Unconventional Design for Lean Six Sigma (DfLSS) Program Design and Deployment

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Abstract

Many Design for Lean Six Sigma (DfLSS) deployments are typically structured similar to companies' deploy their Lean Six Sigma program. This paper outlines an unconventional Design for Lean Six Sigma deployment model used at Xerox Corporation to enhance the technology and product development organizations' effectiveness, efficiency and predictability. This custom deployment model was structured around a building block training structure, a flexible competency-based certification process and an integrated coaching. DfLSS program deployment results include high employee satisfaction, over 1000 product delivery professionals trained and significant product delivery success stories.

Introduction

I call this deployment "unconventional" because it did not follow other noted deployment "recipes." Xerox's DMAIC (Define, Measure, Analyze, Improve and Control) Lean Six Sigma deployment could be viewed as a standard recipe: some many Black Belts and Green Belt training, management support, dedicated infrastructure to support the deployment, etc. From most accounts, this recipe served Xerox well as we embarked on our Lean Six Sigma journey. However, as we examined our customers, the product delivery teams, and their needs we saw some shortfalls in the standard Lean Six Sigma deployment strategies. Our intent was to build on the positive aspects we saw and look for new ways to overcome some of the shortfalls as we deployed to this unique group of people.

Building Block Program Structure

Our initial goal was to enhance the overall product delivery capability by raising the competency level of Xerox personnel. This is graphically represented in Figure 1 [1]. Reviewing our initial capability, we realized we had a distribution of competencies or skills with a fairly significant population that did not necessarily meet the minimum competency levels we were looking for. The emphasis of the DfLSS initiative was to raise that population from below to above the minimum competency level so that the DfLSS practices, methods and tools became the way we worked. Through the DfLSS initiative, we would raise the average level of the product delivery community's competency level and narrow the overall distribution of skilled people.

One lesson learned from the Xerox DMAIC deployment was to have the Design for Lean Six Sigma Black Belt curriculum "build on" the Green Belt curriculum versus having two distinct programs. As we started the DfLSS curriculum design we were several years into the DMAIC deployment and started to observe individuals who had their Green Belt certification were becoming candidates for DMAIC Black Belts. As they entered the Black Belt program they found that a decent portion of the Black Belt content was the same as the Green Belt content. In fact, most, if not all of the Green Belt content was embedded in the Black Belt curriculum. After teaching the DMAIC Green Belts about the identification and elimination of waste, we turned around and taught them the same material over again. This became an issue for many of the Black Belt candidates as they saw the repeat of material they had already mastered as waste. Now, it's not to say the approach Xerox took was bad as we needed one percent of our population trained and operating as Black Belts for the program to succeed. To "prime the Black Belt pump" at the start of the Xerox Lean Six Sigma deployment, we needed to have separate DMAIC Green Belt and Black Belt programs. However, after several years in, we saw the overlap as a DfLSS element that needed to be changed.

By having the DfLSS Black Belt build on the Green Belt experience, you also enabled people to take the Black Belt classes and meet the requirements over a period of time. This was important given we did not want to give the perception that the DfLSS program was going to burden an already taxed operations and their engineers. By having the Black Belts become practicing Green Belt first, you also get a chance to see how the Green Belt has mastered the skills and competencies before committing them to the Black Belt program. After the success of the DfLSS Black Belt building on the Green Belt, the Xerox Corporate Lean Six Sigma Office is moving toward changing the DMAIC model to match the DfLSS building block structure.

As we started to build the Design for Lean Six Sigma program structure, we started with the graphical representation of the competency framework displayed in Figure 2 [1]. The framework was basically a graph of the number of tools and methods a belt candidate would be expected to master versus the depth of tools and methods knowledge demonstrated by that belt candidate. A starting DfLSS basic principle was that 100 percent of the

eligible product delivery professional population would be Green Belts. For Green Belts there would be a set number of tools and methods that they would have to master at a given depth. From a terminology perspective, we gave this group the title of practioner. As practioners, these candidates would be asked to competently perform a series of DfLSS practices and use related to methods on their own.

