

Annual Report | 2007

Focus on Collaboration



**The Software Engineering Institute (SEI) is a federally funded research and development center (FFRDC) sponsored by the U.S. Department of Defense and operated by Carnegie Mellon University.**

**The SEI mission is to advance software engineering and related disciplines to ensure systems with predictable and improved quality, cost, and schedule.**

**The SEI is the only FFRDC focusing on software engineering. The stories that begin on page 7 exemplify how the SEI advanced the fields of software and systems engineering during the fiscal year that ended September 30, 2007.**



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**Paul D. Nielsen**  
*Director and CEO*



# Message from the Director

A great idea won't change the world unless it's shared. Even the best research makes an impact only when it's been applied to solve real problems.

It's this mentality that drives the people of the Software Engineering Institute. At the SEI, we don't create abstract solutions to imaginary challenges; we collaborate with software creators and users to make sure our ideas solve actual problems facing today's organizations.

Our efforts move software engineering best practices out of the laboratory and deliver them to companies big and small, organizations in the United States and abroad, and systems that operate across land, sea, air, and outer space.

By working with us, our partners and customers gain access to cutting-edge practices in software engineering. These government agencies and businesses benefit from lower acquisition and maintenance costs, quicker returns on technology investments, easier-to-use systems, and shorter product-development timelines.

But the true impact of our work goes beyond dollars and cents. Software product line technologies help keep U.S. Army helicopters operating in combat zones. The new CMMI for Acquisition model improves the way government and businesses acquire software-intensive systems and services. Our research into security breaches by insiders melds technology and behavioral science to help keep companies and government agencies safe from attacks.

These accomplishments come from the passion, dedication, and vision of the SEI's people—and from our collaborators. It's work that we can't do on our own. For this reason, I hope you'll see this year's annual report from the SEI as a celebration not only of the tremendous accomplishments of our staff members, but also of the countless people with whom we work.



Paul D. Nielsen  
Director and CEO

# Strategy

The SEI achieves its goals through technology innovation and transition. The SEI creates usable technologies, applies them to real problems, and amplifies their impact by accelerating broad adoption.

## Create

The SEI addresses significant and pervasive software engineering problems by

- motivating research
- innovating new technologies
- identifying and adding value to emerging or underused technologies
- improving and adapting existing solutions

SEI technologies and solutions are suitable for application and transition to the software engineering community and to organizations that commission, build, use, or evolve systems that are dependent on software.

The SEI partners with innovators and researchers to implement these activities.

## Apply

The SEI applies and validates new and improved technologies and solutions in real-world government and commercial contexts. Application and validation are required to prove effectiveness, applicability, and transition potential. Solutions and technologies are refined and extended as an intrinsic part of the application activities.

Government and commercial organizations directly benefit from these engagements. In addition, the experience gained by the SEI informs

- the Create activities about real-world problems and further adjustments, technologies, and solutions that are needed
- the Amplify activities about needed transition artifacts and strategies

The SEI works with early adopters to implement the Apply activities.

