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EET Capstone Student Project: Multi-sensor device to monitor external atmospheric conditions and GPS location for evaluating rust potential on coils

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EET Capstone Student Project: Multi-sensor Device to Monitor External Atmospheric Conditions and GPS Location for Evaluating Rust Potential on Coils

Abstract

As part of the continuous efforts in developing industry partnerships that will lead to priority consideration of graduates from The School of Technology ArcelorMittal, the world's leading steel company with operations in more than 60 countries, collaborated with The Electrical Engineering Technology (EET) Program at Michigan Tech to engage a group of EET students in solving engineering problems as part of capstone integrating experience and to fulfill the degree program requirements.

ArcelorMittal utilizes railroad system to ship metal coils through different climate zones of the United States. Due to significant temperature and humidity fluctuations during transportation, the coils are subject to corrosion. To understand the severity of climate conditions, have an ability to characterize them geographically, and to fully evaluate the cause and the strength of the corrosion, the data containing the information on the humidity, temperature and associated GPS location must be collected. Further evaluation of this data will allow the company to take the preventive actions for protecting the shipped materials.

To design and build a "black box" capable of collecting all the required data, a Senior Design team of 2 students was formed in the Electrical Engineering Technology program in the School of Technology at Michigan Tech. Working with the sponsor the project significance was identified as the development and proof of concept demonstration of the multi-sensor device enabling the atmospheric and GPS data collection for the materials shipped through different climate zones of the United States. The benefits are significant - the availability of these data allows the company to analyze the atmospheric conditions along the shipping route, register harsh zones with high humidity and extreme temperatures - the conditions that severely affect the corrosion process. The GPS data provides the information on the location as well as the duration on various, including undesired, climate conditions. These valuable data will be used to analyze atmospheric conditions along each route and further pre-treat the shipped materials in order to protect them from the corrosion. Additionally, the project provides an excellent opportunity for EET students to apply their skills and course work, and interact with industry on a real-world design challenge.

In this article, we describe an effective approach of working in industry sponsored SD project, the SD team requirements, the significance of the project, specific project outcomes, and assessment tools used.

Introduction

The capstone project course is an intrinsic part of the undergraduate education. The capstone projects are widely regarded as an excellent mechanism for assessing the outcomes of engineering and engineering technology programs and can serve as a direct measure of the quality of graduates. Capstone projects provide an opportunity for students to demonstrate their critical thinking skills, communication skills, as well as time and project management skills. The capstone course prepares students to better understand the professional roles in the engineering and technology community[1]. In many universities, senior-level capstone courses have been incorporated as an integral part of engineering and engineering technology education in an effort to correlate the practical side of engineering design and the engineering curriculum. Such courses provide an experiential learning activity in which the analytical knowledge gained from previous courses is joined with the practice of engineering in a final, hands-on project.[2-4] The development of capstone design courses and corresponding requirements have been influenced by various sources, including the Accreditation Board for Engineering and Technology (ABET), industrial advisory boards (IAB), faculty leading capstone projects, numerous industrial companies, and engineering research.

Earlier research[4-15] showed the importance if industrial involvement in the capstone environment, which became more than just the financial support described above. However, support in the form of equipment, materials, and technical consulting is common and in most cases necessary.[6,8,11] Most industrial sponsors have a liaison engineer who assists the students and who follows the progress of the project.[7,10] Other forms of industrial support include providing awards for meritorious designs and assisting in the evaluation of teams and projects.[4]

More recent studies provide further in depth analysis on the importance of the various benefits of capstone projects for the students' preparation for real world jobs. These include but not limited to the importance of industry involvement,[16-18]familiarizing students with product development process and system engineering,[16,19-23] improvement in the professional skills of students,[16,21] providing multidisciplinary training,[16,22,24,25]cultivating creative problem solving skills,[16,26] and preparing students for globalization.[16,27,28]

Recently, a new trend in conducting capstone projects became noticeable. Some capstone projects are sponsored by faculty members instead of industrial partners playing an important role of supporting some larger scale externally funded faculty research projects[16]. For example, at Texas A&M University undergraduate students involved in these projects as a capstone team had to work with graduate students, faculty members, and potential customers. Software, hardware, interface, system integration, and testing all involved other researchers instead of just the capstone team[16] . These types of projects may resemble projects conducted in industrial settings, where multiple divisions have to collaborate on a single, large scale project.

