due to a risk of creating defensive posturing, discouraging action and inhibiting creative thinking (Barrett, 1995; Neilsen, 2005; Shendell-Falik *et al.*, 2007), as well as limiting knowledge generation in collaborative work (Baaz *et al.* 2010). Instead, the new paradigm suggests a shift in focus from problems to learning from positive deviations and focusing on affirmative future images. One example of such a change approach is Appreciative Inquiry that has shown capable of creating transformational organizational change (Bushe and Kassam, 2005; Cooperrider *et al.* 2008). Appreciative Inquiry differs from problem solving by reframing the problem into an affirmative topic choice, and instead of investigating root causes of failure it bases change on inquiring into success enablers and strengths from within the organization that can lead to the desired future state (Cooperrider *et al.* 2008). Supporters of this new paradigm argue that a more positive focus better nurtures learning culture and that the active use of positively framed metaphors and future images accelerate change in organizations and thereby enhances the improvement capability.

The purpose of this study is therefore to investigate the differences between these two improvement methods, problem solving and Appreciative Inquiry, through an explorative case study and thereby to explore how the choice of method can influence the development of improvement capability. This leads to two research questions:

*RQ1*: How can the two different improvement methods be characterized empirically?

*RQ2*: How does the choice of improvement method influence a work system's capability for improvement?

### **Understanding a work system's capability for improvement**

A work system can be defined as an organizational subunit at the operational level that transforms inputs into outcomes through a work process. Inspired by open systems theory and the work of Smith & Sainfort (1989), Carayon & Smith (2000), and Kleiner (2006) a work system framework is introduced in figure 1.

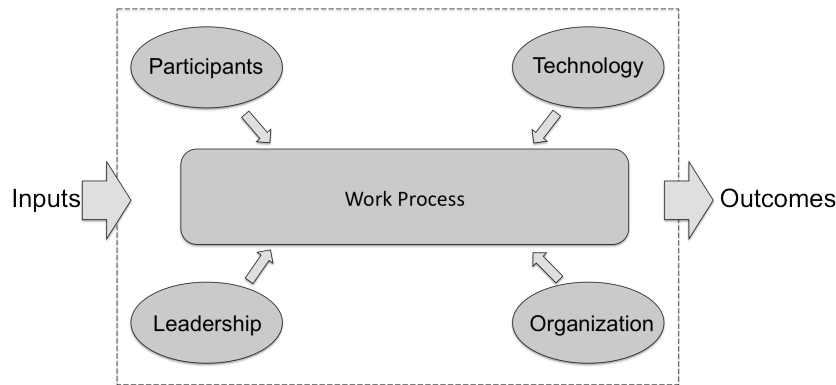


Figure 1 – Work system framework

When in action, the work system transforms inputs into outcomes through its work process based on how the four other elements interact. *Participants* means the actors that participate in the transformation process with their knowledge and actions. *Technology* means the used artifacts, workspace, and methods (such as procedures and mental models). *Leadership* means the actions and expectations from formal and informal leaders that influence the transformation process, such as goals, incentives, language, and meaningful interpretations (Weick and Quinn, 1999). *Organization* means the formal and informal structures, culture, and relational aspects that influence the transformation process in action, such as hierarchy, levels of trust, norms of behavior, and relational coordination (Gittell, 2000). The work process is the series of more or less formalized and tacit steps that lead to transformation of inputs into outcomes based on the interaction between the four other entities.

Based on this work system view the term improvement can be defined as a change of a work system from one state to another that is more efficient or effective in reaching its goals or leads to more desirable side effects. This covers large systemic changes as well as small narrow changes. Since the work system is never in a distinct steady state it can be difficult to measure the effects of a change and to assess if it is an improvement.

It therefore follows that a work system's capability for improvement is its ability to create changes that makes the system more effective or efficient. Bessant and Francis (1999) describe one dimension of such an ability when they argue that a work system's capability for improvement consist of its competence in structured problem solving, idea management, degree of experimentation, ability to connect to strategic goals, and to involve the entire system. It could be argued that these factors are all characteristics of improvement activities, i.e. the process when one or more people work on improvements either as a time-limited project or as part of the daily work. These activities can be more or less structured, experimenting, connected to strategic goals, involving, etc., which will affect their capability for creating work system improvement. Based on this view, the improvement capability can be seen as the product of the improvement activities being practiced in the work system and can thereby be increased by development of the way activities are being practiced.

