Integrating LDP Lean Document Production® solution within the DMEDI Methodology

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Abstract: This paper presents a Xerox case study that demonstrates the use of Xerox’s LDP Lean Document Production® solution within the DMEDI (Define, Measure, Explore, Develop and Implement) framework for designing and optimizing print shops. The DMEDI process that was utilized for new print shop design is described using 18-steps. Various tools that are utilized at each step of the process are highlighted to demonstrate the effectiveness of this approach.

Keywords: DMEDI, print shops, optimization, lean, six sigma, quality, productivity

1.0 Introduction

Large enterprises often outsource their in-house print shops to third party vendors to achieve cost savings and improved service. Vendors such as Xerox Corporation, Pitney Bowes, Williams Lea, Hewlett Packard and Ricoh are among the prominent competitors in this outsourcing business. These outsourcing contracts are multi-year contracts typically ranging from 3-5 years. Under terms of the outsourcing contract, the service provider takes over the in-house print shop and delivers printed products to enterprise clients as per pre-negotiated service levels and cost structures.

The key benefits that the outsourcing vendors bring to the enterprise include lower cost, improved service levels and innovation in print services. To be competitive in the print outsourcing business, the vendors have to develop solutions and services to manage these print shops very efficiently and at the highest levels of productivity. This is critical to retaining existing business at the time of contract renewal, securing new outsourcing contracts as well as operating current service contracts profitably.

In this paper, we will describe how a novel solution developed by Xerox called LDP Lean Document Production® (Rai et al. 2009) was integrated within the DMEDI (Define, Measure, Explore, Develop and Implement) process design framework (Brew, 2005). This was utilized by Lean Six Sigma (George, 2002) black belts for developing efficient and competitive print shop designs that helped Xerox Corporation renew several print shop outsourcing service contracts and win additional new business.

While the focus of this paper is on the printing industry, we believe that the ideas and solutions described in this paper can also be extended to other industries that are facing similar issues.
Workflow in Print Shop Environments

Print shops can be classified into three categories based on the activity that they perform—transaction printing, on-demand publishing, or a combination of both. A transaction-printing environment produces documents such as checks, invoices, etc. Each document set is different. Mail metering and delivery are part of the workflow. On-demand publishing environments focus on producing several copies of identical documents with more finishing options such as cutting, punching and binding. Examples of such products include books, sales brochures and manuals. Other environments perform both types of document production simultaneously with varying emphasis on each one. LDP Solutions encompass all three print shop domains.

The document production steps associated with print jobs are indicated in Figure 1. Typically print shops have departments that support individual steps of this workflow. Each department supports many different types of internal workflows. Print jobs are differentiated by the printing technology involved; offset print jobs and digital print jobs. The offset jobs utilize lithographic presses for printing whereas digital jobs utilize digital printing equipment. These two classes of print jobs are characterized by significantly different workflows.

**Figure 1:** A print production workflow showing the various production operations – (Work-in-progress is denoted by WIP)
Typically each of the six steps in the print production workflow is associated with a department:

*Customer service and production planning department* works with the print shop customers to handle incoming requests, negotiate price and due dates, provide tracking and notification. It also works with production department to plan and schedule delivery.

*Graphics design department* designs the content of the document.

*Pre-press department* performs tasks such as inspection of incoming print jobs, editing jobs for color quality and accuracy, creating proofs and working with the customer service and printing departments to coordinate production.

*Printing department* prints the document. For offset printing, these activities include preparing the offset plates, performing setups on the offset (lithographic) presses, loading paper and ink, performing runtime color corrections, offloading printed material and transporting it to the finishing department. For digital printing, the input to printers is an electronic print stream and the output consists of printed documents. Digital printing is used for short-run-length jobs and when the variable content is high. Digital printing technology is characterized by low setup, simple interfaces and small equipment size.

*Finishing department* takes as input printed material and performs a variety of finishing operations such as folding, cutting, saddle-stitching, binding and packaging.

*Mailing department* packs and labels the finished goods and ships them to customers.

Offset printing is the dominant printing technology used today (US Census Bureau, 2008). More than 98% of print production revenue is associated with offset and offset-like technology. Nevertheless, customer demand for more personalized documents, quicker turnaround time, lower overhead and set-up costs, and geographically distributed printing has led to the migration of offset workflows to on-demand digital printing workflows for monochrome printing. As color digital systems that produce print quality equivalent to or better than offset print quality at competitive costs are developed, the same migration is expected to occur for color documents. For the foreseeable future both of these workflows are expected to co-exist within the printing industry. Therefore any design and operations methodology for print production has to comprehend both workflows independently as well as when they co-exist.

