

Using Team Time Cards to Encourage Accountability in Senior Design Projects

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Abstract

In senior design projects, it is often a challenge to hold all students on a team accountable for their fair share of the work, and the problem becomes worse for large teams. A "Team TimeCard" system has been developed that provides both the instructor and team members more visibility on the efforts and contribution of each student working on a senior design project. 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, and students can use the time cards as input to their peer feedback evaluations. Initial results with three cohorts of aerospace engineering senior design teams are encouraging; the Team TimeCard system appears be a useful tool to confront "social loafing" or "freeriding"- where some students fail to contribute their fair share of the work. This system may be particularly helpful for Capstone instructors with large classes and large teams who are seeking greater visibility on team processes and more quantifiable data for evaluating individual effort.

Introduction and Background

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 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 such as "coasting" or "freeriding" were used to describe the condition [4]. Social loafing tends to increase with team size [3].

At the Florida Institute of Technology (Florida Tech), aerospace engineering majors take a threesemester Capstone Design sequence- a one-credit Junior Design class in the spring, then two three-credit Senior Design 1 and Senior Design 2 classes. 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 project managers after being assigned to a team. One instructor is responsible for grading the entire class (a typical class size is ~70 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 1 and Design 2. The motivation was to develop a system that was predictable, transparent, and grounded upon quantifiable data (i.e., perceived to be "fair"), while making the process efficient for the instructor and the team. The Team TimeCard system was first described at the 2018 Capstone Design Conference [5], and this paper reports the results of surveys that provide insight on how students perceive and respond to the system.

The Team TimeCard System

The "Team TimeCard system" as described here has at a minimum of two elements: a time card record of hours worked by the student, and an instructor evaluation grade based on both reported hours and peer feedback. In this paper the term "TimeCard" refers to the combination of the time card record and the instructor evaluation grade.

Time Card Records. In industry, a "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 modern workplace settings, time card data is transmitted electronically 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 status [6] and to simulate the industry experience [7], 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, the Team TimeCard system was first implemented in spring 2017 for 75 students assigned to nine teams in Aerospace Senior Design 2. The average team had eight members, but sizes ranged from five to thirteen members, depending on project complexity. The process of collecting time card records is described below:

- Teams receive a time card template (i.e. an Excel 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 (Table 1).
- Student project managers (i.e., team leaders) review and consolidate individual team tabs each week and enter weekly totals into the summary tab (Table 2).
- The project manager then uploads the consolidated time card record to the online grade book as a team assignment. This allows all team members to see the work reported 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 is a straightforward process.

TEAM NAME: Team Awesome: WEEK 1- Jan 9th-15th WEEKLY STATUS FOR: Your Name Here (JOHN D						
Day	y Location(s) & Time Activities, Contributions			urs)		
Mon	Class Lecture (3-4); Team meeting- Library (4-5); At home (9-9:30pm)	Lecture. Team Meeting: agreed to get drawing feedback from Mr Jones & look at CDR. At home incorporated CDR feedback	Mon TOTAL	2.5		
Tues	Machine shop(2-230); Computer lab (4-5pm)	Mr Jones drawing feedback. Fixed dimensions on page 2, texted Madeline about her subsystem dimensions.	Tues TOTAL	1.5		
Wed	GDT Lecture 3-5 pm	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		
	L		WEEKLY TOTAL	7		

Table 1. Time Card Template: Weekly entry by each individual

 Table 2. Time Card Template: Team Semester Summary

TEAM NAME: 1	TEAM AWESOME		TOTAL HOURS PER SEMESTER							
									TOTAL	
		Week1	Week2	Week3	Week4		Week 15	Week 16	HOURS	
Team ID	Student Name	TOTAL	TOTAL	TOTAL	TOTAL	continued	TOTAL	TOTAL	TO DATE	
Team Awesome	Doe, John								0	
Team Awesome	Kent, Clark								0	
Team Awesome	Curie, Marie								0	
Team Awesome	Tolkien, JRR.								0	
Team Awesome	etc								0	
Team Awesome	Ride, Sally								0	
	TOTAL HOURS:	0	0	0	0	0	0	0	0	

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 directly from four peer feedback surveys each semester administered through the Comprehensive Assessment of Team Member Effectiveness (CATME) online peer feedback system [8, 9]. 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. Though the CATME adjustment factors are often used to adjust team grades upward or downward for individual assignments, in this class 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 as the semester progresses.

