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## **AC 2012-4990: TRACKING CAPSTONE COURSE PERFORMANCE IN A DATABASE THAT IS USED TO TRACK ACCREDITATION DOCUMENTATION**

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# **Tracking Capstone Course Performance in a Database That is used to Track Accreditation Documentation**

## **Abstract**

This paper documents the efforts to develop a Microsoft Access™ database to maintain assessment data for the purposes of ABET accreditation. The database was developed to serve three programs housed in one department. With the senior capstone project serving as a primary assessment point in the program, it was a natural candidate to pilot the development of this database. In addition to tracking project progress, the database was used to decouple numerical data assigned to multidisciplinary teams, so that the three programs could be assessed separately relative to the student outcome of functioning on teams.

## **Introduction**

The Department of Engineering and Technology at Western Carolina University supports the western region of North Carolina in several key modes. Its primary mission is to provide a strong educational foundation to the students it serves, including those in the region, across the state, and in some cases from out-of-state. Additionally, the department engages with industry to provide an economic development vehicle, which has contributed to a recovery of manufacturing in the region.<sup>1</sup> One of the more successful efforts in merging the efforts of the educational and industrial realms is the senior design capstone project, a two-semester sequence. This capstone project combines senior-level students from multiple disciplines to design a product or improve a process for an industrial partner. Those students are majors in one of the three different programs housed in the department: Engineering Technology (ET), Electrical and Computer Engineering Technology (ECET), and Electrical Engineering (EE).

Maintaining an accredited program is vital to the ongoing success of all three programs in the department. All three programs are accredited by the Accreditation Board for Engineering and Technology, Inc. (ABET) – ET and ECET are accredited by the Technology Accreditation Commission of ABET and EE by the Engineering Accreditation Commission of ABET.<sup>2</sup> As other institutions have learned, continued accreditation entails a host of methods of properly assessing, evaluating, and documenting that a high-quality program is being delivered, and that continuous improvement is taking place. For many programs this assessment and documentation can become very cumbersome. One ABET consultant even warned one assessment coordinator that excessive effort on this front can lead to “death by assessment.” While this comment was meant in jest, every faculty member who has participated in the assessment efforts knows exactly what was meant by the statement.

The department has successfully assessed all three programs and continues to investigate new methods of evaluation for continuous improvement. When considering assessment for ABET purposes, the use of the senior capstone<sup>3</sup> became a natural source of data. In fact, there is an overabundance of data, but the format of those data has not typically aligned with assessment needs. Beginning in the summer of 2011, an effort was started to create a database to facilitate a coordinated effort to allow for easy data entry by the faculty and staff participating in the evaluation of students and their capstone projects, as well as easy report generation for ABET assessment documentation. This paper documents the development of the department’s

assessment database and demonstrates its ability to facilitate report generation that was previously cumbersome, and thus not readily available.

### **Microsoft Access™**

The choice of database programs was the first issue to be resolved. Most university personnel, faculty and staff alike, do not have significant exposure in generating and using databases. There are a host of database options, such as Oracle™, SQL Server™, FoxPro™, and Microsoft Access™. For this particular application MS Access™ was chosen as the backbone to house the data, perform the analysis, and generate the reports. Most university personnel have moderate-to-significant experience using Microsoft Excel™, which is a powerful spreadsheet program, used to sort data, perform calculations, and deliver a host of other functions. Unfortunately, Excel™ is not designed to deal with relational databases, where data in one table need to be linked to another table to generate a new set of data. This is the role of a database program. Since Access™ has a relatively easy user interface, is accessible to any employee on this campus, and has a nearly seamless interface with Excel™, it was chosen as the program to handle this project.<sup>4</sup>

Access™ has four basic objects that it uses to store, manipulate, and display data: tables, queries, forms, and reports.<sup>5</sup> Tables are used to store data in fields that are formatted according to the data type, such as text, numbers, dates, and hyperlinks. Queries are used in a variety of methods, such as linking multiple tables to extract data in a different format; they can also be used to append data to an existing table, remove data from a table, update data in a table, and create a new table. Forms are the method by which the user can enter new data or search for data in a user-friendly interface. Reports are typically used to display final information, according to the user's specifications.

### **The Data Entry Form**

To begin developing the database it was necessary to populate the database with an initial structure. Since the senior capstone course sequence had been offered for several years, it had a well-established gate structure that served to schedule the student projects and configure the grading process. The gates were essentially milestones that each team needed to fulfill prior to moving onto the next phase of the project. Thus, the gate structure of the course from the 2010-11 academic year served to organize the Access™ database.