The intend of this article is to share developed at Michigan Tech an effective approach of working on industry sponsored SD projects. In this article authors present student's team engaged in the industry sponsored project with the goal of the development and proof of concept demonstration of the multi-sensor device enabling the atmospheric and GPS data collection for the materials shipped through different climate zones of the United States. The authors describe the project requirements, the significance of the project, specific project outcomes, and assessment tools used to effectively evaluate the students' success.

ArcelorMittal: Leading Steel Producer

As part of the continuous efforts in developing industry partnerships that will lead to priority consideration of graduates from The School of Technology ArcelorMittal, the world's leading steel company with operations in more than 60 countries, collaborated with The Electrical Engineering Technology (EET) Program at Michigan Tech to engage a group of EET students in solving engineering problems as part of capstone integrating experience and to fulfill the degree program requirements.

ArcelorMittal utilizes railroad system to ship metal coils through different climate zones of the United States. Due to significant temperature and humidity fluctuations during transportation, the coils are subject to corrosion. To understand the severity of climate conditions, have an ability to characterize them geographically, and to fully evaluate the cause and the strength of the corrosion, the data containing the information on the humidity, temperature and associated GPS location must be collected. Further evaluation of this data will allow the company to take the preventive actions to protect the shipped materials.

EET Program at Michigan Tech

Michigan Tech is a public university committed to providing a quality education in engineering, science, business, technology, communication, and forestry. Michigan Tech has a first-class reputation for excellence in science, technology, and engineering education. In fall 2012 total enrollment was 6,947 students, including 1,288 (18.5%) graduate students. Over 64% of Michigan Tech students are enrolled in engineering and technology programs.
The EET program offers a Bachelor of Science in Electrical Engineering Technology and is designed to train the future workforce directly in response to industry needs. The EET program is application-oriented and focuses on preparing graduates for entry into the workforce upon graduation. Graduates of the program are electrical engineering technologists with career options in micro-controller applications, robotics, industrial automation, instrumentation, and control.

A major strength of the EET program in attracting and retaining interested students is the emphasis on applied laboratory experience. The program has a solid record of career placement among employers who are seeking graduates that are productive upon entering the workforce. The university as a whole has maintained a placement rate of over 95% in recent years in spite of the difficult economic times. All School of Technology faculty members have a minimum of three years of industrial experience, which enhances the ability of the School to access industry support and place engineering technology graduates. The faculty members have a strong commitment to the integration of practical laboratory experience with engineering technology fundamentals.

Capstone Course Description

In the past several years EET program in the School of Technology at Michigan Tech was very successful in establishing collaboration with the industry. This, in turn, triggered nearly all the capstone projects conducted in the EET program to be industry sponsored. Only during the last four years, EET program has successfully completed 12 capstone projects with 10 of them being industry sponsored. The benefits of having SD projects industry sponsored are very significant for both the students and faculties.

A capstone course in the EET program requires the application of knowledge gained in lower and upper division courses. Students participating in a capstone project demonstrate the ability to perform independent and creative work by successfully completing a major design project. Projects are normally team oriented, where the team consists of two to four members, with one member chosen as team leader. Team oriented capstone projects provide a better simulation of industrial environment, to better train today's engineers. [2] Weekly progress reports are required, and the work culminates with a final report and oral presentations, including a poster of the project. Six credits of Senior Project are required for graduation, normally satisfied in two three-credit semesters.
Upon successful completion of the capstone project course, students should fulfill the following course objectives:

- Prepare background research on applied electrical engineering technology.
- Research and organize data for synthesis.
- Prepare written reports.
- Prepare and present oral reports.
- Work in teams.
- Coordinate and work to meet scheduled deadlines and facilities, manage resources, etc.
- Consider non-engineering considerations in your work (e.g., Economic issues, marketing issues, esthetics).