Using the same framework, we continued and defined the DfLSS Black Belt configuration. As one might expect, the Black Belt content included a greater number of tools and methods had to be mastered at an overall greater depth. Our initial outlook was that 25 percent of the product delivery professional population would ultimately attain the DfLSS Black Belt competency level when we reached steady state. We referred these Black Belts as Specialists or individuals who have command of the subject matter, can guide other practioners and can apply knowledge to complex problems. At the start, we did not have a very much discussion on the structure of the Master Black Belt curriculum. We were more interested in getting not only the Green Belt and Black Belt content established but also start working on other DfLSS disciplines such as Software and Inbound Marketing.

We also added one other competency definition: Subject Matter Expert or SME. We estimated this population at 1-2 percent of the eligible product delivery community. The SME's were individuals who may not be initially DfLSS belts, but have deep knowledge on a narrow set of DfLSS tools and methods. They typically would be called in on highly complex, cross organizational issues that required their in-depth skills. This SME designation also gave recognition for those internal resources that had attained such reputation and respect within the company. In many cases, these individuals have some fairly significant say in what is accepted and not accepted with the technical community. This designation helped break any perceived notion that the DfLSS program was going to replace their positions in their respective organizations and helped pull them into the discussions around what skills and requirements would be necessary for certification. By using this designation, we helped minimize what would have been a significant barrier to our deployment across each Division and the company.

DfLSS Program Content Framework

To build a new competency-based Design for Lean Six Sigma program model, we needed content and methodology that would support certification. The starting point for this content framework was a cross organizational team that was working independently within Xerox on defining Systems Engineering best practices. The team had worked for over a year to identify and converge on a set of recognized System Engineering practices. This was done by benchmarking various companies and universities as well as industrial associations such as International Council on Systems Engineering (INCOSE). Through their work, the team converged on thirteen System Engineering best practices listed in Table 1.

We generally liked the System Engineering framework as it included all aspects of the product development and delivery from start to finish. That was important as not every Xerox engineer was doing the exact same job function nor was every new product program at the same point in the product delivery process at any given time. By keeping at the System Engineering level, we found almost every electromechanical-based product delivery professional could find an appropriate link between a significant portion of the best practices and their current job responsibilities.

DfLSS Certification Process

Armed with the full set of DfLSS best practices we still did not have an elegant way of implementing the DfLSS certification process. Many other Lean Six Sigma certification requirements include completion of a series of one or more projects. We started at that point, but quickly realized that this model would actually hurt adoption of the DfLSS principles, not support it. This was predominately due to the fact that Xerox product delivery time was typically measured in years, not months or weeks like other DMAIC projects. We felt that no organization or individual could sustain that level of enthusiasm or momentum for the several years necessary to launch a new product. Therefore, we needed to develop a different model.

After a great deal of brainstorming and a little luck, we identified and converged on a certification structure that supported our competency-based model. We took the Systems Engineering best practices discussed earlier and put them down the left hand column and across the top, added five proficiency levels. This skills rating scale had been used extensively by Xerox in the past and was based on a five level of proficiency scale with "1" being awareness, "3" being a practioner and "5" being a subject matter expert or master. Awareness (level 1) was basically what one would expect from entry level of performance with the ability to just describe basic principles and benefits. The practioner level (level 3) was defined as the ability to competently perform, on one's own a particular skill or set of skills. Finally, the subject matter expert or master (level 5) has expert command of set of methods and tools, coaches other candidates on the

job and teaches classes on their area of mastery. They also can synthesize, analyze and solve complex problems in new situations. The even numbered proficiency levels were defined basically as half way between the above mentioned levels.

