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Integration of A3 Thinking as an Academic Communication Standard

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Abstract

This paper discusses the integration of A3 Thinking as an innovative academic communication standard in industrial engineering. The paper begins by providing an overview comparison of A3 Thinking, a critical component in Toyota's PDCA management system, and traditional academic course communication methods. The paper highlights key areas in academics where the use of A3 Thinking has been used in industrial engineering courses to provide a vehicle of effective, value-added communication. The paper concludes with a discussion of benefits relative to integrating A3 Thinking, including reduced waste in teaching, learning, reporting, and evaluation. Also included is a discussion on the use of a collection of A3 documents as an individual portfolio to make industrial engineers more marketable in the job market.

Keywords
Toyota, lean, industrial engineering education, communication standard, A3 Thinking

1. Introduction and Literature Review

Industrial engineering encompasses an ever-growing spectrum of professional opportunities. As a matter of fact, the graduates of industrial engineering programs seem to enthusiastically embrace the ambiguous understanding of their field, believing it prevents them from being boxed in to the extent of other engineering disciplines. Yet in all its abstract diversity, the core of industrial engineering is designing, managing, and improving systems of processes through which value flows to create products or services. Since the inception of industrial engineering practices and education the entities that house these systems of processes have evolved and changed due to many factors, including advancement of technology, the increasing emphasis on the human side of engineering [1], and the changes in the means of manufacture. This evolution has triggered attempts at reforming industrial engineering education content to better align with the needs of industry [2]. This paper will discuss the application of a more fundamental, stylistic approach to upgrading how industrial engineering education is delivered to complement current efforts to upgrade the content of curriculum with modern tools.

1.1 Industrial Engineering Curriculum Development

A 2007 three-round Delphi study of over one hundred university faculty and industry professionals indicated there is a gap between industry needs and the academic teachings of industrial engineering [3]. This causes industry to have to invest precious training dollars into newly hired engineers to equip them with desired knowledge of emerging topics that were omitted from their college education. Among the topics of interest to industry are contemporary process improvement methodologies like lean manufacturing. However, a 2008 University of Alabama in Huntsville study on the coverage of lean topics in higher education curricula suggested a vast majority of the 101 surveyed institutions were beginning to incorporate lean material to at least some degree [4].

While there is evidence of progress with the inclusion of more modern topics in industrial engineering curricula, quite a bit of variation remains in the approaches taken by academic institutions and their effectiveness relative to meeting industry needs. Some universities offer these topics in undergraduate work while others offer it in graduate studies; some offer the topics as core courses while some offer them as electives; some offer the topics as a stand alone course, while others integrate the emerging topics into related courses throughout their curriculum [4].

Additionally, while developing a new curriculum for the industrial engineering program at Texas A&M University, researchers identified limits of traditional curriculum that hindered meeting industry needs—the foremost of which was characterized by a heavy emphasis on teaching tools as opposed to developing engineering problem-solving skills [5].

The findings of this literature review suggest a potential peril: the inclusion of topics of interest to industry, such as lean manufacturing tools, in industrial engineering curricula could still leave graduates unprepared to immediately contribute if those concepts are taught in the same manner academia has traditionally used. To truly align industrial engineering education with industry needs, efforts must go beyond the addition of new tools to curricula to include an over-arching emphasis on developing a problem solving style of thinking and communicating that can be used regardless of the tools being applied.

1.2 Toyota and A3 Thinking

With numerous books and thousands of journal articles featuring their practices, few companies in the world are as studied and analyzed as Toyota [6]. Prior to recent trouble, Toyota's sustained success over 70 years in the increasingly unstable automotive industry made the company a role model for any organization seeking comparable success. Many industries have witnessed an over-two-decade effort by experts, consultants, and researchers to assist organizations in mimicking the Toyota Production System, commonly referred to as lean manufacturing in the U.S., by implementing tools such as 5s, kanban, and total productive maintenance. These are the same tools currently being added to industrial engineering curricula to address industry's desire to hire those familiar with the concepts.

While these tools are important elements to Toyota's business they are only a reflection of a deeper organizational philosophy. Taiichi Ohno, the pioneer of the Toyota Production System, was adamant that the tools were just methods developed to address Toyota's business problems and are only used until better tools are found [6]. At the heart of Toyota's management framework is a relentless system that governs the use of their famous tools—the plan, do, check, act (PDCA) cycle. Originally developed by Walter Shewhart in the 1930s and later championed by Edwards Deming, the PDCA cycle is the embodiment of the scientific problem solving method. PDCA is so central to Toyota's management philosophy that they incorporate a standard method of communicating—A3 Thinking--that reinforces PDCA at all levels of the organization.