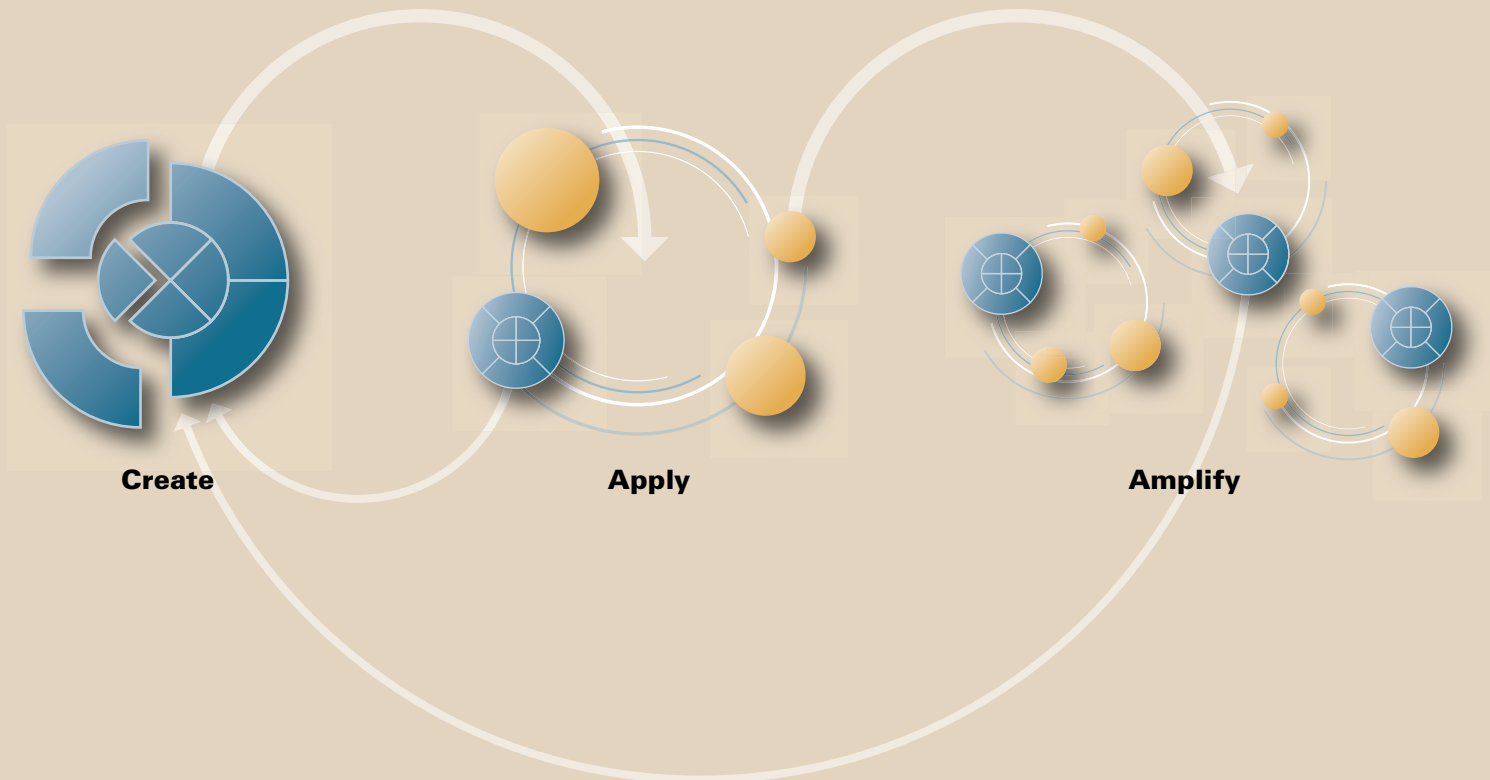
## Amplify

The SEI works through the software engineering community and organizations dependent on software to encourage and support the widespread adoption of new and improved technologies and solutions through

- advocacy
- books and publications
- certifications
- courses
- leadership in professional organizations
- licenses for use and delivery
- Web-based communication and dissemination

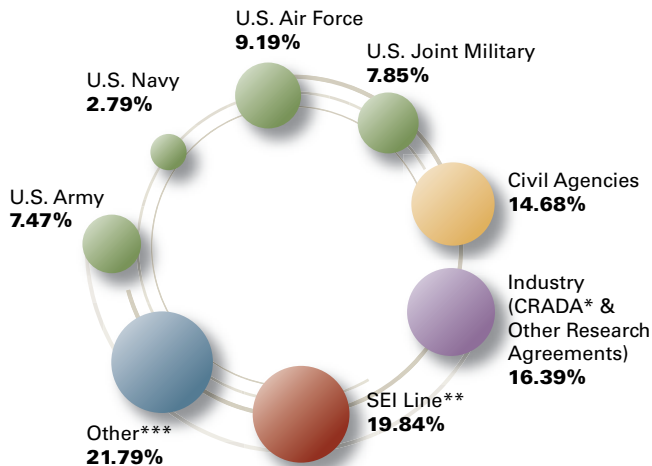
The SEI accelerates the adoption and impact of software engineering improvements.

The SEI engages directly with the community and through its partners to amplify its work.



## Areas of Work

The SEI technical program—created and carried out by world-recognized leaders in software engineering, security, and process management—consists of five technical focus areas. The SEI also conducts new research into emerging topics in software and systems engineering.



### SEI Funding by Source

In FY 2007, the SEI received \$100 million in funding from a variety of sources.

