Integrating Code

▪ ADAM PORTER
▪ VIC BASILI
▪ RANCE CLEAVELAND

Software has become about as ubiquitous as electricity. While many people think of software as something sold by specialized companies like Microsoft, software is developed in all kinds of ways by all kinds of people. General Motors pays more to develop code than Microsoft does. Scientists write their own programs to solve problems in the lab.

Rance Cleaveland (l), Vic Basili (c) and Adam Porter (r)

Large groups of people spread around the world contribute to open-source software. A number of researchers at UMIACS analyze how people develop code and how to help improve that process.

Adam Porter, a professor of computer science, works on ways to test and manage the performance of large software systems with many configurations that are built by people all over the world. Modern open-source software is built, he says, by "loosely coordinated mobs of people changing things night and day. It's kind of a chaotic process." Porter's group develops ways to monitor the changes that are introduced to catch any nascent problems.

In particular, Porter's research team has been working to monitor the

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open-source, database software MySQL. Ticketmaster uses the popular program, as did the Mars Rover mission. Like other open-source programs, MySQL is developed and used all over the world with no single overseer. To scale up quality assurance methods to such complex systems, Porter's strategy is to divide the task into many different pieces. "We intelligently distribute the jobs around the world," he says. Quality assurance is divided into two fundamental steps: first polling through configurations to gauge which changes matter, and then testing the subset deemed important. Afterward, Porter and his team can assess how well they predicted what mattered.

Porter's group applied the same principles to another giant experiment, testing Ace + Tao, another large open-source program. This program runs on military jets, aircraft carriers, in factories and in the stock exchange—all places where many different pieces of software need to communicate. Programmers at major companies like Raytheon, Siemens, Lockheed and Boeing tune the software to incorporate the features their companies need. "We're scaling up quality assurance to these large, modern software systems," Porter says.

"The distributed continuous quality assurance tools developed by Adam Porter and his colleagues have been instrumental in improving the quality and performance of the open-source middleware developed for our" Ace + Tao platforms, says Doug Schmidt, a professor of computer science at Vanderbilt University. He notes that the tools have been very useful in pinpointing and alleviating performance bottlenecks and in identifying and fixing quality defects.

Researchers in UMIACS's Laboratory for Parallel and Distributed Computing and Fraunhofer Center at Maryland also address the question of how people develop code and how to improve that process. Vic Basili, one of the founders of UMIACS and a professor of computer science, is a member of both these research groups and has been studying how people build software since the 1970s. As he puts it, he asks, "What's the relationship between the process and the product?" He has long worked with researchers in NASA-Goddard to help the physicists and engineers working there build better software. Frank McGarry, formerly the head of the ground support system at NASA-Goddard, says, "This idea of truly engineering software development is a lasting concept that has helped the entire NASA community."

Basili works with a wide range of scientists around the country who write code to address their research questions. "Almost all our studies are human-based," Basili says. "We use quantitative and qualitative techniques to understand how people solve problems." In general terms, his research team studies how humans and computers interact. "I ask, how can I help you prevent a mistake in the first place? How can I help you deliver the code in a shorter period of time?" he says. "You can't measure a product without measuring the process, and you can't measure the process without measuring people."

Basili "laid the foundation for software development to become an engineering discipline," says long-time collaborator Dieter Rombach, a professor of software engineering and the head of the Fraunhofer Institute in Germany. "His practical empirical work has defined best practice."

Rance Cleaveland, director of the Fraunhofer Center for experimental software engineering at UMIACS and a professor of computer science, works on embedded software, such as the software used in cars for antilock brakes or for flight control on planes. "Typically car companies test drive cars to see if antilock brakes work. That's an expensive way to test software," he says. Plus, any problem that's observed may have causes other than software. The tools and verification techniques Cleaveland and his coworkers develop allow testing of software in the lab, before it's built into machinery. Software is expected to make up 30 percent of the cost of a typical car by 2010. By testing software before developing a prototype, car companies like General Motors, with whom Cleaveland collaborates, can go a long way toward reducing costs and improving quality.

As with automobiles, the use of software has surged in medicine, for example in infusion pumps and radiation therapy machines. The Food and Drug Administration oversees the safety of software in medical devices, and Cleveland would also like to develop tools to help the FDA verify such software.

— Profile written by Karin Jegalian

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