# Incorporating the 5S Philosophy into a Modern Engineering Education Program at Texas A&M University-Commerce

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Abstract

Professional aviation organizations, National Association for Stock Car Auto Racing (NASCAR) teams, Indy Racing League (IRL) Teams, and Championship Auto Racing Teams, Inc. (CART) have known about and practiced the principles of 5S for years. The 5S acronym stands for 1) Sort, 2) Set in Order, 3) Shine, 4) Standardize, and 5) Sustain. Simply stated, it encompasses the philosophy of workplace safety wherein there is *a place for everything and everything is in its place.* Faculty members in the Industrial Engineering Program at Texas A&M University-Commerce (TAMUC) are developing a curriculum-wide exposure to the 5S Philosophy to introduce students to the importance of workplace safety as it affects enhanced job performance, reductions in lost productivity, and smaller workmen's compensation claims, to name a few. Sensitivity to workplace conditions helps foster a life-long appreciation for well organized work environments, by insuring that the correct tools are available when needed and where needed since they are where they are supposed to be and they are clean and in good repair. Correspondingly, 5S policies help managers and workers focus on effective process improvements without getting bogged down in workplace organizational activities that tend to waste time and energy with little effect on true productivity improvements. In addition, the 5S philosophy is used as vehicle to introduce lean manufacturing philosophies into the workplace and to help reinforce positive technical communication skills. Students from two classes at TAMUC are initially being exposed to the 5S Philosophical elements. This paper describes the 5S Philosophy an provides a high-level description of how it is being implemented in *IE 101 – Introduction to Industrial Engineering* and in *IT 340 – Quality Management and Improvement*. Future classes will be added to the program as appropriate, to reinforce the importance of the 5S model. Additional engineering tools are also being planned for cross-curriculum integration in the near future.

## Introduction

The race is won in the pits! Teams from the National Association for Stock Car Auto Racing (NASCAR), Indy Racing League (IRL), and Championship Auto Racing Teams, Inc. (CART) use the principles of 5S to improve their performance in an environment where extra fractions of a second spent during pit stops can mean the difference between victory and disappointing defeat. This is clearly demonstrated by the fact that for the racing speeds at this level of competition (approximately 200 miles per hour or more), one second of travel equates to

approximately 300 feet on the racetrack. For anyone who has witnessed the close competition of a 40-car NASCAR race at a speedway like Daytona Beach, Florida or Talladega, Alabama, 300 feet could easily mean the difference between a first place finish and 30th place finish (or worse). This variability in the final results would place the 30th place team well down in the "points standings" and far below the high dollar awards paid to the top performing teams.

Surgeons have specific instructions for the order and content of surgical trays to save critical – potentially life-saving – seconds in the operating room. Factories organize their workspaces and streamline work processes using 5S techniques. A factory can increase their flexibility and reduce costs by *dramatically* reducing setup time and batch sizes. One case study that exemplifies the improvements realized by using 5S and Lean Manufacturing (***Lean***) processes is reported by TA Manufacturing [1] wherein *Productivity* was increased by 95%, *Quality Level* was increased to over 99.5% *customer acceptance*, *Work-In-Process Inventory* was reduced by 65%, *Lead Time* was reduced by 27%, and *Floor Space* requirements were reduced by 73%.

To expand the knowledge base of students in several undergraduate courses and to allow students to apply this knowledge, Industrial Engineering (IE) students and Industrial Technology (IT) students are being introduced to 5S and Lean Manufacturing Philosophies much earlier in their educational program. During the Fall 2004 semester, students from two classes (one freshman-level and one junior-level course) at TAMUC were exposed to the 5S philosophy.

