Implementing Lean Manufacturing Concepts in Non-manufacturing Areas

by

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Abstract: *Lean manufacturing is more and more widely accepted and applied in industries. Even though fundamental lean concepts, such as "5S", "one-piece-flow", etc. were developed from manufacturing practices, these principles can also be effectively used in non-manufacturing areas. This paper introduces a student project in which "5S" and "one-piece-flow" were used to improve service of the College Union at our institute. This project not only helped students to obtain a deeper understanding in lean manufacturing, but also demonstrated great application potentials of lean concepts in non-manufacturing fields.*

Keywords: 5S, Engineering education, Lean manufacturing, One-piece-flow, Poke-yoke

1. Introduction

MFG 596, *Lean Manufacturing*, is a graduate course offered at our institute. Lean manufacturing is a philosophy that enables producers to make more and better products with less resource (Womack and Jones, 1996). Lean manufacturing is more and more widely accepted and applied in industries (Sun et al., 2005). Even though most of its concepts were developed from manufacturing practices, these concepts also have great potentials if they are used in non-manufacturing areas (Apte and Goh, 2004; Culbertson, 2006).

In lean manufacturing, "5S" and "one-piece-flow" are two fundamental principles. "5S" represents five Japanese words (Regan and Slattery, 2000):

- Sort (Seiri): get rid of anything not needed
- Straighten (Seiton): establish a place for everything and keep everything in its place

- Scrub (Seiso): keep everything very clean
- Schedule (Seiketsu): establish a daily routine to maintain and improve on the first three S's
- Score (Shitsuke): regularly measure how well it is being done to maintain and improve the first four S's

"One-piece-flow" means that once production starts, the product never goes back to inventory and never stops moving until it is a finished product (Regan and Slattery, 2000).

In MFG 596, students were required to implement lean manufacturing concepts in their final projects. One student project was to use lean ideas to improve service of the College Union at our institute. In the next two sections, the authors will introduce how "5S" and "one-piece-flow" were implemented in this project.

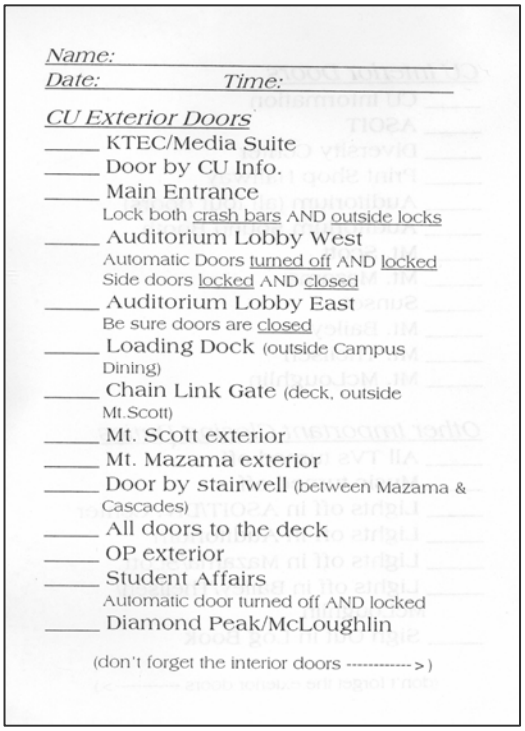
2. Project background

The College Union (Figure 1) of our institute is run by student workers. Every evening, the student workers must lock up the entire building. There are 45 doors and entrances to be checked and secured at the time of closing. The average time for a student worker to lock up the building is about 27 minutes. Currently, there is no set system or "route" for door locking. Each student worker has his own route and preference of securing the building. The lockup times vary between individuals. In an observation, the maximum and minimum times to secure the building were 12 minutes apart.

Figure 1. College Union of our institute.

Besides the fluctuating times, another problem is security concerns. More than twice a month, the doors remain unlocked after closing. With all the valuable information and equipment left in the building, this security issue poses a large problem for management.

To help the student workers, the College Union provided a checklist of all exterior doors and entrances to be secured (Figure 2). This approach solved the problem but made the whole process much more tedious because the doors on the list are not placed in a reasonable order. The student workers have to search through the list over and over to make sure every door is securely locked.