For nearly 25 years, the SEI has served the nation as a federally funded research and development center. The SEI has advanced software engineering principles and practices and has served as a national and international resource in software engineering, computer security, and process management. As part of the world-renowned Carnegie Mellon University—a global research university of more than 10,000 students and more than 4,000 faculty and staff—the SEI operates at the leading edge of technical innovation.

The SEI's technical focus areas together with its outreach activities are aimed at meeting the defined software engineering needs of the U.S. Department of Defense. Within these areas of work, the SEI collaborates with defense, government, industry, and academic institutions to continuously improve software-intensive systems.

### Acquisition

Support for the DoD, federal agencies, and others in institutionalizing and continuously improving their ability to acquire, deploy, and sustain systems that meet cost, schedule, and technical objectives

### Architecture, Product Lines, and Predictable Construction

Practices and techniques for predictably and efficiently designing, constructing, and guiding the evolution of software-intensive systems with the qualities needed to meet business and mission goals

### Process Improvement and Performance Measurement

Process-management practices and performance-improvement and measurement techniques for software and related disciplines in support of the management, development, and acquisition of software and systems

### Security

Technologies, system-development practices, and system-management practices that can significantly improve networked systems security and survivability; includes CERT, a center of Internet security expertise

### Interoperability, Dependability, and Mission Success

Technology and practices to achieve system-of-systems interoperability and to predict and improve the performance and dependability characteristics of embedded and large systems

\* cooperative research and development agreement—an agreement with an industry or academic collaborator

\*\* funding provided by the Office of the Under Secretary of Defense for Acquisition, Technology, & Logistics—the SEI's primary DoD sponsor—to execute the SEI technical program

\*\*\* course fees, conference fees, and other recovered costs

## Message from the President



Carnegie Mellon is proud of the significant contributions that the Software Engineering Institute has made to the software and systems engineering communities. Founded in 1984 as a federally funded research and development center focused mainly on addressing the U.S. Department of Defense's software engineering concerns, the SEI has grown into a national and international resource of best practices in software engineering, process improvement, security, and systems-of-systems integration.

During my tenure as president of Carnegie Mellon, I have had the benefit and privilege of traveling the world to highlight the many accomplishments of our university, our faculty, and our students. And on most of those trips, individuals who have been touched by the SEI—whether it is through courses, conferences, books, or collaborative endeavors—often approach me to talk about their experiences and their admiration for the work conducted by the SEI. Individuals around the world talk passionately about their interactions with the SEI and how their organizations have benefited from the Institute's research efforts.

The SEI has collaborated with many government and commercial organizations, and some of the most recent collaborations are highlighted in this year's annual report. The SEI's contributions to the academic world also have been felt here on our main campus. The SEI has collaborated with our School of Computer Science in the development of the first Master of Software Engineering degree that has been adopted at Carnegie Mellon and other universities nationwide. And in fall 2007, the SEI led the efforts to launch a Master of Science in Information Technology, Software Engineering Management (MSIT-SEM) degree in a joint program with the School of Computer Science and the Heinz School of Public Policy and Management. The new MSIT-SEM degree will give a multi-disciplinary view of software engineering that can give managers a unique edge in today's complex marketplace. This degree is an excellent example of how the SEI collaborates with other Carnegie Mellon units to develop and offer educational opportunities to our students.

On behalf of Carnegie Mellon, I congratulate the SEI on another successful year and look forward to the SEI's continuing contributions to improving the state of the practice of software engineering for many years to come.

A handwritten signature in black ink that reads "Jared L. Cohon". The signature is written in a cursive, flowing style.

Jared L. Cohon  
President, Carnegie Mellon University

# Focus on Collaboration

"A great idea won't change the world unless it's shared.  
Even the best research makes an impact only when it's been  
applied to solve real problems."

—Paul D. Nielsen



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**Sid Faber**

*Software Engineering Institute*

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**Michael Collins**

*Software Engineering Institute*

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**Mark Thomas**

*Software Engineering Institute*



# Network Situational Awareness

## CERT-Supported Programs Gaining Widespread Government Adoption

The White House asked Congress in November 2007 to approve \$115 million to help the U.S. Department of Homeland Security (DHS) expand the Einstein Program to additional federal civilian agencies. Einstein monitors agencies' computer-network gateways for traffic patterns that indicate the presence of malicious activity. And Einstein has already shown how smart it is.

