CONSTRUCTION KATA: ADAPTING TOYOTA KATA TO A LEAN CONSTRUCTION PROJECT PRODUCTION SYSTEM

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ABSTRACT

This paper reports on the efforts and experimentation by a team of consultants and client contractor leaders as they have worked to adapt, adopt and deploy the concepts and tenets of *Toyota Kata* into a lean construction project production system. The experiment has produced new learning and revealed the need for much more experimentation and research in the use of the kata within the construction environment. The paper will introduce and describe a construction project production vision equally challenging as that of Toyota's. This production vision provides the long-term direction and impetus for continuous improvement and adaptiveness. The "conditions of production" within a manufacturing setting and a construction project will be compared and a third kata, the *conformance kata*, will be introduced and described. The combination of the *conformance kata* and adaptations of the Toyota Kata *improvement kata* and *coaching kata* provides lean construction adopters a consistent routine for striving, on a daily basis and in the service of their project production vision, to achieve conformance to required conditions, assembly process improvement and leadership development, all the while simultaneously growing a supportive culture of continuous improvement, adaptiveness and compounding learning. We call this package of kata, the *Construction Kata*. For the sake of brevity the paper will limit its focus to the use of the conformance kata and the initial target conditions of the production environment at the project workface. Learning to date and the opportunities for expanded use and research regarding all three of the kata within Construction Kata will be presented.

KEYWORDS

Lean construction, continuous improvement, adaptiveness, Toyota Kata, Construction Kata, Daily Crew Production Flow

INTRODUCTION

A recent book by Mike Rother, entitled Toyota Kata (Rother 2010), presents a new and fascinating perspective of the Toyota organization and its culture of continuous improvement and adaptiveness; that of daily improvement within every process

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throughout Toyota while striving to achieve the "conditions" of an extremely challenging production vision. Rother describes Toyota's current production vision as:

- Zero defects
- 100 percent value added
- One piece flow, on demand

Toyota refers to this vision as "one-by-one production". This vision describes a very specific set of "conditions" and provides direction for all process improvement efforts. Daily improvement is achieved through the use of two unique improvement and leadership routines (*kata*) Toyota employs to improve processes (the *improvement kata*) and to coach leaders (the *coaching kata*). Rother describes ***kata*** as:

> *"This book describes two particular behavior routines, habits or patterns of thinking and conducting oneself, that are practiced over and over every day at Toyota. In Japan, such routines are known as* kata*. These behavior patterns are not visible, are not described in Toyota documents, and it takes a long time to recognize them. Yet they are how Toyota leads and manages its people. These two kata are taught to all Toyota employees and are a big part of what propels that company as an adaptive and continuously improving organization. If you want to understand Toyota and emulate its success, then these kata, more than the company's techniques or principles are what you should be studying."*

Rather than random and discontinuous improvement efforts such as "waste walks", standing in the circle, and kaizen workshops, continuous improvement at Toyota is a daily event and all improvements are incremental, intentional and in the service of their production vision. As Toyota employees consider improvements the key question is "What do we need to do?" Rother claims the answer to that question is:

> *"Briefly put, the continuously repeating routine of Toyota's improvement kata goes like this: (1) in consideration of a vision, direction or target, and (2) with a firsthand grasp of the current condition, (3) a next target condition on the way to the vision is defined. When we then (4) strive to move step by step toward that target condition, we encounter obstacles that define what we* need *to work on, and from which we learn."*

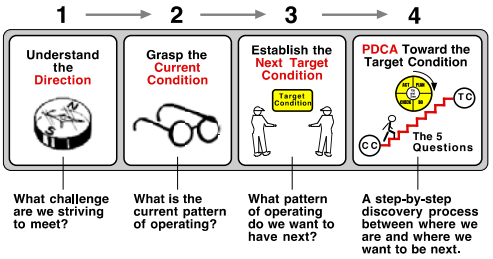


Figure 1: Mike Rother's Improvement Kata Sequence (Rother 2012)

