

Incorporating DFMA into Product Development Cycles in a Lean Business Environment

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Introduction

Every company producing products can utilize DFMA tools. While companies from small start-ups to giant corporations are investing heavily in driving Lean methodologies throughout their organizations, one of the most powerful tools to lead change and drive cost reductions is DFMA. The Lean methodologies and tools start out, within many companies, focused on manufacturing operations. While industries such as health care, government, and service organizations have realized the value of the Lean tools and methodologies, companies developing and producing products have not recognized DFMA as a Lean tool helping to lead them to greater profitability and shorter time to market. We can speculate as to why companies fight the implementation of such a powerful tool but we will instead focus on how to implement the use of DFMA into the daily functions in any size institution. If you understand the DFMA tool and philosophy, you can be the vessel of change that will become part of the daily operation of a company.

Understand your company and its Lean initiatives

Before attempting to implement dramatic change or trying to reason with management on the value of investing in DFMA training for employees, it's extremely important to understand the nuances of your particular company. Are you "doing Lean" or "on the Lean journey"? How much training and education have you personally been given within the company? What do you think Lean means to your company? Is Lean company-wide or manufacturing focused? If manufacturing only, why? Is DFMA part of your Lean discussions?

Why all of these questions? It is important to truly understand your organization, the people, the leadership, and how it functions, in order to establish a strategy of combining Lean and DFMA. Recognize that some people become too focused on the terms like Six Sigma, Lean, TQM, World Class Operations, ISO, rather than the performance of the business. Lean, when implemented properly, is a way of doing business. It becomes the DNA of the business because it creates an environment of continuous improvement where all employees participate in the success of the company. Companies that are truly Lean may not even use the term because of its negative connotation. When mismanaged, people perceive Lean to be a way to reduce the number of employees as opposed to the real meaning of becoming more and more efficient to handle business growth. How does your company portray Lean? It is important to take the time to reflect and understand what this means in your company in order to develop a strategy for DFMA integration that will be successful. Lean utilizes tools such as Kaizen and Value Stream Mapping to bring people together to solve problems and implement continuous improvement. Isn't DFMA a tool to bring people together to improve a product or process? So why then isn't DFMA a tool used in every "Lean" functioning company? Let's drill into the Lean methodology and tools in more detail to better understand how DFMA fits with Lean.

Lean Methodology

Simply stated, Lean is the elimination of waste in your business or life. The eight wastes have been defined as:

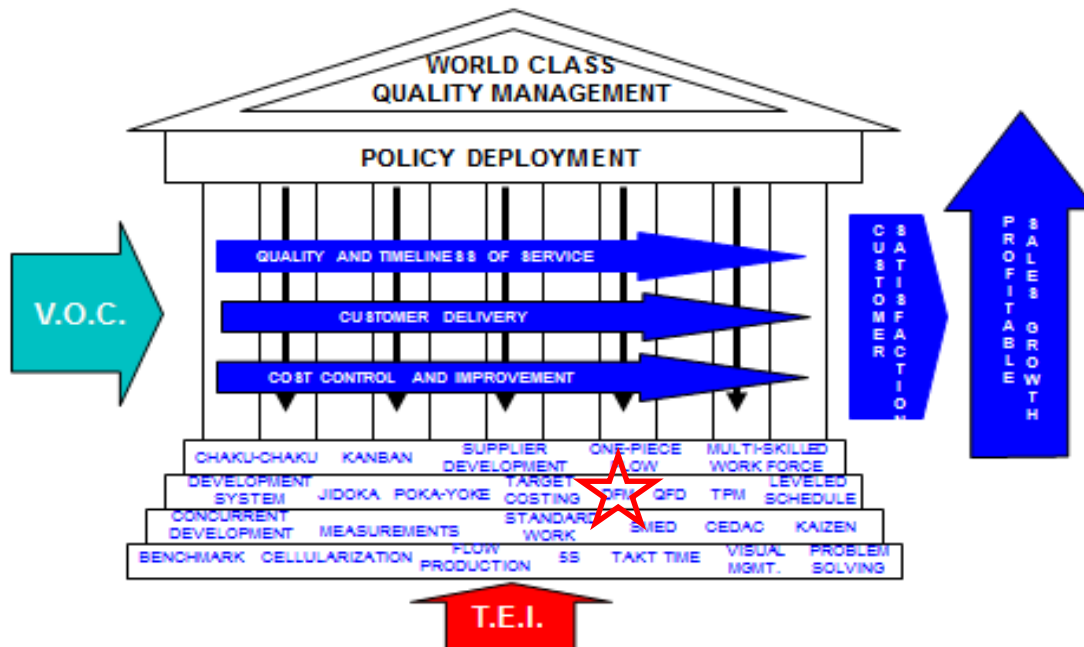
1. Overproduction
2. Inventory
3. Transportation
4. Excess motion
5. Waiting
6. Defects
7. Over-processing
8. Unused creativity

