

Perfect Together



Photo by Carol Shields

by Ken Maskell

Perfect Together

My apologies for appropriating a New Jersey tourism slogan, but pre-engineering and technology education are “perfect together”.

The Center for Innovation in Engineering and Science Education (CIESE) at Stevens Institute of Technology in Hoboken, New Jersey recognizes that relationship and has launched a campaign to bring pre-engineering to the Garden State in grades K-12. CIESE has the support of Verizon, the National Science Foundation, and the New Jersey Department of Education to realize their vision – a comprehensive program called Engineering Our Future, New Jersey (EOFNJ).

Rather than create new curricula, CIESE decided to adopt existing ones. The Museum of Science, Boston, is developing materials to support grades K-5 and high school to help schools in Massachusetts meet their state mandate to provide pre-engineering experiences K-12. For the middle grades, CIESE looked to the Society of Automotive Engineers (SAE) “A World in Motion” (AWIM) materials.

Since 1988, CIESE has collaborated with K-12 school districts nationally to use technology to support mathematics and science education. Their initial focus was software and the Internet. They developed very engaging, real-world, live data collection and analysis systems that support math and science. CIESE also provides excellent professional development for teachers so that they can effectively use these programs. The inclusion of pre-engineering in their offerings is a logical extension of their programs.

The Teacher Quality Enhancement – Recruitment (TQE-R) grant team at The College of New Jersey led by Dr. Sharon Sherman is working with CIESE to help NJ school districts realize the power of this integrated approach to teaching math, science, technology, and literacy through hands-on, pre-engineering experiences. The TQE-R grant, funded by the US Department of Education, is tasked with improving math and science teaching and learning within four selected school districts in central and southern New Jersey. The author is part of the TCNJ team.

HIGH SCHOOL

The high school effort, *Engineering the Future: Designing the World of the 21st Century* (EtF), is the most ambitious and perhaps the one that will depend the most on existing Technology Education programs as the route to incorporating it into a high school’s academic program. EtF is a year-long curriculum that has strong math, physics, engineering, design, and technology elements that depend on student hands-on activities to deliver the content.

Engineering the Future maps directly to the seven Massachusetts standards in technology and engineering for 9th and 10th grade. The Massachusetts standards are based on the National Standards for Technological Literacy. The goals of the program are to have students develop a deep and rich understanding of the term technology and the engineering design process; understand the complementary relationships among science, mathematics, technology and engineering; and to understand how advances in technology affect human society, and how human society determines which new technologies will be developed.

To attain those goals, the high school program uses four projects. Each project is designed for 40 45-minute class periods.

The first project is to design the world’s best organizer. They start with designing a cell phone holder and work up to a locker organizer. They learn how to communicate their ideas through oblique, perspective, orthographic and isometric drawings. They define the problem;

The units aren’t designed to teach the science concepts – they show meaningful ways to apply the understanding of science concepts students have already learned to solve problems.

Previous page:: An engineering team at Rumson Country Day School constructs their sail according to the plans they created as part of the “Catching the Wind – Mechanical Engineering: Designing Windmills” unit.

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conduct research; develop possible solutions; build a prototype; test and evaluate; and redesign.

Students use the lessons learned in the first project to tackle the second one – design a building of the future. They are challenged to work in teams to design a mixed-use, energy-efficient structure that can be used for housing and at least one other function. They learn about live and dead loads by designing and testing a model deck. They construct towers to analyze modes of failure and they test materials for tensile and compressive strength. They investigate mechanical properties of materials and learn how thermal energy transfers through walls and windows so that they can minimize energy losses to maximize heating and cooling efficiency.

It is in the second project students are introduced to a color-coding system they use to analyze the energy flow of their buildings. The same color-coding is very effectively used to analyze the pressure in pneumatic, hydraulic, thermodynamic and electrical systems in subsequent projects.

In the third project, students analyze a toy boat design by building one themselves from specifications; improving that design and developing systems to manufacture their “new” toy. A heat engine powers the Ptot or putt-putt boat. Students build the engine, see it successfully work and then analyze it to discover how it works, what its limitations are, and design improvements.

The first three projects require simple, inexpensive materials. For example, the toy boat built from specifications uses a half-gallon milk or orange juice carton, an aluminum soda can, two bendable plastic drinking straws, duct tape, epoxy cement and a birthday cake candle.

The ultimate goal of the final project is to design an electrical communications system. It requires an electrical circuit kit. The Museum of Science chose a version of Elenco™ Electronics’ Snap Circuit kit to use as a tool for learning about electricity, circuitry and to help develop a mental model of what is going on inside the wires and components of any electrical circuit. Each component is mounted on plastic with the appropriate schematic symbol printed on it. Snapping the parts together creates a circuit and at the same time, creates a schematic diagram of that circuit.

The high school curriculum package includes a student textbook, a student Engineer’s Notebook and a



Photos by Carol Shields

Students at the Wallace School in Hoboken, NJ design and test their water filters as part of the Engineering is Elementary “Water, Water Everywhere — Environmental Engineering: Designing Water Filters” unit.

