SRL.TAMU.EDU | SKETCH RECOGNITION LAB TEXAS A&M UNIVERSITY

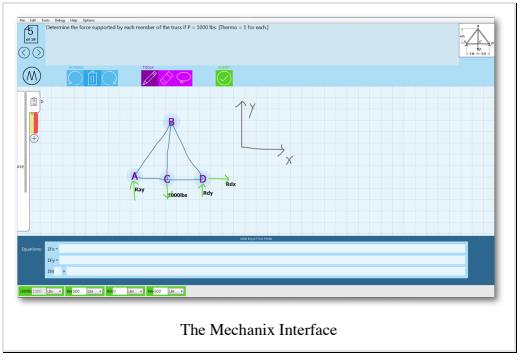
This blog hosts weekly news about the Texas A&M University Sketch Recognition Lab. SRL is directed by Dr. Tracy Hammond, an associate professor in the Computer Science and Engineering Department. More information about the lab can be found at http://srl.tamu.edu

Tuesday, March 31, 2015

Two Summer Research Experience for Teachers (RET) Opportunities with the Sketch Recognition Lab

(Applications Due April 1, 2015)

Two Research Experience for Teachers (RET) will be available for summer 2015 in the Sketch Recognition Lab, mentored by lab director Dr. Tracy Hammond. The two teachers will contribute to the ongoing NSF EEC project 1129525, titled "Collaborative Research: Enabling Instructors to Teach Statics Actively," (PIs Tracy Hammond, Julie Linsey, Erin McTigue, Matthew Green) working with the Mechanix software project in the Computer Science Department at Texas A&M University. Mechanix is a sketch recognition system that automatically corrects students hand-drawn homework assignments for trusses and free body diagrams. The Mechanix software for testing as well as a video tutorial can be downloaded from http://sketchmechanix.com. Applications are dues April 1, 2015.



The Mechanix Interface

About Mechanix:

Introductory engineering courses within large universities often have annual enrollments exceeding several hundreds of students, while MOOCS and online classes have even larger classes. It is very challenging to achieve differentiated instruction in classrooms with class sizes and student diversity of such great magnitude. In such classes, professors can only assess whether students have mastered a concept by using multiple-choice questions. However, in a multiple-choice scenario, students only have to identify the answer rather than create the answer, and the feedback received is only of a binary nature (right or wrong). Additionally, a growing concern among engineering educators is that students are losing both the critical skill of sketched diagrams and the ability to take a real system and reduce it to an accurate but simplified free-body diagram (FBD).

Mechanix is a sketch-based deployed tutoring system for engineering students enrolled in statics courses. Mechanix not only allows students to hand-draw solutions with planar truss and free body diagrams, just as they would with pencil and paper, but it also checks the student's work against a hand-drawn answer entered by the instructor. It uses sketch recognition to determine both the component shapes and features of the sketched diagram and the relationships between those shapes and features. Mechanix then uses those relationships to determine whether a student's work is correct and why it is incorrect, enabling Mechanix to return immediate personalized feedback to the student otherwise not possible in large classes. Additionally, because sketching is the preferred mode of problem solving for many professional engineers, producing a tool that utilizes sketching should increase the transfer of skills from the classroom to the real world. Finally, the iterative correction process facilitates student learning. Preliminary results suggest that Mechanix increases homework motivation in struggling students, and have shown that Mechanix is as effective as paper-and-pencil-based homework for

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teaching method of joints truss analysis. Focus groups have revealed that students believe Mechanix enhances their learning and that they are highly engaged while using it.

Currently, Mechanix can correct three different types of static homework problems: 1) Standard truss problems requiring calculations of method of joints, 2) Free-form free body diagrams, and 3) Creative Design problems. In creative design mode, the student must think creatively to create a viable truss that abides by the constraints. Creative design mode offers an infinite number of possible solutions for the student, and thus presents an interesting recognition problem. Additionally Mechanix contains three different interfaces: 1) the student interface, where the student answers the problem, 2) the instructor question creation interface, where the instructor enters the problem, and 3) the instructor review mode, where the instructor reviews the existing solutions (Figure 5 shows a mockup). To add questions, the instructor simply types the question, uploads an image, draws the answer, and types in the numerical answers. The drawn answer is then compared to the student's answer for correction. Because the student needs to know where he or she is wrong, Mechanix performs sophisticated analysis on the student's solution in an attempt to determine where the student has gone wrong. In the case of creative design mode, no solution is drawn, instead only constraints are specified, and Mechanix then uses these constraints to grade the student's solution. Two types of feedback are given, that of a simple dropdown box, and that of a complete checklist for them to follow. We provide two types of feedback so that the instructor can provide more feedback on initial problems and less later, scaffolding the feedback.