## 5S Basics

Industry has known about and practiced the principles of 5S for years. With 5S, employees create and maintain a work environment that is safer, cleaner, more organized, and more efficient. Moreover, employee attitudes and morale can also improve as they operate in a more organized, less frustrating work environment. The 5S acronym stems from a Japanese system that defines 5S as: 1) Seiri, 2) Seiton, 3) Seiso, 4) Seiketsu, and 5) Shitsuke [2]. The English-version of the 5S Philosophy stands for 1) Sort, 2) Set-in-Order, 3) Shine, 4) Standardize, and 5) Sustain. Simply stated, it encompasses the philosophy of workplace safety wherein there is a place for everything and everything is in its place – and it is kept that way. **"Five S (5S)** is a visually-oriented system of cleanliness, organization, and arrangement designed to facilitate greater productivity, safety, and quality. It provides a foundation for more responsible behavior on the job—better work, better products, better morale." [3]

### Step 1: Sort

The goal of ***Sort*** is to have a workspace with only the bare essentials required to do the tasks. One way to attack this problem is to develop a task/tool matrix. First, one lists the tasks to be performed in the workspace. Second, one lists the tools required to perform those tasks. The focus is placed on bare essentials, not 'just in case' tool storage. A matrix is then developed that matches tasks to tools, recognizing the fact that tools may be needed for more than one task. The catch phrase for this step is "when in doubt, move it out". Tools or items are divided into two categories: 1) *Must Have* and 2 *Red-Tagged*. The team places a red tag on items that are not essential to the tasks defined in the analysis phase. The red-tagged items are then moved to a

designated holding area for further evaluation and disposition. The tag identifies the item, date, tag number, department and disposition. Typically there are four types of disposition: 1) Move to another location, 2) Return to the area, 3) Sell the equipment/tools, or 4) Throw away or donate the unnecessary tools and equipment.

A messy workplace is not the only indicator of the need for 5S. In fact, many clean and tidy workplaces are not efficiently organized to facilitate the flow of work. A flow diagram (sometimes called 'spaghetti' diagram) for a process displays the path traveled by persons or equipment to perform a process, or the path traveled by a part to be processed. If these paths are long or show back-tracking, there is a potential to use the 5S philosophy. If people are constantly hunting for parts or fishing in drawers or cabinets for parts, then there is a potential for the use of 5S to make big improvements (see Figure 1). In Sort, the team should draw a current state flow diagram that shows the path taken for each of the tasks, the linear feet traveled for each path, and the square footage consumed by the workspace.

Disorganized Tools

Sorted Tools

Figure 1. An Example of Disorganized Tool Storage versus a Sorted Tool Storage System

Step 2: Set-in-Order

***Set-in-Order*** is designed to find a place for each item needed in the workspace at their point of use. This means that the workspace will need to be rearranged to improve the work flow. The team creates a future state work flow diagram. The diagram shows where tasks are to be performed and what items are needed for those tasks. The path taken for each of the tasks is drawn and the linear feet traveled is totaled. The team compares the travel distance and square footage of the current state and future state diagrams. The team labels both the item and their storage space. The 5S workplace uses visual controls. Labels are used to identify each item and their storage location. Shadow boards are created to identify what items belong in certain locations and whether or not they are present (see Figure 2). Floor tape is often used to identify the borders of areas as appropriate.

