2021 ASEE ANNUAL CONFERENCE
Virtual Meeting | July 26–29, 2021 | Pacific Daylight Time
Paper ID #33158

Relating Senior Project Time on Task to Student Scores

Dr. Jeunghwan Choi, Central Washington University

John(Jeunghwan) Choi is a professor in the Mechanical Engineering Technology program at Central Washington University. John teaches upper division courses including the Senior capstone course.

Prof. Charles Pringle, Central Washington University

Charles Pringle is a professor in the Mechanical Engineering Technology program at Central Washington University. Charles teaches upper division courses including the senior capstone course.

Relating Senior Project Time on Task to Student Scores

Abstract

It is the shared belief amongst a majority of faculty based on anecdotal data that time on task should be proportional to the achieved score in senior project. The monitoring of student time on task by instructors could potentially allow for a more rapid and focused feedback to students at risk. However, due to the large number of different projects in the past, it was not feasible to clearly assess whether time on task would equate to score achieved. For the first time during the past year, the engineering capstone course at the current institute had a significant number of students engaged in similar projects. This presented a unique opportunity to obtain meaningful data on whether the above hypothesis could be proven true.

The hypothesis was applied to two projects with nine students and seven students, respectively. The metric used to measure the time on task was the Project Status Report (PSR) in which the students self-reported their time and tasks. Each student's weekly time on task was compared to that week's assignment scores. At the end of the quarter, the total time on task was compared to their quarter grade. Data collected up to the time of this writing (Fall and Winter Quarter) indicate that time on task versus achieved score at the weekly level produces a sigmoidal curve in which a lower threshold correlated with students at risk while an upper threshold existed where further time on task did not necessarily yield a better score. It is assumed that the additional data to be obtained in the near future (i.e., Spring Quarter data) will allow the authors to clearly gauge whether total time on task correlated with the final score students received for a given Quarter. Additional work is also planned to review historical data on recurring projects to see if it provides any additional information.

Introduction

The senior students at Central Washington University's Mechanical Engineering Technology program are required to complete a year-long Capstone requirement through Senior Project (SP) I/ II/ III. During Fall quarter (SP I) the focus is on design, where students work on the design and analysis of their project. Analysis also involves elements of Project Management, which are reviewed during the quarter. The culmination of the quarter involves the completion of a Project Proposal by each student, which is reviewed by their academic advisors. Winter quarter (SP II) is when the students focus on manufacturing the parts which were analyzed and documented from the previous quarter. Along with additional purchased parts, students are required to produce a working device by the end of the quarter. During this period their project proposals, renamed as project reports, are continuously updated to reflect new observations, analyses, and revisions which come about during the manufacturing process. Finally, during Spring quarter (SP III) the students perform various tests on their manufactured devices in order to gauge whether requirements set forth in the project proposal have been satisfied. Further modifications to the original working device would occur based on results from testing. The last quarter is completed with a final engineering report and presentation to an engineering review board.

Compared with other courses, the nature of Senior Project requires the instructors to be able to address a large number of unforeseen situations stemming from the wide variety of projects the students choose to engage. As the overall success of the project is dependent on the successful and continuous completion of previous steps with little time to spare, it becomes vital that instructors be able to quickly identify and address issues related to student progress. Therefore this paper focused on investigating whether the amount of time spent by students (time on task) would be an indicator of the final scores students receive, and thereby could be used by advisors to provide rapid and focused feedback to students at risk.

A significant hurdle to performing such a study was the fact that the large variety of projects could pose a situation where "adequate" time for success by a student on one project may be "inadequate" time spent for another student for a different project. This year, however, the investigators were presented with a unique opportunity where most of the senior students would be engaged in just two projects, thus reducing the issue of project variety in obtaining clear trends for the study.

Methods

During the academic year, students were assigned various tasks to complete per week (Appendix A1 and 2). Group "A", comprised of 9 students, worked on a project to build a moving device which would be tested for dynamic performance, while Group "B", comprised of 7 students, worked on building a structure to be tested for load-bearing performance.

Students reported their previous week's results using an individual-based Project Status Report (PSR), in which they also enter the time spent on all of the previous week's tasks. The number of tasks to perform and points to be earned varied by week, and therefore a weekly percentile score was determined to be compared against the reported work time for that week.