### **Understanding the role of improvement trajectories**

Dosi (1982) introduces the concept of a trajectory to describe the pattern of normal problem solving activity of creating solutions to selected problems based on selected principles and methods. The selections are based on a paradigm defined as an "outlook," a set of procedures, a definition of the "relevant" problems and of the specific knowledge related to their solution (Dosi, 1982). Each paradigm has

established a concept of progress based on the specific trade-offs, e.g. between economic and technological factors, and describes a mental model for identification of problems and valid solutions. An improvement trajectory is thereby the normal practice of creating improvements based on a mental model of relevant problems and valid solutions. An example could be the daily problem solving (*normal practice*) on a production line that is not performing as efficiently as it is supposed to (*mental model of problem*) by investigating if the standard work was followed and if the training system is working sufficiently (*mental model of valid solutions*).

A work system with high improvement capability will therefore need to have an improvement trajectory that is effective in addressing the current challenges, as well as being able to change the trajectory when the challenges change. In order to create lasting improvement capability over time the ability to change and develop improvement trajectories will be key since the improvement needs will change over time. This need will be especially important for creating systemic improvements rather than stand-alone-solutions when introducing Lean and for increasing the improvement capability necessary for flexible and innovative manufacturing.

Barrett (1995) calls the process of changing improvement trajectories for generative learning and states that it involves thinking outside the limitations of the initial problem and going beyond the framework that created the current conditions. Gergen (1978) describes generativity as: *the capacity to challenge the guiding assumptions of the culture, to raise fundamental questions regarding contemporary social life, to foster reconsideration of that which is taken for granted and thereby furnish new alternatives for social actions*. Avital and Te'eni (2009) elaborates on this definition and defines generative capacity as: *comprising the ability to rejuvenate, to produce new configurations and possibilities, to reframe the way we see and understand the world and to challenge the normative status quo in a particular task-driven context*.

In order to carry out an improvement activity that leads to thinking outside or ultimately to change the existing improvement trajectory it is therefore necessary to be able to challenge the normative status quo in a particular task-driven context to produce new possibilities for action, and this ability can be termed the generative capability.

The focus of this paper is therefore to explore how the two different improvement methods affect generative capability and thereby the development of long term improvement capability.

### **Characterizing the two improvement methods**

The conceptual difference between root cause based problem solving and Appreciative Inquiry as improvement methods can be illustrated by the improvement step framework shown in Figure 2 (which is based on earlier work by the authors and Cooperrider et al., 2008; Liker, 2004). The root cause based problem solving method starts from a problem statement (1) that describes the negative gap between the current state and the target state. Then root cause analysis (2) is used to identify reasons for the gap by scientific analysis and experiments. The guiding metaphor for this step is a funnel where the focus is gradually narrowed until the 'correct' point of the cause is found, and then investigated through why-questions until the real root cause is identified. Solving the root cause implies that it is not just the initially apparent problem at the surface that is addressed but a deeper underlying problem. Finally, countermeasures are identified in order to design solutions (6), followed by the necessary activities for realization (7) with subsequent check and standardization. This method is also known as the three Cs: Understand the *concern*, investigate the *root cause*, and implement the *countermeasure* (Delbridge and Barton, 2002). It is also the same basic method used in A3 problem

solving (Shook, 2008; Rother, 2010) and Toyota Business Practice (Liker, 2004). It should be noted though, that these practices used together with the Toyota way philosophy leads to more complex improvement activities that include checking if the process is aligned toward principles of customer first, the company vision, broad stakeholder involvement, purpose of work, visualization, etc. (Liker 2004).

Appreciative Inquiry on the other hand starts by reframing the problem into an affirmative topic (4) and thereby shifts focus from “what to eliminate” into “what should be created”. The next step in the process is to create momentum from identifying the best of what already exist that should be sustained and what can be learned from previous success experiences through a success factor analysis (5). This step is a systematic investigation of what knowledge the participants possess that can lead to realization of the affirmative topic as well as uncovering of tacit knowledge. Then, the next step is formulation of a guiding positive image as a future state visualization (3). Finally, design of solutions (6) and activities for realization (7).