In 2007, *Federal Computer Week* wrote about a cyber attack launched by the U.S. Department of Agriculture (USDA) against the U.S. Department of Transportation (DOT). The attack occurred because some USDA computers were infected with a computer worm. The malicious code was attempting to assemble a botnet, or a network of compromised computers that an attacker can control and use for a variety of criminal activities. But the unusual network traffic was discovered at the DOT network gateway because of Einstein.

Einstein is a program of the DHS's US-CERT, and participation is voluntary for federal civilian agencies. The extra funding in 2008 will help DHS bring Einstein to all cabinet-level agencies by the end of the year. This US-CERT effort has its roots in a comparable but more established program called Centaur in the Defense Information Systems Agency. Centaur provides Department of Defense (DoD) network and intelligence analysts a comprehensive means to uncover and measure both strategic and tactical network-security threat activity.

These two capabilities for situational awareness throughout the federal government exist at least in part because of a casual conversation between staff members of the SEI and DoD about seven years ago. That conversation led to the research and collaboration that produced a sophisticated suite of tools that can characterize network threats, assess the impact of security events, and identify vulnerable network infrastructure.

But what is situational awareness, and why is it important? Michael Collins, a security analyst in the SEI CERT® Program explains, "Data is easy—we can develop systems that will provide us with vast amounts of data without much effort, but the real challenge is developing a picture of what's going on. Situational awareness is that 'what's going on,' and the primary focus of our work is to develop ways to tease out a meaningful picture of what networks do from the volumes of data we get."

Einstein and Centaur integrate several distinct data collection and analysis systems and use toolsets for network traffic analysis developed at the SEI by CERT.

The beauty of Centaur for network situational awareness is that it gives access to inordinate volumes of traffic information that can be used for analyses far larger than anything that has been done in the past. Experts can carry out analyses that are not only large in volume, but that also extend over long periods of time. If there's a new phenomenon today, it can be traced back using Centaur to several years ago to follow its progress.

Supporting the human analyst remains a cornerstone of the program. To support Einstein and Centaur in the future, staff members at CERT aim to derive analysis techniques for new threats, adopt the relevant experiences of government and industry analysts, and solve the engineering challenges presented by the immense scale of DoD and government networks.

# CMMI for Acquisition

## Revolutionizing Acquisition of Products and Services

In a global economy, organizations rely heavily on third-party suppliers to provide essential capabilities. With the acquisition of information technology predicted to reach between \$2 trillion and \$3 trillion in 2008, organizations need guidance to improve the way they acquire software-intensive systems and services.

“We are seeing that an organization can no longer compete in the market by developing all of its own software-intensive systems,” says the SEI’s Mike Phillips. “To remain competitive, an organization must have mature software-acquisition practices in addition to its development practices.”

The Capability Maturity Model<sup>®</sup> Integration (CMMI<sup>®</sup>) for Acquisition (CMMI-ACQ) methodology is the outcome of an extensive collaboration among the SEI, General Motors (GM), the Office of the U.S. Secretary of Defense (OSD), a number of government acquisition offices, and the CMMI Steering Group. It is the first comprehensive model that provides a common language for acquirers and suppliers.

Development of the model began when managers at GM realized that while the existing CMMI for Development (CMMI-DEV) model addresses their project-management capability, it did not address their acquisition needs. Acquirers and suppliers were not communicating effectively and were operating at varying levels of capability, causing problems with delivery and schedule, and ultimately adding more costs to projects.

“GM is focused on designing and building great cars and trucks,” says Richard Frost, GM global director for development process and program management. “To do this, we must use the best technology available to run everything, from our global manufacturing computer systems to our consumer Web sites to accounting and finance and much more.”

Frost says that because GM relies on a variety of specialized suppliers to provide these technologies, the company’s leadership believed that a simple, standardized process would benefit not only GM, but also its suppliers.

GM approached the SEI to create a standardized model that would leverage the best practices codified in CMMI-DEV. The team envisioned an acquisition model that would be stronger because the material could be tested and proved in real work environments.

“The organizations that are out there doing the work help make sure that the model represents the work accurately,” notes Phillips. “The SEI brings 20 years of experience on how to construct and adopt models—and that’s essential.”