At the end of each quarter, a final grade for each student was determined based on the sum of all weekly task scores, a final score on the most updated proposal manuscript, and professionalism/ ethics scores based on quarter-wide performance. The final grade was compared against the cumulative work hours to determine relationship.

Time spent versus scores received were expected to exhibit a sigmoidal trend with the current student population. Therefore a curve-fitting method [1] was employed using the equation

$$y = y_{min} + \frac{(y_{max} - y_{min})}{1 + 10^{n(\log x_{50} - \log x)}}$$

where y : score data
- y_{min} : minimum value of y in data set
- y_{max} : maximum value of y in data set
- n : growth rate (fit parameter)
- x_{50} : time value corresponding to sigmoid midpoint (fit parameter)

Current Results

Figures 1a and 1b show the relationship between weekly percentile score earned versus weekly hours spent on tasks by students for Groups A versus B for Senior Project I(Fall) and II(Winter), respectively. The hours students reported as having been spent were binned into 1 hour intervals for analysis. It is noted that mean pairs are available only up to 10 hours for Fall and 6 hours for Winter, with greater-hour data reported only by Group A or B. Repeated t-tests with a significance level of $\alpha = 0.05$ revealed that the mean values for all available pairs were not significantly different, whether Fall or Winter quarter. Therefore, all data points within a quarter were combined to create a score-versus-time graph that did not distinguish the Groups and in which the trends became visibly clearer.

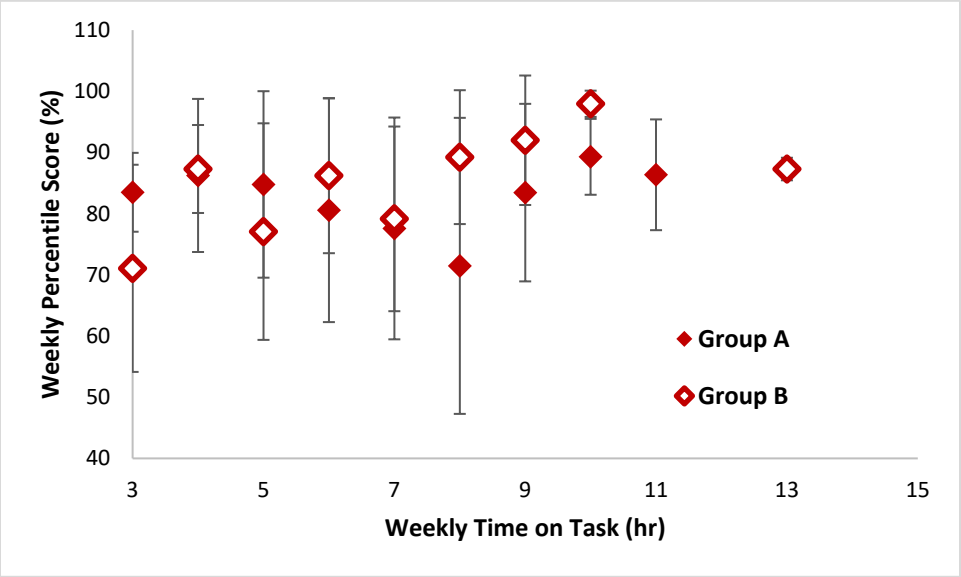

Fig. 1a Weekly percentile scores achieved by Groups A (n = 9) versus B (n = 7) based on weekly amount of hours spent on task from Senior Project I (Fall quarter). Values are mean ± standard deviation. Mean values between pairs were not significantly different (t-test, $\alpha = 0.05$).