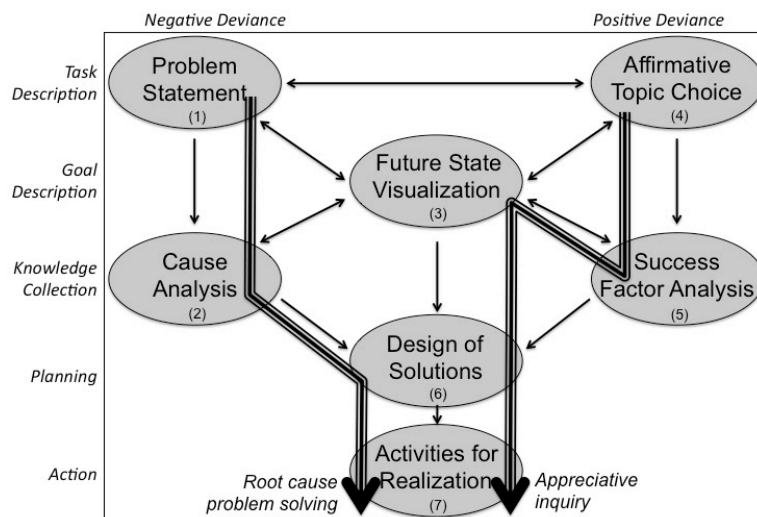


Figure 2 – Improvement step framework

Based on this definition, an improvement activity can be characterized as an Appreciative Inquiry process if it consists of the steps (4), (5), (3), (6), and (7). An improvement activity can be characterized as problem solving if it consist of the steps (1), (2), (6), and (7). And any improvement activity consisting of another combination of steps will be a hybrid.

### Methodology

The methodological approach chosen for this research was an explorative case study in a single organization focused on investigating improvement activities. By choosing an explorative case study it was possible to get in-depth knowledge and investigate the contemporary sets of events within their real-life context (as suggested by Yin, 2003). The choice of focus on a single organization made it possible to get a broader understanding of the organizational context as well as to identify an organization with the necessary criteria of having experience with both systematic problem solving and Appreciative Inquiry. Based on the researchers’ network an organization was identified that matched these criteria of experience and that accepted to allow full access to their improvement activities for the research project. The selected organization was a medium-sized manufacturing facility of pharmaceutical devices that had been working

with Lean manufacturing for eight years and experimented with appreciative inquiry for four years. The research was carried out by following selected improvement activities carried out in the production and production support departments over a period of 12 months. The improvement activities going on at the facility were very different in nature, ranging from one to 100 participants and lasting from an hour to a month, and it was therefore decided to focus on getting in-depth qualitative understanding rather than seeking a large enough quantity for statistical conclusions. A research design was therefore decided that took advantage of the longitudinal availability by allowing for iterative data collection. The sampling criteria were to study 3 problem solving cases, 3 appreciative inquiry cases, and as any types of hybrid cases that turned up. The following procedure was used: 1) Select a relevant improvement activity to study based on sampling criteria, 2) Study improvement activity through qualitative data collection, 3) Transcribe activity into a narrative and characterize its type, 4) Repeat 1-3 until all sampling criteria have been fulfilled, 5) Analyze and compare cases.

Data collection was carried out through qualitative methods of observation as well as interviews with participants. The advantages of participant observation include greater access to otherwise inaccessible information such as unconscious actions as well as deeper understanding of the context. Disadvantages include introduction of bias of the researcher and the interactions with the key informants that know the researcher is present (Kawulich, 2005). Observation data was collected in a field notebook together with copies of documents and pictures. Some improvement activities as well as interviews were recorded. For each of the cases, the activity was transcribed into a narrative that was analyzed in order to divide the process into steps based on coding. The steps were then categorized based on the improvement framework presented in section 3, and from there the cases were characterized as problem solving, Appreciative Inquiry or hybrid activities. The process character of the cases was then analyzed in order to determine whether the activity led to thinking inside or outside the existing improvement trajectory by investigating whether the mental models of relevant problems and valid solutions were changed. That is, if the process demonstrated generative capability by challenging the normative status quo in a particular task-driven context and produce new possibilities for action, e.g. by changing the limitations of the initial problem and thereby exceeding the initial assumptions about solutions.

