GRADUATE EDUCATION IN REACTOR PHYSICS - INFLUENCE OF ADVANCEMENTS IN COMPUTING TECHNOLOGIES

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ABSTRACT

Reactor physics is one major subject that is unique to the Nuclear Engineering discipline, and a justification for having an independent nuclear engineering program. The need for computing resources has been an integral part of reactor physics from its early inception. In this abstract, I will attempt to review the past and present practices in reactor physics education, and elaborate on the future needs and issues.

In the 70's and even first half of the 80's, at universities, reactor physics courses were devoted mainly to theoretical discussions without much emphasis on simulation techniques and applications. This was partly dictated by computational limitations such as memory, disk space, and execution time. Only, the national laboratories and major vendors could do limited realistic simulations, and process nuclear data. As a result, universities could not participate effectively in training students with strong computational skills and interest in developing new methods and codes.

Beginning in mid 80's, however, the playing field started to change because of several factors including: the advent of vector and parallel computers; the establishment of NSF-sponsored supercomputing centers; development of High Performance RISC workstations; and, design of faster and cheaper PCs. Several universities worldwide initiated research in developing new algorithms (for solving particle transport and diffusion, and fluid flow equations) for new computer architectures. Further, a few universities initiated studies on simulation and analysis of real-life nuclear systems. Ironically, these significant advancements in computational tools and availability coincided with the increasing needs of the industry for more accurate and efficient simulation tools. This need can be attributed to issues such as deregulation, nuclear competitiveness (or lack of), reactor aging issues, and plant life extension.

In the past 15 years, at Penn State, there has been a significant change in teaching and research in both neutronics and thermal hydraulics. All courses have a computing component. This spans

from using available codes (commercial and public) for system modeling and analysis to developing numerical algorithms and codes. Moreover, in the past four years, the author along with several College of Engineering faculty have established a new graduate minor in High Performance Computing (HPC). (The author has developed a course entitled “Parallel/Vector Algorithms for Scientific Applications” for this minor.) The author believes that both the emphasis on computing and programming in theory courses, and involvement in HPC has helped in attracting better students, and in improving the quality of PhD and MS theses.

In the author's opinion, the use of simulation tools and development of numerical methods have to become an integral part of textbooks and courses in reactor physics. Universities have to become more involved in development and promotion of new methods, tools and computing environments (e.g., PC clusters) for solving reactor physics problems.

On the issue of shortage of “good” students, we have to intensify our efforts in establishing more scholarships and fellowships. Continue our efforts in attracting good American students (NUCE and non-NUCE), and recruit excellent foreign nationals. Note that with regard to foreign students, not only we tap into a global talent, but also we provide a more vibrant environment for our students who eventually will become part of the global market.