The capstone course has a series of six gates (milestones) that the teams pass through during the two-semester sequence. Each gate has a different presentation format, such as formal presentation, design review, poster session, etc. At each of these gates multiple assessors, such as faculty and customer representatives, evaluate the teams through the use of a rubric. Those evaluations had been hand-written, then transcribed to an Excel™ spreadsheet to generate grades for the student teams. With the introduction of the Access™ database the data are entered into the database instead of Excel™. Ultimately it is the hope that the data can be entered directly into the database by the individual assessors, but for logistical reasons that is not presently possible.

The interface for data entry into the database is an Access™ form shown in Figure 1. The user opens the form for a particular gate with preloaded data, such as team information and gate

description, then enters the numerical score (1-4 scale) and any comments from the assessor. The data entered into this form updates a table that exists in the background.

The screenshot shows a software window titled "Score Teams by Gate". At the top right is the "Engineering Technology" logo. The form contains the following fields and data:

- Gate Number: 3
- Gate Name: Preliminary Design Review
- Team Number: 13
- Team Name: CW 737
- Gate Topic: Schedule and Timeline
- Gate Descrip.: Coherence with design phase, long lead items identified, Key design challenges being addressed in timely fashion, timeline clearly lays out the process
- Score: 3
- Comment(s): Good use of MS Project to identify critical path. Need to ensure critical tasks are met to maintain schedule.

At the bottom, a status bar indicates "Record: 48 of 90".

Figure 1: Form for Data Entry

Once the data are loaded into the table through the form, the database has been populated. A series of reports can be run to analyze the assessments of these teams. Presently reports exist to view the mean and standard deviation of scores for the following combinations:

- All teams for each of the six gates (aggregate scores for the course, shown in Figure 2)
- All teams for each of the six gates, broken down by topic within the gate
- Each individual team for each of the six gates
- Individual team performance at each gate, sorted by gate

Another advantage that Access™ has over Excel™ in this type of application is the ability to generate these reports, sorted by multiple fields without the need to alter the source data. It is simply queried and sorted differently, depending on the user's needs.

## All Teams - Mean and Std Deviation by Gate

Gate No 1a	Proposal Presentation	Mean =	3.0111	St Dev =	0.8676
Gate No 1b	Proposal Project Book	Mean =	2.8667	St Dev =	0.6902
Gate No 2	Conceptual Design Review	Mean =	3.1167	St Dev =	0.8847
Gate No 3	Preliminary Design Review	Mean =	2.8667	St Dev =	0.8100
Gate No 4	Critical Design Review	Mean =	2.8667	St Dev =	0.6902
Gate No 5	Release to Test Review	Mean =	2.8222	St Dev =	0.6963
Gate No 6	Final Review	Mean =	2.9333	St Dev =	0.7039

Figure 2: Sample Report

### The CATME Tool and its Use in Assessment

The capstone project is conducted in a team environment, and as such, is susceptible to the pitfalls that accompany most team efforts—issues with group dynamics, uneven workloads, etc. To assess each team’s ability to work in a group environment and to more fairly assign grades, this course employs the use of a web-based tool, designed to provide team members the ability to provide peer- and self-evaluations. That tool is Comprehensive Assessment for Team-Member Effectiveness (CATME), developed with funding from the National Science Foundation by a multidisciplinary team at multiple institutions. The website is housed at Purdue University and is free to use for educational purposes.<sup>6</sup>

When planning for the next ABET visit, the Engineering and Technology faculty recognized the outstanding opportunity that CATME provides for assessment, especially in the arena of working in teams. The assessments for the three programs—ET, ECET, and EE—in the area of teaming needed to be presented at the team- or course-level, not by individual student. Unfortunately the reports generated by CATME provided data for teams or individual students. The problem with this format is that the assessments for the three programs would have been coupled with one another, which was thought to be problematic when assessing individual programs for ABET purposes. This Access™ database became the natural solution to the problem, since each individual student was identified by major (ET, ECET, or EE).

Shown in Figure 3 is a sample CATME interface where team members, including faculty mentors, evaluate themselves, as well as each other. The team member names have been blurred (to protect the innocent) in Figure 3. The radio buttons on the left panel are used to evaluate each participant on the topic, *Contributing to the Team’s Work* in this case. The selections made correspond to numerical ratings, ranging from one to five, where five is the best score. Those numerical scores are used to generate a weighting factor for each team member. The weighting factors are in turn used for grade determination for the capstone course.