Name: _____

Date: _____ Time: _____

CU Exterior Doors

_____ KTEC/Media Suite

_____ Door by CU Info.

_____ Main Entrance
Lock both crash bars AND outside locks

_____ Auditorium Lobby West
Automatic Doors turned off AND locked
Side doors locked AND closed

_____ Auditorium Lobby East
Be sure doors are closed

_____ Loading Dock (outside Campus Dining)

_____ Chain Link Gate (deck, outside Mt.Scott)

_____ Mt. Scott exterior

_____ Mt. Mazama exterior

_____ Door by stairwell (between Mazama & Cascades)

_____ All doors to the deck

_____ OP exterior

_____ Student Affairs
Automatic door turned off AND locked

_____ Diamond Peak/McLoughlin

(don't forget the interior doors ---------->)

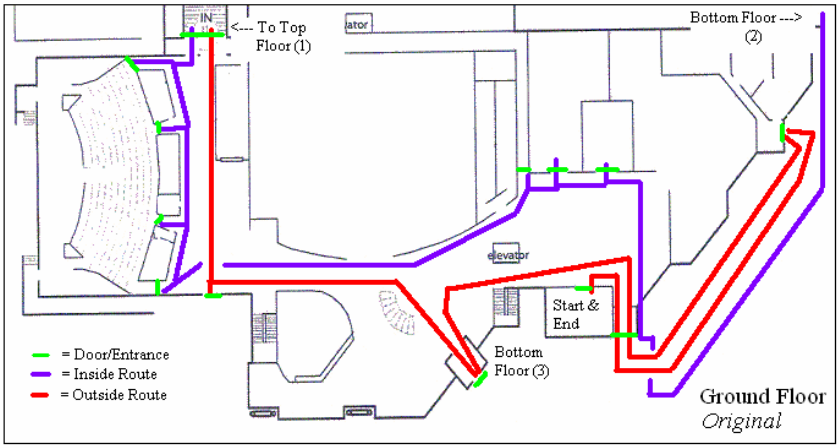
Figure 2. Doors and entrances checklist currently used.

3. Project objectives and implementation

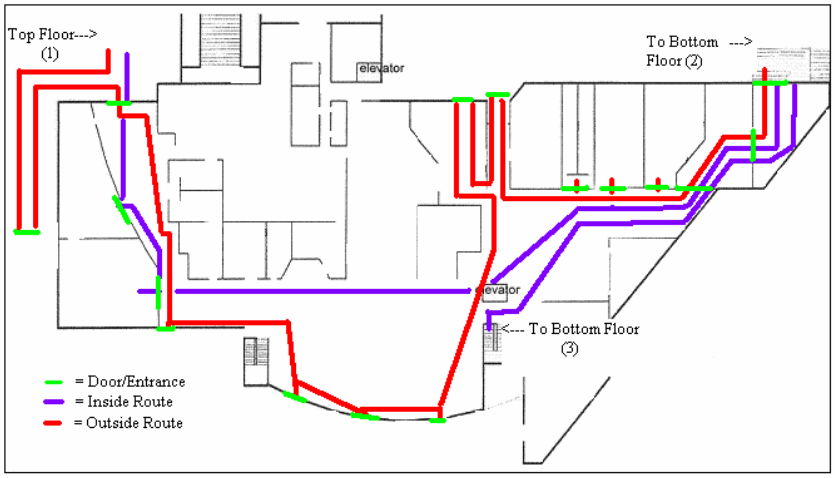
Lean manufacturing concepts are efficient tools to determine unnecessary moving, streamline the process and reduce cycle time in service areas (Buzby et al., 2002; Huang and Liu, 2005). These concepts were applied in MFG 596 project to solve the above-mentioned issues. There are three objectives for the project. Firstly, it will develop a standard and lean (time-efficient) route to lock and secure all the doors and entrances to the College Union. This will reduce the time variances as well. Secondly, it will design a new checklist of doors and entrances based on the lean route around the building. The new checklist will help the student workers to check all the doors. Finally, the project will provide a mistake-proof (*poke-yoke*) security system for the College Union.

3.1 Implementation of "one-piece-flow"

The first step of lean implementation was "one-piece flow". Figure 3 shows typical routes the student workers use currently. The student workers often follow the purple lines to lock the interior doors. And after that, they often follow the red lines to lock the exterior doors. The routes contain a lot of backtracks. "One-piece-flow" in MFG 596 project was to cut all the unnecessary backtracks and keep the student workers constantly going in "one direction". (Vividly, the student represents "one-piece", and once he starts locking the door, he "flows" from door to door and never backtracks.) Based on this concept, a lean route was developed as illustrated in Figure 4. Following the lean route, the locking of every door (interior or exterior) no longer causes the unneeded re-walks for the student workers.