A3 Thinking is Toyota's way of using A3 reports as a standard form of communication throughout the organization at all levels. The idea is that every issue organizations encounter—proposals, problem-solving, status updates, and anything else—can and should be communicated on one sheet of paper, the A3 report [7]. A3 reports have their name because they are created on an international-size A3 piece of paper (approximately 11" x 17"). Conceptually, A3 is a series of boxes that tell the story of what is to be communicated from upper left hand corner to lower right hand corner. Various formats for A3 reports have been developed to communicate different types of information in many different industries who have adopted the practice [8]. However, Toyota is quick to point out that the beauty of A3 Thinking is that it is not the format that matters, but the process that guides the user and the audience clearly and visually through the PDCA thought process [7].

2 Applications of A3 Thinking in Industrial Engineering Education

Companies who utilize A3 Thinking as Toyota intends realize that the A3 process involves communication in two directions; the problem-solver who is the author of the A3 guides his or her PDCA cycle and assumes ownership while managers use A3 Thinking to mentor and teach [7]. The result is employees and managers at all levels constantly developing their ability to effectively plan, implement, and make decisions. Understanding this critical aspect of Toyota's PDCA management system presents a great opportunity for the academic employee (the student) and the academic manager (the teacher) to foster a more effective means of communicating beyond the traditional twenty page research papers and cumbersome PowerPoint presentations. A3 communication can produce graduates who are more properly prepared to communicate in such a fashion with their industry cohorts and college professors and instructors who become better mentors and teachers. The following are some illustrations of how the authors are using A3 Thinking as a standard communication tool in various degrees of interaction with students.

2.1 A3 Thinking as a Reporting Standard for Assignments

The Industrial and Systems Engineering and Engineering Management (ISEEM) department at the University of Alabama in Huntsville has taken a systems perspective of integrating lean tools throughout the undergraduate curriculum and has also made strides toward adopting A3 reports as the common language on which to report assignments [9]. Figure 1 illustrates the model the ISEEM department incorporates:

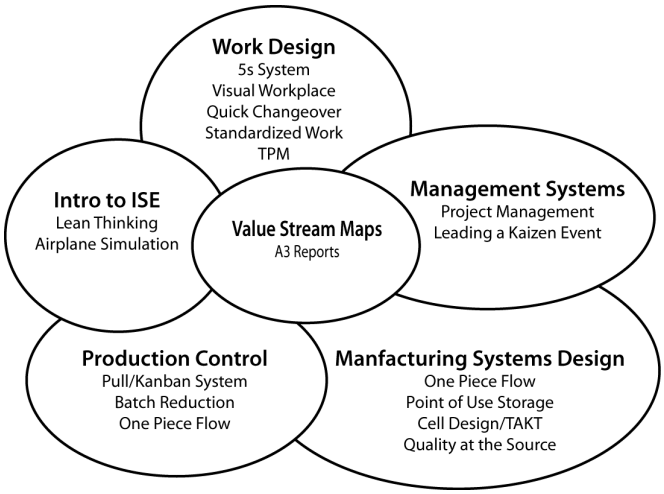

Figure 1: ISEEM Model Incorporating A3 Reports

An example of the implementation of A3 Thinking can be found in the ISEEM Systems Analysis and Design course, which serves as the capstone design course for graduating seniors. In addition to receiving lectures and training on A3 Thinking, student teams are assigned to projects with host companies from industry. The project teams are then given an A3 template that is used as the primary communication mechanism among the students, the course instructor, and the industry point of contact. Figure 2 shows an A3 template used by the ISEEM senior design teams:

