

Team Time Cards: a Tool to Increase Accountability and Reduce Social Loafing in Senior Design

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A common problem in larger Senior Design teams involves "social loafing", where some students fail to contribute their fair share of the work. A team time card system has been developed that provides both the instructor and fellow team members visibility on the efforts and contribution of each student. In the system, each member of the team records weekly project activities and hours worked, and the team leader consolidates and uploads the data as a single team deliverable that all members can see. The instructor uses data from the team time cards along with peer feedback results and faculty observations to generate an instructor evaluation grade for each student twice a semester. The time card and instructor evaluation process was efficient to implement, was well-received by the students, and when used in conjunction with frequent peer feedback, appears to have improved accountability and reduced social loafing for two cycles of senior design students. This system may be particularly helpful for Capstone instructors with large classes and teams who are seeking greater visibility on team processes and more quantifiable data for evaluating individual effort.

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Introduction

The practice of engineering requires individuals to work with others towards a common goal, and engineers spend a surprisingly large amount of time interacting with other people to coordinate and complete work.¹ Capstone Design is typically a team endeavor that allows engineering students to practice "soft skills" such as teamwork and communication that are so essential for work as professionals.²

Though the senior design experience provides an ideal opportunity for students to practice and develop teamwork skills, instructors must deal with the problem of some students "coasting" on the work of others, possibly due to a lack of commitment to the project or poor leadership and delegation skills within the team. In psychology, this behavior is called "social loafing", where individuals work less when they are part of a group and do not contribute their fair share to a project.³ A review of Senior Design research identified social loafing as the most prominent negative behavior in student teams in recent literature, though different terms were used to describe the condition.⁴ Social loafing tends to increase with team size.³

At Florida Tech, Aerospace Engineering majors take a three-semester Capstone Design sequence- a one-credit Junior Design class in the spring (MAE 3291), and two three-credit Senior Design classes (MAE 4291 and MAE

4292). Aerospace projects are complex and costly, and teams tend to be large, averaging eight students per team. Teams are self-organized and pick their own team leaders. One instructor is responsible for grading the entire class (a typical class size is 75 students), though other faculty may act as technical advisors to individual teams. Student grading is based on team products (60%), peer feedback (20%), and individual participation (20%).

Most of the real work of capstone design occurs within the team, and in large classes with large teams, the instructor may have difficulty sorting out individual contributions. This paper describes how team time cards have been used in conjunction with peer feedback to provide an individual evaluation grade as part of Aerospace Senior design. The motivation was to develop a system that was predictable, transparent, and based on quantifiable data (i.e., perceived to be "fair"), while making the process efficient for the instructor and the team.

The Team Time Card System

In industry, the term "time card" is used to describe a record of an employee's work effort; the original time cards recorded starting and quitting times stamped by a time clock. In industry, time card data is transmitted from employee to supervisor and not shared with peers. "Time cards," "time sheets", and "time logs" are used in

some capstone design programs in an effort to monitor project status⁵ and to simulate the industry experience,⁶ but little is published about how this data is used as part of course grading or whether it is shared with others on the team.

At Florida Tech, a "team time card" system was first implemented in spring 2017 for 75 students assigned to nine teams in Aerospace Senior Design 2 (MAE 4292). The average team had eight members, but sizes ranged from five to thirteen members, depending on project complexity. The system is described below:

- Teams receive a time card template spreadsheet with tabs for individual members, a weekly team summary, and a team semester summary tab.
- Every week each team member completes his/her own tab to report hours worked, the time and place of the work, and what was accomplished (Figure 1).
- Team leaders review and consolidate individual team tabs each week and enter weekly totals into the summary tab (figure 2).
- The team leader then uploads the consolidated time card to the online grade book as a team assignment. This enables all team members to see the work reported/performed by other members of the team.
- Twice a semester, the instructor consolidates rows from each team's semester summary into a single large spreadsheet that is used as input to the instructor evaluation. By having all the data in one spreadsheet, comparing effort across teams and individuals was a straightforward process.