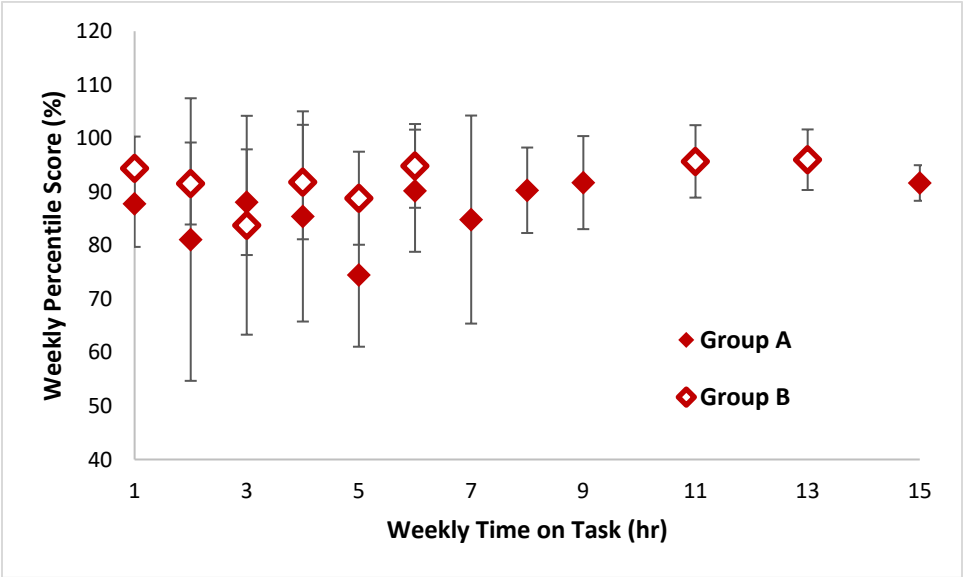

Fig. 1b Weekly percentile scores achieved by Groups A (n = 9) versus B (n = 7) based on weekly amount of hours spent on task from Senior Project II (Winter quarter). Values are mean ± standard deviation. Mean values between pairs were not significantly different (t-test, $\alpha = 0.05$).

Figures 2a and 2b show the result of combining all data for Fall and Winter quarters, respectively in which a clearer trend is observed between the weekly time on task versus percentile score. The sigmoid curve was fit with the equation previously described in Methods. For Fall, scores were predicted to be minimal (<1%) below 8.74 hrs and maximal (>99%) above 9.35 hrs while for Winter, scores were predicted to be minimal below 5.25 hrs and maximal above 11.35 hrs.

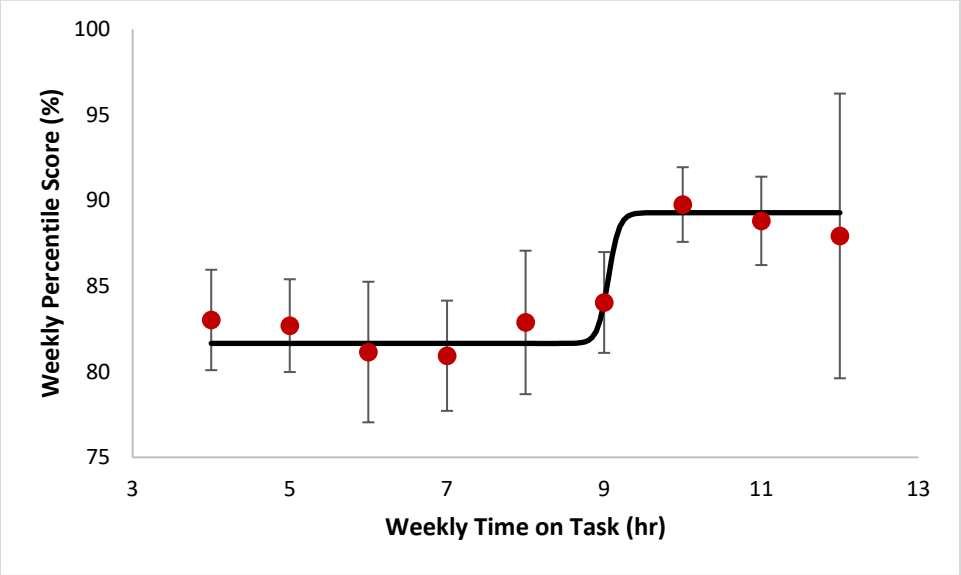

Fig. 2a Weekly percentile scores achieved by all students based on weekly amount of hours spent on task from Senior Project I (Fall qtr). Values are mean $\pm$ standard error. Sigmoid curve fit based on description in text (y_{min} = 81.65, y_{max} = 89.28, n = 132.5, x_{50} = 9.05, R^2 = 0.936).

