One of the recent discussion trends in Lean circles and possibly a more relevant question regarding continuous improvement is “what’s next?” Society has changed significantly; growing exponentially in technology/communication, new regional/national/international concerns, globalization, dynamic population demographics yet Lean has not fundamentally changed over the same period of time. To address “what’s next” we first need to determine if Lean is a culture, concept, methodology, system, the principles, or a set of tools. Lean is all of them, but for the purposes of this discussion Lean is the development of a culture with certain insight and behaviors (associated decision making) that promotes customer wellbeing. There are several key questions that may provide us insight into the possible paths that determine “what’s next?”

First, has Lean resulted in SUSTAINABLE results?

Lean intends long term achievement but studies have reported the inability to sustain results of Lean implementation. For example, Kurt Wooley, a former strategic program manager of Intel states that on an average 60% of Lean transformation efforts fail. Reasons for these findings can be listed as follows:
• Lean reputation in work force
• Inconsistency in Lean expertise and knowledge
• Inconsistency in implementation approaches
• Inability to project impact on personnel
• Inability to integrate cultural factors into design
• Inability to understand system reliability
• Inability to integrate into core business
• Inability to anticipate and plan issues
• Resistance by work force
• Resistance by middle management
• Ability to stop backsliding
• Lack of long term integrated management support to sustain changes

We believe that Lean implementation will be more successful if we can supplement it with explicit ability to:

Identify the right problem from a systems perspective,
Utilize the right strategy, principles and tools to solve the identified problem and
Sustain the solution.

We have developed a Lean based model known as the “DRIVES model”, that has helped us to define the framework to explicitly communicate the above three abilities. DRIVES is the acronym for Define, Recognize, Identify, Visualize, Execute and Sustain, which are the phases or steps of the methodology. The model provides an insight and overall approach to designing, modeling and implementing process improvement in sequenced set of steps that structure the thinking process for problem solving. In other words, is not a modification of Lean, it works together with Lean, but from a more structured and systemic perspective. The first four phases of the model (DRIV) focus on problem identification and problem definition, whereas the fifth and sixth steps (ES) refer to solving the problem and sustaining the solution.

The sustainability of the new system improvement is therefore achieved by a focused effort that can provide a substantial impact to the bottom line and in the environment, along with the consideration of designed reliability. In other words, a system that can perform its intended functions under specifically designed and improved environmental conditions for a specific timeframe, that create a real culture of continuous improvement and enhancement of the quality of life of the people involved.

Second, can Lean effectively address technology driven changes in manufacturing?

What will the automotive manufacturing and its supply chain look like in the in the next couple of decades? This is an important question in Tennessee as the automobile manufacturing and its supporting infrastructure represents a significant portion of Tennessee’s economy. Automotive manufacturing will be dramatically different in the future as the base assumptions are being challenged.

Advanced manufacturing is defined based on categorizing scheme of five key components: Information Technology, Novel Materials, Manufacturing Technology, Manufacturing Methodology and
Manufacturing Workforce Development. For example, the following are a few of the current trends that will impact the automobile industry:

- Policy changes, such as fuel efficiency requirements, affecting automobile design.
- New materials affecting manufacturing and the supply chain.
  - Safer, lighter, lower density material is going to be used in cars, such as carbon fiber, which will result in weight savings, consumption reduction, material recycling and increased safety.
- New technologies such as additive manufacturing will completely reshape the manner in which automobiles are manufactured and how production is managed.
- Changes in workforce demographics will require a new dimension to workforce management.
- Different alternative vehicle energy sources will impact the entire infrastructure and supply chain.
- Technology to track data and manage information will impact the manner in which inventories, transportation and logistics are managed.
  - IT techniques will be used more to track information more easily with regard to market and customers as well as improving the replenishment and inventory management, resulting in lower risk, better collaborating planning with suppliers and vendor and customers, better decision making and lesser human intervention.
  - Big data technologies and super computers are creating opportunities for cost reduction, accelerating sales and building a tested car inside a computer.
- Global competition and global suppliers will create a new level of complexity.

The idea is to understand the impact of these trends on Lean. For example, additive manufacturing has the ability to completely shift the future state of the automotive manufacturing where each “printer” can become a manufacturing cell.

Third, will Lean be able to provide a robust platform to address challenges such as those presented for by the National Academy of Engineering (NAE, 2008)?

It is essential for the future of lean to provide a robust platform to design Lean systems processes as we migrate from manufacturing to other domain areas. At a conceptual perspective, Lean applies, but from a tactical perspective, there has to be a level of adaptation.