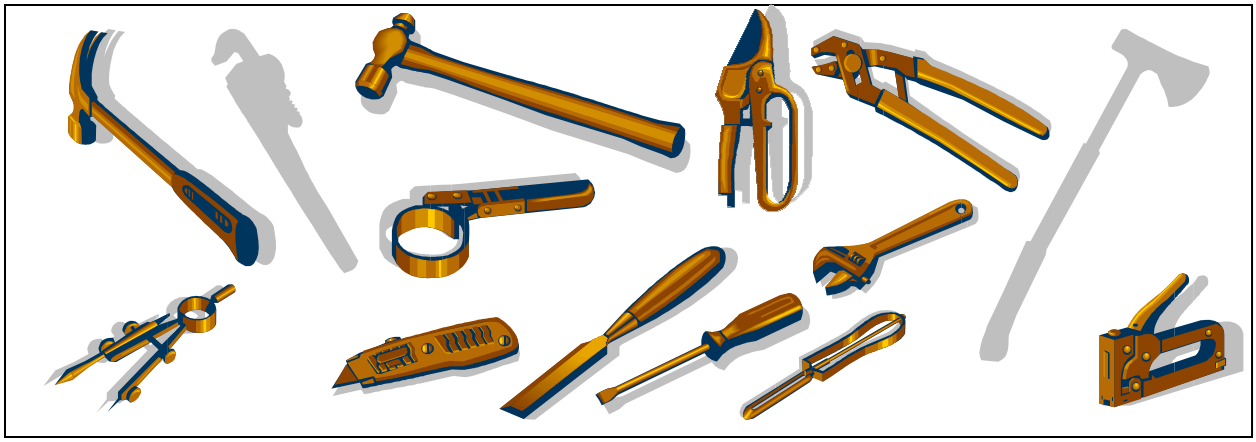

Figure 2. An Example of a Shadow Board used in the Workplace

Step 3: Shine

The goal of ***Shine*** is to create a safe, clean and waste-free work environment. By working together, the team sweeps the area, scrubs and cleans the equipment and tools, paints areas and equipment that needs to be painted, and repairs those items that require repair. The team creates a list of daily shine activities and responsibilities. This list is normally posted in the work area.

Step 4: Standardize

***Standardize*** incorporates ***Sort***, ***Set-In-Order***, and ***Shine*** as part of the daily work routine. Using visual controls, the team agrees to what is to be put where by whom and how often. Photographs of the workplace are taken and posted as visual documentation of what the workplace should look like. Visual aids for the workplace tasks are documented. The team documents procedures for sort, set-in-order, and shine.

Step 5: Sustain

***Sustain*** is emphasized to instill the self-discipline required to maintain the area in a clean, organized, and safe condition. The team schedules audits of the area to check for each of the 5S's. During the audit, the area is scored. The audit score sheet is posted in the area. The team also asks for improvement suggestions from other team members and other stakeholders.

Incorporating 5S into the IE Curriculum

As part of a current Industrial Engineering curriculum-wide assessment, in preparation for an Accreditation Board for Engineering and Technology (ABET) accreditation visit during 2005, faculty members in the Industrial Engineering Program at Texas A&M University-Commerce (TAMUC) are developing a multi-phase exposure to the 5S Philosophy. This exposure will introduce students to the importance of workplace safety and its impact upon job performance, productivity, and workmen's compensation claims, to name a few. In addition, the 5S philosophy is being used as a vehicle to introduce the ***Lean*** philosophy to our students and to enable students to master and apply their technical communication skills. Initially, two courses at

TAMUC, *IE 101 – Introduction to Industrial Engineering* and *IT 340 – Quality Management and Improvement*, are being used to introduce the 5S Model to IE and IT students. These two courses will also serve as a baseline for future curriculum evaluations as the 5S Model is incorporated into other courses. These two courses were selected due to an inherent alignment of the 5S model with faculty interests and course content. The educational component is designed to introduce students to the 5S *early* in their academic program and to *reinforce* the learning process by emphasizing and expanding the concept during future courses. Initially, the students learn the 5Sconcepts and conduct a simple implementation. In other courses, later in the curriculum, the students will build upon their early learning process and will expand their skill set as they discover additional applications for the 5S Philosophy.

Introduction to Industrial Engineering (IE 101)

Introduction to IE covers basic engineering principles, foundations of Industrial Engineering, design methods, problem-solving, SI units, engineering ethics, and communication. As part of a strong foundation for IE, the students are exposed to lean (the lean manufacturing process that is based on the Toyota Production System). The focus of lean is to increase speed, increase value, and reduce waste. Two of the seven wastes of lean are 'transportation' and 'motion' waste. The 5S approach specifically addresses these two wastes through workplace organization and rearrangement of the workspace in line with work flow. The instructor's lectures contain lean philosophy, seven wastes, 5S philosophy and techniques, and photographs of real-world examples of 5S.

In this Fall 2004 freshman level course, students were divided into teams of 5 to 7 members. They identified potential targets for 5S implementation and reviewed them with the instructor. The instructor's role was to help scope the project and to ask the team questions about resources, permissions, and schedules. The teams planned their projects and described their plans to implement 5S into each project. To plan their projects, the teams were given two one-hour class periods to discuss their projects with each other and with the instructor, as needed. Two additional class periods were devoted to the team's meeting and to conducting their 5S implementation. It should be noted that the implementation actually takes more time to complete than is allotted in class, therefore student teams must plan to use time outside of class to develop an effective project. Teams typically devoted six to eight hours conducting their individual 5S implementations. Communication of each team's results was emphasized. Each team prepared both a formal, written report and a class presentation. The quality of each report was expected to be at a level where team members would be able (*and willing*) to add the project to their portfolio of work. The portfolio is an appropriate document to take to job interviews and may also be used as an artifact of student work during the upcoming ABET accreditation process.