The vision or direction is expressed in terms of conditions, as are the "Current Condition" and desired "Target Condition", rather than an output metric or target. "Conditions" are easily seen, imagined, understood, envisioned, and observed or evaluated. Daily striving to improve on a "current condition" and incrementally transforming it toward a next "target condition" is fundamental to Toyota's culture of continuous improvement and adaptiveness. *Understanding the difference between a target and a target condition is critical to understanding the Toyota Kata.*

The coaching kata is a routine in which a coachee is coached in the use of the improvement kata through daily striving and guided experimentation toward the achievement of one target condition after another. It ensures a consistent routine and a common sense of purpose in the pursuit of the production vision throughout Toyota.

CONDITIONS OF PRODUCTION; PROCESS AND ENVIRONMENT

Three of the authors attended Rother's *Toyota Kata* seminar and two-day "hands on" workshop in Michigan in late March of 2012. The manufacturing process that was evaluated within the workshop was a relatively stable, cyclical-repeating process with high value-added work effort. The physical condition of the production cells in which the work took place included custom designed production equipment, high quality lighting, material conveyors, and designated staging areas; all which seemed to be in stark contrast to the conditions of the production environment in which the average construction crew performs its work.

Conditions of the Production Environment within a Lean Manufacturing Environment

As we learned in the Michigan workshop, in order to adapt Toyota kata fundamentals to a construction project environment, one must first understand and appreciate the condition of the production environment in which it evolved and is currently flourishing. Within a Toyota facility product design engineers, industrial engineers, manufacturing equipment and production cell engineers, and shop floor supervisors all collaborate on the development of a production cell for a new product and the environment in which the work will take place. From the time the very first product is assembled, the specific and synchronized preparation of the production environment are conducive to relatively reliable and predictable production flow.

Thus, long before the minutia of manufacturing production "process conditions" are evaluated and methodically improved, the *conditions of the production environment* have been so well thought through and specifically prepared that improvement of the *conditions of the production process* is both appropriate and productive.

The authors believe the gap between the specificity of work area preparation within a lean manufacturing environment and that of construction is so profound it is underappreciated and often overlooked. We concluded this gap to be an obstacle to the application of the Toyota process improvement kata within a construction project environment and that assembly process improvement at the workface is initially inappropriate and likely unproductive until that gap is dramatically reduced.

Current Condition of the Production Environment within a Construction Project

The impact of the lack of specific work area preparation was first understood and fully appreciated, when during a fourteen month period in 2003-2004, two of the authors (Casten and Plattenberger) facilitated a study of the relationship between the estimated or current rates of production and the potential capacity of well over one hundred routine construction operations. The study discovered potential, and ultimately achieved, production rates to exceed estimated by a factor of 4.29 to 1. One of the most significant variables in the performance of the operations the extent

to which work areas were specifically and intentionally prepared and maintained as planned. Clearly the lack of specificity in the preparation and maintenance of the conditions of the production environment had a much more profound impact on the performance of the operation than could have been imagined prior to that study.

Today it is still quite common to observe the start of a well-planned field operation in which the required assembly inputs and the crew are there, willing and able. But, as they enter the work area the crew finds a crane of a different size and the lack of staging and fabrication areas of the size and location as planned. These "minor changes" instantly inject variability into the operation. The simple physics of the operation are suddenly radically different from the plan. The process and resource utilization chart instantly takes on a whole different structure. Non-value adding work goes up, value adding work goes down, daily production crashes while effort expended spikes; all due to increased material handling that exceeds anything that was anticipated. "Minor" changes in the conditions of the production environment are considered to be a normal part of construction. And adjusting to them is acceptable within the "Can Do" attitude at the crew level. (Ballard and Howell 1997)

Even after years of effort to balance and control workflow and implement many lean construction practices, we find work area conditions remain the most challenging constraints to stable and reliable construction operations and reliable workflow. In this environment the improvement of construction crew assembly processes through the use of an improvement kata will more likely be constrained by the *conditions of the production environment* than by the *conditions of the production process*.