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teacher's guide. The teacher's guide contains a guide to the textbook, framework connections, materials lists, detailed lesson plans and assessments, and Gantt charts depicting the number of 45-minute class periods each project will take.

ELEMENTARY SCHOOL

Integrating pre-engineering concepts into the K-12 curricula has reached a new level. The latest successful examples are the units developed by the Museum of Science, Boston. Their goal for Engineering is Elementary is to develop 20 units covering 17 engineering disciplines that include ties to the science concepts appropriate for students K-5. The units aren't designed to teach the science concepts – they show meaningful ways to apply the understanding of science concepts students have already learned to solve problems.

Each unit has a storybook that gives a purpose for developing a solution to a problem and an explanation of the engineering field being explored. Each story is set in a different country, opening the door for explorations in social studies and geography.

The teacher's materials include literacy assessments for the storybook as well as grade-appropriate assessments for design, engineering, science, technology and mathematics. Because these units are suitable for a range of grades, each assessment indicates the grades for which it is appropriate – K-2 or 3-5.

Each unit is designed for 8 to 10 40-minute classes and is "stand alone". There is no sequencing -- a unit does not depend upon learning from a previous unit to make it useful. Each unit does contain science tie-in units. For example, the EiE agricultural engineering unit, *Designing Hand Pollinators*, describes appropriate units from GEMS, FOSS and STC and has lesson plans that describe exactly what to use from those science kits to support the learning objectives for the EiE unit. Those kits are not required by the EiE units, but will significantly strengthen the science content if they are used. Remember, the point of the EiE program is to add an appreciation of the human-engineered world we live in and to show elementary students they can be engineers and problem solvers.

Nine of the units are available and another four should be ready in August 2007. To see more details and the current list of available and planned units, go to <http://www.mos.org/eie/>.

MIDDLE SCHOOL

For middle school, Engineering Our Future, New Jersey uses curriculum and materials developed and supported by the Society of Automotive Engineers (SAE). SAE's "A World in Motion" series includes explorations of

Here are web connections to:

- [CIESE](#)
- [Engineering Our Future, New Jersey](#)
- [Engineering is Elementary](#)
- [A World in Motion](#)

flight, motorized vehicles and electricity and magnetism. In these activities, middle school students become engineering teams who receive letters asking them to design or to improve on a design for a toy.

The SAE Foundation provides the materials to support a class of 30 students and an extensive teacher's guide for each unit. The caveat is that the teacher must attend a formal training session on using the materials and get their principal's written approval to ask for the materials. SAE wants to ensure the materials will be used and that they are used appropriately. For more details on the AWIM programs see <http://www.awim.org/teachers/programs.htm>.



Ken Maskell

is the editor of
Ties Magazine.



New Set Teaches Scientific Inquiry & More

SCIENCE & TECHNOLOGY SET REPLACES MOTORIZED SIMPLE MACHINES SET

For years, thousands of teachers have used the LEGO Education Motorized Simple Machines Set to teach physical science concepts to elementary, middle, and high school students. Now LEGO Education introduces an innovative alternative, the new Science & Technology Set.

The Science & Technology Set enables students to develop skills in scientific inquiry, physical science, technology, teamwork, problem solving, and creativity in a fun and

engaging way. Students explore problems and invent their own solutions, behaving as scientists do and making discoveries along the way. Students study forces and motion, simple machines, measurement, energy, magnetism, and more.

With the set and corresponding activity pack, students can complete 12 45-minute lessons, plus 12 extension activities and even more open-ended challenges. The activity pack comes complete with reproducible worksheets, teacher notes, and a CD-ROM containing helpful animations.

A key feature of the Science & Technology Set is its versatility and hands-on approach to learning abstract concepts. The set and activities are appropriate for fourth grade and up in any classroom where learning scientific discovery and technology principles is a high priority.

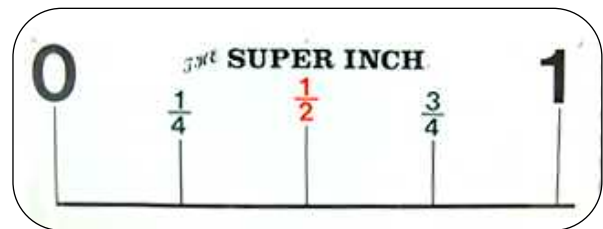


The Super Inch

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The Super Inch

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Liz

“Being an M/S/T major has taught me that I love to learn. Each class is small and I feel extremely close with all of the professors. There are many opportunities for growth.”

- Liz is a junior Math/Science/Technology (M/S/T) Elementary Education major.
- She enjoys playing club field hockey.
- Liz was a member of the TCNJ-TES team winning 2nd place in the TECA-East Regional Elementary Challenge at Virginia Beach in February.
- She is looking forward to completing her student teaching in Croatia in January.

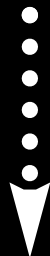
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Liz Gallo is a TCNJ Math/Science/Technology Major, graduation date May 2008

TECHNOLOGICAL LITERACY:

use



manage



assess



understand