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 reported hours as part of the instructor evaluation grade described below.

Instructor Evaluations. In 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 develops a formula using a weighted combination of hours worked and peer feedback grades, and then the result is 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."

Initial Launch of TimeCards in Senior Design 2 (2016-2017 Capstone Cohort)

In spring 2017, team time cards and the instructor evaluation were first implemented in Senior Design 2. In Senior Design 2, teams work independently to fabricate and test the product designed in Senior Design 1. Because instructor meetings with teams were infrequent (once every two weeks), time cards and the instructor evaluation were established to provide insight into the team processes and discourage social loafing. For this cohort, roughly equal weighting was given to peer feedback and time card hours reported.

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 TimeCard system. Their enthusiastic response is of particular interest because these students had completed Senior Design 1 with the same teams without the time cards, so they have a sense of how the time card system affected team dynamics [5]:

- "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... This can also supplement the CATME surveys by providing more insight into whether team members are contributing fully and equally to the project."

Year 2 of TimeCards (2017-2018 Capstone Cohort)

Based on this perceived success, TimeCards were introduced to the 2017-2018 Capstone in Senior Design 1 (Fall 2017), and students were surveyed about their attitudes about the system at the end of Senior Design 2 (Spring 2018). The new class had 78 participants allocated to eight teams. Students were told that 10 hours per week was the effort goal for senior design, and then time card data entry was a primary factor in the first instructor evaluation (i.e., peer feedback was deemphasized). After receiving their first scores, most students with the lowest reported hours increased their reported hours for the second half of the class [5]:

- 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.

Though the time card/instructor evaluation system did achieve one desired result- students increased their self-reported hours dedicated to the class- some students felt the heavy emphasis on reported hours penalized efficient and honest students, while providing too much incentive for others to over-report hours worked. Even though the importance of total hours was reduced in subsequent instructor evaluation grades, the 2017-2018 cohort had was generally less enthusiastic about the TimeCard system than the 2016-2017 students. Of the 17 survey comments at the end of the year, six were generally positive ("It was a good way to hold people accountable", etc.), four were generally negative ("filling in time cards was a pain…"; "…people will cheat", etc.), and six suggested that the weighting on hours should be reduced and some way should be found to measure quality over quantity of effort.

Year 3: Updated TimeCard Weighting and Expanded Student Surveys (2018-2019 Capstone Cohort)

For the 2018-2019 cohort, the calculations used to determine the first draft of instructor evaluation grades was revised, with peer feedback operating as a proxy for quality of effort. In the first draft, time card hours and peer feedback were equally weighted, similar to what was done in the first year of the system. These draft scores were then reviewed by the instructor, with special attention paid to individuals who had a significant gap between peer feedback and peer evaluations. CATME peer comments to the instructor were also carefully reviewed, and the average hours worked by each team was noted (i.e., some teams reported lower average hours than others, so a high performer on that team may have a lower initial score than an average performer on another team).

The 2018-2019 cohort had 67 students distributed across nine teams. As was seen in the previous year, most students with the lowest reported hours increased their reported hours for the second half of the class, though the effect was less pronounced:

- 68% of the students in the bottom third of the class increased their weekly hours logged.
- 48% of the students in the middle third of the class increased their weekly hours logged.
- 32% of the students in the top third of the class increased their weekly hours logged.

The 2018-2019 cohort also took three surveys- before and after using TimeCards in Senior Design 1 (Fall 2018), and then at the end of Senior Design 2 (Spring 2019). Results are presented

below, along with similar questions from the final survey taken by the previous 2017-2018 cohort.

Student Survey Participation Rates and Results.

Student participation in all four surveys is listed in Table 3. All surveys were anonymous and voluntary, with a small amount of extra credit provided for participation.