Consequently we chose to first adapt Toyota Kata to initially focus on the improvement of the conditions of the project production environment and defer working on assembly process improvements until they were the greatest opportunity for improvement.

ADAPTING TOYOTA KATA TO A LEAN CONSTRUCTION PROJECT PRODUCTION SYSTEM

In *Toyota Kata*, Rother states:

> *"There are perhaps only three things we can and need to know with certainty:* ***where we are****,* ***where we want to be*** *and* ***by what means we should maneuver the unclear territory between here and there****. And the rest is supposed to be somewhat unclear because we cannot see into the future! (Bold face added by the authors.)*

From the beginning our desire was to adopt the most basic and powerful concepts of the Toyota Kata while adapting the pursuit of operational perfection to the unique challenges of a construction project environment. Therefore we have adopted an extremely challenging project production vision, an audit of the current condition and the daily routine of striving to achieve target conditions in the service of the production vision. We chose to start with a limited scope, the challenge of significantly improving the conditions of the production environment at the crew level. And, because of this focus on the *conditions of the project production environment* we decided to develop and experiment with a new kata; one specifically designed to create a *routine of achieving conformance* to production environment target conditions. We have called this kata the *conformance kata*.

By adding the *conformance kata*, adapting the *improvement kata* to accommodate the conditions and metrics of construction operations and employing the *coaching*

kata without any changes, we have developed an adaptation of Toyota Kata to provide the approach and means with which to incrementally close the gap between the current condition and the desired conditions of the production vision. We have called this combination of kata the *Construction Kata*. We believe practicing all three of these kata on a daily basis will significantly enhance the skills, mindset and culture critical to the daily pursuit of a production vision. However, this paper will report only on the application of the conformance kata and its use in incrementally improving the extent to which the requirements specific to a quality crew work assignment, a safe work area and a well prepared work area (the conditions of the production environment) are achieved.

A CONSTRUCTION PRODUCTION VISION

No one change in the Toyota Production System had a more dramatic impact on the overall manufacturing process than engineer Ohno's vision of continuous, single piece flow. In manufacturing single piece flow is achieved within a production cell made up of several work stations, each adding value as the product is moved from one work station to the next with no work in process between work stations. In construction, a parade of project crews, each completing a portion of a project, is fundamentally the same stream of value adding processes Ohno referred to as a value stream. Consequently nearly all of the lessons and concepts incorporated in Ohno's production model can be adapted as a project production vision we call *Daily Crew Production Flow* (DCPF), in which production flow is, ideally, the daily production output of one crew being passed on to their downstream "customer" crew the very next day or shift with no work in process between crews.
The vision statement of Daily Crew Production Flow is:

> ***"Every crew on every project effectively and efficiently completes their daily work assignment and specific production target free of incidents and defects while working within a safe, well prepared work area."***

As we began the Construction Kata experiment, Daily Crew Production Flow was adopted as the production vision of "where we want to be".

THE GAP BETWEEN THE PRODUCTION VISION AND CURRENT STATE

The pursuit of the production vision logically started by accurately and objectively understanding the prevailing current conditions relative to the quality of crew work assignments and work areas. Detailed audits of the conditions of the production environment and crew assignments were conducted and the results indicated work area conditions were randomly prepared, poorly managed and extremely variable and unpredictable throughout the life of the project operations studied. Crew assignment quality was no better. Most frustrating was that the operations studied were all within project environments that had long been attempting to employ the Last Planner® (Ballard 1994) concepts of "Should, Can, Will and Did". The audit indicated the condition of crew assignments and the production environment was a "target rich environment". With "Where we are now" well understood and the gap between the production vision and the current condition defined, the first three production environment challenges were agreed to: Strive to 1.) Provide crews with high quality

crew assignments, 2.) Provide crews with a safe (not safer or very safe, safe) work environment and 3.) Provide a high quality work area.