**LDP Lean Document Production®**

The Xerox LDP Lean Document Production® is a simulation-based print production operational framework that utilizes the notion of autonomous cells and a hierarchical dynamic scheduling architecture to route and process jobs (as shown in Figure 1). The key idea is to identify job types that have common overlapping workflows and/or dynamic flow characteristics and dedicate equipment and personnel clusters to process these classes of jobs from start to finish in their entirety within the clusters. For example, in cases of high product workflow variety, cells are designed for a limited number of self-contained manufacturing workflows within individual cells. On the other hand, when job size variability is very high, cells are optimized to handle small jobs that are below a certain-threshold and another different set of cells to handle larger job sizes. The latter group is further segmented into multiple streams based on a combination of job size and setup characteristics and then dedicating autonomous cells to process these different streams. A hierarchical scheduling policy directs the incoming jobs to the appropriate cell while attempting to load balance the workload across cells. Dynamic release control, dispatching and batch-splitting policies validated through discrete-event simulation models.
process jobs queued at the interface to each autonomous cell. The personnel within each cell are cross-trained to work on all stations within the cell. Efficient communication, product focus and WIP control within the autonomous cell leads to quick defect detection that is fixed as it occurs thus leading to significantly reduced error rates and improved quality.

![Figure 1: A schematic showing the LDP tools and the production solution with autonomous cells and hierarchical scheduling policy](image)

This methodology has been described in some detail in a previous paper (Rai et al. 2008) to which we refer the reader for details. The solution is presently protected by 64 patent filings (with 14 patents granted).

**DMEDI Methodology**

The DMEDI methodology deals with new product, service or process creation (Brew, 2005). The first two steps of this methodology are the same as for DMAIC (George, 2002) but the other three phases are different. Several tools are utilized within the DMEDI methodology. In this paper we will demonstrate how LDP was integrated within the DMEDI methodology and utilized for new print shop design by Xerox black belts.

Figure 2 describes the DMEDI process broken down into 18 steps and the various tools and activities associated with each step for new print shop design.

**New Print Shop Design using DMEDI and LDP Lean Document Production® toolkit**

In the remainder of this paper, we will take each step discussed in Figure 2 and discuss it in further detail within the context of its applicability to the design of efficient print shops using the LDP Lean Document Production® toolkit. The discussion is in the form of a case study using specific data from a typical print shop.

1.1 Define - Project Charter Defined

The print shop services contract are vulnerable at time of renewal to competitive bids. Xerox needs to demonstrate its ability to be the best service provider to ensure that customer renews its services contract and does not include the service contract in an RFP (Request for Proposal) to other vendors. The goal is to design a new process within 3-6 months that will meet or exceed customer service level agreements of 95% on-time performance and accuracy and maximize profitability for Xerox. The critical problem from a customer’s standpoint is the ability of the print shop to meet on-time performance as measured by the job lateness metric.

1.2 Define – SIPOC

In this step, a SIPOC of the print shop service process is created.
## Integrating LDP Lean Document Production solution within the DMEDI methodology