With the this basic matrix in hand (competencies listed down the page and competency levels across the top), we envisioned that each cell made up from the intersection of a best practice area and competency level could have a written definition of what was required to be at the level (from awareness to master). We divided each of the best practice rows to team members who had the responsibility to draft a set of competency definitions. Through a series of meetings, we plowed through each set of competency definitions until resident Subject Matter Experts and team members agreed on each cell's description. With an agreed upon set of operational definitions for each best practice area and each level of competency, we had to set up some overarching certification principles. We agreed that all level one (awareness) and two (candidate) levels of competency could be met through "teachbacks." In this context, a teachback refers to the belt candidate teaching back or explain to their coach in their own words what the skill or methods is, how it's used and how it would apply in the belt's work environment. For competency levels three (practioner) and above, hard evidence of applying the tool into their work environment would be required. Since we already realized that full blown DfLSS projects didn't make sense for Xerox when we were starting out, we converged on the use of "studies." For the purposes of this DfLSS certification, a study is an application of a tool or method in a product delivery professional's work environment. Conducting a scouting Design of Experiment (DoE), a Measurement System Analysis (MSA) or exercising other DfLSS tools within their respective best practice area would be considered a study. This concept was critical as it enabled the desired demonstration of skills within a belt's work environment that they could get certification credit for without having candidates wait until the entire product is launched. Unlike many DMAIC projects, DfLSS studies were not specially assigned special tasks or projects to be completed for certification. For the DfLSS certification, the belt candidates were expected to take DfLSS tools and apply them to their normal, day to day assignments or objectives. Again, we were striving to get engineers and others to apply these techniques to the way they worked and not having it perceived as "something extra to do."

With the certification framework in hand, the next step was to set what collection of best practices and levels of competencies would be required for both DfLSS Green and Black Belts certification. Given we started with Electromechanical curriculum, we began to look at what type of product delivery professionals would fall into this category. In a company like Xerox, the product delivery professional jobs ranged from the research chemist working on innovation breakthroughs to a manufacturing engineer working on the factory floor and everything in between. As mentioned before Xerox product delivery times were relatively long. This meant that an engineer in the later phases of a new product development cycle would not have the opportunity to demonstrate tools such as QFD that are typically applied early in the product development cycle. The one item that we all quickly agreed to was that a practioner level of competency (level 3) for Design of Experiment (DoE) was a minimum requirement all Green Belt candidates as it was the heart and soul of developing transfer functions, the cornerstone of DfLSS. To round out the required level 3 requirements for certification, we decided that each candidate could choose two other best practice areas for the required practioner-level performance that were consistent with their job function and where they were on their product program delivery. This certification flexibility helped ensure each job function, independent of where they were in the product design cycle, could find at least two other areas to physically demonstrate competency in a reasonable timeframe. Each Green Belt candidate also needed to demonstrate their mastery of the important analytical DfLSS software tools as well as how the Xerox DfLSS burning platform impacted their job functions. For all other best practice areas not evaluated at level 3 or above, the candidate needed to meet at least level 2 (which we defined as could do with help) and demonstrate their knowledge through teachbacks. This was required to ensure each candidate had internalized the entire set of DfLSS competencies and skills.

To help support the Green Belts candidates after training sessions and to validate the completion of the best practice areas, we instituted pushed based coaching. Here, we gave each Green Belt candidate initially eight coaching sessions scheduled roughly 4-6 weeks apart. These would be the only coaching and validation sessions offered to each candidate, so we stressed to them that their competencies needed to be validated in the allotted times and within the allotted number of coaching sessions. Each candidate would get roughly 1 hour of face to face time with a highly skilled coach. The timing between each coaching session was done for several reasons. One was to ensure there was enough time between coaching sessions to ensure work could get done between them such as setting up and running a DoE. Second, we wanted to ensure that each belt candidate had regular spaced engagements with a DfLSS professional over an extended period of time. This would help reinforce the new tools, techniques and methods by having multiple and regular cycles of learning. The more cycles of learning, the greater the probability of making DfLSS stick. In the end, we felt this was a critical enabler for a

sustained deployment. For coaching, we utilized our consulting partner's Master Black Belts. This was due to that we did not want to burden operations by having them take the significant time to coach and that Xerox was better off using their own DfLSS trained resources to drive new innovative products. There was at least one positive unintended consequence of using the partner's Master Black Belts. By having the partner Master Black Belts coaching waves of belt candidates, it accelerated their knowledge of the xerographic process, key products that Xerox was either developing or improving and most importantly, picking up the Xerox language, terminology and acronyms. This helped the coaches bring Xerox-specific terminology and examples back to training which helped the short term acceptance of the training and long term "stickiness" of the entire program.