For example, can hospital management and healthcare delivery be efficiently and effectively be improved by Lean? There is no argument that Lean philosophy and its concepts play an important role in decomposing and understanding healthcare processes. At a conceptual and philosophical level Lean is very relevant and explicitly addresses the design and improvement of healthcare processes/systems. However, at a more tactical level a more robust set of tools (including IE tools) are required to effectively design and improve healthcare processes. Decomposing healthcare processes into three categories as discrete, stochastic, and Bayesian processes highlights the limitation of Lean tools. Value Stream Mapping is very applicable to discrete processes, which are defined as repetitive processes with minimal variation in process times. An example of a discrete healthcare process is the preparation of surgical tools. However, Value Stream Mapping is not the most effective tool for analyzing systems that route entities in a probabilistic fashion through different parts of the system where process times vary significantly for each entity. An example of a Bayesian process is highlighted by the variability of how
patients are “processed” in the emergency room. Imagine a person who has come to the Emergency Room with a substantial pain in his abdominal area. The process of waiting and or determining how critical his condition is can only be based on the initial assessment performed by the nursing staff appointed at that moment. From here, the waiting time, subsequent examinations or procedures, treatment, dismissal, and any number of variables and decisions that happen in the hospital are big unknowns for what lean tools can support fractions of it to make the “flow” of the patient be the shortest possible to bring him back to a healthy condition.

For the development of a robust platform, Lean could look to inspiration from the visionaries at the National Academy of Engineering (NAE) who in 2008 compiled through experts in science, engineering and the general public, the challenges (Figure 1) that the engineering disciplines will have to address for a better future. It’s been a bit more than 6 years since the publication of these challenges, but still, they remain current for the topic of the needs that will shape the future.

**Figure 1: Adapted Engineering Challenges (www.engineeringchallenges.com)**

It is important to mention (and if you are not an Industrial Engineer or a Lean practitioner, you might have wondered already…) that the Grand Engineering Challenges are implicitly intended to be addressed by their own discipline among all engineering fields, but could this be a framework to help guide the discussions of “what’s next”, in the development of Lean by raising questions such as:

- How can better policies and their deployment support the development of cleaner energy?
- How can energy consumption be optimized for efficient living and working spaces?
- How can user interfaces be improved to enhance the quality and effect of training?
- How can we develop operational metrics and technologies that help reduce decision making to be able to react to unexpected situations and urgent needs?
- How can a better understanding of cultural dimension positively impact an organization?
- How can hospital management and healthcare delivery be improved?
Fourth, what are new possible developments in Lean?

Can (a long) learning curve be considered a type of waste? It can be implicit in other Lean wastes, but would there be a benefit of explicitly addressing it, given that Lean practitioners have frequently overlooked it.

An example of this waste can be found in training and education, as for how organizations and Lean practitioners can benefit from the development of improved learning and enhanced virtual environments to achieve more personalized, better and quicker results for the development of the multi-skilled workforce. Ultimately, based on Professor Yasuhiro Monden’s model of the Toyota Production System, the goal is to reach flexible management of the workforce, for the achievement of Shojinka.

Natural Interaction according to Dr. Alessandro Valli, a researcher at Oblong Industries, is “people naturally communicating through gestures, expressions, movements, and discovering the world by looking around and manipulating physical stuff” while interfacing with technology. The essence relies over the sensing technologies that allow closing the communication loop for interaction with devices (machines). Developments with this technology are achieved every day, and some applications are still a work in progress. However, we can see it applied to things we use in an everyday basis such as “smart” phones, where we can perform the function intended by the touch and motion of a finger, or the orientation of the device.

The University of Tennessee has been working in applying cutting edge interaction technologies that break down or weaken the barriers of the learning curve, and the communication that interoperates between people and machines, to form an innovative teaching and research environment that refreshes ergonomics theories and serves to increase productivity and reliability in industry. This in itself can be considered Lean, due to simplifying the manipulation of devices and machines, but that is not really the point here. The potential benefits that these technologies can offer for the field of continuous improvement are extensive, not only in the areas of manufacturing. Training in enhanced environments through natural interaction could be a substantially radical achievement for organizations that demand constant change (flexibility) for their associates.

These were just a few questions and examples that can be considered, but what are other opportunities? We invite you to help us discuss and convey how Lean can help to address these challenges by participating in the “Future of Lean” panel discussion that will be held in the ISERC 2015 in Nashville TN.

For further information please contact sawhney@utk.edu or emaciasd@utk.edu.