<table>
<thead>
<tr>
<th>Steps</th>
<th>DMEDI</th>
<th>Description</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Define</td>
<td>Project charter defined</td>
<td>To ensure the goals align with corporate &amp; group goals</td>
</tr>
<tr>
<td>2</td>
<td>Define</td>
<td>SIPOC</td>
<td>To understand customer and supplier inputs and outputs</td>
</tr>
<tr>
<td>3</td>
<td>Measure</td>
<td>VOC/VOB/MSA</td>
<td>To ensure that the important customer &amp; business issues are addressed. Pareto Chart</td>
</tr>
<tr>
<td>4</td>
<td>Measure</td>
<td>Prioritization/AHP tool recommended</td>
<td>To focus on the top customer and business priorities</td>
</tr>
<tr>
<td>5</td>
<td>Measure</td>
<td>House of Quality 1</td>
<td>Visualize relationship between CCR &amp; VOC and prioritizes and correlates CCRs. Understand contradictions. Identifies gaps with respect to competition.</td>
</tr>
<tr>
<td>6</td>
<td>Measure</td>
<td>Scorecard</td>
<td>Identify Targets for CTQs/CCRs</td>
</tr>
<tr>
<td>7</td>
<td>Explore</td>
<td>Application &amp; Functional Analysis</td>
<td>Pre-requisite for coming for generating concepts &amp; solutions. Concepts should address contradictions.</td>
</tr>
<tr>
<td>8</td>
<td>Explore</td>
<td>High level Concept generation</td>
<td>At least 3 concepts generated to ensure that concept space is fully explored</td>
</tr>
<tr>
<td>9</td>
<td>Explore</td>
<td>Pugh matrix</td>
<td>Evaluate and select concepts</td>
</tr>
<tr>
<td>10</td>
<td>Explore</td>
<td>House of Quality 2</td>
<td>High-level design correlated with CCRs. Current state capability to address CCRs evaluated vis-à-vis competition.</td>
</tr>
<tr>
<td>11</td>
<td>Explore</td>
<td>House of Quality 2a/2b</td>
<td>Detailed process map for each function</td>
</tr>
<tr>
<td>12</td>
<td>Explore</td>
<td>Scorecard tolerance</td>
<td>Identify USL/LSL for CTQs(CCRs) and SQL</td>
</tr>
<tr>
<td>13</td>
<td>Explore</td>
<td>Capability assessment for all scorecard/dashboard metrics</td>
<td>Identify current state of process capability and gaps and prioritize</td>
</tr>
<tr>
<td>14</td>
<td>Explore</td>
<td>FMEA</td>
<td>To address the gaps of process capability, understand the root cause and take action on failure modes</td>
</tr>
<tr>
<td>15</td>
<td>Develop</td>
<td>Evaluate Lean concepts embedded in the process map</td>
<td>To develop a detailed process design with a goal to improve profit and reduce defects</td>
</tr>
<tr>
<td>16</td>
<td>Implement</td>
<td>House of Quality 3 Detailed designing</td>
<td>Relationship between new process characteristics and controls implementations to detailed design or lowest level. Evaluate the new process vis-à-vis competition.</td>
</tr>
<tr>
<td>17</td>
<td>Implement</td>
<td>Scorecard</td>
<td>To demonstrate statistically the process capability before transferring to operations</td>
</tr>
<tr>
<td>18</td>
<td>Implement</td>
<td>Process control charts &amp; dashboard</td>
<td>To sustain gains made and set up metrics for future conformity</td>
</tr>
</tbody>
</table>

**Figure 2**: A breakdown of the DMEDI process into 18 steps showing the activity performed, the tool used in each step and the purpose of the activity

### 1.3 Measure- VOC/VOC/MSA

During this phase, the voice of the customer and voice of business is captured and measurement systems are put in place. For print shops, these are as follows:

**VOC (Voice of the customer):**
- Service level agreement of 95% on-time delivery is not being met.
- Print equipment utilization is low leading to higher cost per print.
- Several people in the enterprise served by the Xerox print shop are not aware of the service capabilities and capacity of the print shop.
VOB (Voice of the business)

- Improve services so that the account is not included in the RFP (Request for proposal)
- Renew contract and improve profitability for Xerox

MSA (Measurement system analysis)

Data collection tools are installed in the print shop to measure the equipment performance. The collected data revealed the following trends.

- Measured throughput of machines is significantly lower than 85% of rated throughput.
- On-time performance is low. Even though the shop believes it is meeting the 95% on-time SLA (service level agreement) -- analysis of the collected data shows otherwise.
- Utilization of equipment is low

Other observations made by black belts at this phase include:

- No structured scheduling policy in place
- Operators set unrealistic internal job completion time expectations
- No formal tool for job processing time estimation currently exists
- Departmental batch-and-queue work process being utilized
- Customers vend out work because they are not aware of Xerox print shop capabilities. (No marketing effort is being undertaken by Xerox print shop)

Based on the above measurements and observations, the following inputs for AHP, HoQ1 and initial scorecard development were summarized.

VOC/VOB

Xerox print shop is under pressure to reduce cost, improve on-time performance, maintain high quality, attract new customers and hold on to existing customers. The print shop would like to renew the contract and increase profits.

CCRs (Critical customer requirements also referred to as Critical to Quality in some places)

The profit margins can be improved if the black and white and color volume growth can occur.
Customer satisfaction is strongly dependent on timely production and delivery of documents without errors.
A large number of customers are unaware of the existence of the printshop. Some of those that are aware of the existence of the printshop are not aware of its entire set of service capabilities. By implementing a marketing initiative in the form of customer presentations, the printshop can address this issue.