It is quite easy to define and discuss each of the eight wastes when focused on manufacturing operations because of the products and processes involved. So naturally, people will focus on manufacturing when implementing Lean to grab the easy wins. But Lean has slowly migrated into service organizations, health industries, and now government. Think about the leadership and change requirements to transform government operations to be more efficient. How do you convince people who may feel that the way things are is the way they should be and change is not required? Do you have people in your company who think like this? Do you have leadership in your company who may think this way? You have to step back and take stock of how your company functions to understand the role of DFMA in a Lean strategically lead company. And even though DFMA may be listed in the toolbox, is the company committed to using it properly? Think about how DFMA can impact each of the eight wastes, either in development or used during Kaizen.

For example, using DFMA to reduce part count will lead to short cycle times to build product which in turn allows a build-to-order business model to be developed thus eliminating production of product for the warehouse. This eliminates overproduction, reduces inventory, and minimizes transportation of material. With a better design using fewer parts and eliminating fasteners we create products that are built bottom up and snapped together. This will eliminate excess motion, waiting for information or material, and helps to mistake proof the process thus eliminating defects.

Let's take a look at the Danaher Business System, the foundation for what is now known as Lean. In the mid 1980's Danaher had a facility, Jake Brake, in Connecticut that was struggling. Competition was fierce and their performance on delivery and quality was not competitive with foreign suppliers moving into the market. They convinced a group known as Shingijitsu, former Toyota employees now consultants, to work with them on implementing changes within their business. The work became the Danaher Business System and it looks like this.

DANAHER BUSINESS SYSTEM



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The tools or the steps, along with TEI (Total Employee Involvement), make up the foundation of the system. Note that DFM is included as one of the tools. The importance of this is that DBS was developed in the late 1980's which made it relatively new since DFMA by Boothroyd & Dewhurst was an early 1980's product. We must also remember that the DanaHER Business System was developed from the Toyota Production System which is the model most Lean companies will refer to. What differentiates so many Lean companies from the DanaHER Business System is DanaHER's commitment to this model. Every acquisition is required to adopt the DBS in its entirety. Facilities are not allowed to randomly choose what tools they want to use, they are required to educate their employees in all of the tools to ensure the proper use of each. In contrast, Lean companies tend to focus on specific tools such as 5S, Cells and Kaizen and forego all of the other tools. It takes the proper leadership, commitment, and environment to duplicate the success that DanaHER has had. By far the most important tool in the DanaHER system is Policy Deployment. This is the strategic plan that gets established for every facility within their company and creates the framework for the tools that will be required to improve each business. They don't have "a Lean initiative" like so many companies today will say they have. They have a business model they follow that is their way of life. They drive continuous improvement through every department and require participation from all employees. How many of you have been on a Kaizen team addressing a process outside of your department? How many of you have witnessed an executive participating in a week long Kaizen event? Truly