Finalizing DfLSS Training Content

With the general training structure, certification process and coaching in place, we looked to finalize the actual training content. We went through a disciplined partner selection process and chose to work with Air Academy Associates. We liked their KISS (Keep It Simple Statistically) approach, overall enthusiastic and passionate leaders, instructors and coaches as well as their use of SigmaZone's statistical tools package. As we reviewed the Air Academy standard DfLSS content we found it fit well within our developed best practice, competency-based training and certification processes. Together, they were the best fit for the Xerox product delivery culture.

The standard Air Academy Associate's DfLSS offering included two weeks of instructor led training which we used for our DfLSS Green Belt initiative. The first week called Fundamentals gave belt candidates an introduction to probability, Measurement Systems Analysis and a significant amount of Design of Experiment (DoE) content. It also included exercising the suite of statistics and DoE software. The only elements that we added to Air Academy's Fundamentals content were a DMAIC-based on-line training prerequisite, a one day DMAIC and Lean overview and the Xerox DfLSS burning platform. The addition of the DMAIC on-line training and overview day were based on the fact that evaluation of our product delivery professionals found that only 30% of their time could be considered Customer Value Added [2]. Customer Value Added activities are those essential for delivering a product or service that the customer values and would pay for. Though one might look at DfLSS as a way to optimize the Customer Value Added portion of a product delivery professional's time, DMAIC training was intended to focus on eliminating or minimizing the non-value added portions. The on-line training was the same training taken by DMAIC Green Belt candidates and was a prerequisite for DfLSS structured classroom training. We liked the on-line delivery methodology as it gave belt candidates the opportunity to absorb the content at their own pace and ensured that everyone got consistent messages. It took roughly two to three cumulative days to complete the on-line DMAIC training. The one day DMAIC training was intended to remind the candidates of the DMAIC lessons they learned on line, give them some incremental lean training and submerse them into a simulation where they could immediately apply what they had learned. The Xerox DfLSS burning platform was developed to help identify the critical need to change by making the connection between Xerox's overall financial performance, product delivery performance and why Xerox was committing to the DfLSS initiative.

Week two of the DfLSS Green Belt training relied heavily on the standard Air Academy Capstone content and simulation. It basically followed the IDOV (Identify, Design, Optimize and Validate) roadmap, focusing on Voice of the Customer and building on the use of Design of Experiments to establish low fidelity models that could be optimized with various techniques such as Monte Carlo analysis. The only additions we made were adding about an hour or so worth of high level content on reliability (reliability overview, Accelerated Life Testing, Highly Accelerated Life Testing, etc.) and reference material on Xerox's Critical Parameter Management and high fidelity modeling.

DfLSS Results

Since the launch of the DfLSS Green Belt program in early 2005, Xerox has trained over 1000 product delivery professionals. To assess how the belt candidates felt about the overall training experience, we developed and maintained a four page belt candidate evaluation and feedback survey. We asked questions about the overall effectiveness of the training as well as the effectiveness of the instructor, printed materials, hands-on exercises and printed materials just to name a few. Looking at the belt candidate feedback, it was clear that they liked the DfLSS training giving it very high marks for the program, training and instructors. Written comments confirmed that the belt candidates were impressed with the training's applicability to their jobs and that the Air Academy instructors were able to effectively connect with and transfer knowledge to the students in the class room.

