

*Mechanical Engineering
Curriculum Change for
Diversity Improvement: the
DEEP Project Status Report*

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Our Hypothesis

ME will be more able to attract and retain a diverse community of students if

- It has **greater linkages** between fundamentals and applications, and technical and nontech. subjects
- Includes more **teaming** experiences
- Uses **shorter critical path lengths**
- Has more focus on the impact of engineering on the **human experience**
- Promotes a general atmosphere of **inclusively** rather than **exclusivity**.

The Team

- Cal State University at Los Angeles
- Howard University
- Tuskegee University
- Smith College
- Michigan State University
- University of Washington
- Stevens Institute of Technology
- JHU
- Campbell-Kibler Associates

Research Protocol

- Curriculum dissection into topics
- Topic evaluation
- Topic map generation
- **Assembly of new curriculum**
- Development and testing of new applications
- Pilot tests (pieces and then the whole)

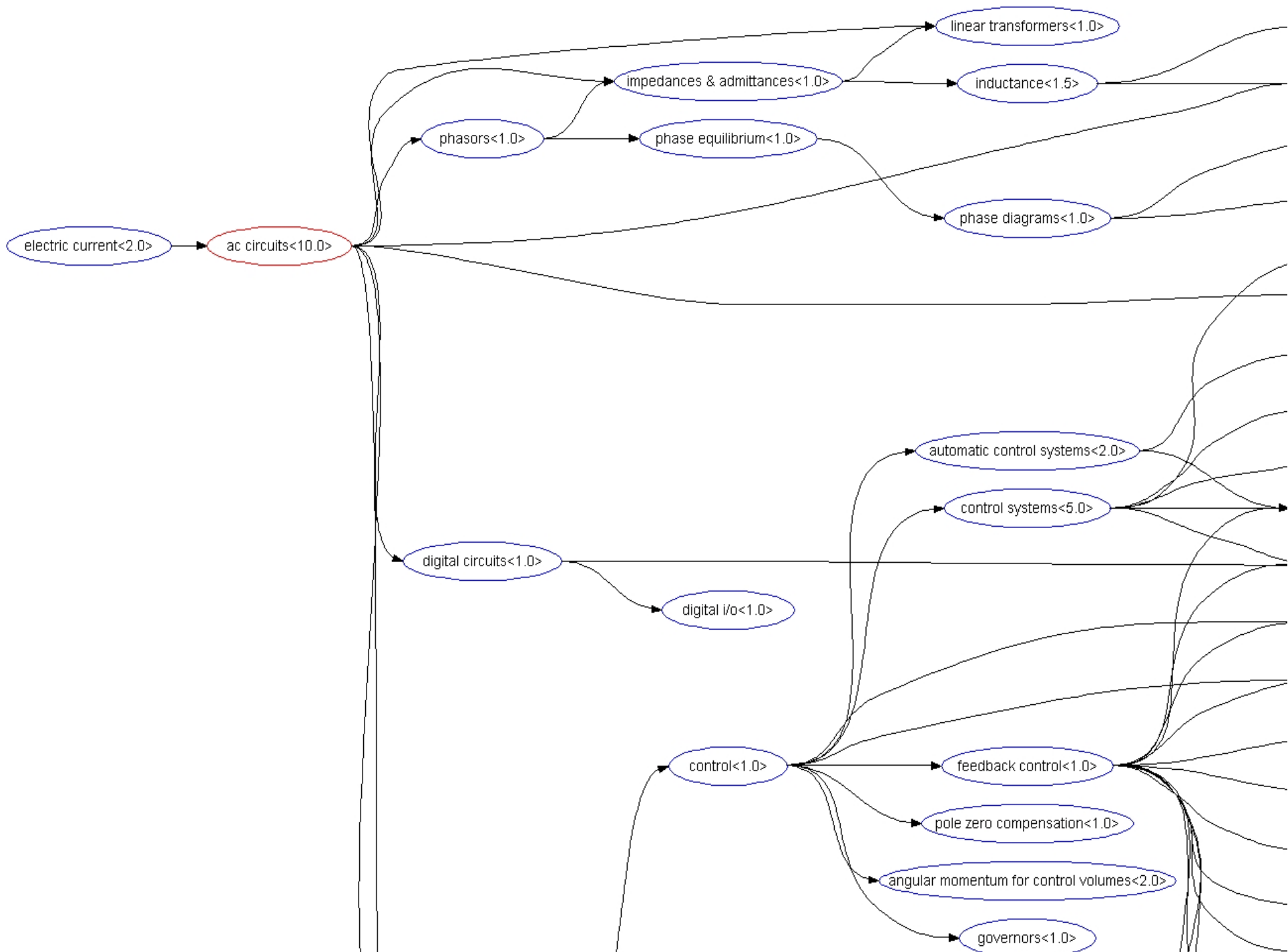
Curriculum Dissection and Topic Evaluation

