Diffusion of Industrial Engineering Concepts at Beth Israel Deaconess Medical Center

Design Team
Stephen Asay, Bonnie Baker
Kimberly Eng, Lauren Hale
Elsa Mueller

Design Advisor
Professor James Benneyan

Sponsor
Alice Lee, Special Assistant to the President, BIDMC

Abstract
Healthcare is the largest industry in the United States, accounting for more than 16% of the Gross Domestic Product, with an estimated 20–40% of this spending being waste. Beth Israel Deaconess Medical Center (BIDMC) is making efforts to increase internal productivity and reduce waste through the use of Lean: a process improvement method using a broad range of industrial engineering concepts. This project’s “one-point lessons” can educate employees at all levels of the organization to create just in time problem solving in day-to-day operations. Their simple, concise format allows ideas to be learned quickly and easily despite differing native languages and levels of education. Focus group testing has shown that the lessons create a statistically significant increase in Lean knowledge, plus high user satisfaction and interest in using lessons to solve problems.
The Need for Project

Employees at all levels of the organization lack the skills and resources necessary to solve problems, leading to unnecessary waste and expenses. Healthcare’s high labor expenses and fixed costs force providers to make significant efforts to improve internal productivity to remain competitive. The structure at Beth Israel Deaconess Medical Center (BIDMC) focuses on drilling deep and fixing systemic problems but lacks the resources necessary to meet all demand (Rep. 4.2).

Problems are not being solved at every level across the organization. This results in waste and increased costs for the hospital and patients (Rep. 5).

The Design Project Objectives and Requirements

To create accessible and understandable training material; must instill knowledge that can be used to solve problems in daily operations in as close to real time as possible.

Design Objectives

The chosen design must make Lean and industrial engineering (IE) concepts accessible to all employees as the information is needed (just in time). Staff with varying degrees of education and differing native languages must understand the training presented. The resulting materials must be standardized and sustainable by BIDMC (Rep. 6).

Design Requirements

The training materials must provide a way for employees to learn Lean concepts without using physical space at the hospital (Rep. 6).

Training effectiveness was evaluated using focus groups and pre-/post-tests of knowledge. Users had to indicate interest in receiving other lessons and recommending their use to others. The pre-/post-tests allowed the evaluation of a statistically significant gain in Lean knowledge and problem-solving skills (Rep. 6.4).

Design Concepts Considered

Alternative design concepts considered varying approaches for conveying Lean knowledge: a physical training center, a training website and training sessions or classes.

Training Center

A training center would have been a dedicated space housing computers and training materials; employees would have had a known location in which they could educate themselves about Lean. Business Transformation (BT) staff (those currently responsible for Lean) and self-directed materials would have been available to employees.

The center would have provided just in time training, because employees would have visited the location whenever a problem was affecting them. When BT staff members were available, the center would also have provided personal interaction, which is always
beneficial to training efforts (Rep. 7.1).

**Training Website**

A training website would have used materials similar to those in the training center but in an entirely electronic form; it would have been housed on the BIDMC intranet. A simple decision tree would have guided staff to the type of problem being experienced, and then supply a list of tools and techniques to help remedy the situation.

This alternative would also have provided just in time training without the need for staff to leave their departments. No permanent staffing would have been required, but only those employees with access to a computer could have utilized the materials (Rep 7.2).

**Training Sessions**

Training sessions would have included presentations about specific Lean/IE concepts, chosen on the basis of need; hands-on games and materials would have accompanied the presentations. The sessions would have been designed so that professional trainers could have conducted them without being familiar with Lean concepts.

The sessions would not have required dedicated space, and they would have been accessible to the majority of hospital staff. The inclusion of a facilitator and the establishment of a group-learning environment would have encouraged personal interaction. The training sessions were seen as a way to mitigate the drawbacks of the two other alternatives while maintaining many of their benefits (Rep. 7.3).

**Recommended Design Concept**

One-point lessons teach Lean concepts (with key takeaways and real-world examples) in a visual, standardized manner on a single 8.5 by 11 inch page. Testing indicates high user satisfaction and a statistically significant increase in Lean knowledge.

**Design Description**

A “one-point lesson” presents a single Lean concept or tool using small, specific components. All of the material required to convey each topic fits on one side of a standard 8.5 by 11 inch piece of paper. Each lesson functions as a stand-alone document.