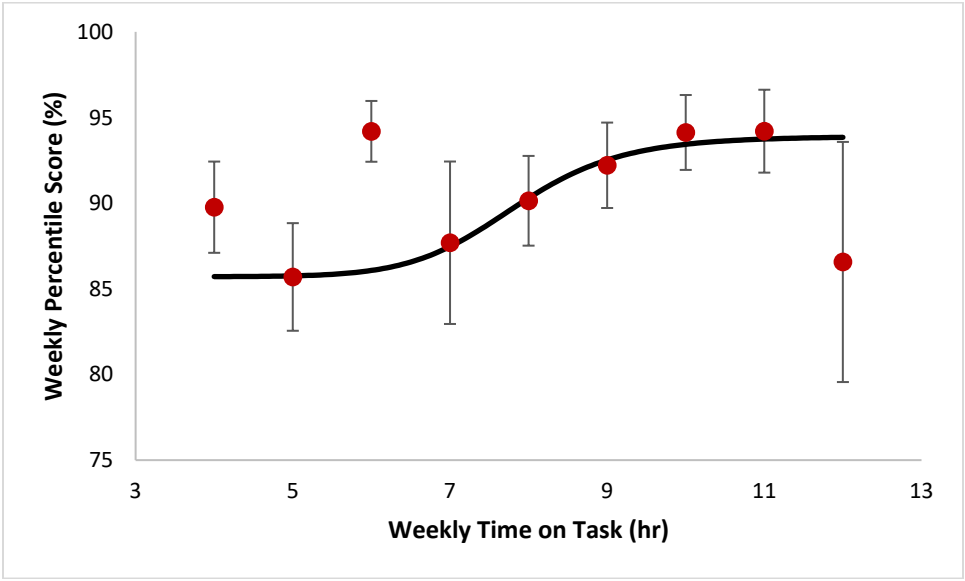

Fig. 2b Weekly percentile scores achieved by all students based on weekly amount of hours spent on task from Senior Project II (Winter qtr). Values are mean $\pm$ standard error. Sigmoid curve fit based on description in text (y_{min} = 85.71, y_{max} = 93.84, n = 11.51, x_{50} = 7.84, R^2 = 0.968).

Figure 3a and 3b summarize the relationship between final percentile score earned versus total hours spent on tasks for Fall and Winter quarters, respectively, by all students. The cumulative hours reported by students were binned into 10 hour intervals for analysis. It is noted that data points without error bars are single data points. Unlike weekly data, the cumulative graphs per quarter did not display any noticeable trend.

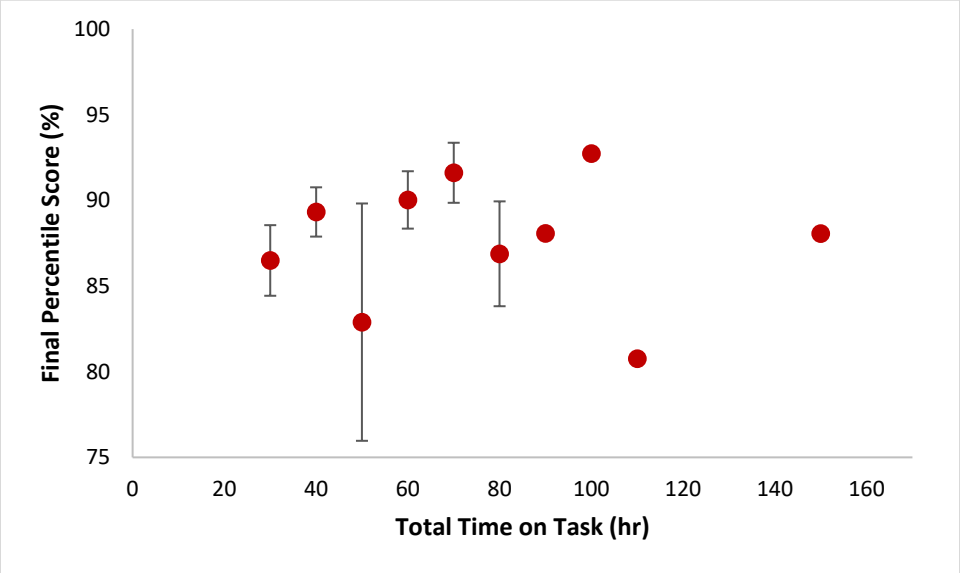

Fig. 3a Final percentile scores achieved by all students based on total amount of hours spent on task for the quarter from Senior Project I (Fall qtr). Values are mean ± standard error. No error bars indicate single data points.