Interest/Applicability to K12 Teachers:

We have presented the Mechanix project to over 300 K-12 teachers and over 2000 high school students thus far. There has been enormous interest from K12 teachers to include the Mechanix software as part of their curriculum. Presentations to K12 teachers include: *2014 TAMU Teachers' Summit Workshop: Mechanix Hands-On Workshop*, 2014 *WIPTTE* (Workshop on the Impact of Pen and Touch Technology on Education) Mechanix You-Try-It, *ASEE 2012*: *FIE 2012 Mechanix Workshop, TAMU Teaching with Technology Conference 2014, TAMU Assessment Conference 2011, Duke TIP High School Program*, *TAMU Recruiting (Aggieland Saturday, etc.)*, *and TAMU 2014 CSE High School Contest on Tablet Computing*.

Mechanix & Applicable TEKS Standards

§112.39. Physics (c) Knowledge and skills.

(4) Science concepts.

(E) develop and interpret free-body force diagrams

§111.35. Mathematics – Precalculus (c) Knowledge and skills.

(6) The student uses vectors to model physical situations. The student is expected to:

(A) use the concept of vectors to model situations defined by magnitude and direction;

(B) analyze and solve vector problems generated by real-life situations.

What will Teachers Do During the RET?

The teachers will participate in the work required to achieve the following research objectives from that project:

1) To provide instructors with a software tool where instructors can create their own custom questions that are automatically evaluated. This will allow for more open-ended questions instead of multiple-choice questions to be used on exams and quizzes in large classes.
2) To scale Mechanix up to multiple sections and multiple schools. Mechanix has been implemented at TAMU and LeTourneau on first year engineering students, this RET would give the opportunity to also test the software at a high school level.
3) To develop and refine the instructor interface that includes (1) An easy way to add problems, (2) automatic grading and student assignment and (3) review collation of student performance to aid in teaching. The RET teachers will provide feedback and assist with general design of the instructor interface
4) To measure the generalizability of the student learning effects observed with Mechanix at TAMU to other institutions,

specifically high school classes.

5) To create a database of questions for use by a wide variety of instructors.

The teachers will gain research experience through the completion of the following tasks:

1) Evaluate and help design improvements to the instructor and student sides of the interface
2) Design a course plan using Mechanix in their classroom that aligns with their curriculum needs for the following year.
3) Create problems and assignments for use in their classroom and add these to the Mechanix problem database.
4) Evaluate Mechanix in their classroom and analyze the data along with a graduate student.
5) Write a research paper describing their experience in the classroom.

In addition to participating in the research activities in the Sketch Recognition Laboratory, the RET teacher will participate in the professional development activities associated with the E3 program. This includes sessions to aid the teacher in preparing an engineering-related inquiry-based project for implementation in the high school STEM classroom.

Transfer of New Knowledge to the Classroom

The teacher will develop a classroom activity based on his/her research experiences in the laboratory. The classroom project will be implemented in the teacher's high school classroom during the subsequent academic year. The teacher will be required to submit a final report to the E3 team which will outline best practices and lessons learned with their classroom implementation. The PI's research in Mechanix would become part of the outreach and dissemination.

RET Program for the Dwight Look College of Engineering (COE) at TAMU

The teacher(s) will participate in professional development activities of the E3 program in addition to working with the research team. Historically, the E3 activities have included engineering research, educational discussion sessions to facilitate transfer of research into the public high school classroom, industry field trips, leading edge engineering discussions, and teacher presentations.