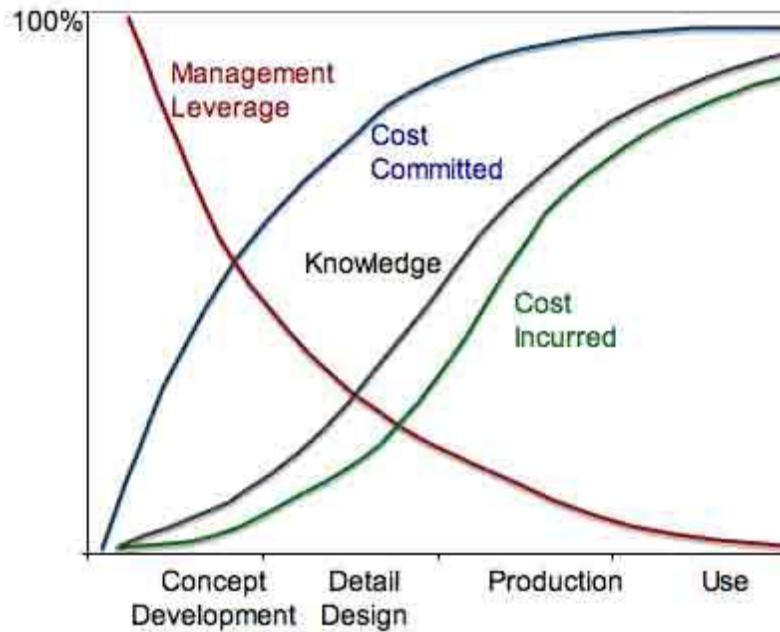
Lean companies require every employee, including all levels of management, to be in at least one Kaizen event every year.

Lean – What does it mean in your company?

Is your company “Lean” or striving for world class? Are the Lean terms used in your company as part of every conversation? Do the terms have a bad connotation to them because of the way they have been implemented? How long has your company been on its Lean journey and if you were to assess it, how has it progressed? Is Lean a manufacturing operations program only or is it a program that has spread through the business focused on improving all processes? These would be a few of the high level questions to ask when doing an assessment of your company’s Lean program. You must understand and be honest in evaluating how Lean is perceived. For some it is still being tested as the flavor of the month program while others are fully vested in building a great company through the development of a Lean organization.

Implementation in a small company

In 1997, Fire Control Instruments was a company looking to re-invent itself. It had a very successful line of fire alarm control systems designed to protect commercial, industrial, and institutional facilities throughout the US and Russia. It was privately owned, had approximately 120 employees operating in a 50,000 sq. ft. facility in Massachusetts. It had a traditional structure of R&D, Development Engineering, Quality, Sales, Marketing, Manufacturing, Manufacturing Engineering, Tech Support, Customer Services, HR, and Finance. As one may expect, the groups functioned very independently. The lack of a strategic plan and everyone working towards common goals were lacking. While the company was ISO certified, the focus was on manufacturing processes even though engineering was covered in the ISO standards. Continuous improvement was operations driven and extremely effective in creating substantial improvements in delivery, quality, safety and cost. As internal customers such as Sales and Customer Service came to realize the power of the programs that operations was implementing via their reduced work load chasing customer related issues, they too requested help in improving their processes. The one area that remained an island was Product Development. As those who have been involved with DFMA well know, most of product costs are captured or lost in the concept and design phases of product development. So, while delivery to customers of existing products rose to 100% on time and in full, new products continued to be released well past their initial due dates and typically over budget.



We recognized the value of DFMA but had not been able to convince management in R&D of the importance of using this tool to help speed time to market, reduce product costs, improve out-of-the-box quality, and even begin designing product for automated assembly. The focus was on deadlines and features, not costs associated with parts, material, or assembly. We had to find a way to change in order to remain competitive and survive. Smaller businesses were being purchased and consolidated throughout the industry. Technology was changing rapidly, competition was increasing and customers were more demanding with make to order configurable systems becoming the norm. While operations became more and more flexible, R&D remained traditional in its way of doing business. How do you convince someone there is a better way?