		Class size	Surveys Completed	Participation rate
2017-2018 Cohort	End of Senior Design 2, after two semesters of time cards	79	29	37%
2018-2019 Cohort	Start of Senior Design 1, before use of time cards.	67	53	79%
	End of Senior Design 1, after one semester of time cards	67	22	33%
	End of Senior Design 2, after two semesters of time cards	67	33	49%

Table 3. Student Survey Participation Rate

Senior Design 1 Survey before TimeCards (2018-2019 Cohort). The 2018-2019 cohort completed their first survey at the beginning of Senior Design 1. These students had worked with their team for nine weeks in Junior Design, but had not yet been exposed to the TimeCard system. Survey questions and responses are shown below in Table 4 and Table 5.

Table 4. Survey Results before using TimeCards- part 1 (2018-2019 cohort)

	Total "agree"	Total "disagree"	Strongly Disagree	Disagree	neither Agree nor Disagree	Agree	Strongly Agree
1. I do not always know what OTHER	34%	49%	9%	40%	17%	32%	2%
PEOPLE on my team are doing to support							
the project.							
2. OTHER PEOPLE on my team do not	34%	40%	13%	26%	26%	32%	2%
always know WHAT I AM DOING to							
support the project.							
3. It would be helpful to know more	68%	4%	2%	2%	28%	49%	19%
about what other team members are							
doing to support the project.							
4. On SOME senior design projects (but	74%	2%	0%	2%	25%	60%	13%
not including my team), some students							
work less than they should, and do not do							
their fair share of a project.							
5. On MY senior design team, some	42%	36%	2%	34%	23%	34%	8%
students work less than they should, and							
do not do their fair share of a project.							
6. The hours a student works should be	43%	25%	4%	21%	32%	36%	8%
considered in senior design grading.							

Table 5: Survey	Results be	efore using	TimeCards-	part 2 (20	18-2019 cohort)

7. On team projects, does the amount of work done by others on the team affect your own work effort?				
N/A- In general, my own work effort is not influenced by how much my team members work.	34%			
When I see other people on my team working more, I work more.	43%			
When I see other people on my team working more, I work less				
When I saw other people on my team working less, I work less.				
When I see other people on my team working less, I work more.	15%			

As seen in question 6 of Table 4, prior to using TimeCards student opinions were mixed about whether hours worked should be considered in grading: 43% agreeing, 25% disagreeing, and 32% being neutral. Most students (68%) felt more information about teammate contributions would be helpful, though many felt they already knew what others were contributing. Social loafing was seen as a problem in other teams by 74% of students, but only 47% thought it was an issue in their own teams. In table 5 students reported that seeing the work that others do can increase their own output- either to work more with hard-working peers (43%), or to compensate for the lack of work of others (15%).

Survey Results and Themes after Using TimeCards in Senior Design

Responses to end-of-semester surveys are shown below. Many of the same questions were used in both Senior Design 1 and Senior Design 2, so they are reported together, clumped by theme, and in some cases compared with initial survey results.

Some students on Senior Design Projects work less than they should, and do not do their fair share of a project								iect		
			Total "agree"	Total "disagree"	Strongly Disagree	Disa	gree	neithe Agree n Disagre	r or Agree ee	Strongly Agree
Senior Design 1 Start (2018-2018	On SOME senior a (but not including	lesign teams my team)	74%	2%	0%	2	%	25%	60%	13%
Cohort)	On MY Senior De	esign team	42%	36%	2%	34	4%	23%	34%	8%
Senior Design 2 End (2017-2018	On SOME senior a (but not including	'esign teams my team)	79%	10%	0%	10)%	10%	41%	38%
Cohort)	On MY Senior Design team		55%	17%	0%	17	7%	28%	24%	31%
On MY senior	design team, some	e students w	ork less th	an they sh	ould, and	d do no	ot do i	their fai	r share of a	project.
Total "agree"		Total "agree"	Total "disagree	Strong Disagre	ly Disa	igree	ne Agre Disa	ither ee nor agree	Agree	Strongly Agree
Design 1 start (2018-2019 cohort) 42%		42%	36%	2%	3	4%	2	3%	34%	8%
Design 1 end (2	018-2019 cohort)	45%	28%	5%	2	3%	2	7%	27%	18%
Design 2 end (2	018-2019 cohort)	66%	18%	0%	1	8%	1	.5%	30%	36%
Design 2 end (2	017-2018 cohort)	55%	17%	0%	1	7%	2	8%	24%	31%