The content includes both the topic’s key concepts and an embedded example that applies those concepts to a more tangible situation; the exact format of examples varies. Their function is to reinforce the key concepts in the lesson and aid in understanding the topic. Examples are not hospital or healthcare-specific. Because all staff at BIDMC may use the lessons, the examples relate to activities any person might experience in everyday life.
Lesson Content:
Spaghetti Diagram

What is a spaghetti diagram?
A spaghetti diagram is a drawing that is used to visually show wasted movement of people for things so that improvements can be made. The spaghetti diagram is also known as a layout diagram.

Why might you use a spaghetti diagram?
- To identify unnecessary travel between steps
- To figure out ways to combine steps to save time
- To create an efficient floor plan

Key Takeaway:
Spaghetti Diagram

Reducing travel & combining steps makes a more efficient process.

Real-World Example:
Spaghetti Diagram

Want an example?
Here we followed the path of a person making scones

Original Process:

All lessons are consistently formatted to aid in the recognition of certain components (e.g. all primary information in yellow boxes, key pieces of information highlighted by an actual key, all examples in green outlines). The visual nature of the lessons (boxes, outlines, bubbles) makes them less daunting to end users (Rep. 10.1).

Each lesson has a page of supplemental materials: quiz, practice exercise and recommendations for additional materials. The quizzes have approximately 10 questions that relate to the lesson content; they act to reinforce lesson content, not test competency or comprehension. The additional exercises are open-ended examples that the user may choose to try at a later time. Additional materials listed include applicable outside resources and other one-point lessons (Rep. 10.2).

Analytical Investigations

A Kepner-Tregoe decision analysis that considered a list of “musts” and “wants” for the design determined training sessions as the best design alternative. This approach was refined to the one-point lesson concept based on sponsor feedback and the benchmarking of training methods used by Toyota (one concept, concise, self contained, always available, no instructor required) (Rep. 8 & 9).

The team conducted a Pareto analysis of the problems most often identified at BIDMC. These problems were weighted and matched against a researched list of possible lesson topics for development. The lessons that most met the needs of the hospital were the first targeted for creation (with considerations for voice of the customer and focus group testing requirements) (Rep. 10.5 & 10.6).

Experimental Investigations

Qualitative feedback was generated through three tiers of testing (Rep. 11 & 12). Tier one included friends and family; they read lessons to determine the time required and their ability to understand content. Tier two was the team’s sponsor; she read lessons to ensure they were consistent with hospital training materials. Tier three was a focus group of BIDMC staff; they evaluated five lessons for understanding and applicability. Surveys about understanding, usefulness and likelihood of recommendation were given to all participants. Of 30 questions spanning five lessons, all received a score higher than 3 on a 4-point Likert scale (3 = mostly/probably yes, 4 = definitely/definitely yes).

Pre-/post-tests were created using Bloom’s Taxonomy to address
all levels of knowledge and skills (Rep. 11.6). These tests were given to members of the focus group and a control group that did not receive lessons. Data (scores) were analyzed to test for changes in scores from the pre- to the post-tests for both groups. Analysis showed no increase in scores for the control group and a conclusively statistically significant increase in scores for the focus group. With 95% confidence, the increase in focus group scores fell between 24.52% and 39.00%, with a mean increase of 31.76% (Rep. 13).

**Key Advantages of Recommended Concept**

One-point lessons provide training materials in an accessible, easily understood manner available to all BIDMC staff when the information is needed. They are highly adaptable and may be used one-at-a-time or in conjunction with other lessons, by an individual or in a group. They do not require physical space or large time commitments; lesson content can be fully understood in less than 15 minutes.

BIDMC received 15 completed lessons, and the capstone team produced a standard approach to lesson development so the hospital may create additional lessons as needed. Instructions on choosing the next lessons to develop, placing them in context of existing lessons, and creating the actual lessons were included in a development guide that was presented to BIDMC (Rep. 14).

**Financial Issues**

A no-cost training approach that will allow immediate hospital-wide implementation upon handoff to BIDMC. One-point lessons may be viewed in an entirely electronic format and do not require any additional materials; there is no cost associated with the implementation and use of the lessons throughout BIDMC. Costs will only be generated in terms of labor-hours required to generate any additional lessons BIDMC desires.

**Recommended Improvements**

The development of additional lessons and a dedicated intranet website to host them will provide the most effective training resource for BIDMC. Though the lessons that most address the needs of BIDMC were developed, additional lessons should be created to provide the hospital with the most complete, effective resource for problem solving.

Due to the current fiscal environment, BIDMC lacks the resources to develop the ideal method of deployment: a dedicated one-point lesson website. Instead, the team recommended the use of a public folder in MS Outlook to allow immediate access to lessons.