Defining the first target condition for each of these three challenges and designing, experimenting with and deploying a "conformance kata" remained.

QUALITY WORK ASSIGNMENTS AND WORK AREAS

Crosby described "Quality" as conformance to requirements (Crosby 1979). Ballard and Howell described quality crew work assignment requirements in 1997. (Ballard and Howell 1997) The authors developed an expanded list of *Daily Crew Assignment Requirements* (DCAR's) in conjunction with their early pursuit of Daily Crew Production Flow. Additionally *Minimum Workzone Requirements* (MWR's) have been developed over the past fifteen years that generically break the workarea of a construction operation into three distinct zones; those of *Preparation*, *Installation/Conversion* and *Completion*. Groups of required conditions for each zone provide a clear mental model of the conditions a work area must conform to if it is to be considered a "high quality" work area. The audit, referred to earlier, used these requirements (DCAR's and MWR's) as evaluation criteria and, because of the low level of conformance to them, the authors chose to start with target conditions that contained only the most basic requirements from these detailed lists of required conditions for both crew assignments and work areas.

SAFE WORK AREAS

UCI, the Wichita, KS construction organization that is the contractor partner in the experiment has enjoyed over two million manhours and eight years without a lost time accident. Recently UCI developed and has adopted a crew centered safety planning and behavioral regimen they call Task Specific Safety Planning (TSSP). TSSP entails the daily creation of a Task Specific Safety Plan by each crew. Each TSSP is built around and into a detailed operation production plan for the day's work. The initial target conditions for a *safe* work area were drawn from the UCI TSSP guidelines and requirements.