Table 6. Survey Results: Student perceptions of social loafing

The results in Table 6 indicate though most students consider social loafing a problem, they perceive more of it going on in other teams as compared to their own team. As time progressed, an increasing number of students in the 2018-2019 cohort identified social loafing as a problem within their own teams, either because the tendency to loaf increases with time or students become more aware of it as time progresses.

Team time cards helped ME understand what OTHER people were doing to support the project.									
	Total "agree"	Total "disagree"	Strongly Disagree	Disagree	neither Agree nor Disagree	Agree	Strongly Agree		
Design 1 end (2018-2019 cohort)	59%	18%	5%	14%	23%	45%	14%		
Design 2 end (2018-2019 cohort)	66%	21%	3%	18%	15%	30%	36%		
Design 2 end (2017-2018 cohort)	52%	17%	7%	10%	31%	38%	14%		
Team time cards help	ed OTHER p	eople under	stand what l	was doing t	to support th	ne project.			
	Total "agree"	Total "disagree"	Strongly Disagree	Disagree	neither Agree nor Disagree	Agree	Strongly Agree		
Design 1 end (2018-2019 cohort)	50%	32%	9%	23%	18%	41%	9%		
Design 2 end (2018-2019 cohort)	63%	15%	3%	12%	21%	42%	21%		
Design 2 end (2017-2018 cohort)	55%	21%	7%	14%	24%	38%	17%		
Comptinger Luguid look at other team memberie time carde before completing their seer feedback									
Sometimes I would look a	t other tean	n member's i	time cards h	efore compl	etina their n	eer feedhau	~k		
Sometimes I would look a	t other tean Total "agree"	n member's t Total "disagree"	t <i>ime cards b</i> Strongly Disagree	<i>efore compl</i> Disagree	<i>eting their p</i> neither Agree nor Disagree	<i>eer feedbac</i> Agree	ck. Strongly Agree		
Sometimes I would look a Design 1 end (2018-2019 cohort)	t other tean Total "agree" 36%	n member's i Total "disagree" 50%	<i>time cards b</i> Strongly Disagree 18%	efore compl Disagree 32%	<i>eting their p</i> neither Agree nor Disagree 14%	eer feedbaa Agree 36%	ck. Strongly Agree 0%		
Sometimes I would look a Design 1 end (2018-2019 cohort) Design 2 end (2018-2019 cohort)	t other tean Total "agree" 36% 51%	n member's a Total "disagree" 50% 30%	time cards b Strongly Disagree 18% 3%	efore compl Disagree 32% 27%	eting their p neither Agree nor Disagree 14% 18%	eer feedbaa Agree 36% 39%	ck. Strongly Agree 0% 12%		
Sometimes I would look a Design 1 end (2018-2019 cohort) Design 2 end (2018-2019 cohort) Design 2 end (2017-2018 cohort)	t other tean Total "agree" 36% 51% 55%	Total "disagree" 50% 30% 34%	time cards b Strongly Disagree 18% 3% 10%	efore compl Disagree 32% 27% 24%	eting their p neither Agree nor Disagree 14% 18% 10%	eer feedbaa Agree 36% 39% 41%	ck. Strongly Agree 0% 12% 14%		
Sometimes I would look a Design 1 end (2018-2019 cohort) Design 2 end (2018-2019 cohort) Design 2 end (2017-2018 cohort) The team time card system	t other tean Total "agree" 36% 51% 55%	Total "disagree" 50% 30% 34%	time cards b Strongly Disagree 18% 3% 10%	efore compl Disagree 32% 27% 24%	eting their p neither Agree nor Disagree 14% 18% 10%	eer feedbaa Agree 36% 39% 41% who was po	ck. Strongly Agree 0% 12% 14%		
Sometimes I would look a Design 1 end (2018-2019 cohort) Design 2 end (2018-2019 cohort) Design 2 end (2017-2018 cohort) The team time card system	t other tean Total "agree" 36% 51% 55% n helped inc Total "agree"	Total "disagree" 50% 30% 34% rease aware Total "disagree"	time cards b Strongly Disagree 18% 3% 10% eness of who Strongly Disagree	efore compl Disagree 32% 27% 24% Disagree	eting their p neither Agree nor Disagree 14% 18% 10% ng hard and neither Agree nor Disagree	eer feedbaa Agree 36% 39% 41% who was no Agree	ck. Strongly Agree 0% 12% 14% t. Strongly Agree		
Sometimes I would look a Design 1 end (2018-2019 cohort) Design 2 end (2018-2019 cohort) Design 2 end (2017-2018 cohort) The team time card system Design 1 end (2018-2019 cohort)	t other tean Total "agree" 36% 51% 55% n helped inc Total "agree" 50%	Total "disagree" 50% 30% 34% rease aware Total "disagree" 23%	time cards b Strongly Disagree 18% 3% 10% eness of who Strongly Disagree 5%	efore compl Disagree 32% 27% 24% Disagree 18%	eting their p neither Agree nor Disagree 14% 18% 10% 10% neither Agree nor Disagree 27%	eer feedbaa Agree 36% 39% 41% who was no Agree 36%	ck. Strongly Agree 0% 12% 14% t. Strongly Agree 14%		
Sometimes I would look a Design 1 end (2018-2019 cohort) Design 2 end (2018-2019 cohort) Design 2 end (2017-2018 cohort) The team time card system Design 1 end (2018-2019 cohort) Design 2 end (2018-2019 cohort)	t other tean Total "agree" 36% 51% 55% m helped inc Total "agree" 50% 57%	Total "disagree" 50% 30% 34% rease aware Total "disagree" 23% 18%	time cards b Strongly Disagree 18% 3% 10% eness of who Strongly Disagree 5% 3%	efore compl Disagree 32% 27% 24% 0 was workin Disagree 18% 15%	eting their p neither Agree nor Disagree 14% 18% 10% 10% mg hard and neither Agree nor Disagree 27% 24%	eer feedbaa Agree 36% 39% 41% who was no Agree 36% 30%	ck. Strongly Agree 0% 12% 14% t. Strongly Agree 14% 27%		