Quality Management and Improvement (IT 340)

Quality Management and Improvement (IT 340) is a junior-level course that covers the fundamental constructs of the Quality movement, including quality improvement methodologies cited by various authors and practitioners throughout industry today. IT 340 is a combined textbook-based and current issues-based course that requires substantial outside research to complete a semester-long team project. The projects focus on current quality initiatives or

quality programs. Even though teams were not specifically required to implement the 5S Philosophy into their research, many determined as a result of their research that 5S was appropriate for their domain. Of the nine team projects presented to the class during the Fall 2004 semester, five of the project teams identified 5S as a leading component in their specific area. These five projects included Six Sigma projects at Motorola and General Motors, Quality Control in Manufacturing, Lean Manufacturing, and Six Sigma to CMMI (Capability Maturity Model® Integration). The remaining four projects were more focused on quality processes used in specific industries such as: Wal-Mart Cold distribution Center, Evolution of Automobile Safety Standards, Just-In-Time Manufacturing, and the Malcolm Baldrige National Quality Award Program.

The 5S Model was also introduced to students enrolled in IT 340 as part of the in-class lecture process (specifically, Chapter 16).[4] In future semesters when IT 340 is offered, a more detailed 5S scenario will be developed and implemented, in order to build upon the background provided in courses like IE 101 . The vision of the faculty, by combining related topics across multiple sections, is to reinforce the most important elements of an IE degree program and enhance student mastery of discipline specific tools. The 5S model serves as the first of many such cross-course and cross-section opportunities.

## Plans for the Future

The Industrial Engineering faculty at Texas A&M University-Commerce are involved in a curriculum-wide review of courses and course content, with the help of various stakeholders including the faculty, the students, the members of the IE Industry Advisory Board, and others, as part of the Accreditation Board of Engineering and Technology (ABET) Self-Study preparation process. Engineering tools, such as the 5S Model addressed in this paper, have been discussed, to help build an integrated IE curriculum that reinforces key concepts within each course as students proceed through the curriculum. Other examples of this curriculum-wide integration effort involve the cross-course usage of complementary engineering tools such as:

1) AutoCAD, Solid Works and Delmia 3D Engineering Drawing tools
2) Excel and MiniTAB
3) Full integration of the Microsoft Office Suite, including:
   Word, Excel, Access, PowerPoint, Project, Visio, Publisher, and an Introduction to Visual Basic for Applications (VBA) Programming.

## Conclusion

Students in the Industrial Engineering program at Texas A&M University-Commerce are being introduced to tools and techniques that will be used throughout their academic program and throughout their chosen careers. The IE faculty team at Texas A&M University-Commerce is attempting to break the cycle of courses that often appear to be isolated, in the eyes of the students. The contents of the course must continue to meet the stated objectives of each course within the curriculum, however, students must also recognize that many of the skills they master in one course will be utilized and developed as they progress through the curriculum. A primary objective in conducting the cross-curriculum assessment is to help students recognize the need

for curriculum-wide integration of knowledge and skills as they progress through their courses. At Texas A&M University-Commerce, the IE Faculty are taking the advice of Kevin Saunders [5] by adding a sixth "**S**" to the existing 5S Philosophy – that is "Getting **S**tarted Now." By creating the baseline study during the Fall 2004 semester, it is anticipated that the resulting cross-course flow of engineering tools within the TAMUC program will enhance the student's ability to understand and apply important IE tools in other courses offered later in the student's programs. We believe this approach will ultimately lead to better-prepared students as they enroll in upper division courses in the IE curriculum and will further enhance the entry-level skills of graduates who enter the workplace soon after graduation. Once students understand the benefits of 5S and other process improvement techniques, it will empower them to make world-class improvements in the organizations they join. By understanding and implementing these techniques, they too may be able to achieve those precious "seconds" needed to cross the finish line first and share in the substantial rewards that are waiting for them and their organizations.

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## Biography


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