The key word here was convincing. We could not convince or sell someone on the idea that we had to work together to be successful and competitive in a new business environment. We recognized that we had to expose our employees to new tools and techniques so they could judge for themselves the effectiveness and value of the tools. DFMA has always been a tool in the toolbox of Lean but not many people had been exposed or educated in the science of DFMA. Remember, it was the mid 1990's and Boothroyd Dewhurst had only been around for a mere decade. At the time, this was not a program widely taught in engineering schools and it wasn't a highlighted element of the Toyota Production System that everyone was copying at the forefront of Lean methodologies. Since the Toyota Production System was mainly driven through manufacturing operations, DFMA was radical and unknown to many. So, when people are uneducated or have not been exposed to a technology, tool, or scientific method the

expected reaction is one of defensiveness. Fear of the unknown is extremely powerful and if not addressed it can be the downfall of many new creative and innovative programs or ideas.

Fortunately, we recognized this. We evaluated our organization, took the pulse so to speak, of our people and processes. We identified our strengths and weaknesses. Our ISO certification that we had obtained only three years earlier had been a success not only for establishing a solid structure that our business functioned on but it had established a common goal and objective for the entire organization. While Finance could have been exempt from certification, at FCI it wasn't. Every single department was involved. Every process was documented and by doing so we were able to identify gaps in our processes. One of the most critical and important processes that was missing in our organization was a formal New Product Introduction process. We did not have a documented process that we followed of identifying, developing, and releasing new products. Sales would identify a so-called need, R&D would develop a prototype to meet the understood need and Sales would reject it. This was the beginning of a vicious cycle. Without a formal process, Sales was able to change the requirements of the product as frequently as they wanted which in turn would impact the scope, duration and cost of product development. There were no records of the so-called customer requirements, no records of the changes required, no records of the changes made, simply stated there was no documentation within the front end of the business, the area that had the highest overhead and expenditure costs within the business. ISO structure helped identify these shortcomings and as such, we developed a New Product Introduction process with formal tollgate reviews and sign offs. This was the first step in establishing teamwork across every department and required involvement by management throughout the process. VOC, Voice of the Customer, was the starting point and put the proverbial stake in the ground. Sales & Marketing had to supply factual data on specifically what customers wanted in new or upgraded products.

While this is all background information leading to the use of DFMA in the company, one must note the importance of having structure and teamwork. This takes away much of the fear within the work environment and without fear, people are receptive to education and change. That became our next step. Knowledge in the value of the DFMA tool in a Lean environment and having new products in different phases of development put us in a position where the percent of successful implementation was much greater. The first step was to expose upper management, in this case the owner of the company, to DFMA. Fortunately, he was the driver for change and the lead behind Lean implementation at FCI. He was not familiar with the DFMA tool but with some explanation and more importantly a visit to an organization that was using DFMA in its development program was all that was needed to have backing for the expenditure required to educate our employees and invest in the tool.

Contacting Boothroyd Dewhurst, we were given an instructor who provided three days of on-site education. It is important to recognize that the proper set up of the class can lead to a greater success of implementing the program. By this I mean that properly pairing up employees to create cross-functional groups in the class is critical. If you allow employees to sit with whomever they choose, they will migrate directly to their comfort zones and pair up with people within their own department. This alone can lead to a failed program. Evaluating your employees by department, inter-personal skills, product knowledge, years with the company and other criteria, you can establish teams of creative employees with a penchant to learn and more importantly, apply the knowledge they receive. Cross pollination of ideas, skill sets, experience, knowledge is critical to the success of implementation so invest the time up front to select the right people for the initial class. Think of it the same way you would product development in that the time spent at the beginning of the process will reduce overall costs and ensure success later in the project. To fill the first class of 24, we involved the managers from Sales, Engineering, Quality, Manufacturing, Customer Service, Tech Support, and even Finance. Getting leadership involved was critical. We then focused on our Engineers (Development and Manufacturing), technicians, office, and shop employees to fill the rest of the class. Once again, these were employees selected because of their attitudes towards learning and applying their ideas, not afraid to speak up and share, had shown creativity through their idea suggestions for improving the business, and truly cared about the success of the company. These were people with leadership qualities, people we were confident would be pro-active with DFMA. Six teams of four were formed for the class and the commitment was made for these employees to be out of their regular jobs for three full days.