Table 7: Survey Results: TimeCards and awareness of the contribution of others

Table 7 shows students feel that time cards provide insight on the contributions of others, and 36% to 55% would look at them prior to filling out peer feedback. This trend to look at timecards increases in senior design 2, where social loafing may be more of a problem.

How many students do you think reported more hours on their time cards than they actually										
worked with an intent to mislead others? NOTE: This question addresses the quantity of time that could be claimed to										
be part of senior design, not the value added. Assum	e any time wi	th the team c	an be conside	ered "work" a	nd can be					
legally added to the time card, even if the person is adding little to the project.										
	a few	some, less	about half	more than	Most					
Survey set	arew	than half	about han	half	WIOSt					
End of Senior Design 1 (2018-2019 cohort)	End of Senior Design 1 (2018-2019 cohort) 50% 32% 9% 5% 5%									
End of Senior Design 2 (2018-2019 cohort) 48% 24% 15% 9% 3%										
End of Senior Design 2 (2017-2018 cohort)	31%	34%	21%	7%	7%					

Table 8: Survey Results: Student Perceptions about Time Card Falsification

In all surveys students believed that some students were reporting more hours than worked, but a majority of respondents (65% to 82%) believed more than half of the students were being honest and the problem was confined to either "a few" or "some, less than half". The 2017-2018 cohort believed there was a greater tendency to inflate reported hours, possibly because that cohort's first instructor evaluation grade had excessive weighting on hours reported.