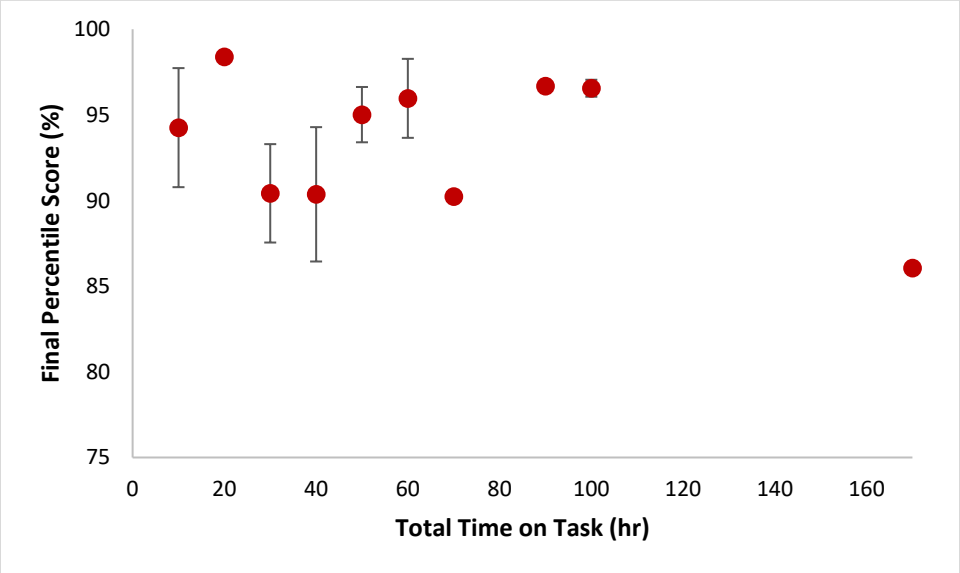

Fig. 3b Final percentile scores achieved by all students based on total amount of hours spent on task for the quarter from Senior Project I (Winter qtr). Values are mean ± standard error. No error bars indicate single data points.

In order to gauge whether a clearer trend could be obtained by combining Fall (Fig. 3a) and Winter (Fig. 3b) data, repeated t-tests with a significance level of $\alpha = 0.05$ were performed with

all available data pairs based on binned time and it was confirmed that the data for total time versus final score were not significantly different for Fall and Winter. Therefore all data points were combined to create a total time versus final score graph representing both quarters combined, as shown in Figure 3c. A reliable sigmoid fit, however, was still not possible.

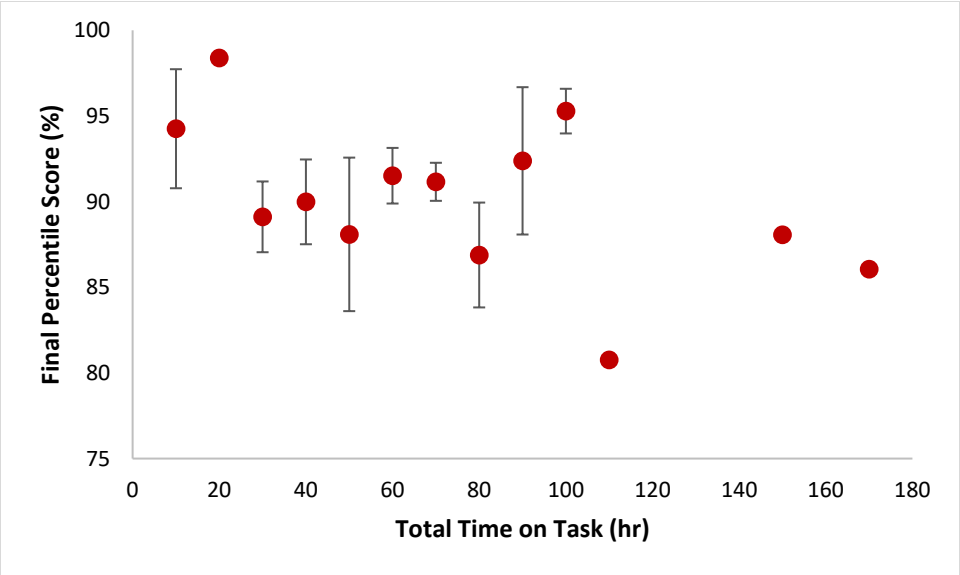

Fig. 3c Final percentile scores achieved by all students based on total amount of hours spent on task for the quarter from Senior Project I/II (Fall & Winter combined). Values are mean ± standard error. No error bars indicate single data points.