Working with the SEI made sense to GM. “Beyond bringing model knowledge and market needs, the SEI was able to get IT suppliers involved and created a collaboration hub for suppliers and acquirers,” says Frost.

After the two-year collaboration that included piloting the model with organizations familiar with acquisition practices, the team is confident that CMMI-ACQ provides effective acquisition-management processes that enable an acquisition organization to properly prepare for, communicate with, and manage a supplier relationship.

“That’s the beauty of CMMI-ACQ. It’s applicable to any organization—whether government or industry—involved in acquisition of software-intensive systems,” says Phillips.

**Mike Phillips**  
*Software Engineering Institute*

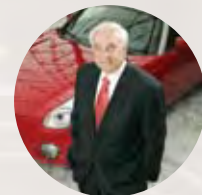
**CMMI-ACQ V1.2 Model Team**

The CMMI-ACQ Version 1.2 Model Team used the baseline developed by the initial draft development team and input from reviewers and users to revise the initial draft and create CMMI-ACQ Version 1.2.

- Lloyd Anderson, *Department of Homeland Security*
- Larry Baker, *Defense Acquisition University*
- Roger Bate, *Software Engineering Institute*
- Rhonda Brown, *Software Engineering Institute*
- Aaron Clouse, *Software Engineering Institute*
- Brad Doohan, *Defence Materiel Organisation*
- Tom Keuten, *General Motors*
- Mike Konrad, *Software Engineering Institute*
- Keith Kost, *Software Engineering Institute*
- Madhav S. Panwar, *U.S. Government Accountability Office*
- Mike Phillips, *Software Engineering Institute*
- Margaret Porteus, *Institute for Defense Analyses*
- George Prosnik, *Defense Acquisition University*
- Karen Richter, *Institute for Defense Analyses*
- John Scibilia, *U.S. Army*
- Sandy Shrum, *Software Engineering Institute*
- Deborah K. Yedlin, *Borland Software Corporation*



**Richard Frost**  
*General Motors*



**Ralph Szygenda**  
*General Motors*

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**Carol Sledge**

*Software Engineering Institute*



**Boot camp participants**

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**Boot camp participant**

**Kevin Sly**

*Grambling State University, La.*

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**Boot camp participant**

**Abraham Asher**

*California State University, Long Beach*

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# Building Capacity

## Information Assurance for Minority-Serving Institutions

Carol Sledge of the SEI credits her education for helping her advance in her career and wants to help others—particularly those who may not have had access to as many educational benefits and who live in a world where knowledge can quickly be surpassed by the pace of technological change.

“Education levels the playing field—regardless of your background growing up, what socioeconomic class you were in, or the range of opportunities you had. Education opens up a myriad of opportunities,” says Sledge, who holds a doctorate in computer science. In 18 years at the SEI, Sledge has been involved in many educational initiatives.

One of those initiatives is a month-long boot camp, held every summer on the Carnegie Mellon campus, for faculty at colleges and universities that serve high percentages of minority students. It aims to equip teachers with the skills needed to develop or advance programs to instruct students in information assurance, or the secure transfer of information.

The boot camp is funded through a grant from the National Science Foundation and awarded to schools like Carnegie Mellon that the National Security Agency and the Department of Homeland Security have designated as Centers of Academic Excellence in Information Assurance Education. In 2006, Carnegie Mellon received its third two-year grant.

“Carnegie Mellon has made it a priority to create an atmosphere where diversity is an integral part of student life, representative both in the students’ backgrounds and their educational experience,” says Sledge, who serves as co-principal investigator on the grant.

And, in her experience, colleges and universities that serve high percentages of minorities often have fewer resources and face more obstacles.

As of 2007, 54 faculty have attended, including Everett Roper, assistant professor of computer information systems at Oakwood College, a historically black, primarily liberal arts school in Huntsville, Ala.

After attending in 2004, Roper returned to develop a new course at Oakwood called Information Security. “It teaches students about the importance of security in computing, how to be knowledgeable about risks in cyberspace, and how to detect and prevent viruses and attacks that may occur on their computer systems,” Roper says.

Two other Oakwood professors have since attended and returned to incorporate their newfound knowledge of cyber security into existing courses such as Web Design, Introduction to Computers, and Introduction to Networking, Roper says.