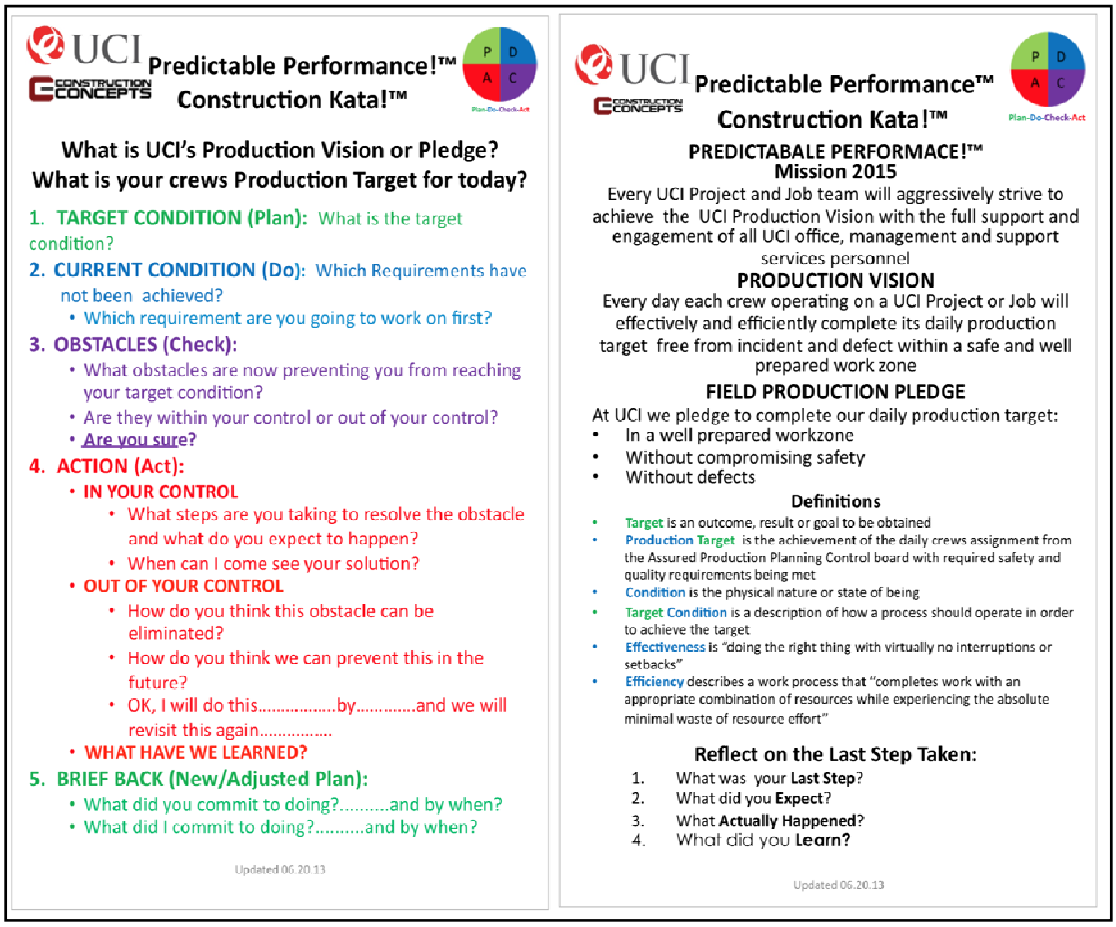
THE CONFORMANCE KATA AND THE FIVE QUESTIONS

Within the improvement kata described by Rother is a continuous process of assessing the current condition, establishing a target condition that clearly serves the production vision and then "PDCA-ing" through the encountered obstacles until the target condition is achieved. Through the use of five questions, the coach repeatedly leads the coachee through a conversation that ultimately results in a thorough understanding of the current condition of a process and a commitment to a series of experiments designed to incrementally achieve a target condition, all the while learning the improvement process. The five questions keep the entire routine contained, focused and consistent.

Achieving conformance to production environment target conditions is quite different from making changes in the conditions of an assembly process, enough so that we decided to experiment with a different protocol and a slightly different set of questions. The change in protocol was that the authors, rather than a crew supervisor and coach, determined the current conditions and established target conditions. We

chose to limit the questions in such a way as to create a daily conversation around current conditions at the workface each day, their relationship to the target conditions and the action required to conform to them

After some experimentation, a *Brief Back* was inserted into the questioning routine to ensure the conversation built around the conformance kata questions resulted in both upward and downward looking commitments. The front and back of the "*Five Questions + Brief Back*" shirt-pocket card for the conformance kata are shown below.



UCI CONSTRUCTION CONCEPTS

Predictable Performance!™
Construction Kata!™

P D A C Plan-Do-Check-Act

What is UCI's Production Vision or Pledge?
What is your crews Production Target for today?

1. **TARGET CONDITION (Plan):** What is the target condition?
2. **CURRENT CONDITION (Do):** Which Requirements have not been achieved?
   - Which requirement are you going to work on first?
3. **OBSTACLES (Check):**
   - What obstacles are now preventing you from reaching your target condition?
   - Are they within your control or out of your control?
   - Are you sure?
4. **ACTION (Act):**
   - **IN YOUR CONTROL**
     - What steps are you taking to resolve the obstacle and what do you expect to happen?
     - When can I come see your solution?
   - **OUT OF YOUR CONTROL**
     - How do you think this obstacle can be eliminated?
     - How do you think we can prevent this in the future?
     - OK, I will do this.....by.....and we will revisit this again.....
   - **WHAT HAVE WE LEARNED?**
5. **BRIEF BACK (New/Adjusted Plan):**
   - What did you commit to doing?.....and by when?
   - What did I commit to doing?.....and by when?

