# A Proposed High School Course for Improving Secondary School Recruit Quality

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Many educators and education administrators have retained the perception of engineering as a vocational elective, not true rigorous academics. As with “business education” vs. “education for business”, such pursuits and offerings are seen as being for the academically less able, an almost dropout alternate strategy, something close to “shop”. To cloud the issue, there is a relatively new technology shop program in place around the country that is being confused with engineering education. Increasing numbers of enlightened schools are offering light, survey, hands on, fun project courses to generate interest in engineering. This is a good thing, an obviously necessary first step in recruiting individuals for engineering education and practice. However, some enthused students that succeed in building a kit or playing with software may “hit the wall” in their sophomore year of university studies when confronted with real engineering mechanics or systems problems, not to mention design projects later on.

Courses are needed that give an accurate preview of and background preparation for university demands of pursuing an engineering degree. These courses would incorporate a few specific examples of problems in circuits, statics, dynamics, thermodynamics, microeconomics, and general systems, to name most. No, students will not master the subjects. This is not an AP or concurrent enrollment proposition. The problems would be selected and presented so that in depth background would not be required. The courses would emphasize clear thinking processes and discipline required to work on more involved, lengthy, integrated problems. Such study would be a natural follow up from the introductory course. The quality of recruits for university studies would be enhanced; professors will have better clay to mold.

This paper presents a few proposed specifics of a course being taught at the Arkansas School for Mathematics, Sciences, and the Arts and a brief discussion supporting the offering of such a course.

The following are a few problem used in a course called Special Engineering Problems.

- From statics, the classic ladder on a box and against a wall with three static friction coefficients and a possibly tipping box. (How far up can an entity climb)?
- From dynamics, the off-center weighted wheel or cutout cylinder analysis using work-energy methods.
- From statics and materials (strength of materials), the two metal problem of a cylinder within a hollowed cylinder or pipe with the ends welded together. (Final length after a given temperature change)

- From circuits, a graphical analysis of resistor voltage and current phase frequency response for a series LRC circuit.
- For real world problem analysis and computer simulation, a problem involving dunce hat shaped tanks emptying with flow rates dependent on pressure and time varying viscosity.

Note that this listing is not the complete course, nor is every discipline covered. For example, also included from statics are force system resolution and force component problems, two body problems, and even a truss or two.

Problems are often chosen to familiarize the student with concepts that college sophomore engineering students initially find difficult. The course was partially motivated by the discovery that one of our best students had to take statics twice on the way to her chemical engineering degree.

The introduction to engineering course at ASMSA is taught in the science department. The chair of that department, a physics PhD., is supportive of engineering and taught engineering courses at the science and math school in Oklahoma. The special problems course described is taught through the computer science and engineering department. There is an ongoing effort to make the introductory course a "feeder" to the special problems course the second semester.

At least three different concepts play a role in the feasibility and execution of an early offering of an engineering problem solving course: proper underpinnings, hands-on experience, and solution execution. Some teachers argue against assigning a problem to students who don’t have a complete understanding of all the underpinnings and derivations required for the solution. Others may even require prior “hands-on” experience. Others see moving steadily on to the end point execution of the solution as enhancing and speeding up the learning process, in part by allowing the student to see where they are going. On the student side, one student stated that he could not understand or work a problem until he acquired a thorough hands-on understanding. That approach is good when there is time. But the fact is that there is not enough time to always learn that way, especially in an engineering school. Labs will enhance learning, but much must be done with reading, listening, and abstraction. The argument against the requirement of complete background understanding before problem solution is similar. Solving a problem with demonstrated techniques will often be a vital part of attaining complete understanding later. There is some analogy with the way typing (now keyboarding) is taught. Some exercises emphasize and assess accuracy. Then alternately, some emphasize speed, placing a minimum value on accuracy. In this way, both speed and accuracy can be attained.

In summary, a high school course using actual problems from the university sophomore level of engineering school would go a long way toward identifying and edifying potential engineering students.

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