“Because our faculty were trained at the boot camp, we were able to return and instill that knowledge in our students and spark their interest in the field,” Roper says.

Li Richard Ye, a professor at California State University, Northridge, attended in 2007. Ye is the third professor from the information systems degree program at Cal State, Northridge, to attend. The other professors in Ye’s department who attended before him—David Miller and Yue Jeff Zhang—have established two new academic courses, which became the basis for a continuing effort to bolster the school’s offerings in information assurance and information security.

“We see a strong demand for graduates who have expertise in this area,” Ye says.

# Predictable Security

## Security Analysis Extends Use of High-Performance Chip

What would help a soldier crouching at the edge of a battlefield, a firefighter intently peering at the horizon, and a tornado tracker racing through the countryside? They would benefit from real-time pictures of what they cannot see provided through the high-assurance collection, processing, and dissemination of airborne imagery.

Rockwell-Collins used a technology developed by the SEI to enable the high-assurance handling of data from multiple sensors having varying levels of security, such as airborne imagery, using a powerful, fast, integrated circuit called a field programmable gate array (FPGA).

“One FPGA does the work of thousands of computers,” says Yves LaCerte, a Rockwell-Collins systems engineer in Cedar Rapids, Iowa. It is easier to develop applications on an FPGA, too, reducing the cost and time to market, according to LaCerte. And the chip can be reprogrammed at runtime—to fix bugs, for example, which can lower maintenance-engineering costs.

“Typically, you use a high-assurance processor to securely tag variable input. Rockwell-Collins wanted to demonstrate the high-assurance potential of FPGAs,” LaCerte explains. “Because FPGA behavior is more complex, architecture-level definition and analysis are needed.”

Meanwhile, at the SEI in Pittsburgh, Pa., Jörgen Hansson began investigating ways to use the Architecture Analysis & Design Language (AADL) and the Open Source AADL Tool Environment (OSATE) to model system architecture and analyze it for data quality attributes, including security.

“By verifying security using an architecture model, we can validate confidentiality and integrity and also determine that sanitization is done in a controlled way,” Hansson says. Sanitization is the lowering of security levels; controlled sanitization assures that lowering security occurs only within allowed boundaries. Hansson’s work culminated in an OSATE plug-in for security analysis.

Using AADL and Hansson’s OSATE security-analysis tool, LaCerte built a prototype system that demonstrates “the correctness of the FPGA architecture and the correctness of the system’s behavior.”

The SEI and Rockwell-Collins stand out among the organizations leading development and transition of AADL. From the SEI, Peter Feiler provides technical leadership, and Bruce Lewis—an SEI resident affiliate from the U.S. Army Aviation and Missile Research, Development, and Engineering Center—runs the Society of Automotive Engineers (SAE) subcommittee guiding enhancement and expansion of the standard. Rockwell-Collins participates in the development of the AADL standard, publishes papers about the standard, creates example models, and demonstrates how to incorporate AADL into the development life cycle. Because of that involvement and interest, LaCerte learned of Hansson’s OSATE security analysis plug-in.

While his achievement is significant for FPGAs and their use, LaCerte sees that the work he began with AADL and the security-analysis plug-in can go further. “We need to certify FPGAs for high-assurance use according to the NSA [National Security Agency] common criteria. AADL can be used to generate the artifacts needed to obtain that certification,” LaCerte says.

Hansson’s work goes on, as well. “We are currently investigating how to conduct tradeoff analysis by evaluating the effects of security on performance and resource usage.”

**What High Assurance Means for Software**

For software to be considered high assurance, there must be a convincing argument that the software will always perform (or not perform) key functions.

A system that controls an aircraft's actions in flight, for instance, must be high assurance, as must one that carries out satellite communication.

**AADL, a Language for Collaboration**

AADL is becoming a lingua franca—a common language—for sharing information on problems and solutions among investigators in commercial, research, and academic organizations. In support of that notion, Bruce Lewis, head of the Society of Automotive Engineers subcommittee guiding the standard's development, points to the many consortia employing the standard. In particular, Lewis notes the AVSI (Aerospace Vehicle Systems Institute) and SPICES (Support for Predictable Integration of mission Critical Embedded Systems). The AVSI uses AADL to demonstrate model-based validation of a system through architecture models. SPICES, an Information Technology for European Advancement (ITEA) project, offers designers of distributed, real-time, embedded systems a modeling, analysis, generation, and integration environment based on AADL.



