Beyond Software, beyond Engineering

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Abstract

The evolution from coding to engineered software is reviewed. The most rapidly growing area today is real-time and embedded applications. Here software is the glue holding the pieces together but the pieces are often electro-mechanical devices. This calls for the tight cooperation of engineers of virtually all disciplines.

Large and networked application systems cannot be designed and installed without domain knowledge that is often beyond engineering expertise. And in the case of small companies general business background is needed. Finally, suggestions are presented to align education with the above requirements.

Extended abstract

Science is observations organized and engineering is the application of generalized observations. The first experimental observations of software focussed on the performance of programs in execution. Later, as a result of painful experience, interest focussed on the reliability of the (executing) software and the performance of its development and modification by humans. Models were proposed, sometimes crudely borrowed from engineering. Contrary to earlier engineering practices, models were rarely verified by experiments, mainly because of high expenses and industry’s confidential handling of collected statistics. In spite of this, the penetration of engineering methodology into the world of computer software started expanding.

Problems further exacerbated by continued advances in hardware: large capacity and direct access storage; computers’ convergence with telecommunication that lead to distributed systems; powerful microprocessors; and overall miniaturization. Interconnected systems became huge (e.g. the Internet) whose behavior could then be modeled by employing systems science and engineering. Some of these systems must work in real time with even higher requirements for reliability. Many computers are now small and embedded into well-known artifacts such as portable devices, vehicles, industrial processes, and even human bodies.

Embedded real time systems represent the next challenge facing computer engineers. They call for co-design, the developing of hardware and software concurrently in tight cooperation of hardware and software engineers. Furthermore, due to the growing universe of applications, the engineering teams performing design and installation must include domain experts.

In the IT systems industry both small and large companies face international competition. For commercial success, technical ideas must lead to products that are useful and reach the market fast. Moreover, the complexity and unpredictability of business conditions require the teaming of not only engineers and domain experts. To successfully compete, experience and know-how in marketing, finance and leadership must be present in tightly knit teams.

This techno-business environment asks for the revision of high level education. The world of technology and markets is changing rapidly and at an accelerating rate. Universities at all cost must avoid obsolescence by dropping some courses to accommodate new courses guided by the above requirements. Even more importantly, they should prepare the fresh high school graduates for efficient lifelong learning by providing courses predominantly in fundamentals: communications, mathematics, physics, and some business knowledge. This could be done in significantly less time than today’s four or five-year requirement. The graduates then go to work but continue attending courses offered at universities and thus keep building their know-how on solid foundation during their entire career.