Competition

The competitive landscape is not in favor of Xerox print shop. Print shop customer feels that competition such as A, B, and C can deliver superior performance at lower costs.
Scorecard

Contract Requirements: 95% on time delivery and 95% print quality. This means LSL is 95% for both while we can assume 100% meeting the requirement - USL. From the quality standpoint and Sigma Quality Level Job lateness is an issue. There has been no complaint on print quality. Internal targets are no print errors and a maximum of 6000 defects per million opportunities for on time delivery.

1.4 Measure – Prioritization using AHP tool

The input described above forms input to the AHP tool as shown in Figure 3.

| Name                        | Reduce cost | Keep print shop customers happy | Ensure high job quality | Market services to print shop customers | Criteria 5 | Criteria 6 | Criteria 7 | Criteria 8 | Criteria 9 | Criteria 10 | Criteria 11 | Criteria 12 | Normalized Ratings | Relative Score |
|-----------------------------|-------------|---------------------------------|-------------------------|----------------------------------------|------------|------------|------------|------------|------------|-------------|-------------|------------------|-----------------|
| Reduce cost                 | 1.00        | 0.14                            | 0.11                    | 7.00                                   | 1.00       | 1.00       | 1.00       | 1.00       | 1.00       | 1.00         | 1.00         | 1.00 | 1.00 | 1.00 | #VALUE! |
| Keep print shop customers happy | 7.00        | 1.00                            | 1.00                    | 7.00                                   | #VALUE!    | #VALUE!    | #VALUE!    | #VALUE!    | #VALUE!    | #VALUE!     | #VALUE!     | #VALUE! | #VALUE! | #VALUE! | #VALUE! |
| Ensure high job quality     | 1.00        | 1.00                            | 1.00                    | 7.00                                   | #VALUE!    | #VALUE!    | #VALUE!    | #VALUE!    | #VALUE!    | #VALUE!     | #VALUE!     | #VALUE! | #VALUE! | #VALUE! | #VALUE! |
| Market services to print shop customers | 0.14       | 0.14                            | 0.14                    | 1.00                                   | #VALUE!    | #VALUE!    | #VALUE!    | #VALUE!    | #VALUE!    | #VALUE!     | #VALUE!     | #VALUE! | #VALUE! | #VALUE! | #VALUE! |
| Criteria 5                  | 1.00        | #VALUE!                         | #VALUE!                 | #VALUE!                                | #VALUE!    | #VALUE!    | #VALUE!    | #VALUE!    | #VALUE!    | #VALUE!     | #VALUE!     | #VALUE! | #VALUE! | #VALUE! |
| Criteria 6                  | #VALUE!     | #VALUE!                         | #VALUE!                 | #VALUE!                                | #VALUE!    | #VALUE!    | #VALUE!    | #VALUE!    | #VALUE!    | #VALUE!     | #VALUE!     | #VALUE! | #VALUE! | #VALUE! |
| Criteria 7                  | #VALUE!     | #VALUE!                         | #VALUE!                 | #VALUE!                                | #VALUE!    | #VALUE!    | #VALUE!    | #VALUE!    | #VALUE!    | #VALUE!     | #VALUE!     | #VALUE! | #VALUE! | #VALUE! |
| Criteria 8                  | #VALUE!     | #VALUE!                         | #VALUE!                 | #VALUE!                                | #VALUE!    | #VALUE!    | #VALUE!    | #VALUE!    | #VALUE!    | #VALUE!     | #VALUE!     | #VALUE! | #VALUE! | #VALUE! |
| Criteria 9                  | #VALUE!     | #VALUE!                         | #VALUE!                 | #VALUE!                                | #VALUE!    | #VALUE!    | #VALUE!    | #VALUE!    | #VALUE!    | #VALUE!     | #VALUE!     | #VALUE! | #VALUE! | #VALUE! |
| Criteria 10                 | #VALUE!     | #VALUE!                         | #VALUE!                 | #VALUE!                                | #VALUE!    | #VALUE!    | #VALUE!    | #VALUE!    | #VALUE!    | #VALUE!     | #VALUE!     | #VALUE! | #VALUE! | #VALUE! |
| Criteria 11                 | #VALUE!     | #VALUE!                         | #VALUE!                 | #VALUE!                                | #VALUE!    | #VALUE!    | #VALUE!    | #VALUE!    | #VALUE!    | #VALUE!     | #VALUE!     | #VALUE! | #VALUE! | #VALUE! |
| Criteria 12                 | #VALUE!     | #VALUE!                         | #VALUE!                 | #VALUE!                                | #VALUE!    | #VALUE!    | #VALUE!    | #VALUE!    | #VALUE!    | #VALUE!     | #VALUE!     | #VALUE! | #VALUE! | #VALUE! |
| Column Totals               | 17.14      | 2.29                            | 2.25                    | 22.00                                  | 1.00       | 1.00       | 1.00       | 1.00       | 1.00       | 1.00         | 1.00         | 1.00 | 1.00 | 1.00 | #VALUE! |