At the beginning of the first semester team is required to prepare a typed project proposal in a formal memo format, including a proposed timeline. During the course of the project student's team meet with their faculty advisor weekly to discuss the progress report. The weekly formal memo is required the day prior to each weekly meeting and addresses the following three areas: current progress, problems encountered and their resolution, and plan for the following week. To stay on the top of industry requirements sponsoring the project and to receive valuable engineering feedback students conduct by-weekly web conference calls with industry liaison. The oral and written reports due near the end of each semester are to concern themselves with the progress made in each semester. The one at the end of the first semester will be a progress report, with a full final report due at the end of the second semester. To further improve the quality of capstone projects conducted in the EET program in the SoT at the Michigan Tech and make students experience as participating in undergraduate research, in the middle of the second semester the team led by the faculty prepares the paper to be further submitted in one of the engineering journals or conference proceedings. In the author's opinion, this experience should become an integral part of any capstone project since it derives an additional benefits previously not included in the capstone environment. First, this requirement makes the students to fill them proud to be engaged in undergraduate research, which in-turn derives more responsibility and teamwork. Second, it provides the students with the opportunity to learn different styles of technical writing following required formats associated with various journals and conference proceedings. The last but not the least, it significantly improves graduates portfolio that while looking for the job can "bring to the table" more than their competitors - applicants.

Technical Content of the Project

To design and build a "black box" capable of collecting all the required data a Senior Design team of 2 students was formed in the Electrical Engineering Technology program in the School of Technology at the Michigan Tech. Working with the sponsor the project significance was identified as the development and proof of concept demonstration of the multi-sensor system enabling the atmospheric and GPS data collection for the materials shipped through different climate zones of the United States. The benefits are significant - the availability of these data allows the company to analyze the atmospheric conditions along the shipping route, register harsh zones with high humidity and extreme temperatures - the conditions that severely affect the corrosion process. The GPS data provides the information on the location as well as the duration on various, including undesired, climate conditions. The device will be attached to the steel and record current position, temperature, and humidity every 30 minutes. Once the device has completed its trip, all data can be easily retrieved and analyzed. These valuable data will be used to pre-treat the shipped materials in order to protect them from the corrosion.

System Overview

The unit is primarily comprised of 5 main components, as shown in the diagram below.

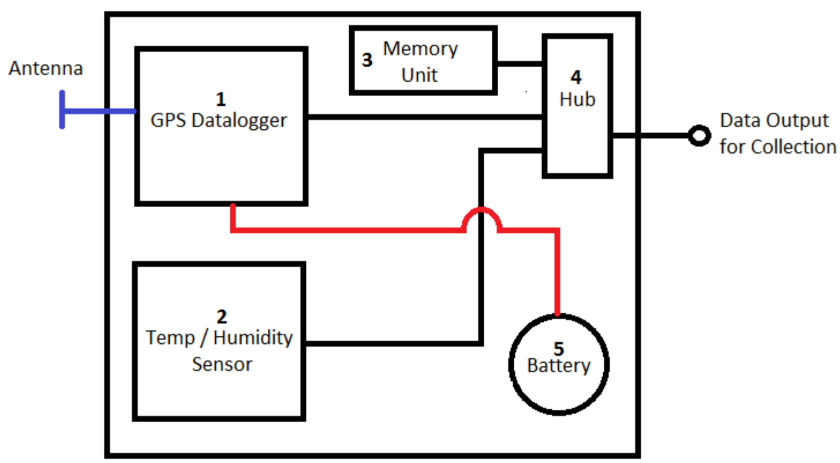


Fig. 1 Block Diagram of Unit

When the unit is turned on, the GPS data logger (1) begins to record the unit's position every 30 minutes. To help ensure a clear signal is obtained, the unit must be equipped with an external antenna. The GPS is connected to an external battery pack (5) for the GPS to last for 30+ days of continuous operation. The integrated temperature/humidity sensor (2) samples the temperature and humidity of the area every 30 minutes and records it in internal memory. The external memory unit (3) consists of a flash memory drive and its main purpose is to hold the programs needed to extract the data when the unit reaches its destination. The GPS, temperature/humidity sensor, and memory unit are all connected to a single hub (4). The hub's main function is to allow the device's data to be extracted from a single point, making the device more user-friendly.