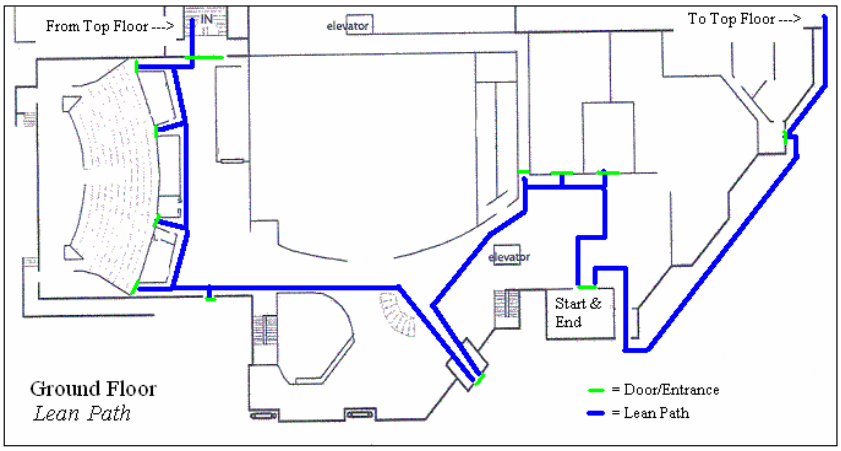


(a) On ground floor.

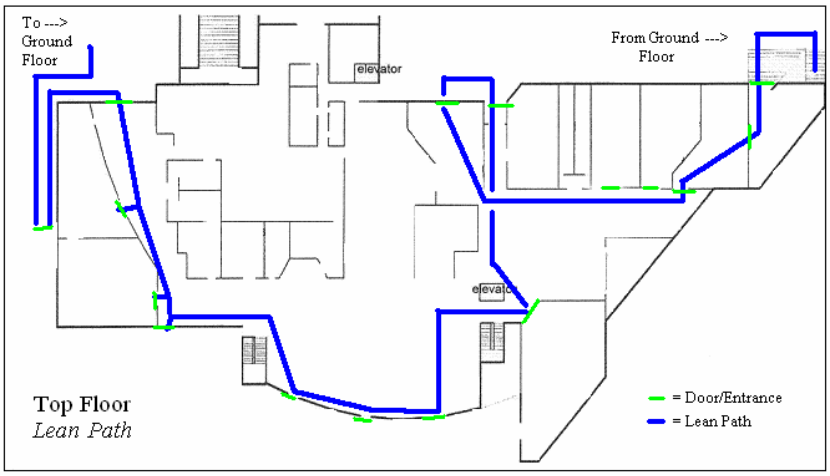


(b) On top floor.

Figure 3. Current routes at the College Union.



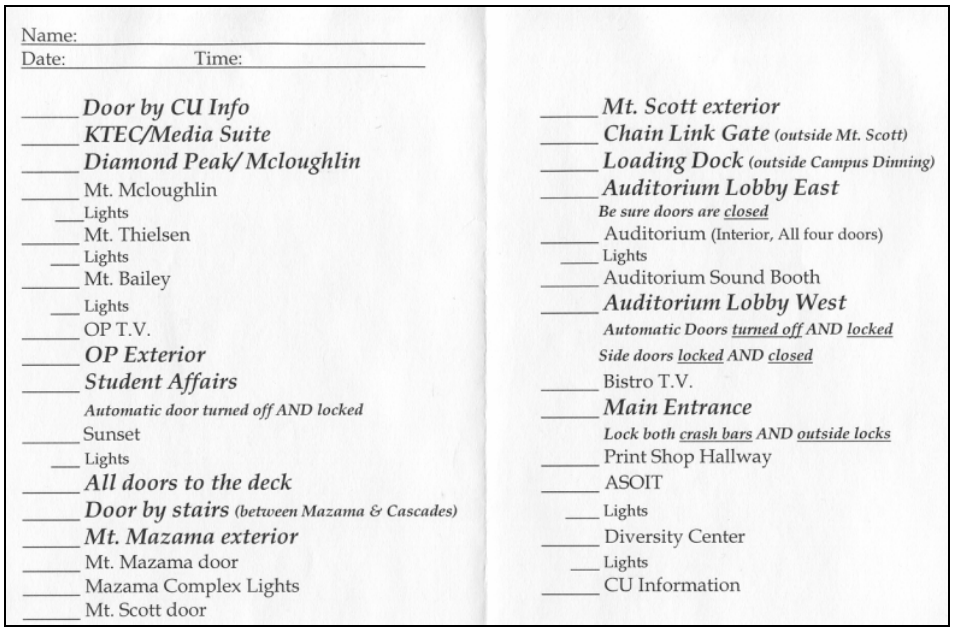
(a) On ground floor.



(b) On top floor.

Figure 4. Proposed lean routes for the College Union.

