The need to educate computer professionals about the process, methods and tools used to create and maintain software systems is being met by The Johns Hopkins University at three levels. In the graduate program, which offers an M.S. in computer science to part-time students, a course in software engineering recently has been established as a degree requirement. At a second level, students in the program with an interest in software engineering may choose from a relatively comprehensive group of courses. Finally, at a third level, a short course program makes much of the same material available to non-matriculating professionals in a two to five full-day format. This paper describes the program, details the offerings, provides measures of the size and impact of the software engineering effort, and makes some general observations about the teaching of software engineering to practicing professionals.

BACKGROUND

Since its opening, The Johns Hopkins University has had the tradition of providing part-time education. Public lectures by faculty and visitors at Hopkins were a prominent feature of Baltimore's cultural life that predates radio. Formal courses and degree programs for part-time students, with courses held primarily in the evening, were established before World War I. It is in the context of this commitment to continuing education for practicing professionals that Johns Hopkins established what has become one of the nation's largest part-time graduate programs in computer science. In what follows, we outline the history of that program and show how it has been adapted to address professional needs in software engineering.

Origins of the Masters Degree Program

Starting with the 1964-65 academic year, the JHU Evening College (then known as the McCoy College) began offering courses leading to a masters of electrical engineering. These courses were held at the Applied Physics Laboratory, a division of the University located in a rural setting half-way between Baltimore and Washington. There were several reasons for selecting this site. First, the APL staff numbered over 2,000 people with an additional 1,000 on-site contractors. Thus, it was anticipated that APL would benefit directly from this program. Secondly, a large per capita proportion of the residents in
the Baltimore-Washington corridor was made up of scientists and engineers. Consequently, a general need also was identified.

The emphasis of this masters program was the graduate training of practicing engineers. Very few of the graduates were expected to continue their education at the Ph.D. level. This emphasis on graduate education of practicing engineers and scientists remains a key feature of what has become five separate masters degree programs.

- **Electrical Engineering.** This was the first of the part-time masters degree programs; it was begun in 1964-65.

- **Applied Mathematics.** This was the first of the separate programs to be spun off; it was created in 1966-67.

- **Applied Physics.** This program was established in 1967-68.

- **Computer Science.** As will be discussed below, this program started in 1971-72.

- **Technical Management.** This program was established in 1981-82.

In 1983, these programs were integrated into the Whiting School of Engineering as part of what now is called the Continuing Professional Programs.

### The Computer Science Masters Degree Program

The first course in computer science, Numerical Analysis and Computer Science, was introduced in the 1966-67 academic year. This was a two semester course that covered topics in numerical analysis in the first semester and selected topics in programming techniques (mostly at the assembly language level) during the second semester. A course entitled Introduction to Computer Arts and Science, which concentrated on FORTRAN programming, was offered on the JHU Homewood campus in Baltimore.

These two were the only evening course offerings in computer science for the next four years. However, during that time there was a growing recognition of the need for advanced training in this new discipline. In particular, it was acknowledged that practicing engineers required special training to learn what was not taught at the time of their undergraduate education. Consequently, plans were made to institute a masters degree program in computer science. The program was introduced in the 1971-72 academic year. It offered the following mandatory (later called core) courses: operating systems, organization of data and files, programming languages, and computational models. The elective courses included numerical analysis, symbolic logic, probability and statistics as well as courses in operations research.

New computer science courses were introduced each year. The core courses, initially designed to provide a formal introduction to concepts that may not have been available when the student was an undergraduate, underwent continuing change as the students' undergraduate backgrounds improved. Course materials were upgraded, and some courses were replaced by an admission prerequisite or competency test. By 1979-80, there were 22 different computer science courses