- **Identify technical courses required of all ME majors at team institutions (+MIT)**
- **Break courses down into small topics ...2059 topics**
- **Alphabetize all topics.**
- **Edit list – combine duplicates, eliminate unnecessary topics ... 854 topics**
- **Add topics that should be there in the future.**

Topic Map Generation

- For each topic, we have listed
 - **Prerequisites for understanding**
 - **Successors**
 - **Applications to which it might relate**
 - **Nontechnical material which could be linked**
 - **Number of hours dedicated to topic**

PreReq		Topic
2d visualization	->	3d visualization
3d geometrical transformations	->	complex numbers
a/d & d/a conversion	->	computer data acquisition
a/d & d/a conversion	->	measuring instruments
a/d & d/a conversion	->	nyquist criteria
ac circuits	->	actuators & sensors
ac circuits	->	closed loop control concepts
ac circuits	->	digital circuits
ac circuits	->	impedances & admittances
ac circuits	->	linear transformers
ac circuits	->	lumped parameter linear elements
ac circuits	->	phasors
ac circuits	->	proportional derivative integral control
acceleration (measurement of)	->	force, mass & acceleration
acceleration (measurement of)	->	motion, instruments to measure
acids & bases	->	batteries & fuel cells
acids & bases	->	buffer solutions & titrations
acids & bases	->	corrosion



Genetic Algorithms

A genetic algorithm is a computer simulation in which a population of abstract representations of candidate solutions to an optimization problem evolves toward better solutions. (Adapted from Wikipedia, the free encyclopedia).

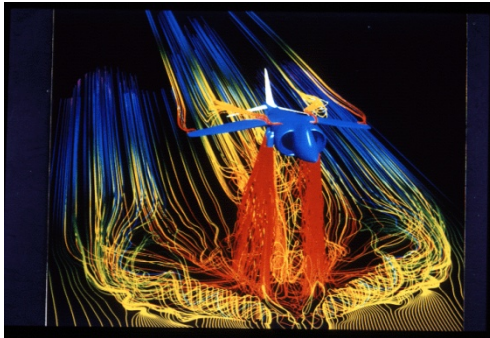
We are using genetic algorithms to develop curricular map of topics which we can then turn into courses.

An Overview of the Process

- Assign topics to clusters via prerequisite affinity up to max hours for a cluster.
- Run simulation to minimize cross cluster prerequisite relations.

Using Relevant Applications Because Dreams Need Doing

Google's First Six Images of ME



DEEP's First Six Images of ME (in Relevant Applications)



A Sample of Areas Covered in DEEP Relevant Applications

Balloons

Bottle Closures

Bike Pumps

Dust Pans & Brushes

Mock Trials

Skateboards

Staplers

Walnut Trees

Basketball Goals

Bike gears

Cellos

Kids on a water slide

Rockets

Sneezing

Tennis Ball Throwers

Wiggle Writers

Relevant Applications Don't Just Change ME's Image, They Make a Difference

Almost all students felt hands-on lab and classroom-based applications increased their interest in mechanical engineering and that increased interest was very highly correlated with their ratings of their learning.

Students in one course that was fully applications-based had significantly higher final course grades than comparison students matched by instructor and course who did not receive application-based teaching.

Relevant Applications Don't Just Change ME's Image, They Make a Difference

Students rated 14 of 17 tested applications as contributing to their understanding of ME concepts at medium or high levels.

Students rated their learning of concepts covered by the applications higher than did other students in the same courses taught by the same instructor without those applications. There were no differences in the groups' ratings of their learning of other concepts.

Relevant Applications Don't Just Change ME's Image, They Make a Difference: Comments from Participating Faculty

“Any time you do something different, experiential teaching, it reveals various aspects about one's teaching... by getting involved with these real life applications, it reveals things about the teaching and learning styles, so it helps in that way, helps one adjust the strategy and technique used for learning. And it also reveals, maybe something that would be difficult to identify clearly, where students have misconceptions.”

“It changed my teaching because I had to be more responsive to students being incredibly creative.”

“I talked more about how to manage projects, not just numbers.”

Future Work

- Expand applications to fluid mechanics and dynamics.
- Complete cluster analysis.
- Publish applications lesson plans.
(Copies of lesson plans of relevant applications for solids courses can be purchased at cost at www.engineeringexamples.org)