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**Jörgen Hansson**  
*Software Engineering Institute*

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**Bruce Lewis**  
*U.S. Army Aviation and Missile  
Research, Development, and  
Engineering Center*

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**Rich Caralli**

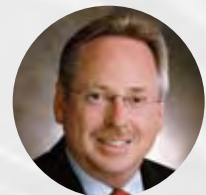
*Software Engineering Institute*

**FSTC Project Participants**

- AMD
- Ameriprise
- Bank of America
- Capital Group
- Citigroup
- Discover
- DRII
- EMC
- IBM
- JPMorgan Chase
- Key Bank
- KPMG
- MasterCard
- Marshall and Ilsley
- NY Federal Reserve Bank (observing)
- PNC Bank
- US Bank
- Wachovia

**Intro to CERT Resiliency  
Engineering Framework**

This three-day course, to be offered in 2008, introduces participants to the convergence of security, business continuity, and IT operations management as a means for directing and controlling operational resiliency. The course explores the Resiliency Engineering Framework as a tool for protecting and sustaining important organizational assets—people, information, technology, and facilities—and a roadmap for improving operational resiliency processes. See the Education and Training page on the SEI Web site for details about course dates and locations.



**Charles Wallen**  
*Financial Services  
Technology Consortium*

# Resiliency Engineering

## Security and Business Continuity Expertise Converge in Framework

Banks, credit card companies, and other financial services institutions are among the most regulated and security-conscious organizations in the United States. They must have highly skilled staff to manage resiliency—the ability to stay in business despite disruptions such as security breaches, regional infrastructure failures, and natural disasters.

But escalating physical and cyber threats, complex technologies, interdependent supply chains, and the global marketplace have made the job of managing disruptions increasingly difficult. Members of the Financial Services Technology Consortium (FSTC), a forum for financial services organizations to solve shared challenges, recognized a need for a consistent, systematic resiliency-management process and a common set of related metrics and terminology. In the fall of 2004, the FSTC's Business Continuity Standing Committee began a project to explore the development of a resiliency model.

In an initial literature search, the committee came upon a report by CERT staff member Rich Caralli, *Managing for Enterprise Security*, in which Caralli presents ideas about how organizations can move toward security-management processes that are strategic, systematic, and repeatable. Caralli and others at the SEI had already started developing a capabilities framework for improving organizational resiliency from a security perspective. "When the FSTC contacted me, we realized that our goals were the same; we were just coming at them from the perspective of different disciplines, security and business continuity," says Caralli. "We saw that the best way forward was to acknowledge the convergence of these disciplines through the development of a single model."

Caralli and his team have met with FSTC project participants in a series of workshops over the past three years. "These are generally senior-level people with responsibility for resiliency, some very smart people with a lot of knowledge about their fields," Caralli says. "Without FSTC, I could never have put together a focus group that represented the level of knowledge and experience that their members brought to the table." Through the three phases of the project so far, they have gathered foundational data, built the model architecture, and produced an initial framework and assessment tool. An outline of the framework was published in an SEI report, *Introducing the CERT Resiliency Engineering Framework: Improving the Security and Sustainability Processes*, in May 2007. FSTC participants have been piloting the framework and the assessment tool to do benchmarking and to validate the framework's design and refine its maturity components.

Charles Wallen, managing executive of FSTC's Business Continuity Standing Committee, says, "Our partnership with the SEI has been extremely valuable. The expertise that the SEI has gained in developing methods, models, and frameworks over the past 20 years, combined with the financial sector's expertise in managing risk, made it a lot easier to come to something that would be usable for us."

Wallen stresses that while the Resiliency Engineering Framework has been initiated and driven by the financial sector, it is applicable and recommended to all organizations. "This is an industry-agnostic, non-proprietary piece of work," says Wallen. "It's for the public sector, the private sector, everyone. And the SEI has the infrastructure and experience in managing process-improvement model implementation to enable the framework to be widely and consistently applied."

# Performance Improvement

## It's a Small World After All

“Small businesses account for 99 percent of all employer firms in the U.S. and are critical to the U.S. economy. In other countries, small business *is* the economy. Organizations and governments around the world are approaching the SEI for help,” says Caroline Graettinger.