## Contributing to the Team's Work

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Description of Rating			
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<ul style="list-style-type: none"><li>• Does more or higher-quality work than expected.</li><li>• Makes important contributions that improve the team's work.</li><li>• Helps teammates who are having difficulty completing their work.</li></ul>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Demonstrates behaviors described above and below.
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<ul style="list-style-type: none"><li>• Completes a fair share of the team's work with acceptable quality.</li><li>• Keeps commitments and completes assignments on time.</li><li>• Helps teammates who are having difficulty when it is easy or important.</li></ul>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Demonstrates behaviors described above and below.
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<ul style="list-style-type: none"><li>• Does not do a fair share of the team's work. Delivers sloppy or incomplete work.</li><li>• Misses deadlines. Is late, unprepared, or absent for team meetings.</li><li>• Does not assist teammates. Quits if the work becomes difficult.</li></ul>

Figure 3: CATME Interface

In the context of this database development, the numerical scores for individuals are also used to generate the relative performance of the team members in each program on their respective teams. An Access™ query was run to sort out those team performance levels by program, as shown in Figure 4. On the five-point scale, it shows a difference in the three programs, as well as the faculty mentors. While these differences are not considered statistically significant for the sample sizes available, this does provide the ability for the faculty to separate the CATME team-based data for the individual programs for assessment purposes.

AvgOf	StDev	Major	CountOfMajo
4.1	0.767	ECET	8
4.7	0.245	EE	6
4.638	0.362	ET	8
4.456	0.453	Faculty	9

Figure 4: Program Team Performance According to CATME

## Conclusions

This Microsoft Access™ database has been successfully piloted to allow for data entry and analysis. The reports are structured to provide faculty the data needed to support program assessment and evaluation, necessary to maintain ABET accreditation. Additional reports might be necessary to supply the supporting documentation in a format consistent with the previous assessment and evaluation efforts.

This same database has also been used to sort the teaming data for multidisciplinary student teams into their component programs for assessment and evaluation purposes. The capability to use existing CATME data and an Access™ query alleviate a significant analysis load, hopefully avoiding “death by assessment.”

## Future Work

While these efforts are very promising, the implementation of this Access™ database is still in process. The pilot has been successfully completed, but now it is necessary to train all faculty and staff who will use the tool for data entry and analysis.

It is also anticipated that the database will be expanded to serve additional roles. It is likely that it can be used to track assessment data in other courses, as well as document the server location of supporting documents, such as samples of student work. An ocean of scanned documents exists to support ABET documentation; it is becoming imperative that these documents are consolidated and organized, likely with this database.<sup>7</sup>

Finally, it is hopeful that the efforts to sort the CATME data for this project will result in collaboration with the personnel who maintain CATME to initiate changes that will benefit the other institutions that use CATME. It is a powerful tool that can be used not just for team performance evaluation, but also for program assessment and evaluation purposes.

## Bibliography

1. Center for Rapid Product Realization website: <http://www.wcu.edu/3632.asp>
2. ABET website: <http://main.abet.org/aps/AccreditedProgramsDetails.aspx?OrganizationID=354>
3. Sanger, P., Ferguson, C., & Stone, W. (2009), Integrating Project Management, Product Development, and Senior Capstone into a Course Sequence that Creates New Products and Patents for Students. *Proceedings of the 2009 American Society for Engineering Education Annual Conference & Exposition*, Austin, Texas, June 14-17, 2009.
4. Cliver, R., Leonard, W., Dell, E., & Merrill, R. (2011), ABET Report Generation. *Proceedings of the 2011 American Society for Engineering Education Annual Conference & Exposition*, Vancouver, British Columbia, Canada, June 26-29, 2011.
5. Microsoft Access: [http://office.microsoft.com/en-us/access-help/access-2010-database-tasks-HA101829991.aspx#\\_Toc254780070](http://office.microsoft.com/en-us/access-help/access-2010-database-tasks-HA101829991.aspx#_Toc254780070)
6. CATME website: <https://engineering.purdue.edu/CATME>
7. Schneider, S. (2011), Developing an Application to Manage and View ABET Course Material. *Proceedings of the 2011 American Society for Engineering Education Annual Conference & Exposition*, Vancouver, British Columbia, Canada, June 26-29, 2011.