TEAM NAME: Team Awesome				
WEEK: WEEK 1- Jan 9th-15th		WEEKLY STATUS FOR: Your Name Here (JOHN DOE)		
Day	Location(s) & Time	Activities, Contributions		
Mon	Class Lecture(3-4); Team meeting- Library (4-5); At home (9-9:30pm)	Lecture: Required attendance. Team Meeting: agreed to get drawing feedback from Mr Jones & look at CDR feedback for my section.	Mon TOTAL	2.5
Tues	Machine shop (2-230); Computer lab 4-5	Mr Jones drawing feedback. Fixed dimensions on page 2, texted Madeline about her subsystem	Tues TOTAL	1.5
Wed	GDT Lecture 3-5	Required lecture, follow-on meeting	Wed TOTAL	3
Thurs	0		Thurs TOTAL	0
Fri	0	Missed mandatory lecture- FIT Soccer "away game". Coach sent emails to all instructors	Fri TOTAL	0
Sat	0		Sat TOTAL	0
Sun	0		Sun TOTAL	0
WEEKLY TOTAL				7

Figure 1: Individual Time Card Template

TEAM NAME: TEAM AWESOME							
TOTAL HOURS PER SEMESTER							
Team ID	Student Name	Week1 TOTAL	Week2 TOTAL	... continued	Week 14 TOTAL	Week 15 TOTAL	TOTAL HOURS TO DATE
Team Awesome	Doe, John						
Team Awesome	Kent, Clark						0
Team Awesome	Albright, Madeleine						0
Team Awesome	Feynman, Richard						0
Team Awesome	Curie, Marie						0
Team Awesome	Tolkien, JRR.						0
Team Awesome	Ataturk, Mustafa						0
Team Awesome	Ride, Sally						0

Figure 2. Team Semester Summary- Template

Peer Feedback

Peer feedback is a well-established practice in senior design classes.⁴ At Florida Tech, 20% of the Aerospace senior design grade comes from four peer feedback surveys each semester administered through the Comprehensive Assessment of Team Member Effectiveness (CATME) online peer feedback system.^{7,8} The system allows students to anonymously rate their team members. Once the instructor reviews and releases the data, the CATME system sends qualitative feedback directly to the students and provides the instructor an adjustment factor for use in grading. Formulas are used to convert an "average" peer feedback score into a grade of 85% and a "best possible" peer feedback score to a grade of 100%. This scaling is identified in the course syllabus, which helps to calibrate student expectations. All scores are posted to an online grade book visible to the students, allowing them to make adjustments in how they interact with their team.

The CATME system also allows students to provide private comments to the instructor on how the team and its individuals were working (or not working). These peer comments and the numerical peer feedback grade are used along with time card hours as part of the instructor evaluation grade described below.

Instructor Evaluations

In both aerospace senior design classes, 20% of the grade comes from "Individual Participation", which consists of two instructor evaluations each semester along with attendance, in-class exercises, and individual writing assignments. As stated in the syllabus, "The instructor evaluation considers time card data, input from staff members, faculty and industry advisors, feedback from student leaders and peers, and the subjective assessment of the course instructor."

To come up with a grade, first the instructor developed a formula using a weighted combination of hours worked and peer feedback grades, and then the result was adjusted up or down based on qualitative factors for each student. These qualitative factors included the quality of student contributions to team

products, CATME peer comments, input from machine shop staff, faculty advisors, industry mentors, and direct observation by the instructor. As stated in the course syllabus, "In rare cases, serious behavior issues, significant ethical lapses, or non-contribution to the team may result in a zero score for the instructor evaluation."

Effects of the Time Cards in Spring and Fall 2017: Perceived Advantages and Drawbacks

In spring 2017, team time cards and the instructor evaluation were first implemented in MAE 4292, Senior Design 2. In this class, student teams work independently to fabricate, test, and display their products at Student Showcase, where all senior design projects are judged by a panel of industry experts. Because instructor meetings with individual teams were infrequent during this semester (once every two weeks), the time card system was established to provide some insight into the team processes.

At the end of the course, all 75 students wrote a 500-word essay about their "lessons learned" in the areas of technical product development and working with teams, and some students used the assignment to provide unsolicited input on the time card system. Their enthusiastic response is of particular interest because these students had completed Senior Design 1 (MAE 4291) with the same teams without the time cards, so they have a sense of how the time card system affected team dynamics.

