Lean Energy Management: Suitability Matrix for estimating value of Lean Processes and Tools for reducing cycle time and costs in the Ultradeep Offshore Industry

By Roger Anderson and Albert Boulanger, Columbia University, Palisades, NY

The realization of major cost and cycle time savings in the ultradeep water requires the intersection of three major Lean Energy Processes discussed in Parts 1-5 of this series: Subsurface uncertainty must be merged with Lean engineering design and real options economic models to drive decision making. The value proposition for conversion to Lean Energy Management must be laid out, agreed to, and examples developed (from generic to specific) before such a major engineering transformation can occur in the offshore industry.

The automotive, shipbuilding, aerospace and military industries are already experts in Lean Engineering & Management. A common understanding of languages, tools, and processes is required to propagate their techniques to the ultradeep offshore industry. The challenges of reservoir uncertainties in the ultra deepwater cloud the industry's belief that similar cost and cycle time savings will come with the Lean tools and techniques. Suitability of importing Lean tools and processes into the appraisal, planning, construction, installation and operational phases of ultra deepwater development must be demonstrated before widespread acceptance will follow. Such system-wide, enterprise-wide improvements have not yet been demonstrated.

We have developed an analysis technique that can be used within individual companies to estimate those cycle-time and cost savings from conversion to Lean processes and tools. A generic "case history" is presented below to illustrate how our "Lean Suitability Matrices" can be used to establish the return-on-investment that would justify the risk associated with conversion of the ultradeep industry to a Lean Energy management paradigm.

Lean Principles

A key requisite is to fully describe how Lean Energy Management is able to perform more accurate design studies and eliminate waste in the fabrication, assembly, and operations of ultradeep offshore facilities. Lean processes shorten the time and cost of building any great structure by paradoxically maximizing the digital design time and preserving options for as late in the build process as possible. This dichotomy of shortening cycle time while providing more design time is a hallmark of the Lean Management process. The savings are brought about through software that allows conflicting issues to be worked in parallel and through the use of 3D Solid Models that contain the complete and accurate descriptions of all components of the entire project at all times throughout the history of the project. For example, Lean techniques point to an obvious need to provide flexibility to subsystems through modularity of design, while enhancing the concept definition and its cost, schedule and risk assessment accuracy. At the same time, uncertainty must be dealt with in each of these critical processes of the Lean enterprise.

How to go about the implementation of Lean Energy Management is the final step, and Toyota has paved the way. Toyota begins with a road mapping of existing processes so that a plan for migration from "unhealthy to healthy" processes can be developed (Figure 1, top). Boeing, GE Lockheed-Martin, and countless other great corporations throughout the world have adopted and modified their model. In fact, if GM, Ford and Chrysler can successfully convert to Lean, then surely the ultra deepwater industry can too.