Figure 3: AHP including the VOC

1.5 Measure – House of Quality 1

Figure 4 shows the House of Quality 1 that was developed based on data collected that was collected.
Figure 4: House of Quality 1

1.6 Measure – Scorecard

Next, an initial scorecard was developed as shown in Figure 5.

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Target</th>
<th>LSL</th>
<th>USL</th>
<th>SQL (Target)</th>
<th>Yield</th>
<th>DPMO</th>
<th>Predicted SQL</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-time</td>
<td>95%</td>
<td>95%</td>
<td>100%</td>
<td>4.0</td>
<td>87%</td>
<td>135000</td>
<td>2.65</td>
</tr>
<tr>
<td>Job Quality</td>
<td>100%</td>
<td>95%</td>
<td>100%</td>
<td>6.0</td>
<td>100%</td>
<td>0</td>
<td>6</td>
</tr>
</tbody>
</table>

Figure 5: Scorecard showing the requirements and process capability
1.7 Explore – Application & functional analysis, High level concept generation and Pugh matrix using Xerox’s LDP Lean Document Production software tools

The explore phase of the DMEDI process is greatly improved by utilization of the LDP Lean Document Production toolkit. Several scenarios for new print shop design are rapidly evaluated using discrete-event simulation and modeling using Xerox’s proprietary LDP Lean Document Production software tools.

For example, the impact of the two job sequencing policies (SPT and LS) on shop performance are evaluated using the LDP toolkit:

SPT – (Shortest Processing Time First) Jobs are sequenced in the order of their individual processing time. Jobs that take less time to process get higher priority.

Least Slack – (Least Slack First) Jobs are sequenced in the order of their individual slack. Slack is defined as the difference between the due time and the expected completion time. For example, if a job is estimated to finish by 10AM and the due date is 12:00 pm, then the slack is 2h. Jobs that have lower slack get higher priority.

The results of using the two scheduling policies are evaluated using LDP simulations and are shown in Figure 6.

<table>
<thead>
<tr>
<th>Number of Jobs</th>
<th># of Operators</th>
<th>Late jobs_SPT</th>
<th>Late jobs_LS</th>
</tr>
</thead>
<tbody>
<tr>
<td>122</td>
<td>1</td>
<td>66</td>
<td>101</td>
</tr>
<tr>
<td>122</td>
<td>2</td>
<td>24</td>
<td>29</td>
</tr>
<tr>
<td>122</td>
<td>3</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Current</td>
<td>3</td>
<td>15</td>
<td>15</td>
</tr>
</tbody>
</table>

Figure 6: Results of simulation showing the impact of various sequencing policies on number of late jobs

The simulations output is used as the input to the Pugh Matrix. For the purpose of illustration, we consider four scenarios (resulting from varying the scheduling policy and number of operators) namely:

- LDP(SPT-Sequencing) with 2 operators
- LDP(SPT-Sequencing) with 3 operators with internal presentation
- LDP(LS-Sequencing) with 2 operators
- LDP(LS-Sequencing) with 3 operators with internal presentation

The resulting Pugh Matrix is shown in Figure 7.
1.8 Explore – House of Quality 2, 2a and 2b

This leads to the House of Quality 2. There are multiple ways to address the CCR’s derived from the HoQ1. These include:

- Cellular production process
- Optimize batch sizes for production
- Optimize job scheduling and sequencing policies
- Optimize labor allocation
- Labor multi-tasking
- Conduct seminars for the print shop customers
- Control and improve on-time delivery
- Control and improve labor utilization
- Control and improve equipment utilization

The resulting HoQ2 is shown in Figure 8.
Figure 8: This shows the House of Quality 2

The HoQ-2a and 2b are not applicable in this specific case study and will not be discussed further.