### **Empirical findings**

A total of ten improvement activities were followed and the cases were categorized into problem solving, Appreciative Inquiry or hybrid cases based on which steps they used as described earlier. Table 1 shows a summary of the cases' improvement steps and the result of the analysis of the process character. All three problem solving cases started from a problem statement of a negative deviation from the standard and used root cause analysis to deeper understand the problem and its causes, and they used processes that stayed inside the existing narrow trajectory. The hybrid cases were very different in nature. Three out of four had processes that stayed inside the existing improvement trajectory while one had a process outside the existing trajectory. Case 4 was similar to cases 1-3 by starting with a concise problem statement, but instead of generating knowledge about solutions based on investigating root causes it investigated the success factors leading to positive deviations in performance. This led to a solution without needing to understand the causes of problems, but instead by understanding the interventions to create success. The cases 5 and 6 were both based on an affirmative topic choice of sustaining a specific positively deviant performance by investigating success factors in order to create improvement, and both stayed inside the existing

trajectory of continuing the existing practices. Case 7 was more complex, lasted much longer and had more participants involved than the other cases. It started as problem solving with a problem statement and root cause investigation, but was expanded to include the Appreciative Inquiry steps of affirmative topic, future state visualization, and investigation of success factors. The case ended up addressing the original problem statement and using root cause analysis, but it also took a broader systemic view that led to changes not originally considered. During the affirmative topic and future state steps the perspectives expanded and enabled broader ideas to emerge by changing the mental model from narrow focus on improving coordination across departments to creating a new improvement structure, thereby leading to a process outside the existing trajectory.

Two of three Appreciative Inquiry cases led to processes outside the existing trajectories, even though they all used the same steps. Cases 9 and 10 even had the same overall design, but were carried out by different teams with some variations. Case 9 led to a process outside the existing trajectory during future state envisioning and ended up focusing on much wider areas than the immediate problem such as elevation of capability building. Case 10 on the other hand followed the existing improvement trajectory and the existing assumptions about problems and solutions to the apparent challenges ahead. The appreciative inquiry improvement steps alone are therefore not a guarantee for thinking outside the existing trajectory, but may enable it.

*Table 1 – Summary of improvement steps and process character for the ten cases\**

Case no.	Task definition		Knowledge collection		Goal description	Process character	
	Problem statement	Affirmative topic	Root cause	Success factors	Future state visualization	Inside trajectory	Outside trajectory
1	X		X			X	
2	X		X			X	
3	X		X			X	
4	X			X	X	X	
5		X		X		X	
6		X		X		X	
7	X	X	X	X	X		X
8		X		X	X		X
9		X		X	X		X
10		X		X	X	X	

*\*White = problem solving cases. Silver = hybrid cases. Carbon = Appreciative Inquiry cases*

### **Discussion – what enables generative capability?**

The second research question of this study asked how the choice of improvement process influences the improvement capability. Since the method was explorative with a limited number of very different cases there is no basis for statistical conclusions but instead opportunity for qualitative investigation of the content to get a deeper understanding. The presented findings lead to a new question of how the processes of these three cases shifted to be outside the existing trajectories while seven did not, i.e. to identify what created the generative capability of challenge the normative status quo in a particular task-driven context to produce new possibilities for action.

The three cases that shifted trajectories had one thing in common; they all used the steps affirmative topic, success factor analysis, and future state visualization. By comparing the story lines of the three cases some similarities were found. In the cases, the affirmative topic led to the formulation of a new challenge that not only was different from the original problem understanding but also implied a new mental model with new assumptions about relevant problems and valid solutions. Furthermore, it led



to the emergence of a new language about the challenge. When the following success factor analysis was carried out it reinforced the new mental model and language while the participants studied past success experiences in the new view. The following future state visualization was then based on a new situational understanding from the affirmative topic and then led to a shift in improvement trajectory. An example of the shift can be shown from case 8: First, the task of “optimizing cleaning time” was reframed into the affirmative topic of “how to achieve perfect efficiency?” Then, the team investigated into past experiences about perfect efficiency such as quick change over, non-stop manufacturing, and coordination between activities. This step reinforced the focus of the affirmative topic and its new language. Based on this language they visualized a future state, i.e. “cleaning only during other stops,” that implied a solution outside the existing improvement trajectory. Instead of optimizing the cleaning process, the team investigated how to create a flexible cleaning system with optimal coordination with all planned and unplanned stops on the machine.

