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# Lean Management in a Student Engineering Laboratory: First Results

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**Abstract**

*This paper reports on our experience in adopting Lean Management principles in the student engineering laboratory "Schluckspecht" at the Offenburg University of Applied Sciences. The laboratory's purpose is to provide students with the space, equipment, and materials needed to design and build an automobile for maximum fuel efficiency. As seen from the annual worldwide energy-efficiency Shell Eco-marathon results, the students' attempts were quite successful. Unlike the vehicles, the efficiency and resource-saving of the laboratory itself were questioned only recently, and by one the students. This became the starting point for his master's thesis and our subsequent research. Using Lean Management, which rooted in automotive manufacturing, as an improvement method, we aimed to find a way to reorganize the laboratory so that its operational efficiency was self-maintained at a sufficient level and did not burden the employees and students with additional time-consuming tasks. Given the laboratory's long operating hours and students' flexible schedules, we needed a comprehensive approach that affected not only the laboratory itself but also students' perceptions of working in the laboratory. The implemented changes impacted three key aspects—physical, cognitive, and affective—and this paper presents an assessment of those changes.*

**Keywords:** *Lean Management, student laboratory, laboratory design, engineering education, Schluckspecht*

## 1. Introduction

Our research began with a student's question. In 2022, Dirk Schoening was a Master's student and a member of the *Schluckspecht Team* at the Offenburg University of Applied Sciences. His question was: why is our lab—where we design and build efficient, resource-saving vehicles—not efficient and resource-saving itself?

The laboratory in question, known as the *Schluckspecht Lab* is a place where students from various departments work together to achieve the highest possible fuel efficiency of a vehicle [1]. For more than 25 years, the Schluckspecht Team has participated in the annual, world-wide energy efficiency competition, the *Shell Eco-marathon*, and has won numerous international awards [2]. Each semester, 20-25 students enroll in *Project Schluckspecht* as an elective course, receive tasks corresponding to their major, and work in small groups. There are three employees whom students may ask for assistance, materials, or instruments. However, Schluckspecht is the student project and mentioned employees do not work for the project and have other responsibilities.

While the laboratory has sufficient space, cabinets, shelves, and tables, D. Schoening observed that students spent excessive time searching for both consumable and non-consumable items. This resulted in a significant reduction in the team's efficiency and work quality, especially given the limited time students have available for the project [3]. The first steps toward solving this problem, specifically the development and implementation of a new room concept, were conducted within the framework of D. Schoening's Master's Thesis [3]. Although these changes were highly appreciated by students and staff, they represented only the first step.

Subsequent communication with the employees provided feedback regarding the difficulties they frequently encounter due to students working in the lab. The primary issue was a general disorder: students often fail to return materials and instruments to their assigned places. This leaves the lab disorganized, forcing other students to spend considerable time searching for items and distracting employees with frequent questions. The goal of our research is to find a way to reorganize the laboratory, so that order and cleanliness remain at a sufficient, self-maintaining level, without burdening the employees and students with additional time-consuming tasks.

## 2. Methods

### *2.1. Laboratory Reorganization Process*

Since Lean Management (see, for example, [4, 5]) is recognized as an effective method for quality and process improvement method and its implementation had already helped D. Schoening succeed, it was decided to continue the transformation of the lab in the spirit of Lean Management. This methodology is applied across many industries, and there are also numerous reports of implementing Lean methods in teaching and administrative processes at universities [6-9].
Because our research aimed to achieve a *self-maintained student* laboratory, the implemented changes affected various areas—not only the laboratory itself but also student perceptions of working in the environment. These changes could be seen in three aspects: physical, cognitive, and affective (see Table 1).

**Table 1.** Key aspects of the implemented changes

| The aspect | The undertaking changes related to … | Used Lean Management tools |
|---|---|---|
| physical | storage and accounting of materials and tools | 5S methodology (*Sort*, *Set in Order*, *Shine*, *Standardize*, and *Sustain*) [5]<br>Kanban system in cabinets [5]<br>Kanban boards [5] |
| cognitive | students' knowledge about effective ways to organize their own work in the laboratory | Elimination of waste in administrative processes<br>Lean Management workshop<br>Monthly cleaning day<br>Mandatory use of Kanban boards for discussions and repots |
| affective | the emotional state of students, changes in their motivation and commitment | Areas of responsibility (each of the students was assigned a small area of the laboratory and had to maintain the "target state")<br>Gratitude to the authors of successfully implemented improvement ideas (for example, a suggestion to use a certain type of calendar for self-organization of teamwork) |

The described sets of changes took place between May and December 2025. During the preparatory phase (May-September 2025), we found that students felt they were working under considerable time pressure. This observation, as well as discussions with employees, led us to choose *immersion in the Lean environment* as the main strategy of the reorganizational process. Rather than offering an additional course or using specially designed seminars and games described in literature [10-13], we immersed students in the laboratory where specific Lean tools (5S and the Kanban system) had already been implemented, providing them with only the basic information about using the tools.
A team of tutors played a significant role in implementing these changes. Five students from the Mechanical and Process Engineering department worked on reorganizing storage areas and inventory system for materials and tools. Meanwhile, administrative issues, such as the ordering process, booking the Cubicle for meetings, and entry/exit procedure, were addressed by tutors from the Media department.
The active phase of the study began at the start of the semester in October 2025. At the first general meeting, students were introduced to the core concepts of Lean Management and their

implementation within the laboratory. Issues of order and cleanliness were also briefly discussed at each monthly general meeting. In addition, a "Laboratory Cleaning Day" was introduced: on the last Friday of each month, students were required to visit the laboratory for approximately thirty minutes to return it to its "target state."