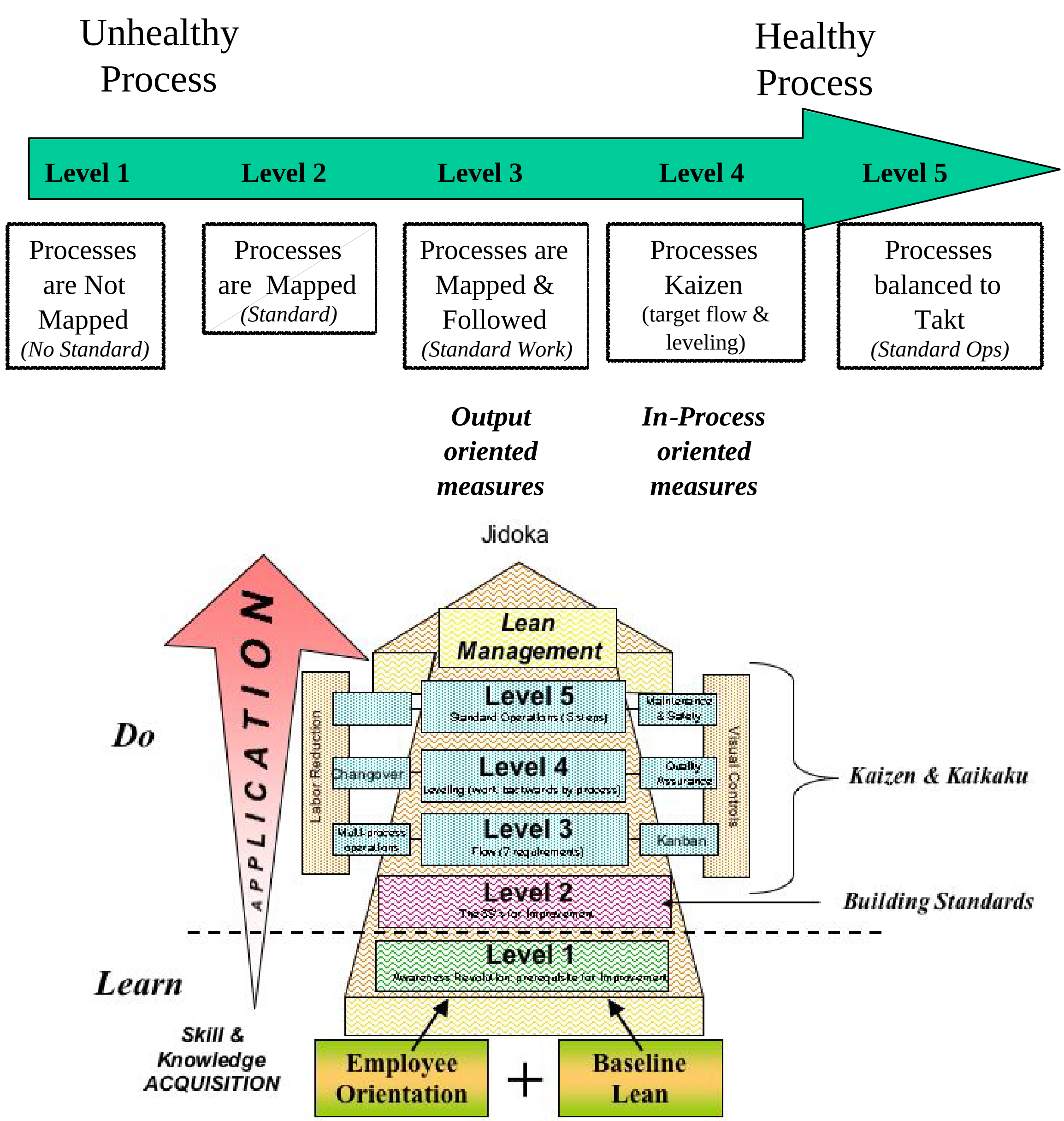

Figure 1. The Toyota institutional learning system.

Toyota has described how to manage the learning of Lean processes with their Jidoka strategy that defines 5 levels of growth (Figure 1, bottom). Level 1 requires the benchmarking of the existing manufacturing processes, whatever they are, to create a baseline to measure future progress. In addition, employees and subcontractors are all introduced to Lean process theory. They are challenged to stop measuring specific actions and instead think of each and every process in terms of the whole system they are producing. It is only the cumulative results of all those actions that results in a quality product. In Level 2, powerful software tools are put into place to build and enforce standards, identify and eliminate waste in materiel, machines, effort and methods. Level 3 tools escalate to the introduction of a common, 3D solid model for all to use to standardize and streamline work. Level 4 introduces a continuous improvement plan and level 5 finally achieves Lean Management. The level of software rigor increases steadily up this improvement ladder.

As with automotive and aerospace workers before, the ultradeep offshore industry will encounter a predictable set of reactions to these Lean Energy concepts, processes and tools:

1. You don't understand our business – ours is harder – the offshore is different
2. We don't need Lean, we just need to be quicker and cheaper in what we do now
3. We are already using Lean – we're doing that, and that, and that…..as each new Level is introduced
4. But only design/build will benefit from Lean processes, not HR, not finance, and certainly not operations…..

Lean Energy Management will take any company several years to fully implement – and the above reactions must be worked through. Examples of success become critical teaching tools to overcome the considerations of the risks involved in conversion. Honest awareness of previous "train wrecks," and a realization that technologies alone will not produce the step change improvements promised by Lean management are two human barriers to overcome. Fundamentally, Lean is a people-process, and "soft side" change is hard to achieve.

Ultradeep a Difficult Factory

In our discussions with decision makers from many companies, the most common reason offered for why Lean processes and techniques have not yet spread into the ultradeep offshore industry is that we face a much harder manufacturing environment than that found in "Traditional Lean Industries". The manufacturing process in deepwater "factories" involves fuzzy resolution of the assets that are being produced (the reservoir). Oil and gas are found miles underground with a mile or more of ocean on top of that. And perhaps the biggest differentiator offered is that, over time, the oil and gas reservoirs change drainage patterns in often unpredictable ways. Therefore, we must learn to design-in uncertainty over the life-cycle of the production process in order to fully exploit our reservoirs. This flexibility turns out to be one of the biggest strengths of Lean Energy Management, but our “show-me” industry must be convinced.

So how do we begin? Current offshore practices are slanted towards overbuilding of facilities for maximum production volumes and rates, and therefore, excess hardware is permanently installed on offshore platforms for the life of the field as a matter of routine practice. However, conversion to a “Lean Approach” requires “proof-of-success” in order to change this mindset. In Lean Energy Management, several solutions are simultaneously developed at the beginning of the design cycle (see Figure 3 for a Design Roadmap example). Each scenario is parametrically modeled so that they can be compared and changed as the design space evolves. The Lean systems engineering approach is to identify and assess the response of modular solutions to uncertainties all along the process.

Lean Suitability Matrix

As a general beginning point, we should concede that the offshore industry does not do a good job of understanding the linkages between surface performance and uncertainty within the subsurface reservoirs. Electronic schematics, 3D routing and installation layouts, systems engineering analyses, digital parts libraries, and virtual prototyping are all Lean techniques that are foreign to our industry. Transparent design shared with all relevant suppliers all the time by software is too. Consequently, we routinely have version mismatches, modifications that are incompatible with each other, and design conflicts that are solved during construction by the welding torch. Such are easily identified in the 3D solid model long before any construction occurs on a Lean project. And virtual prototyping extends to fabrication so that modular change-out is built into the structures from day-one. Reworking required from structural obstructions is eliminated. The assembly sequence itself, along with work instructions for the fabrication yard, are tested, optimized and distributed virtually. Besides deriving requirements as early in the process as possible, Lean maintains a logic trail of the consequences of any given modification on all other parts of the entire system. Below we show how to value the cycle-times and cost savings from these Lean benefits.