GPS Data Logger

For this project it was determined that a pre-made GPS unit will be utilized. This conclusion was reached primarily due to the reliability of prebuilt GPS units, cost effectiveness, and time constrains. The GPS unit selected by the team was the GlobalSat DG-100 Data Logger with the external antenna capability. The last feature was particularly important for the reliable operation of a final product due to the fact that the device will most likely be encased in a steel rail and internal antenna will not be sufficient. This GPS is equipped with internal, non-vulnerable memory unit and companion software to help extract and view data. It is capable of holding 60,000 individual data points before its memory is full. It also has an adjustable sampling rate that can be programmed to the user desires. The sampling rate of twice per hour was determined to be sufficient and comes nowhere close to using up the entire memory of the device. The GPS companion software is easy to use and is packaged along with the unit in the removable flash drive. This will allow the user to install the software on their computer if needed. This will also allow the user to utilize the companion software to examine the data points by exporting them to Google Maps. According to the GPS data sheets, the device can run continuously for 30 hours. We have found the power consumption to be closer to 24 hours. Out of the box it runs on two (2) AA NiMh batteries connected in series. This means the device runs on 2.4 VDC with a capacity of 2500 mA hours. This power source is inadequate to power the unit for the thirty plus days that is required by the device. The battery unit is discussed in further detail in the battery unit section of this paper.

Temperature/Humidity Sensor

The temperature/humidity sensor (THS) used in this project is a pre-built, portable unit equipped with internal memory. It comes with companion software that allows data points to be easily extracted from the device. This software will also be placed into the flash memory unit so that it can be installed by the user if needed. Initially the team planned to connect both the GPS and THS to a single battery source but this was determined to be rather unnecessary. The THS utilizes a 3.6 V lithium battery for its power source and has an average battery life of three (3) years. The THS also exports its data through USB, making it easy to integrate into a data hub so the data can be extracted from a single point on the device.

Memory Unit

The memory unit (MU) of the device consists of a simple flash drive. Flash drives have proven to be reliable technology that is cost effective and can hold large amounts of data. It also utilizes USB, allowing for easy integration into a data hub. This memory unit includes all the relevant programs for the devices individual components, the programs created by the team for the device along with user manuals and other relevant data. Having all this data in a single MU allows the device to be more portable. The user only needs to plug the device in to have an access to all the programs and files. This negates the need to include software CDs and paper user manuals. The MU also allows the user to make quick backup copies of the programs if needed. Since the MU is flash memory, it requires no additional power to preserve the data stored on it. It largely has no role in the actual data collection of the device and is only used for data extraction resulting in relatively small chance of the data being corrupted.

Data Hub

The data hub is a quite simple, yet essential part of this project. It is simply a USB hub that permits four different USB devices to be connected to a single point and to have a single connection with a computer. The hub takes its power from the computer it is plugged into, making it unnecessary to connect it to a battery source. Like the flash drive, it largely has no role during transit and data collection of the unit. It is only utilized when data is being extracted, at which point it will tie all the subsystems together.

Battery Unit

The battery unit needed to be designed to enable the device to run for thirty days of continuous operation. Since the cost of the unit was a factor, the disposable batteries instead of a rechargeable lithium batteries were selected. The GPS can run for about 24 hours on two AA batteries in series. For a single day of operation, the unit requires about 2.5 amp hours at 2.4 V. Calculated for thirty days, the device requires around 75 amp hours (2.5 amp hours * 30 days). A typical D cell battery provides about 12 amp hours, as compared to an AA which provides around 2.5 amp hours. For the unit to run in ideal conditions for thirty days would require around 7 D cells. The battery design includes 10 D cell batteries as shown in Figure 2.