Given the proprietary nature of the products that Xerox develops and delivers, it's difficult to get into specifics associated with projects and/or studies conducted with the DfLSS trained belts. In general, the belts and belt candidates who applied the DfLSS tools, methods and principles found their design solutions were

more robust against noises, completed in a fraction of the time as compared with past designs with similar complexity and they felt confident that the designs or technologies would work right the first time. Right from the beginning of the DfLSS deployment, technical problems that had been lingering for years were solved in a matter of months. This helped gain important credibility with skeptical management and other personnel. Quincy Allen, President of Xerox's Production Systems Group and who was DfLSS Green Belt trained, indicated that the previous design and development work process for a new product could take up to 18 months, however "using the DfLSS approach we did it in five months." [3]. He went on to say that "the product worked exactly the way we thought it would work and at the level of defects we thought it would have." When asked about the translating that product delivery success into impacting the Xerox bottom line financials, Mr. Allen indicated "I spend the same number of engineering dollars and get twice what I did before."

Through the successful deployment of Xerox DfLSS we were able to make significant strides in improving not only the effectiveness and efficiency of our product delivery, but also become more predictable in the delivery.

References

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2. Norman Fowler, *Best Practices in Blended Learning: Xerox Design for Lean Six Sigma Development and Lessons Learned*, MoreSteam Users Conference (2006)
3. E. Schmidt, *Duplicating Success: Xerox Reinventing Itself*, iSixSigma Magazine, **2-5**, 21-28, (2006).

Table 1. DfLSS best practice competencies.

1.	Project Management
2.	Voice of the Customer Gathering and Product Requirements Generation
3.	Concept Generation and Selection
4.	System Design
5.	Requirements Engineering
6.	Statistical Tool Box
7.	Analytical Modeling & Simulation
8.	Design of Experiments for Empirical Modeling and Simulation
9.	Robust Design and Optimization Methods
10.	Tolerancing and Specifications
11.	Reliability Methods
12.	Design and Process Capability
13.	"Design for X" (e.g. service, regulatory, release management, reuse, manufacturing, etc.)

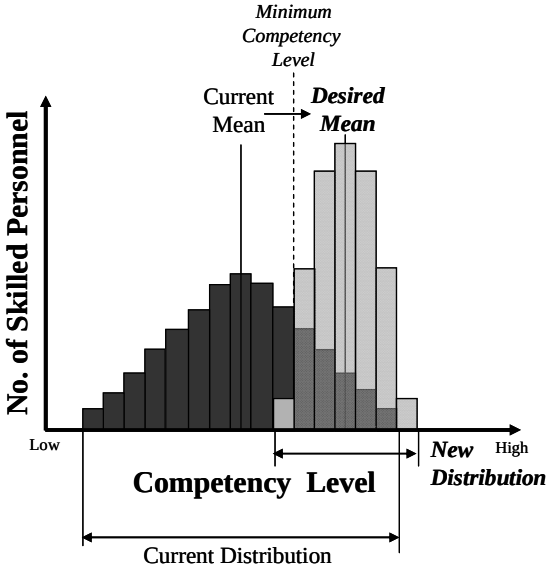

Figure 1. Skilled personnel versus competency level [1].

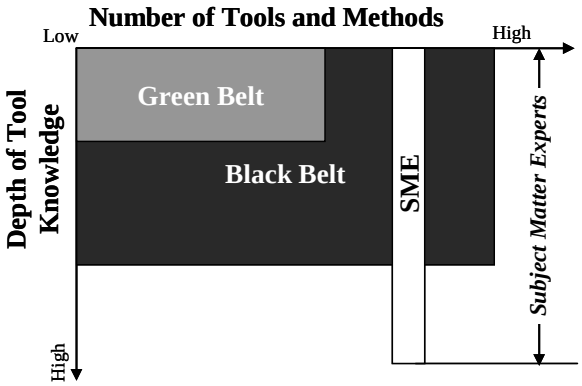

Figure 2. Representation of DfLSS belt programs [2].

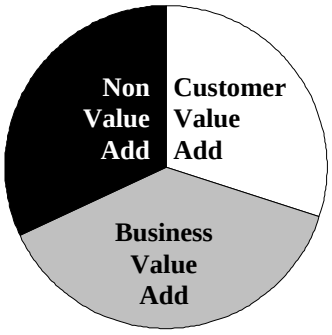

Figure 3. Breakdown of Product Engineers' Time [2].

Key Words: Lean, Six Sigma, Design for Lean Six Sigma,
DfLSS, DMAIC