1.9 Explore – Scorecard tolerance/Capability assessment for all scorecard/dashboard metrics, FMEA, Exploration of lean concepts embedded in the process map

During this phase, the process maps were carefully analyzed using Lean Principles to identify sources of waste (non-value added steps) and steps were taken to reduce or eliminate them. FMEA and RSM (Response Surface Methodology) analysis was performed to understand the sensitivities of metrics (%late jobs) to design parameters (number of operators, scheduling policies).

1.10 Explore – House of Quality 3/ Detailed designing

This leads us to detailed design of print shop using HoQ3. The following actions were taken to develop a new print shop solution for the client. These include:

• Moving equipment into cells
• Installing and using the LDP Scheduling tool
• Cross training operators in multiple skills
• Preparing and delivering seminars to improve awareness of print centers within the enterprise
• Measuring BW volume
• Measuring Color volume
• Measuring on-time jobs
• Measuring Profit

The resulting HoQ3 was developed and is shown in Figure 9.

![Figure 9: House of Quality 3 developed using the LDP analysis, FMEA and RSM and other related actions](image)

1.11 **Implement – Scorecard**

A scorecard related to the new optimized print shop as shown in Figure 10 was developed.
1.12 Implement – Process control charts and dashboard

Finally, the process metrics and profit was controlled using process control charts. In this specific example, the control charts for profit (continuous variable) and %on-time was plotted to insure that performance improvements were tracked and sustained as shown in Figure 11.

Figure 11: Process control charts for total proportion of late jobs and profit from the account.

Utilizing the above steps, black belts and process improvement consultants can develop highly optimized print shop designs that are economically competitive and address the on-time performance issues faced by many outsourced print operations. The methodology can easily incorporate other constraints and customer inputs within its framework—beyond those that are specifically discussed in this case study.

2. Conclusions

This paper described a powerful methodology for designing print shops using Xerox’s LDP Lean Document Production solution embedded within the DMEDI methodology. The process steps were described in considerable detail within the context of print shop design to illustrate the key concepts. The methodology described in this paper was offered as part of the DMEDI curriculum as an illustrative case study within
the Xerox Corporation. The LDP solution has been utilized in over 200 engagements within the Xerox Services business since 2000.

We believe that this methodology is applicable to the design of other processes that share similarities with the print shops. This includes financial transaction processes, imaging and scanning operations and manufacturing or service processes with flexible and high-mix outputs. These are the subject of ongoing and future work.

References


Sudhendu Rai is the Principal Scientist, Project Leader and a certified Lean Six Sigma Black Belt at the Xerox Research Center in Webster, N.Y. He received his Ph.D. from MIT in 1993, M.S. from Caltech in 1989, and B.Tech. from IIT, Kanpur (India) in 1988 – all in Mechanical Engineering. Dr. Rai joined Xerox in 1995 as a Member of Research & Technology staff. He was promoted to Principal Scientist in 2001. During 1996-97 he demonstrated the feasibility of virtual prototyping of xerographic components. He created, validated and implemented a new methodology for performing quantitative trade-offs in large-system design. Between 1997 and 1998 he developed and implemented a novel distributed control architecture for moving paper across multiple paper handling modules. He is the lead inventor of the LDP Lean Document Production® Solution that was selected as a finalist in the Franz Edelman (worldwide) competition sponsored by INFORMS. Starting in 1998 he led a team that developed the algorithms, software toolkit to support the initial offering and a training curriculum to train Xerox Global Services consultants. He has personally led and implemented process improvement initiatives in dozens of small and large print shops spanning multiple industry segments. He holds 17 patents (with 40 additional pending) and has published more than 20 technical papers in conference proceedings and technical journals. He is a member of IIE, ASME, INFORMS and a senior member of IEEE. He is a recipient of the Xerox Excellence in Science and Technology Award and was selected as a finalist for the Rochester Engineer of the Year award in 2007.

Thimmiah Gurunatha is ASQ Fellow, Certified Master Black Belt Lean Six Sigma, Design For Six Sigma, Facilitator for Accelerated Life Testing’ Problem Solving, and Design For Reliability. He is a Facilitator for Revenue Growth Projects at TG Rainbow Inc. For detailed biography, please see page 530 of this issue.