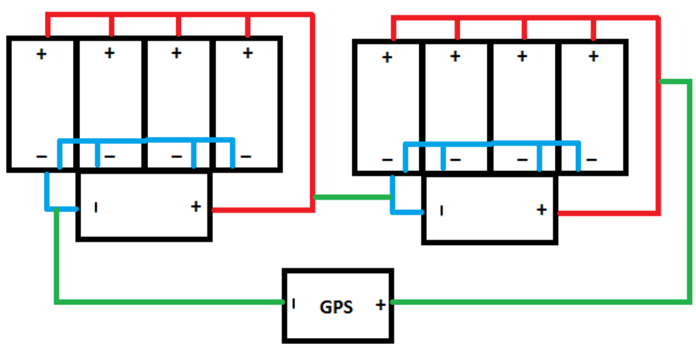


Fig. 2 Battery Diagram

Enclosure

Another important design consideration is the enclosure where all the subsystems are housed. A plastic enclosure measuring 10" x 6" x 3" was selected to fit all the systems snugly to sustain vibrations yet allow room for proper ventilation. The enclosure did not have to be weatherproofed due to it be traveling in an enclosed space and the unit needs to accurately measure temperature and humidity which it would be unable to do in a completely sealed case.

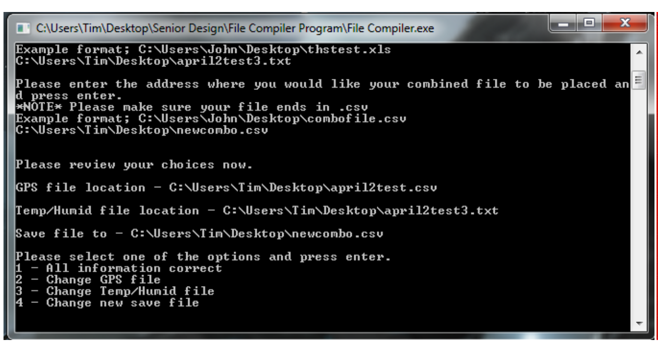
Software Development

Some attempts were initially made to create a program that would extract all information from both the GPS and THS units and assemble it into a single file. This program had limited success and there were numerous difficulties with getting the program to work on different computer operating systems. This idea was put aside in favor of creating detailed instruction manuals on how to retrieve the data and creating a program that would combine the two data files together. A file compiler program has been created to combine the GPS and THS data files into a single file. The program was written in C++ and correlates data based on its time stamps. The program first reads in both the GPS and THS data files and populates both files into separate databases. Then it begins to compare the two databases looking at the first data entry in the GPS and THS databases, specifically the date the sample was taken. If a match is found with regards to date then the program looks at the hours and minutes of the GPS entry and compares it to the THS entry. If the times are within 15 minutes of one another, the data is compiled together and saved into another database. This process continues until all the files are compared and compiled. This program also converts the latitude and longitude from NEMA to KML format. The main reason for this is that most online programs utilize KML so it is more user-friendly to convert the data rather than make the user do it by hand. Individual GPS and THS database files are shown in Figure 3. The screenshot of the compiler is provided and the compiled database of GPS and THS datasets is presented in Figure 4.

Number	Date	Time	Latitude	Longitude	Speed(mph)
1	4/2/2012	12:02:01	4707.16	-8832.89	0.5
2	4/2/2012	12:32:01	4707.165	-8832.89	0.25
3	4/2/2012	13:02:02	4707.18	-8832.89	0.12
4	4/2/2012	13:32:02	4707.164	-8832.9	0.06
5	4/2/2012	14:02:02	4707.165	-8832.9	0.5
6	4/2/2012	14:32:02	4707.166	-8832.89	0.19
7	4/2/2012	15:02:02	4707.157	-8832.9	0.25
8	4/2/2012	15:32:02	4707.155	-8832.86	0.19
9	4/2/2012	16:02:02	4707.162	-8832.88	0.12
10	4/2/2012	16:32:02	4707.151	-8832.91	0.31
11	4/2/2012	17:02:02	4707.145	-8832.9	0.19
12	4/2/2012	17:32:02	4707.161	-8832.88	0.25
13	4/2/2012	18:02:02	4707.156	-8832.89	0.19
14	4/2/2012	18:32:02	4707.158	-8832.88	0.31
15	4/2/2012	19:02:03	4707.161	-8832.86	0.12