The TAMU Enrichment Experiences in Engineering (E3) RET program brings high school science and mathematics teachers to the university campus for a summer residential experience where the teachers are mentored by engineering faculty. The teachers learn about engineering research, gain heightened awareness of engineering career opportunities for their students, and develop an engineering project for classroom implementation. The E3 program has been an integral component of the College of Engineering's outreach plan, which has the overarching goal to increase the pool of undergraduate engineering applicants into the College, as well as to build a network to recruit partner teachers.
E3 Schedule: http://easa.tamu.edu/e3/docs/2015%20E3%20Sample%20Schedule.pdf

Based on past E3 participant responses to online post-program surveys, indicators of E3 program impact on the teachers include (1) Increased awareness of engineering careers; (2) Improved knowledge of engineering as an academic discipline; (3) Better able to promote the field of engineering to their students, and (4) Better understanding of attributes assets needed for engineering (e.g., creativity, team player, problem solver, desire to contribute to society).

Sustained Follow-Up

Typically, the E3 teachers are invited to participate in the annual Teacher Summit hosted by the TAMU Colleges of Engineering and Science. This professional development opportunity has been hosted since 2008, and has been very well received by attending teachers. In addition, an annual E3 Workshop has been hosted immediately after the Summit concludes. This half-day workshop allows the E3 teachers to reconnect with each other and to stay engaged with TAMU College of Engineering. PI Hammond presented Mechanix on January 31, 2014 at the TAMU Teacher's Summit Workshop.): Through four sequential 1-hour sessions, 120 K-12 STEM teachers were introduced to the Mechanix system and each solved 6 problems through the system. Numerous instructors requested to participate in the Mechanix program and wished for help in integrating Mechanix into their curriculum (which is what provoked this RET submission). Participating teachers could also help present at future Mechanix presentation and hands-on interactive sessions.

Application Process:

Teachers should apply through the E3 website: http://easa.tamu.edu/e3/app-teacher.htm
More information about the E3 program can be found here: http://easa.tamu.edu/e3/info.htm
Please note your interest in this project somewhere on the application.
Applications are due April 1, 2015.

Any teacher supported under RET should be a US citizen or a permanent resident; all teachers considered for RET support will meet this eligibility requirement. STEM teachers from high schools with high achieving, majority minority students who are predominately first-generation college and economically disadvantaged are particularly encouraged to apply.

Timing and Funding:

TAMU Onsite E3 2-week session: June 17- July 1 ($3,000)
TAMU Onsite SRL-Extended 2-week session June 7th - July 4rd ($6,000)

Additional $1,000 stipend for follow up activities during academic year.
Supplies include a Tablet PC for use in the classroom implementation.
Additionally, a limited amount of funds will be available to support presentation at national conference.

Posted by Tracy Hammond at 10:03 AM

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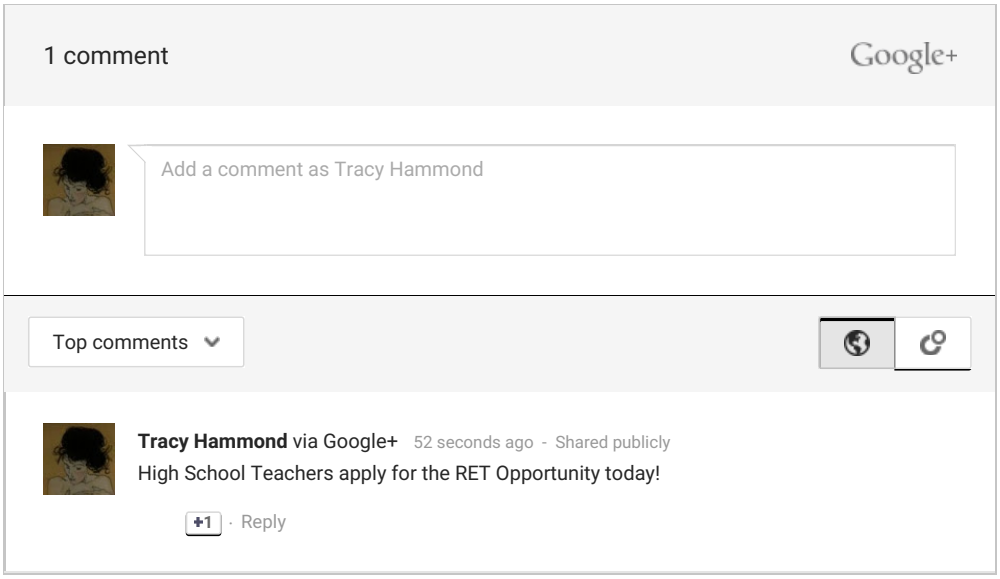

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