Discussion

Based on results from the first two quarters of a one-year senior capstone course, a relationship between time on task versus percentile score received by students was visible in a data set comprised of all students. For Fall quarter, the threshold times for low scores (<8.74 hrs) versus high scores (>9.35 hrs) results in a narrow band (i.e. steep curve) available to discern success/failure. This would make decisions for intervention challenging. The threshold times for Winter quarter, however, resulted in a wider band (low < 5.25 hrs, high >11.35 hrs) which would allow time on task monitoring to be a more effective tool for instructors. Results for Spring quarter are pending.

Unlike weekly data, the scarcity of data points resulted in Quarterly hour versus Final score graphs (Fig. 3a and b) which did not display any noticeable trend. This was also true when Fall and Winter quarter results were combined (Fig. 3c) with the hope of obtaining a clearer trend. One possible explanation is that with end-of-quarter results and completion of tasks weighted heavily on a student's final grade, weekly time on task figures may not have a significant impact on overall student success (i.e. their grades). It should be mentioned that the data collection process could also be a source of noise affecting the clarity of results and should be further examined in a future study. Results for Spring will be analyzed and appended to see if the trends become clearer.

Conclusion

Data from the first two quarters of Senior Project suggests that although time on task does affect weekly student scores, its use for monitoring student success may be limited and that time on task may not be an effective indicator of the final grades that students receive.

Additional data analysis from the third quarter will be appended to this study as they become available. Cross-quarter and cumulative data analysis will be performed to gauge whether the relationship between time on task and weekly/final scores become clearer and whether cumulative data would present methods that would allow the use of time on task as an effective monitoring tool. At such time, historical data on recurring projects will be reviewed to see if it provides any additional information.

References

[1] Kemmer, G., Keller, S. Nonlinear least-squares data fitting in Excel spreadsheets. Nat Protoc 5, 267–281 (2010). https://doi.org/10.1038/nprot.2009.182

Appendix A1. List of weekly assignments for Senior Project I (Fall Quarter)

Week	Assignment
1	Meet Faculty, review web
	Function Statements and Requirements for Project Proposal
	Web: Business Card
	Ethics
2	PMBOK(Project Management Body of Knowledge) 1&2 Quiz
	Sketch on website
	Introduction (a-g) of Project Proposal
3	PSR02
	PMBOK 3 Quiz
	Web: Introduction
	Analysis 1 of Project Proposal
4	PSR03
	PMBOK 4 Quiz
	Project Outreach Summary
	Analysis 2, Design & Analysis (a-e) of Project Proposal
5	PSR04
	PMBOK 5 Quiz
	Web: Analysis summary
	Analysis 3, 4, Drawing 1, Schedule of Project Proposal
6	PSR05
	PMBOK 6 Quiz
	Web: Schedule
	Analysis 5, 6, Drawing 2, Part list, Budget of Project Proposal
7	PSR06
	PMBOK 7 Quiz
	Web: Budget
	Analysis 7, 8, Drawing 3, Testing of Project Proposal
8	PSR07
	PMBOK 9 Quiz
	Analysis 9, 10, Drawing 4, Methods of Project Proposal
9	PSR08
	PMBOK 11 Quiz
	Analysis 11, 12, Drawing 5, Construction of Project Proposal
10	Assembly drawing, Discussion of Project Proposal
11	Final version of Project Proposal

Appendix A2. List of weekly assignments for Senior Project I (Winter Quarter)

Week	Assignment
1	Upload final version of project proposal
2	PSR01
	Manufacturing Design Review presentation
3	PSR02
	Manufacturing 01 of Project Report
	Methods 01 of Project Report
	Construction 01 of Project Report
4	PSR03
	Web 01: update webpage
	Discussion 01 of Project Report
5	PSR04
	Manufacturing 02 of Project Report
	Schedule of Project Report
6	PSR05
	Budget of Project Report
7	PSR06
	Manufacturing 03 of Project Report
	Methods 02 of Project Report
	Construction 02 of Project Report
8	PSR07
	Web 02: update webpage
	Test of Project Report
9	PSR08
	Discussion 01 of Project Report
10	PSR09
	Working Device inspection
	Final version of Project Report