NO.	DATE	TIME	TEMP	HUMIDITY	DEW-POINT
1	4/2/2012	11:41:55	69.9	30.5	37.5
2	4/2/2012	12:11:55	69.2	29.7	36.2
3	4/2/2012	12:41:55	68.7	30.4	36.3
4	4/2/2012	13:11:55	68.5	30.8	36.5
5	4/2/2012	13:41:55	68.5	30.9	36.6
6	4/2/2012	14:11:55	68.5	31.1	36.7
7	4/2/2012	14:41:55	68.7	31.1	36.9
8	4/2/2012	15:11:55	68.9	30.7	36.8
9	4/2/2012	15:41:55	68.9	30.3	36.4
10	4/2/2012	16:11:55	68.9	29.9	36.1
11	4/2/2012	16:41:55	68.9	29.4	35.7
12	4/2/2012	17:11:55	68.9	29	35.3
13	4/2/2012	17:41:55	68.9	28.8	35.2
14	4/2/2012	18:11:55	69	28.6	35.1
15	4/2/2012	18:41:55	69	28.9	35.3

Fig. 3 GPS and THS data files



Sample	Date	Time	Latitude	Longitude	Temperat	Humidity	Dewpoint	Speed
1	4/2/2012	12:02:01	47.1193	-88.5482	69.2	29.7	36.2	0.5
2	4/2/2012	12:32:01	47.1194	-88.5482	68.7	30.4	36.3	0.25
3	4/2/2012	13:02:02	47.1197	-88.5481	68.5	30.8	36.5	0.12
4	4/2/2012	13:32:02	47.1194	-88.5484	68.5	30.9	36.6	0.06
5	4/2/2012	14:02:02	47.1194	-88.5483	68.5	31.1	36.7	0.5
6	4/2/2012	14:32:02	47.1194	-88.5482	68.7	31.1	36.9	0.19
7	4/2/2012	15:02:02	47.1193	-88.5483	68.9	30.7	36.8	0.25
8	4/2/2012	15:32:02	47.1192	-88.5477	68.9	30.3	36.4	0.19
9	4/2/2012	16:02:02	47.1194	-88.548	68.9	29.9	36.1	0.12
10	4/2/2012	16:32:02	47.1192	-88.5486	68.9	29.4	35.7	0.31
11	4/2/2012	17:02:02	47.1191	-88.5483	68.9	29	35.3	0.19
12	4/2/2012	17:32:02	47.1194	-88.548	68.9	28.8	35.2	0.25
13	4/2/2012	18:02:02	47.1193	-88.5482	69	28.6	35.1	0.19
14	4/2/2012	18:32:02	47.1193	-88.548	69	28.9	35.3	0.31
15	4/2/2012	19:02:03	47.1193	-88.5477	69.2	28.6	35.2	0.12

Fig. 4 Program compiler and its output: compiled database of GPS and THS datasets

After the initial debug phase, the program was tested by combining many different data files. The program was given files with samples that were taken within a minute of one another and it successfully correlated all the data. Conversely the program was also given files that had no dates in common and it would correlate none of the data. As long as the original files are saved into the correct format, the program performed reliably. The only difficulty with using this program could come from user error. A user error has been minimized by searching for valid files, but the program does not check the address of newly created file. If the address of the newly created file is not valid, the program will not save the file. Also, if the file name given is the same as an already created file, the program will replace the old file without prompting the user if they want to continue. To minimize the chances of this happening, a user manual has been created for the program and was included in the memory device of the unit. The complete, fully commented source code of this program was also included with the device in case the user wants to change any parameters of the program themselves.

Final Test

The final testing of the unit consisted of a multi-week test to confirm the reliable operation of the final unit. The longest test focused on ensuring that the battery would last for the specified amount of time, thirty days. The fully constructed unit was powered on at 9:30 AM on 3/23/2012 and was tested for 27 days after which was delivered to the sponsor upon its request. During the battery testing, the unit went through a series of temperature swings, from below freezing to over 100 degrees Fahrenheit. The unit was also taken on a series of road trips to see how accurately it would give GPS readings. Even with the temperature swings the unit did not shut off and the battery life did not seem to be impaired in any way. The unit took accurate and consistent readings and appeared to have no problems with running at prolonged periods. Some further testing involved placing magnets within the device enclosure to see if they would have an adverse effect on the readings and the unit was found unaffected by magnetic fields. The greatest form of test is still to come for the unit as our team at the Michigan Tech cannot fully simulate the conditions that the unit will undergo when it travels by rail. However, the team felt confident that the device will handle the rigors of railcar travel.