Based on the lean route, all the exterior and interior doors were re-ordered and a new checklist (Figure 5) was designed. On the list, all the exterior doors were bolded and italicized to distinguish from interior doors. By simply following the checklist, the student workers can easily know if a door is secured before they move onto the next one. Whenever they meet an exterior door (bold and italic on the list), they will pay special attention to make sure that door is safely locked. The lean route and new checklist greatly reduced the possibilities of leaving the doors accidentally unlocked, according to the student workers' observation.



Name: _____
Date: _____ Time: _____

_____ *Door by CU Info*
_____ *KTEC/Media Suite*
_____ *Diamond Peak/ Mcloughlin*
_____ Mt. Mcloughlin
___ Lights
_____ Mt. Thielsen
___ Lights
_____ Mt. Bailey
___ Lights
_____ OP T.V.
_____ *OP Exterior*
_____ *Student Affairs*
Automatic door turned off AND locked
_____ Sunset
___ Lights
_____ *All doors to the deck*
_____ *Door by stairs (between Mazama & Cascades)*
_____ *Mt. Mazama exterior*
_____ Mt. Mazama door
_____ Mazama Complex Lights
_____ Mt. Scott door

_____ *Mt. Scott exterior*
_____ *Chain Link Gate (outside Mt. Scott)*
_____ *Loading Dock (outside Campus Dinning)*
_____ *Auditorium Lobby East*
Be sure doors are closed
_____ Auditorium (Interior, All four doors)
___ Lights
_____ Auditorium Sound Booth
_____ *Auditorium Lobby West*
Automatic Doors turned off AND locked
Side doors locked AND closed
_____ Bistro T.V.
_____ *Main Entrance*
Lock both crash bars AND outside locks
_____ Print Shop Hallway
_____ ASOIT
___ Lights
_____ Diversity Center
___ Lights
_____ CU Information

Figure 5. New checklist of doors and entrances.

3.2 Implementation of "5S"

As shown in Figure 6, there are six types of doors at the College Union. Currently, the student workers need to carry 17 keys, as shown in Figure 7 (a), when they lock the doors. However, as what they observed, only 5 keys are actually needed for a normal lockdown. Other keys are seldom or never used. The student workers often waste time fumbling through the key ring to find the correct keys.

Figure 6. Different types of doors at the College Union.

In MFG 596 project, "5S" concept was used to improve the key ring:

- Sort - the doors and entrances based on the checklist in Figure 5. The keys not used for normal lockdown were taken off from the key ring.
- Straighten - the keys by different colors. Green color was put on the most widely used key. Yellow and orange colors were put on the keys used in the entire lockup procedure.
- Schedule - the time to train the student workers how to use the new checklist and color code.
- Score - the performance and efficiency of the student workers on bi-weekly basis by the management.

Since the project is not a manufacturing operation, the fourth "S" (Scrub) was not used.

After implementing "5S", a much simpler and color-coded key ring was developed as illustrated in Figure 7 (b). According to the student workers, it is much quicker to locate the proper keys with the improved key ring.

(a) Key ring currently used. (b) Improved key ring.

Figure 7. Comparison of key rings before and after implementing "5S".

3.3 Benefits of the project

By implementing "5S" and "one-piece-flow", some obvious benefits were achieved. Firstly, the lean route and new checklist greatly reduced the chances of improper lockdown. The College Union got a *poke-yoke* security system that guarantees all the doors and entrances to be locked safely, preventing possible burglary and vandalism. Secondly, re-walk of the student workers for door locking was cut to the minimum. Considerable amount of time was saved. As indicated in Table 1, the operation time was cut down from 27 minutes to 14 minutes. In addition, the time variation was narrowed

down to a couple of minutes. Thirdly, about 600 dollars annual wage savings (about 80 student-hours) were anticipated. The details of the savings are itemized in Table 1.

Table 1. Monetary benefits from lean implementation

	Original Route	**Lean Route ***
Time (minutes per trip)	27	14
Steps (per trip)	1188	661
Distance (mile per trip)	0.478	0.251
Distance (miles per year)	174.5	91.6
Savings (annually $)	0	593 **

* implemented with new checklist and improved key ring
** savings = (27 – 14) minutes * 365 days * ($7.5/hour per student)

The initial implementation of lean manufacturing concepts has shown promising results already. The management of the College Union is in the process of approving and standardizing the suggestions proposed by MFG 596 project.

4. Conclusions

Lean manufacturing improves the process efficiency. The implementation of lean manufacturing concepts at the College Union through MFG 596 project not only illustrated how lean concepts were utilized in a service area, helping the students obtain a deeper understanding in lean manufacturing, but also demonstrated great application potentials of lean concepts in non-manufacturing areas. The authors of this paper are seeking opportunities to introduce lean manufacturing concepts to service, business, medical and other engineering fields in our institute as well as in the local community.

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