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# Commentary

## Cyberscience and 21st-century education

Technology changes at an exponential rate, yet engineering courses and curricula may take years or even decades to change. If you compare course requirements and Ph.D. examinations from 20 years ago with today's, you'd find little difference, in part due to the inability of humans to keep up with technological changes. We must modernize engineering education in order to keep up with these rapid changes. We owe it to our students to prepare them for the future.

The 'old aerospace engineering' (aerodynamics, structures, propulsion, dynamics, and control) was adequate for aircraft designed, built, and flown without computers or software. But since about 1970, cyberscience, for lack of a better word, has become increasingly important in aerospace systems. Cyberscience is broadly defined here to comprise computing, software, networking, numerical algorithms, electronics, computational intelligence, digital avionics, human-machine interactions, and the like. For current aircraft, the cost of the onboard computers and software is roughly 50% of the total cost, not including the cost of computers and software used to design and build the systems.

Faculty often argue that it is not possible to add more material to the curriculum. This is true if you do not remove any of the older material, much of which is taught primarily for historical reasons. Similar problems probably exist within almost all academic disciplines, including computer science, and are not limited to undergraduate education. How can this material remain unchanged while technology changes exponentially?

We need to stop preparing students to solve yesterday's problems.

Hiring practices also reflect a disconnect. In 2009 the Lockheed Martin employment Web page showed 1,914 openings in the areas of systems, software, EE, and IT; they had 21 in aerospace engineering. Likewise, Boeing in 2009 showed 190 openings in systems, software, EE, and IT, and just four openings for aerospace engineers.

We cannot keep teaching the same material we taught 50, 20, or even five years ago. There is not time in four years to teach students all the accumulated material over the history of aerospace engineering. They need courses in software engineering, systems engineering, electronics, computing, autonomous systems, navigation, and so much more.

The other change needed is in faculty hiring and learning. Aerospace engineering departments need to hire cyberscience faculty, not just experts in old aerospace engineering. Faculty also must continuously learn new technology. This would improve and expand the research, as well as help enormously in educating the students. Many aerospace faculty incredibly and wrongly equate software engineering with programming, and fail to keep up with modern languages.

For much of the history of aerospace engineering the focus has been on physics-based teaching and research, and justifiably so, but those areas are now fairly mature. It is time to focus on the system as a whole and recognize the importance of cyberscience to designing, building, and flying aerospace systems. A paradigm shift is required in university education. It is not enough to tweak the curriculum. It is time to completely redefine what it means to be an aerospace engineer.

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