### *2.2. Participants and data collection*

In the preparatory phase of the study (May-September 2025), we asked students to evaluate the order and cleanliness of the laboratory and to share ideas for improvement. An anonymous Moodle questionnaire provided data from 13 responses. Respondents were mostly from mechanical engineering (9), but also included students from biomechanics (2), informatics (1), and media (1). For five of the participants, it was their first semester in the project; four had worked in the project for 2-3 semesters, and four had been with Schluckspecht for 7-9 semesters.
In the active phase of the study, 21 students participated: mechanical engineering (12), biomechanics (2), mechatronics (4), medical technology (2), and energy systems (1).
To obtain objective, quantitative information regarding order and cleanliness, we defined a parameter $N$, representing the number of items (instruments and materials) that were not in their assigned places early in the morning (before the first student came to the laboratory). By knowing $N$ and using the "function of order" $f(N) = (1 + \alpha \cdot N)^{-1}$ that yields a value of $1.0$ for a perfectly ordered laboratory ($N = 0$), we were able to evaluate the level of order numerically at different points in time. The coefficient $\alpha$ is the scale coefficient and was set to $0.01$. Three measurements were conducted during the preparatory phase, followed by ten measurements during the active phase of the study.

## 3. Results

In the Moodle questionnaire conducted during the preparatory phase, students were asked to evaluate the order and cleanliness of five areas within the laboratory using a discrete scale from $-3$ to $3$. The obtained scores ranged from $-2$ to $3$ with the average score of $1.0$, which was not considered sufficient. We also identified a trend: the longer students had worked on the project, the lower they rated the lab's order and cleanliness.
In response to the question "What could be better?" students provided various suggestions that were categorized into three groups (see Table 2). Most of these wishes can be fulfilled by the students themselves, with Lean Management giving the necessary "nudge" in the right direction. Some of the suggestions were rejected but they were used to initiate discussions during team meetings to foster student involvement in the reorganization process. This approach allowed us to explain the reasoning behind certain decisions and to reinforce ideas of Lean Management.

**Table 2**. Students' wishes for changes in the laboratory and reactions of the university staff

| Group of wishes | Examples | Reaction |
|---|---|---|
| Wishes about order and cleanliness | - Everyone should always leave their workspace in the same condition as they found it.<br>- The refrigerator should be emptied of expired food every two weeks.<br>- Everyone should leave Cubicle tidy. | Agreed |
| Suggestions about information transfer | - Regular short meetings of individual team groups (10-15 minutes). Briefly discuss the current status.<br>- Better document and communicate decisions made. | Agreed |
| Propositions about infrastructure changes | - More lighting. | Already planned |
| | - A larger refrigerator. | |
| | - More soundproofing and privacy screens to shield the lab from the hustle and bustle during meetings. | Rejected with explanations |
| | - Different positioning to prevent everyone from walking past it, creating more peace and quiet and reducing distractions from the environment. | |

Some changes in the laboratory's state before and after project implementation are illustrated in Figure 1: the result of the 5S methodology and the Kanban system [5] in a storage cabinet and the effect of assigning a student to be responsible for a certain area of the laboratory. The full scope of physical changes also included:

- Color-coding hazardous liquids (varnishes, paints, glues, etc.) and their corresponding storage.
- Floor markings to clearly demarcate different laboratory zones.
- Displaying photos of the "target state" for helping students to assist students in maintaining the desired level of order.
- Posting information boards with details about laboratory professors and employees.
- Installing three Kanban boards to track students' project progress.
- Creating foam inserts for tool organization.


**Fig. 1.** Photos of some laboratory areas before and after implementation the changes

The values of the "order function" calculated on various days during the preparatory and active phases are presented in Figure 2.

One of the goals of implementing Lean Management was to reduce the burden on laboratory employees and professors caused by disorder. In further conversations, the employees noted a decrease in student inquiries regarding the location of instruments. They also positively assessed the Kanban system, pointing out that it "smoothed out" the procurement process. The professor responsible for the laboratory and the course noted that the Kanban boards were highly convenient and time-saving for project discussions and reports. However, it was necessary for him to add the

topic of Lean Management to the agenda of each general meeting and be present during the monthly laboratory cleaning events.