Capstone Project Assessment

To effectively assess the capstone project course outcomes the direct and indirect assessment tools have been implemented. In general, direct assessment involves looking at actual samples of student work produced in the course. These may include initial project proposal and a time line, team weekly memos, written report & project brief, team poster, and oral presentation. Indirect assessment is gathering information through means other than looking at actual samples of student work. These include student's self evaluation, faculty and IAB members' evaluations, and exit interviews. Each serves a particular purpose. Indirect measures can provide an evaluator with the information quickly, but may not provide real evidence of student learning. Students may think that they performed well or say that they did, but that does not mean that their perceptions are correct. As an indirect assessment tool the authors developed and implemented senior project peer feedback form and oral presentation scoring rubric with the last one being distributed to the faculty and IAB members during the final presentation conducted by the team at the end of the second semester.

The final grade is derived using both direct and indirect assessment tools and based on the satisfactory completion of the capstone project and the presentation of the final results in an appropriate engineering report. The final grade is based on individual and team performance throughout the semester. The points are awarded as follows:

- Initial Project Proposal and Time Line 10% Team
- Weekly Memos 20% Team
- Written Report & Project Brief 30% Team
- Poster 10% Team
- Oral Report 20% Individual
- Peer and Self Evaluation 10% Individual

To conduct peer and self evaluation, students of the team were asked to complete and submit to the faculty advisor a senior project peer feedback form shown in Figure 4. To collect the faculty and IAB members' feedback, oral presentation scoring rubric shown in Figure 5 was distributed during the final presentation conducted by the team at the end of the second semester. Students participated in the described in this paper capstone senior design project provided highly positive feedback to the team peers and scored 21.7 out 22 possible points on oral presentation scoring rubric filled by the faculty and IAB members.

Conclusion

Academic programs in the School of Technology at Michigan Tech are designed to prepare technical and/or management-oriented professionals for employment in industry, education, government, and business. EET program in the SoT at Michigan Tech is constantly revamping the curriculum to meet the expectations of industry by supplying qualified technicians and technologists who have extensive hands-on experience.

As part of the continuous efforts in developing industry partnerships that will lead to priority consideration of graduates from The School of Technology ArcelorMittal, the world's leading steel company with operations in more than 60 countries, collaborated with an EET program at Michigan Tech to engage a group of EET students in solving engineering problems as part of capstone integrating experience and to fulfill the degree program requirements. Working with the sponsor the team was challenged to develop a proof of concept demonstration of the multi-sensor system enabling the atmospheric and GPS data collection for the materials shipped through different climate zones of the United States.

With the conclusion of this project the team was able to meet all of the requirements given by the sponsor and fulfill the degree program requirements at the Michigan Tech. Successful assembly and testing of the unit was accomplished. The unit has gone through various test and proved to be reliable in operation. The unit reliably samples and records position, temperature, and humidity every 30 minutes with a battery life of 30 days. Two user guides were created which include step-by-step instructions with images and figures on how to install the unit retrieve all the data.

Acknowledgement

EET program in the SoT at Michigan Tech, faculty advisor, and the team of students participating in the project would like express their deep appreciation to ArcelorMittal for providing sponsorship and great opportunity to collaborate.