Table 9: Surve	ey Results: Peer	Observations an	d Student Leader	Engagement
	2			00

If you were NOT a project manager, pick the response that best describes your use of the time card system.	Senior Design 1 (2018-2019)	Senior Design 2 (2018-2019)	Senior Design 2 (2017-2018)
I provided my own inputs, but did not look at what other teammates entered.	13%	12%	23%
I provided my own inputs, and sometimes looked at what other teammates entered.	67%	62%	55%
I provided my own inputs, and often looked at what other teammates entered.	20%	27%	23%
	100%	100%	100%
If you WERE a project manager, pick the response that best describes your use of the time card system.	Senior Design 1 (2018-2019)	Senior Design 2 (2018-2019)	Senior Design 2 (2017-2018)
As a project manager, I consolidated time card inputs, but did not question the hours reported by others.	73%	25%	33%
As a project manager, I consolidated time card inputs. I did not question the hours reported by others, but thought some people were reporting more hours than worked.	9%	50%	22%
As a project manager, I consolidated time card inputs, and sometimes talked to members of the team if I thought they had over-stated the work done that week.	18%	25%	44%
	100%	100%	100%

Did seeing the hours reported by others affect your own work effort?	Design 1 2018-2019 Cohort	Design 2 2018-2019 Cohort	Design 2 2017-2018 Cohort
N/A- My actions were not influenced by what other people entered on their time card.	45%	49%	62%
When I see other people on my team working more, I work more.	55%	39%	28%
When I see other people on my team working more, I work less	0%	0%	0%
When I saw other people on my team working less, I work less.	0%	9%	0%
When I see other people on my team working less, I work more	0%	3%	10%
	100%	100%	100%

Table 10: Peer Influence associated with hours worked

Table 9 indicates that over 78% of students would occasionally look at other teammate's time card entries. Student project managers reported a greater tendency to challenge time card entries in Senior Design 2. As seen in Table 10, most Senior Design 1 students (55%) increased their work when they saw others working hard.

Table 11: Student Survey Responses: Should hours worked be considered in grading?

The hours a student works should be considered in senior design grading.							
	Total "agree"	Total "disagree"	Strongly Disagree	Disagree	neither Agree nor Disagree	Agree	Strongly Agree
Design 1 start (2018-2019 cohort)	43%	25%	4%	21%	32%	36%	8%
Design 1 end (2018-2019 cohort)	77%	14%	5%	9%	9%	59%	18%
Design 2 end (2018-2019 cohort)	72%	6%	3%	3%	21%	45%	27%
Design 2 end (2017-2018 cohort)	43%	50%	18%	32%	7%	36%	7%

As shown in Table 11, the 2018-2019 student cohort in Senior design agreed that the hours a student works should be considered in senior design grading, with the level of agreement increasing after using the Team TimeCard system. The 2017-2018 students who had endured an instructor evaluation cycle that heavily weighted used time card hours disagreed.

This suggests that the use of time cards as part of grading can be an effective motivational tool when used in conjunction with peer feedback or some other measure of the quality of student work. If only the quantity of hours is considered, the system will encourage cynicism and fraud.

Conclusions, Recommendations and Forward Work

A team TimeCard system consisting of a time card record and an instructor evaluation based on both time card hours and peer feedback has been used for three cohorts of aerospace engineering senior design teams. When used as part of an instructor evaluation and in conjunction with peer feedback, time cards can be used to discourage social loafing. The system is especially helpful for instructors who are managing large classes and/or large teams and have a well-established process of peer feedback. The author has also found time cards helpful in sorting out individual contributions to team projects and dealing with student complaints about team mates who don't contribute as much as they should.

The fact that time cards are visible to the entire team provides several benefits. Student surveys indicate that most students look at the hours and effort reported by others and are motivated to work harder as a result of it. Time cards provide objective data for team members to use as part of their peer feedback evaluation, and increase 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.