A Boothroyd & Dewhurst certified trainer was brought in to the facility for the class. We selected our own products to work on but we didn't want to focus on six different products. We chose to demonstrate how different people and thus different teams could generate novel and unique improvement ideas so we had two teams work on the same product. Also, if you are the driving force behind the implementation of DFMA, focus more on the people involved with the program rather than the DFMA material itself. Your people will make or break the success of implementation so observe the interactions of the participants, ensure they are all involved. Look for anyone who is not engaged and address it quickly. Was the team not listening to their ideas? Were they distracted by outside issues not related to the project? What was the root cause for anyone not being engaged? If you do not address it immediately, one negative response could undermine the entire implementation program.

In this case, the class was an overwhelming success. There wasn't a single negative comment or response to the training and the ideas that were generated were easily translated into action. More importantly, the attitude towards teamwork and communications was now extended throughout the organization. R&D was no longer an island speaking its own language and

marching to its own beat. It had become part of the organization. R&D was now on common ground with all other departments. Where Lean focused on Supply Chain external to manufacturing up to that point, it now became clear to everyone that internal customers exist. DFMA as a tool in the Lean toolbox became the lynch pin connecting Sales to Engineering to Manufacturing to the Customers. We made DFMA a reportable item in the New Product development cycle so all new products and product changes required a report out on the DFMA analysis conducted. This linked the voice of the customer with management's expectations closing the loop of communications

The results were unquestionable. Products scheduled to take three years were being completed in 6 to 9 months. Part counts were reduced minimizing supply chain management requirements and shop floor space. Fewer parts meant less labor and investment in low cost automation. Work centers were smaller allowing for increased output from the existing facility. 50% of the manufacturing work space was cleared out using the Lean tools and we moved into contract manufacturing with the excess capacity and space. The newest controller product design released using DFMA methodology and software created a snap together product produced in a 12' x 18' U-shaped work cell supported by a single manufacturing employee. We broke away from our stereotypical flat, unattractive, sheet metal door on the controller to a plastic, swirled and textured door that looked great in the foyer of any 5 star hotel. We replaced a traditional, high cost, rubber mat covered keypad with a tactile feel membrane keypad color coordinated with the control box making it aesthetically pleasing in any facility. DFMA was the tool to rally people around a common objective and release the innovation juices welled up inside, previously constrained by traditional business processes.

Implementation in a large, multi-facility company

No matter the size of a company, some will find it easier to make excuses why you can't do something rather than take on the challenge and see it through. Some may say that it is much easier to implement DFMA in a smaller company where things can get done quickly while large organizations are too bureaucratic. Smaller companies, in some cases, are harder because of the financial challenges and the closer relationships among employees. ROI may be more demanding in small or mid-size companies. You can still create change at any level if you take the time and have the commitment. If I've learned one thing about implementing DFMA DNA into a culture it is patience and perseverance.

In late 2013, we embarked on a mission to bring DFMA into Hayward Industries. Hayward has facilities throughout the world but the majority of their product development and manufacturing is conducted in the U.S. Within the United States, Hayward has four major plants with three of the four staffed for new product development. Hayward also has in place a new

product introduction process (HDLS) that is very similar to the traditional phase gate or toll gate review process.

Lean processes are being implemented and used in manufacturing operations. The concept of applying Lean outside of that area has been minimal. While the HDLS (Hayward Design for Lean Sigma) process has been in place and used sporadically, it was clear we had a foundation on which to build. The most important element of Lean is observation. Without taking the time to observe, one may speculate on the root cause of a problem and draw the wrong conclusions. Delving into the workings of Hayward RI and gathering an understanding of the workings within other Hayward facilities was critical to developing a successful implementation plan.

Let's summarize the consolidation of our observations leading into 2014. While DFMA was mentioned in the HDLS process documentation it was not being used by all facilities. The process consists of 5 phase gates and a unanimous agreement by the executive staff at the report out for a project to move forward. The elements of each step of the HDLS process had training material associated with it as part of the kick off for each Kaizen or 3P (conceptual or design "product preparedness process") event. The HDLS process had been developed in Hayward N.C. before HRI was purchased in 2007. In HRI there was no one to educate employees or facilitate critical elements of the process. Unlike Danaher and its business system, Hayward did not use its Lean methodology as a system that ensured every new acquisition functioned in a similar manner, or in Lean terms, they did not have standard work.