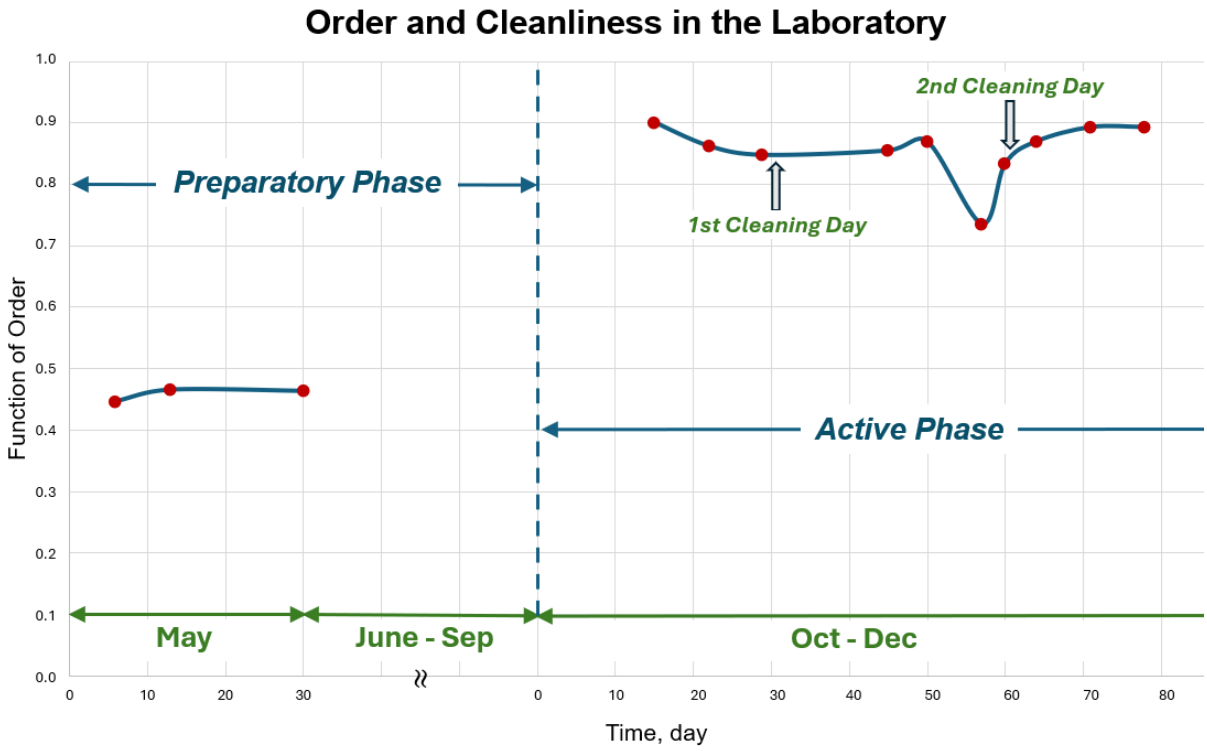


**Figure 2.** "Function of order" $f(N) = (1 + \alpha \cdot N)^{-1}$ vs time, where $N$ is the number of instruments and materials that were found not at the assigned places and $\alpha = 0.01$ is the scale coefficient

## 4. Discussion

The results of measuring order and cleanliness in the laboratory (see Figure 2) show that after implementing Lean Management number of items misplaced by students decreased by an average of five times. While the "order function" fluctuated over the three-month period, it consistently remained within the $0.7$ to $0.9$ range, whereas in the previous semester, it ranged from $0.4$ to $0.5$. These data allow us to conclude that the measures undertaken significantly improved the level of order and cleanliness within the laboratory.

However, to assert that this level will be self-maintained, observations must continue into the next semester. This is particularly important because the intensity of work in the laboratory increases noticeably during April and May, leading up to the *Shell Eco-marathon*.

Another question that cannot yet be answered at this stage of the research relates to the students' subjective evaluation of the changes. To address this, we plan to have students complete the same anonymous Moodle questionnaire at the end of the semester (February 2026). This will allow for a direct comparison of student perceptions before and after the implementation of the Lean environment.

## 5. Conclusion

In this study, we presented the first results of applying Lean Management at the student engineering laboratory "Schluckspecht" at the Offenburg University of Applied Sciences. This laboratory was planned to be a facility where students design highly efficient vehicles. As it is a student laboratory, the responsibility for maintaining order and cleanliness within the premises lies with the students who work there.

Our preliminary research revealed that both students and employees were dissatisfied with the state of the laboratory. By adopting Lean Management principles and involving students directly in the reorganization process, we achieved a noticeable improvement in the level of order and cleanliness in the laboratory. Measurements taken over a three-month period indicate that students who were

immersed in the environment with implemented Lean-tools were able to maintain the target laboratory state without significant additional efforts from either the staff or the students themselves.
The results indicate that Lean Management has a positive influence on the laboratory environment, which is consistent with existing reports regarding the implementation of Lean methods in traditional university laboratories.
Nevertheless, at least two questions remain unanswered at this stage. First, it is unclear whether students will be able to maintain the sufficient level of order as work intensity increases, particularly during the peak period of April and May. Second, the students' subjective evaluation of the reorganized laboratory remains to be fully assessed. We plan to address these limitations in future studies and explore the potential for transferring this experience to other student laboratories.

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