Updated 06.20.13

UCI CONSTRUCTION CONCEPTS

Predictable Performance™
Construction Kata!™

P D A C Plan-Do-Check-Act

PREDICTABALE PERFORMACE!™
Mission 2015

Every UCI Project and Job team will aggressively strive to achieve the UCI Production Vision with the full support and engagement of all UCI office, management and support services personnel

PRODUCTION VISION

Every day each crew operating on a UCI Project or Job will effectively and efficiently complete its daily production target free from incident and defect within a safe and well prepared work zone

FIELD PRODUCTION PLEDGE

At UCI we pledge to complete our daily production target:
- In a well prepared workzone
- Without compromising safety
- Without defects

Definitions

- **Target** is an outcome, result or goal to be obtained
- **Production Target** is the achievement of the daily crews assignment from the Assured Production Planning Control board with required safety and quality requirements being met
- **Condition** is the physical nature or state of being
- **Target Condition** is a description of how a process should operate in order to achieve the target
- **Effectiveness** is "doing the right thing with virtually no interruptions or setbacks"
- **Efficiency** describes a work process that "completes work with an appropriate combination of resources while experiencing the absolute minimal waste of resource effort"

Reflect on the Last Step Taken:

1. What was your **Last Step**?
2. What did you **Expect**?
3. What **Actually Happened**?
4. What did you **Learn**?

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Figure 2: Five Question + Brief Back Shirt Pocket Card

TARGET CONDITIONS

Over a period of nearly six months target conditions were defined for each of the three challenges. They have become known as "*LIFTOFF Target Conditions*". Because we know achieving conformance to these initial production environment target conditions will likely take a long time and be used as if starting all over early in the life of virtually every future project, we chose to put these initial target conditions on a laminated card of the same size as the *Five Questions +Brief Back* cards.

Due to the dynamic nature of construction operations, conformance to all the requirements within the three target conditions on the same day within an individual operation has proven to be challenging. However, the experiment with the *LIFTOFF Target Conditions* and the conformance kata has proven to be beneficial way beyond

all our initial expectations. We now know what many of the obstacles are to achieving these target conditions. Quoting Rother, "We now know what we need to do." and that is much more than we knew before we started. Additionally, acceptance at the crew level has been universal and we believe the enthusiasm the conformance kata has created will greatly enhance the improvement of the conditions of assembly processes. The "LIFTOFF Target Conditions are shown below.

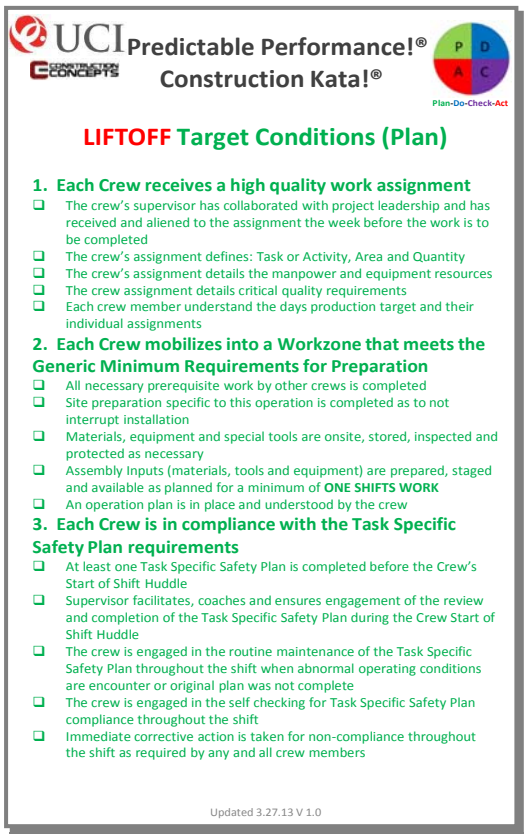

Figure 3: Liftoff Target Conditions

LEARNING TO DATE

In the *Toyota Kata* workshop Rother repeatedly referred to the "edge of knowledge" and that we really don't know what to expect as we attempt to push past it. The experiment with the adaptation, adoption and initial deployment of Construction Kata into a lean project production system has certainly enabled us to push past the edge of our knowledge. Each phase of the process has provided much learning and many more questions.