So, we have a formal, detailed and well documented process. We have intelligent, educated and willing employees. We happened to have a state training grant for education of personnel in programs of Lean. Lastly, we had a leader who had a basic knowledge of the value of DFMA who also, as head of manufacturing operations, inherited the new products that had been designed to deadlines not to manufacturability. Understanding the business, the environment, the people, the technology, we could now formulate a winning game plan. We recognized we needed to educate and win over executive level management to ensure that the support to move forward but more importantly, the support to ensure utilization of the DFMA tool would become standard work within Hayward.

Leveraging the HDLS process requirements, we focused on education of our executive management in the value of DFMA for both cost reduction of existing products and simplification in design of new products. Unlike FCI where we could engage the owner of the company directly, this was an environment where education would not be a classroom overview, sales pitch, or a visit to a user of DFMA. This had to be a one, 2 or 3 minute "heads up" discussions on the fly when we could corner them during a visit to the facility. Since these were the people who signed off at each phase gate in the HDLS process, we linked DFMA to this and brought to their attention the fact that DFMA was a tool in their process that we wanted to

expand upon. We created a few talking points associated with time to market and product costs, the two major elements nearly every new product development struggled with. We knew this was an area of frustration. Simply stated, we created a solution to their problem. We also had a game plan for education and implementation. In the course of only two months, we were able to get every executive to agree to move forward.

Our next step was developing the training plan. We focused on key personnel within three key U.S. facilities to attend the DFMA class. Working with management from each plant, we identified employees who we were confident would propagate the program in each of their facilities. We also made it a point to include personnel from non-engineering disciplines within the company. It involved selecting key product managers, customer service/tech support personnel, supply chain and finance. We wanted disciples of DFMA to come out of the initial program and demonstrate the value of the tool in their respective areas.

Because of the success in implementing DFMA in FCI, we followed a similar format. We created six teams of four for the class presented by Boothroyd Dewhurst. We picked five products and had two teams work on a similar product so during the report out, everyone would see the value in having diversity within the teams when promoting creativity and innovation. We communicated with all levels of management throughout the training and report outs. We required each employee to conduct a report out with their respective managers and facility leaders upon returning to their plants when the education was completed. We supported them in preparing and presenting their reports. There wasn't an option in reporting what they had learned. It was critical to the success of the program so while some were concerned with public speaking, we gave them everything we could to eliminate the fear, especially confidence and knowledge. This planted the seeds of the value of DFMA throughout the organization.

Within HRI, additional work was required because the organization lacked consistency in the use of the HDLS process. We instituted education prior to every 3P Kaizen event with a focus on Design for Lean Sigma, a combination of Lean tools, DFMA, and Six Sigma methodologies. This became our standard work, a consistent and repetitive message which gradually has exposed nearly the entire engineering, sales and manufacturing organizations to both the HDLS process expectations and the supporting tools. When analyzing the tools being used, the one that stood out was what is referred to as the 7 Ways. This particular tool was used in new product events as well as cost reduction/redesign value engineering events. We recognized the importance of leveraging a widely utilized tool as critical to the successful implementation of DFMA. 7 ways was the ideal tool as a lead in because we weren't stifling or slowing down the innovation and creativity. The 7 ways tool works by putting pen to paper to sketch as many ideas or solutions as can be conceived.

For example, in our NPD process we may be designing a new controller. The product will be made up of various electronic, electrical, software and mechanical elements within the system. Utilizing a traditional QFD (Quality Functional Deployment) or HOQ (House of Quality) we translate the VOC (Voice of Customer) into critical design criteria. From these criteria we partition the product design into subcomponents. We then focus on these subcomponents using the 7 ways tool. To address an enclosure, individuals would sketch out their ideas on large sheets of paper and hang them on the wall. The sketches would show various design ideas and the material that would be utilized. With the 7 ways tool we take the many concepts and using specific requirements and weights we narrow down the focus to the 3 or 4 best solutions. We then use the DFMA tool to run these ideas through the software to help answer questions regarding feasibility and cost. This reduces the lead time between generating ideas and developing product while ensuring the teams are making the best business decisions.