Project Title:	**Team Members:**
Background/Scope/Goal: *Why was this project chosen? What process(es) are involved? How does this support the company's business objectives? What is the desired outcome?*	**Implemented Countermeasaures:** *-What were the countermeasures you implemented to address the problems and wastes discussed in the analysis section?* *-- Represent with sample pictures, diagrams, sketches, etc. if possible*
Current Situation: *Where do we stand currently?* *Describe the current state using sample pictures, flowcharts, diagrams, data, etc*	**Results/Benefits:** *-what benefits were achieved by implementing the countermeasures?* *-- Represent with sample pictures, tables, cost analysis data, or whatever is appropriate for the specific project*
Analysis of Waste and Key Problems: *-What waste and key problems exists in the current situation?* *-What are the root causes of the problems and waste?* *-What requirements, constraints, and alternatives need to be considered?*	**Follow-Up/Sustainment Plan:** *--What follow-up activities need to be addressed for implementation of this project to be complete?* *--What performance measures or activities should management focus on to ensure sustainment of this projects results?* *--Are there other concerns remaining relative to this project?*

Figure 2: A3 Report Template for ISEEM Design Teams

The student teams are given milestones throughout the semester at which they must present on each block of their A3 report. The instructor uses the A3 format to provide feedback and coaching at each milestone. Projects do not progress to the next block until the previous block is satisfactory. The PDCA cycle is reinforced as projects are "planned" as the project scope is developed, and the current situation is assessed, measured and analyzed. The "do" phase is accomplished as the design teams implement their recommended countermeasures. Results are measured

and benefits are quantified to accomplish a "check", and "action/adjustment" is achieved in the form of a follow-up sustainment plan. As a final deliverable, each student team provides all final presentation attendees with a simple one-page copy of the final A3 report. The respective presentations are made in a format following the same A3 flow, and the instructor is given a 3-ring binder of support documentation and material accrued during the project organized per each block of the A3. In this course, every interaction between students, the instructor, and the industry point of contact is driven through management of the A3 report.

Some instructors from the ISEEM department also teach classes in other colleges at the university and are spreading the idea of A3 Thinking. Students of the Operations Management course in the College of Business have been exposed to A3 Thinking in the form of an assigned case study to be analyzed and reported on using a simple one-page A3 report. Students are often relieved at the beginning of the semester to find they will not be required to perform the traditional multi-page written report, only to find themselves pondering at the end of the semester how to sort through the information they generated by using the PDCA cycle and fit it all on a single A3 document. Through involvement with organizations like the Lean Advancement Initiative Educational Network (LAI EdNet) and the Lean Education Academic Network (LEAN) members of the ISEEM department are also active in knowledge sharing with other institutions on the use of A3 Thinking in academia. Other university departments are able to benefit from learned best practices, such as the Rochester Institute of Technology's adaptation of A3 reports for use in preliminary and critical design reviews for their mechanical engineering cornerstone design course [10].

2.2 A3 Thinking as a Communication Standard for Course Administration

Because of the robustness of A3 Thinking, opportunity also exists to use it as the communication standard for various course administration needs. Flexible A3 formats are used to present course syllabi on one page in a concise, visual manner. This allows effective communication of course and instructor contact information, illustrations of course objectives and required text, expected outcomes, grading criteria, and course deliverables, and a semester schedule. Additionally, instructors may use various A3 formats to administer assignments and/or communicate class lecture notes. The more often A3 Thinking is used as a communication vehicle, the more familiar both the instructors and students can become with this critical component of Toyota's system. Also, if a student has a problem and must visit the instructor outside of class, the A3 format is helpful in ensuring the problem is properly framed before arriving and is effectively addressed in a timely manner.

2.3 A3 Thinking Used for Course Evaluation

Some instructors have even taken to using A3 Thinking as a way to garner feedback from students at the conclusion of courses, as opposed to the more traditional and impersonal forms of course surveys. An A3 template for course evaluation includes the following:

- Background- the students may state their name, major, and any other background information they choose to provide
- Current Situation- the students state what their expectations and impressions of the course were coming into the semester
- Goal- what were the students' goal in taking the course
- Analysis- what were the students' experience after taking the course relative to their expectations and goals
- The Good- students state the most valuable concepts or most memorable moments taken from the course
- The Bad- students provide feedback on ways to improve the course

Students typically become creative when preparing this evaluation A3 report. Their experience in creating the document develops a more personal atmosphere between the students and the instructor, the assignment is generally considered fun and relaxing, and it only further reinforces the A3 Thinking methodology taught during the course.

3 Benefits

Incorporating A3 Thinking as a standard communication tool in industrial engineering education has benefits for the students, the faculty, and the industries that hire graduates of the program. Embracing A3 Thinking can result in more value-added teaching, learning that is more compatible with industry needs, the development of more effective problem solving capabilities, and equipping graduates with resources that make them more marketable and effective.