Adaptation started with the realization of just how crude our efforts have been in the past in terms of creating conditions within the production environment that are conducive to stable operations and reliable workflow. After years of working to ensure the completion of MakeCertain! Tasks prior to allowing an operation to pass through the "Can" filter, we realized we were not even close to being able to provide and maintain the conditions of a production environment conducive to reliable operations and predictable workflow. Worse, we realized how little was known about the production vision of Daily Crew Production Flow (which had been the production

vision for three years) and Minimum Workzone Requirements at the crew level. *Adoption* has required new concepts, vernacular and behaviour's. *Implementation*, however, is where the real learning has occurred. As simple as the concepts appear upon first reading the book, adapting and deploying Toyota Kata is no minor undertaking.

As best we can, we have limited "Learning to Date" to a minimum of items that we feel are most critical to a new adopter and prioritized them in order of importance.

- Implementation of Construction Kata is not delegable; that is, it must be led by senior leadership with their full support for and understanding of the concepts of the production vision, current conditions, target conditions, the kata themselves and the time it takes to get it up and running.
- If an organization has not done so, first order of business should be to align to an extremely challenging production vision defined in terms of conditions such as that of Toyota's and Daily Crew Production Flow. In fact, whether an organization chooses to incorporate Toyota Kata into their organization or not, we strongly suggest defining and aligning to such a vision.
- Take the time to thoroughly audit and understand the current conditions of both the production environment and production assembly processes. Only by first having both a production vision and solid understanding of the current conditions at the workface can an organization begin to define challenges and/or target conditions that are in the service of the vision.
- To our surprise, the use of target conditions and the conformance kata questions about them was welcomed at the workface as a way of standardizing expectations and creating conversations around conditions as opposed to pressure for and anxiety over vague performance goals. The kata provide structure to break down barriers to coaching and collaborative intervention and, ultimately, a standard way to think and converse throughout the organization.
- Three of the answers to the question, "What do we need to do?' are:
- Radically improve the process of "making work ready". It is currently, at best, random and extremely unreliable and, at worst, a myth.
- Concurrently increase the specificity of the conditions of the production environment while ensuring management of resources and space ensure these conditions are met prior to and throughout the operation life cycle.
- The conformance kata creates a whole new level of awareness and feedback (through continuous "go and see") as to the effectiveness of the can filter and upstream planning, preparation and assembly input supply systems. That leads to new, more serious and collaborative discussions as to what must be done and the commitments to do it. We now know we have serious work to do upstream of the can filter.
- A superintendent committing to a crew supervisor what he will do and when it will be done is clearly a new experience for most crew supervisors, and,

superintendents for that matter. Satisfaction of commitments made in both directions quickly gives credence to the whole kata concept.

- Here to fore, a Harry Potter-like Cloak of Invisibility seemed to shroud the work at the crew level. Candid conversations about it and suggestions for improving it were often difficult, frustrating or simply non-existent. The conformance kata clearly provides a positive way with which to remove that cloak and bring the supervisor and crew to the continuous improvement table in a new and refreshing way. We all believe the conversations and habits created by first using the conformance kata will create a very positive process improvement environment and culture.

FURTHER LEARNING REQUIRED

Because of the positive results and reception to date, we believe the use of the conformance kata can be expanded to requirements or commitments such as product quality, quality of meetings and the conditions of satisfaction between upstream supplier operations and downstream customer operations. While we are experimenting with both protocol and condition evaluation criteria, to date we have not made use of the improvement kata and have made limited use of the formal coaching kata in terms of anything but experimentation and use with early adopters. The improvement kata will likely have to be altered slightly to accommodate the unique nature of all those construction operations that do not employ a repeating, cyclical process. There is much left to learn, but we now know and appreciate both the "edge of our knowledge" and the means with which we will expand it; one target condition at a time.

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