One major concern with the system is that some students may deliberately over-report their work effort and falsify their time cards. Another concern is that 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. If the instructor evaluation grade is based primarily on hours worked, it can backfire and sour students on the system. To minimize the likelihood of this, the following measures are recommended:

- To calculate the first iteration of the instructor evaluation grade, weight time card hours and peer feedback scores equally. In this calculation, peer feedback is used as a proxy for work quality.
- Look out for big discrepancies between hours reported and peer feedback grades- this helps identify both efficient top performers and those who report many hours but contribute little to the team. It also takes into account that the average work performed may vary from team to team. Adjust the first iteration of the instructor evaluation grade accordingly.
- Require students to log contributions and the location and times where work is done- not just the hours worked.
- Make it clear that falsification of time card data is an example of an "ethical lapse" that would result in an adverse (zero) instructor evaluation grade.
- Have student leaders process the time cards and asked them look out for suspicious disconnects between hours logged and contributions to the team.
- Retain the right to include subjective factors in the instructor evaluation grade, including direct observation by staff and faculty and quality of individual contributions to the team products.

Though the initial implementation of TimeCards has been encouraging, more work is needed to refine the system and quantify its effects. Surveys will continue for future cohorts, and iterative improvements are planned. Others have noted that team effectiveness theory from industrial and

organizational psychology may be helpful in dealing with student teams [4]. The instructor is currently collaborating with the School of Psychology at Florida Tech to evaluate team dynamics and trust in aerospace capstone teams [10]; additional collaboration may yield insights on how to further improve the combination of time cards and instructor evaluations and to better prepare student team leaders to deal with the challenges of holding their teams accountable. Another area of forward work is to seek out other capstone instructors with large classes and an existing peer feedback system who may be willing to experiment with the approach described here and to provide an independent assessment of its effectiveness. Social loafing is a significant challenge for instructors of senior design teams and no one tool will be a miracle cure, but the TimeCard system may help to encourage all students to fully engage and contribute their best efforts.

References

- 1. J. Trevelyan, "Technical coordination in engineering practice," *Journal of Engineering Education*, 96(3), pp. 191-199, July 2007.
- 2. L. McKenzie, M. Trevisan, D. Davis, and S. Beyerlein, "Capstone Design Courses and Assessment: A National Study," *Proceedings of the 2004 American Society of Engineering Education Annual Conference & Exposition*, Session 2225, pp. 9.286.1-.18, June 2004.
- 3. B. Latané, K. Williams, and S. Harkins, "Many Hands Make Light Work: The Causes & Consequences of Social Loafing," *Journal of Personality and Social Psychology*, Vol. 37, No. 6, 1979, pp. 822–832, 1979.
- 4. M. Borrego, J. Karlin, L. McNair, and K. Beddoes, "Team Effectiveness Theory from Industrial and Organizational Psychology applied to Engineering Student Project Teams: A Research Review," *Journal of Engineering Education*, 102(4), pp. 472-512, October 2013.
- 5. K. Demoret, "Team Time Cards: a Tool to increase Accountability and Reduce Social Loafing in Senior Design," 2018 Capstone Design Conference, Rochester New York.
- J. Baker, M. Yoder, B. Black, R. Throne, and W. Kline, "Scorecards: Tracking Progress In Senior Design Project Courses". Paper presented at 2009 ASEE Annual Conference & Exposition, Austin, Texas. ASEE conference paper ID #1843.
- 7. D. Bowie, X. Xu, and A. Donaldson, "Teaching Engineering Project Management via Capstone Designs that Develop a Viable Product". Paper presented at *2014 ASEE Annual Conference & Exposition*, Indianapolis, Indiana, ASEE conference paper ID #10635.
- M. Ohland, M. Loughry, D. Woehr, C. Finelli, L. Bullard, R. Felder, R. Layton, H. Pomeranz, and D. Schmucker, "The comprehensive assessment of team member effectiveness: Development of a behaviorally anchored rating scale for self and peer evaluation," *Academy of Management Learning & Education*, 11 (4), pp. 609-630, December 2012.
- 9. "CATME Smarter Teamwork." Copyright 2017. Internet Site by Sumy Designs LLC. Available: www.CATME.org [last accessed: January 2018]
- 10. K. Demoret, K. Nyein, and J. Wildman, "Aerospace Capstone Design and Team Psychology: Traits, Competencies and Trust Measured in Student Surveys". Paper to be presented at 2018 ASEE Annual Conference & Exposition, Salt Lake City, Utah.