Rather than compete with existing tools, we saw the opportunity to utilize the existing Lean tools to enhance our processes with DFMA. It didn't require convincing or selling the value of the tool. We demonstrated and won over people associated with the process and developed an environment where management is looking for a DFMA report at the concept and development phases of each project. In parallel to new product development, employees who participated in the DFMA education began to independently focus on VA/VE (value add/value engineering) projects for their respective products. Successes have been recognized and celebrated as report outs have become a common form of communication.

This may be considered by some as a bottom up approach since upper management is just beginning to establish DFMA analysis as a required element of the HDLS process. The employees have embraced the tool and methodology and use it in their daily activities with management being the recipient of the successes as opposed to management requiring the use of DFMA as a Lean tool. Lean is about people taking ownership, solving problems, and being empowered to do the right thing. DFMA is the tool that takes these philosophies off of the shop floor and into the office. It is the tool that can be used to bring people together for a simple common goal, that is, to produce a highly reliable product through the reduction of components leading to simplified assembly and thus reduced costs with higher quality levels.

Analyzing your business

If you are already using DFMA in your company, take a look at how it is used and even more specifically, who is using it. Is it leadership driven and embraced by all employees or is it used in silos by individual personnel or groups? Does management know it exists and how valuable it is to the company? Not doing Lean? Then look at DFMA as a stand-alone tool and identify the leader who is willing to implement change, drive new ideas, is continuously working to make the company better. Educate them in the value of DFMA and leverage their standing within the

company to help you implement a successful program. Is your company doing Lean? Do you have a Lean leadership group or individual? Does the group or person appear open to new ideas or are they so regimented in doing Lean only one way that they stifle creativity? How is Lean being expanded, by leadership or by one department saddled with the responsibility but not the authority to ensure everyone is on board with the use of the tools? If you are a Lean company, utilize the people promoting it to embrace DFMA as an upstream Lean tool, one that will help connect development with manufacturing. It is extremely important to understand the people within the company who can help you and those that would just as soon spend their energy on ensuring your failure.

Be cognizant of the way your company handles the financial aspects of the business. What time frame do they look for in an ROI? Do you have a sustaining or value engineering group responsible for cost reduction? Are there measurable goals and objectives for improving product margins? Remember, Product Managers, Manufacturing and Supply Chain management may all have cost reduction goals that DFMA can help them with. If Lean, look to the company's Policy Deployment objectives. You can be a solution to their problems as a supplier of DFMA services.

Some other broad categorical things to think about are the culture within your company. Is yours a learning organization willing to accept new ideas or does it run on autopilot, doing things the way they have always been done? What is the attitude in the organization? Is it more of an us versus them environment with a win/lose measurement system or is it more of a rewarding system for ideas that stimulate continuous improvement? How about the leadership in the organization? Is it threatened by new ideas or receptive and empowering? Gaining the knowledge of the business will help you define what direction to take when bringing DFMA into your organization. If you are unfamiliar with Lean tools or methodologies and your company is a Lean leader, then make sure they realize that Lean is not just about manufacturing and be that leader who brings research and development into the Lean program using DFMA as the appropriate continuous improvement tool.

Finally, self-reflect and determine why you? Why do you want to drive change with DFMA? Are you looking for a pat on the back and accolades or is it because you believe in the tool and know it is the right thing to do in your company? I can almost guarantee, from experience, that you won't get the accolades you deserve but you will feel good about what you have accomplished. And if the organization is truly believes in Lean, then someone should see the value of your work and recognize your leadership qualities because Lean is all about people making things better through observation. So remember this little saying. To gain knowledge, one must study. To gain wisdom, one must observe. Take the time to watch and understand

your organization's workings. Observation is the Lean tool that will help you create the proper plan for a successful implementation.

Simplified:

Assess the need

Assess the willingness

Assess the environment