Faculty who use A3 Thinking as the communication standard in their courses will have more time to provide value-added teaching. Instead of wading through lengthy, unwieldy term papers or presentations and grading them in

isolation, faculty members are able to engage in more frequent, dynamic feedback by managing A3 reports. A3 communication goes two ways, giving the course instructor many coachable moments with their students. Just like a manager's role in industry, faculty are responsible for using the A3 process to make sure their students understand their problem, develop appropriate countermeasures, and cultivate lessons learned [7].

Courses that properly utilize A3 Thinking to manage communication will provide more compatible learning relative to the needs of industry. Rarely will graduates find themselves in a job where their supervisor asks them to deliver a properly formatted term paper, complete with references, on his desk for a thorough review. Graduates are much more likely to encounter a situation where the knowledge and ability to use A3 problem-solving is applicable. Additionally, preparing assignments, papers, and reports using traditional methods allows the student to bury lifeless data among pages of potentially disconnected analysis. A3 Thinking forces the author to tell a story and communicate both facts and meaning. This brings the data and the reality of the condition to life and allows the reader to clearly understand the story within the context of the problem [7]. Individuals who are properly mentored through the use of A3 Thinking are forced to present facts, defend ideas, align improvements to meet goals tied to business objectives, and have a plan for sustaining. Ultimately, this results in graduates who are better problem-solvers and familiar with communication methods more common in industry.

Students who are well educated on, and familiar with, A3 Thinking throughout their industrial engineering education will be more immediately valuable to industry because of the more compatible learning experience mentioned above. In addition to this strong emphasis on the PDCA cycle that industry desires, A3 Thinking instills other critical aspects into its disciples--a keen focus on synthesis, alignment, coherency, and systems thinking [6]. Students with experience in A3 Thinking also have the opportunity to make themselves more marketable to potential employers. Imagine the advantage an applicant who could provide numerous one-page visual summaries of real project work would have over another applicant who simply had a resume. Industrial engineers can use their collection of A3 reports as a personal portfolio complete with innovative documentation of their professional work.

4 Summary & Conclusions

Industrial engineering is a discipline that exists to enhance systems of processes, and as those systems evolve the discipline must evolve as well. Research has shown evidence that efforts have been made to update material in industrial engineering curriculum to include tools popular in today's industry. However, indications from industry suggest that simply learning modern tools under the traditional framework and thinking process of academia still left a gap in meeting the need of available problem-solvers. An investigation into industry power Toyota reveals that the company's insiders attribute their history of success less to the popular tools associated with Toyota and more to the rigorous PDCA thinking process that is engrained at all levels throughout the organization.

Integrating A3 Thinking, the critical component that drives Toyota's PDCA management system, as the standard method of communication in industrial engineering education provides an opportunity to better meet industry needs by providing learning that is more compatible both in language and in content with what graduates will experience in the workplace. The use of A3 Thinking also allows a more enriching, empowering relationship between faculty and students through fostering dynamic dialogue throughout the A3 process, strengthening both the students' abilities to be good problem solvers and the instructors' abilities to be better teachers and mentors.

In closing, it is recommended to any institution interested in implementing A3 Thinking to follow the same process *Lean Thinking* suggests to industries looking to begin their lean journey. Step one is to find a change agent who believes this is the right thing to do, sees the value in the benefits, and is committed to making it happen. Second, that change agent must obtain the knowledge of proper A3 application by seeking the mentorship of industry professionals astute in the area. Inviting qualified professionals to partner or even join the faculty could only strengthen a department's efforts in establishing this reform. Third, seize a crisis that gives urgency to the change. If industry's outcry for industrial engineers to be better problem solvers upon graduating is not enough to provide a sense of urgency to investigate A3 Thinking I would challenge those of that opinion to look internally at their own commitment to the industrial engineering cause. Step four is to identify the value stream--those processes that directly convert raw material (incoming students) into desired finished goods (adept problem-solving graduates)--and develop a holistic view of that value stream. The final step is to get started [11]. Using examples given in this paper and any other related resources, progressive industrial engineering programs can begin piloting A3 Thinking immediately at the individual instructor level, course level, or department wide. Much like Toyota, the future of industrial engineering education's success will be less dependent on the occasional addition of trendy tools and more

dependent on instilling a foundational method of thinking, teaching, and learning that withstands the test of time and is just as effective when better tools are found.

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