Based on these empirical findings the answer to what creates generative capability and thereby solutions outside the existing improvement trajectories can be explained by the following mechanisms, summarized in figure 5:

- 1) Reformulation into an affirmative topic enables a new understanding to emerge with new assumptions and a new language, i.e. a precursor for a new trajectory
- 2) The collective investigation of success factors reinforces the new assumptions and language as well as consensus about characteristics of the desired future state
- 3) When a future state is then defined within the affirmative topic, it can pull the improvement activity to shift to a process outside the existing trajectory

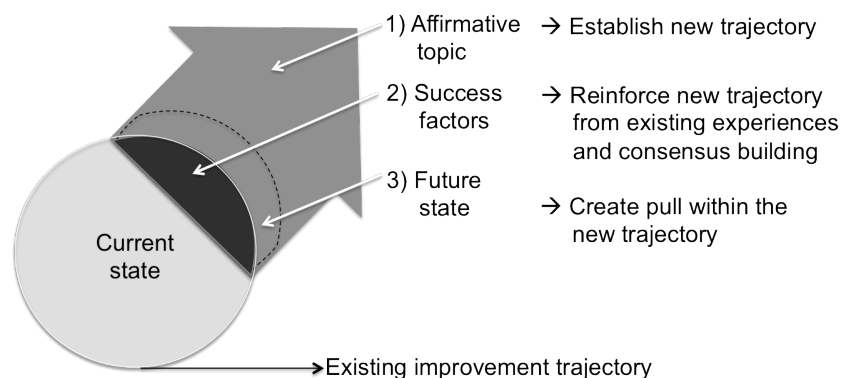


Figure 3 – Steps and mechanisms for creating a trajectory shift through appreciative inquiry

Based on an analysis of the other seven cases another series of patterns was found about barriers for shifting from the existing improvement trajectories. The first pattern was found in cases 1-3 that showed how the root cause analysis step reinforced the existing improvement trajectory by using normative arguments disguised as rational logics. In case 1 the root cause analysis led to the identification of either a training system or a human-machine interface as the root cause based on the rational argument that another design of either could have avoided the problem. The conclusion that an event is caused by a specific system’s failure because it should have been designed differently is a logical mistake of normative argumentation based on assumptions within the existing improvement paradigm. This method of “should”-arguments thereby reinforces a focus on creating solutions based on the existing systems because they are the natural targets of this normative attribution, thereby reinforcing the existing improvement trajectory.

Case 4 presented another barrier: Without an affirmative topic choice that points in a

new direction the following steps reinforce the existing trajectory. New knowledge and improvement was created during success factor analysis, but no changed mental models. Cases 5 and 6 illustrated another barrier, namely no change catalyst, i.e. no pull and specific direction from a future state vision, even though they did have an affirmative topic and success factor analysis. Since cases 9 and 10 followed the same steps but only 9 had a process outside the existing improvement trajectory, it can be concluded that following specific steps is not a guarantee for creating a shift and the qualitative analyses pointed to execution of facilitation as an important component. This summarizes to the following barriers for creating processes outside existing trajectories:

- 1) **Normative logics.** Root cause analysis reinforces the existing trajectory by attributing cause-and-effect relationships based on normative logics.
- 2) **No new direction.** Without an affirmative topic choice that points in a new direction the subsequent steps will sustain the existing trajectory.
- 3) **No future state.** Without a future state visualization the improvement activities will not lead to a shift in trajectory even with an affirmative topic choice and a success factor analysis due to a lack of pull past the existing systems.
- 4) **Execution.** The steps alone are not enough.

## Conclusion

This paper shows how improvement activities based on problem solving and Appreciative Inquiry can be characterized empirically based on which improvement steps they use. It was found that the two methods use different mechanisms to create improvements and that these mechanisms influence the improvement capability differently. Problem solving reinforces the existing improvement trajectory and leads to solutions based on existing mental models. Appreciative Inquiry on the other hand uses a combination of steps to increase the generative capability of challenging the assumptions of the existing trajectory and thereby furnish new possibilities for improvements not available in the existing trajectory.

The improvement capability of a work system depends on the effectiveness of its existing improvement trajectory as well as its ability to change trajectories when the challenges from the environment change. It is therefore necessary to be capable in both creating improvements inside and outside the existing trajectory. Work systems with a need for flexibility and adaptiveness or systemic changes such as culture change or Lean implementation will need higher generative capability, and it is therefore suggested for these systems to supplement problem solving methods with more generative methods such as by integrating Appreciative Inquiry into daily improvement activities.

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