SENIOR PROJECT PEER FEEDBACK FORM

Assessment of (name): ______________________________ ☐ *Co-worker* ☐ *Self* **Semester:** ____________

Instructions: For each statement below, check one of the columns at the right to rate this individual's performance as a senior project team member.	+2 Strongly Agree	+1 Agree	0 Neutral	-1 Disagree	-2 Strongly Disagree	0 No Opportunity to Assess	**Comments** **(use back of sheet if more room is needed)**
Results Orientation							
Sets and achieves challenging goals that meet project needs.							
Takes initiative.							
Accountable for behavior and decisions.							
Persists in spite of obstacles and opposition.							
Integrity							
Behaves ethically in all situations and reports or challenges unethical behavior of others.							
Builds trust through honest interactions with others.							
Shows consistency among words, actions and values.							
Interpersonal Effectiveness							
Communicates effectively with others.							
Values individual differences and multiple viewpoints.							
Tries to foster a team environment.							
Handles conflict constructively.							
Quality Orientation							
Continually seeks to understand current and evolving project/group needs.							
Ensures that work meets the quality requirements of the course.							
Seeks to improve the project.							
Continuous Learning							
Demonstrates flexibility in adapting to change, uncertainty and shifting priorities.							
Learns from experience.							
Embraces opportunities to learn new skills and approaches.							
Innovation							
Makes creative suggestions for solving problems.							
Looks at issues in new ways and supports others when they do.							
Overall, this individual is a productive member of the team.							
Add up the number of checks in each column and enter it on the corresponding blank at right:	A ____	B ____	C ____	D ____	E ____	F ____	

Points earned = (2 × A) + B – D – (2 × E) = ________ **Points available = 40 – (2 × F) =** ________

Percentage = (Points Earned / Points Available) × 100 = ________

Figure 4: A senior project peer feedback form

Oral Presentation Scoring Rubric

Presenter ______________________________ Date ______________

Course ______________________________ Scorer *(Optional)* ______________

Part 1: Preparation				
	2	**1**	**0**	**Score & Comments**
Technical Soundness	Oral presentation and visual aids free of technical errors. *(Get a promotion!)*	Enough technical errors to erode your credibility, *(but not enough to get you fired).*	Severe technical flaws. *(Might get you fired.)*	
Content	No information is lacking. No irrelevant information is included.	May be missing some key information or a significant amount of irrelevant information is included.	Poor choices made when deciding what information to include and exclude.	
Organization	Presentation includes introduction, body and conclusion. Body information is presented in logical order. Smooth and timely transitions.	Presentation includes introduction, body and conclusion. Order in which information is presented is somewhat unclear or confusing.	Talk is very poorly organized.	
Grammar, Spelling, Vocabulary	Oral and visual presentation free of grammatical, spelling, and/or vocabulary errors.	Grammatical, spelling, and/or vocabulary errors are frequent enough to create some problems for the listener.	Grammatical, spelling, and/or vocabulary errors make the information very difficult to understand.	
References	References are clearly reliable, cited correctly and shared with audience.	Some references are unreliable or incorrectly cited.	No references cited. *(Go directly to jail for plagiarism!)*	
Visual Aids	Attractive and informative visual aids that compliment the information being presented.	Visual aids are cluttered or not informative.	No visual aids or better off not using the ones you have.	

Part 2: Delivery				
	2	**1**	**0**	**Score & Comments**
Length	Efficient use of time to present and handle questions from audience.	Some time management problems, either too short or too long.	Significant mismanagement of time.	
Personal Appearance	Professional, effort made to look sharp, right level of formality.	Neat but inappropriate (too casual or too formal).	Sloppy.	
Enthusiasm	Voice and body language reveal enthusiasm and interest in topic.	Neutral. Doesn't appear disinterested but not obviously enthusiastic.	Voice and body language seem unenthusiastic, bored with own presentation.	
Audience Rapport	Frequently checks for audience understanding; keeps audience engaged by maintaining eye contact and modifying delivery style if needed; attentive to questions and answers questions thoroughly.	Occasionally focuses on audience for reaction; responses to questions are generally relevant but little elaboration may be offered.	Oblivious to audience reaction; very abrupt when answering questions.	
Poise	Good posture and pacing; speaks clearly with sufficient volume; limited use of filler words; minimal reliance on notes; called on visual aids at appropriate times.	Not bad but could appear more confident.	Very stressed; reads visual aids to audience; composure is lost if distracted; significant use of filler words; speaking too fast or too softly.	

Total Score: _________ out of a possible 22

Figure 5: A senior project oral presentation scoring rubric

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