- "The time cards really show who is doing what and why stuff is or isn't getting done. Time cards were a brilliant idea and should have been implemented sooner in my opinion."
- "Team members are more accountable and willing to put in work when their grade depends on it. This was seen through the implementation of timecards during the second semester."
- "The implementation of timesheets ensured that team members were being held accountable for the work they were assigned, and also to ensure that team members were being recognized for the amount of time and effort they put into the project.... I think that in future Capstone Design cycles the time sheets should be implemented at least by the start of the first Senior Design class, MAE 4291... This can also supplement the CATME surveys by providing more insight into whether team members are contributing fully and equally to the project."

Based on this perceived success, in fall 2017 time cards were introduced to a new student class as part of Senior Design 1, MAE 4291. The new class had 78 participants allocated to eight teams. Time card data entry was a primary factor in the first instructor evaluation, and a

change in hours logged was noted in the second part of the class. Most students with the lowest reported hours for the first half of the semester increased their reported hours worked.

- 84% of the students in the bottom third of the class increased their weekly hours logged
- 76% of the students in the middle third of the class increased their weekly hours logged
- 35% of the students in the top third of the class increased their weekly hours logged.

Summary of Perceived Benefits

The following benefits were noted when the time card system was used:

- Increased instructor insight into team processes- useful for both team guidance and disciplinary action, if needed.
- Objective input to the instructor for grading individual effort. Total hours worked provided one (but only one) measure of an individual's contribution to the team.
- Objective data for team members to use as part of their peer feedback- all students on the same team see each other's time cards
- Increased student appreciation of peer efforts. In large teams, not all members are aware of what others are doing. The time card system provides greater visibility on contributions of the more quiet members, both those who are naturally reserved or are not fluent in English.
- An explicit grade motivation for low-effort students to modify their behavior, since time cards factor heavily in the instructor evaluation grade.

Potential Issues and Preventative Measures

Two issues have been identified as part of this system:

- Some students may over-report their work effort and falsify their time cards.
- Hours worked do not always equate to contributions to the team. Some students may be very efficient, and feel they are penalized by the system; others may spend hours on activities that do little good to the team.

To minimize the likelihood of these issues occurring and to reduce the impact if they do occur, the following preventative measures were built into the system:

- Throughout the course, students are warned that falsification of time card data was an example of an "ethical lapse" that would result in an adverse (zero) instructor evaluation grade.

- Students must log contributions, not just hours worked.
- Student leaders must approve time cards and are asked to look out for disconnects between hours logged and contributions to the team.
- Time card hours worked are only one input to the instructor evaluation grade. Hours reported are compared to peer feedback grades, which helps to identify both efficient top performers and those who report many hours but contribute little to the team.

As long as the instructor retains the right to include subjective factors in the instructor grade, the system appears to have more benefits than drawbacks.

Though the initial implementation of time cards has been encouraging, more work is needed to refine the system and quantify its effects. At the end of the semester, the seniors of the 2017-2018 capstone class will be invited to participate in a research survey to better understand student perceptions of time cards and their potential usefulness in reducing social loafing. Others have noted that team effectiveness theory from industrial and organizational psychology may be helpful in dealing with student teams⁴. The instructor is currently collaborating with the School of Psychology at Florida Tech to evaluate team dynamics and trust in aerospace capstone teams⁹; additional collaboration may yield insights on how to further improve the time card system and to better prepare student team leaders to deal with the challenges of holding their teams accountable.

Conclusions

Team time cards have been implemented for two large class for two cycles of aerospace senior design. A total of 75 students on nine teams first used the system in Spring 2017. A second group of 78 students on eight teams used the system during the 2017-2018 year. Initial results are highly encouraging; when used as part of an instructor evaluation and in conjunction with peer feedback, time cards appears to reduce social loafing and improve accountability among team members. Most students like the system since it allows the instructor and their team members to see the effort they are putting into the project. The system also provides data the instructor can use to encourage all students on every team to be fully engaged and contribute their best efforts. More work is planned to quantify the effects of the system and improve its implementation.

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