4th Annual Meeting National Engineering Mathematics Consortium

University of Cincinnati Implementation

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OUTLINE

- History
- Computer Integration
- Description of the Course Modules
- Assessment Results & Lessons Learned
- Moving Forward



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HISTORY

- During our last major curricular reform (1997), the Department of Civil and Environmental Engineering added *CVE 100: Introduction to CVE*; 3 QCH. It is still taught in Fall Quarter, Freshman Year.
- One goal of the class was to show students how freshman year classes in Math and Science related to Engineering.



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HISTORY

- UC joined the CCLI grant with WSU in 2007.
- *CVE 103: Introduction to CEE Math*, was added to Fall Quarter, Freshman Year. It is a 2 QCH class.
- The class specifically showed applications of Math to Civil & Environmental Engineering (CEE).



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HISTORY

- At this same time, it was clear UC was switching to semesters.
- In a parallel effort, Electrical and Computer Engineering proposed a semester based, year long course called *"Math and Models"* which became *"Engineering Models."*
- Since this was similar to CVE 103, CVE 103 became the beta version.



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HISTORY

- In 2008, the Department of Engineering Education was formed in College of Engineering.
- UC moved to semesters in 2012. In 2010, the College of Engineering accepted semester curricula for all Degree Programs which included *ENED 1090* and *ENED 1091*; *Engineering Models I and II*.

HISTORY

- In July of 2010, the College of Applied Science and the College of Engineering were merged.
- In the merger, the School of Engineering Education got two former CAS faculty (one from Math and one from EE) who were placed in charge of *Engineering Models I and II*.

HISTORY

- CVE 103 is still a one quarter pilot for Engineering Models.
- From 2007-08, 2008-09 and 2009-10, it was taught only to CE Freshmen.
- In 2010-11 and 2011-12:
  - CVE 103 was taught to CE Freshmen in F and Arch. Eng. Tech. (AET)/Const. Mgt. (CM) Freshmen in W.
  - School of Eng. Edu. Taught a year long Engineering Models to BME.



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HISTORY

- Initially, CVE 103 was a lecture based class on math applications with some labs.
- About 50% of the class was Vector Mechanics with Lab:
  - Addressed many math subjects (algebra, trig, matrix/systems) and showed their use in the engineering curriculum.
  - Helped the students in Physics 201.
  - Fundamental to CE.
- Stats, Diff. Eq., Graphing also covered.



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HISTORY

- In 2009-10 the CVE class was converted to MATLAB.
- The BME class is MATLAB based.
- Under semesters Engineering Models is to be MATLAB based.
  - For most degree programs, this will also replace programming in semesters.

WHY MATLAB?

- Forces students to “break down the problem.”
  - Observations by the Faculty indicate that student knowledge of Math/Science is based on rote learning.
- Allows for parametric “what if” analysis.
  - Shows students that not all parameters in an engineering problem are equal.

WHY MATLAB?

- Introduces numerical solutions to problems:
  - Shows that numerical solutions can be applied to problems without closed form solutions.
  - Shows limitations of numerical solutions (e.g., maxima and minima can be missed if steps are too large).
  - Shows these are often approximations.



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WHY MATLAB?

- Has good graphic packages:
  - Students have trouble with graphing.
  - Introduces semi-log and log-log graphs.
  - Introduces the idea of using graphic solutions.
  - Provides a data analysis tool for future labs.
- Has symbolic packages.
- It is hoped students will use MATLAB for future classes.



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CVE Modules

- Vector Mechanics (lecture and lab)
- Programming vectors (addition, subtraction, dot/cross products).
- Matrix math, systems of equations.
  - Solve a truss
- Graphing
  - Use of graphical solutions/data analysis
  - Log and semi-log plot (weir problem)



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CVE Modules

- Numerical Differentiation, Integration
  - Distance, velocity and acceleration
  - Show limitations of numerical solutions
  - Shows these are usually approximate, based on step size.
- Differential Equations – dynamic response of buildings (CE only)
- Statistics – qualification of concrete by cylinder strengths.



MATH READINESS

- Each year we give a math readiness test.
- Given in the first class.
- 15 – 25 questions:
  - Due to scheduling, some years we have three 1 hour classes and some years we have two 1.5 hour classes/week.

Math Readiness

Area	2008-09	2009-10	2010-11	2011-12
Graphing	88	86	50	76
Algebra	24	19	7	45
Geometry	18	0	10	50
Trigonometry	41	41	25	51
Probability	31	38	45	52
Logs/Exp	33	38	21	40
Derivatives	40	68	46	56
Integrals	29	47	32	40
Matrix	18	12	6	44

% Receiving 4 or 5 on a question

Maximum score = 5



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OBSERVATIONS

- Students tend to do well in graphing and in calculus questions:
  - But have trouble with definite vs. indefinite integral.
- Problems with geometry and trig:
  - The further they are away from the subject when finishing HS, the poorer they do.
- None to limited knowledge of matrix math.



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LESSONS LEARNED

- Information used to craft specific modules:
  - Geometry, Trig. and Pre-Calculus reviewed and emphasized with engineering applications.
  - Matrix added.
- Class specific information helps instructor pinpoint areas to emphasize.

STUDENT SURVEY

	2009-10	2010-11	2011-12
This course has increased my motivation to study engineering/technology.	3.52	3.36	3.01
This course has increased my chances of success in engineering/technology.	3.79	3.93	3.39
This course has increased my motivation to study math.	3.42	3.48	2.92
This course has increased my chances of success in future math courses.	3.65	3.71	3.31
The lectures aided my understanding of vector math and mechanics.	3.44	3.77	3.73
The lab section aided my understanding of the lecture material.	3.27	3.41	4.01
Application of MATLAB was a valuabe component of this course because it helped me break down problems and learn problem solving skills.	3.63	3.61	3.49

Maximum score = 5



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OBSERVATIONS

- Change for 2011-12 was in instructor:
  - First time for this instructor teaching class.
  - In general, student comments show satisfaction, but there were a "few bugs."
- Students tend to get bogged down in MATLAB.

RETENTION

- We look at end of 2nd year as that is where class “stabilizes.
- Traditionally, when matched name for name for CEE students who started as Freshmen, the retention rates are as follows:
  - 2010-11 Freshmen: 55% (now Sophomores).
  - 2009-10 Freshmen: 50% (now Pre-Juniors).
  - 2008-09 Freshmen: 51% (now Juniors).
  - 2007-08 Freshmen: 51% (now Seniors).

MOVING FORWARD

- Entire College adopts ENED 1090/1091 for Semester Conversion in 2012-13.
- Class will emphasize Engineering Modeling.
- Nate's book will be used as supplemental text.

MOVING FORWARD

- ENED 1090 Modules:
  - Introduction to MATLAB
  - Graphs and Graphical Solutions
  - Matrix Math/Simultaneous Eqs.
  - Vector Algebra
  - Iterative Solutions
- This class will concentrate on shoring up basic math skills.



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MOVING FORWARD

- ENED 1091:
  - Curve fitting
  - Derivatives (symbolic and numerical)
  - Integrals (symbolic and numerical)
  - More iterative solutions
- This class will seek to reinforce calculus concepts.



MOVING FORWARD

- Instructors being selected from best in each school.
  - Chair of Engineering Education has “right of refusal.”
  - Training over summer.
- Class will combine MATLAB and hand calculations so students do not get bogged down by programming.

MOVING FORWARD

- Examples being provided for each major engineering discipline.
- Classes will mix disciplines so students see:
  - How each discipline uses the same base concepts.
  - How a given Math concept is applied in different ways in different disciplines.

QUESTIONS?



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