Graettinger is leading the Improving Processes in Small Settings (IPSS) project, a recently formed SEI project that focuses on small businesses, projects, and organizational units. It is part of the International Process Research Consortium (IPRC), an SEI-led collaboration of industry, government, and academia from around the world seeking to advance process research.

“It is sometimes said that ‘Process improvement is only for large companies,’” says William Peterson, director of the SEI’s Software Engineering Process Management Program. “IPSS will give motivation, insight, and guidance to small organizations so that they can also get the associated performance-improvement benefits, but at an affordable cost relative to their size and resources.”

The first sponsors of and collaborators in the IPSS project are the University of Pittsburgh Medical Center (UPMC) and Lockheed Martin Corporation. Why would these two organizations—with employees numbering in the tens or hundreds of thousands—be interested in small settings? Suzanne Garcia of the SEI responds, “Because, like many large organizations, they are amalgams of small projects, business units, partners, and suppliers.”

Health care companies such as UPMC contend with almost constant change in regulations that must be reflected in their information technologies. One-day projects are common. Large DoD contractors such as Lockheed Martin regularly subcontract to small businesses and obviously benefit from contractors with effective, efficient processes.

Lynn Penn of Lockheed Martin says, “Small settings are part of our daily lives. Although everyone associates Lockheed Martin with a large company, the interfaces are often not so large. We must manage small projects as well as large ones, and the small ones can often be more challenging. Through IPSS, we hope to gain guidance on skills and competencies needed to sufficiently manage small-settings projects,” Penn says. “Understanding the requirements going in is crucial to quality coming out.”

Both Penn and Chris Carmody of UPMC say that working with other IPSS sponsors and team members has been a learning opportunity. Carmody adds, “Another benefit to me and to UPMC has been assessing how we currently approach our process-improvement work in our small departments and projects. We’ve used the structure of the emerging IPSS Field Guide to reassess and modify our own Project Management Guide to improve its acceptance and usability.”

“We are early in the development of the Field Guide,” Graettinger says. “Our first prototype details a few tasks, and with input from the process community, we’ll create step-by-step instructions for various situations.”

Penn says it is significant that the IPSS Field Guide will be the first research product out of the IPRC. “Individuals put stock in first impressions. To start in small settings emphasizes their worldwide importance. Isn’t it time that the little guy got attention?”



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**Lynn Penn**

*Lockheed Martin Corp.*

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**Chris Carmody**

*University of Pittsburgh  
Medical Center*

**IPSS Field Guide**

The IPSS Field Guide will be an on-the-job resource to help answer questions and solve problems, independent of the process model or standard used. Caroline Graettinger describes the guide: "We intend it to help the small-setting practitioner be a smarter consumer of process-improvement products and services or be better at improving processes themselves."

She continues, "Our plan for populating the Field Guide includes collecting real-world experiences from experts across the process community who can provide knowledge, examples, checklists, and other artifacts to help others succeed in small settings."



**Caroline Graettinger**

*Software Engineering Institute*



**William Peterson**

*Software Engineering Institute*



**Suzanne Garcia**

*Software Engineering Institute*

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**Phil Bianco**

*Software Engineering Institute*

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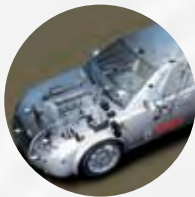
**Felix Bachmann**

*Software Engineering Institute*

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**Charles Shelton**

*Bosch Research and  
Technology Center*



*Examples of Bosch components  
in passenger cars*

*Photo: Bosch*



*The BE 300 LSN control unit on the  
compact NZ 300 LSN intruder alarm  
central unit from Bosch*

*Photo: Bosch*

# Architecture Expert

## SEI ArchE Provides Assistance for Bosch RTC Software Architectural Decisions

The ability of a car's software systems, which may have more than 10 million lines of software code, to satisfy such quality-attribute requirements as reliability and performance is critical.

Software architecture is the structure of a software program or system, and its design process is complex. To develop an effective structure, software architects must define the quality attributes that will determine the design. Determining early in the software development life cycle how effectively an architecture will satisfy quality-attribute requirements is crucial for successful product development.

Researchers at the SEI identified specific skills and knowledge needed to design effective software architectures and decided to develop a tool to interact with the architect. The SEI's Felix Bachmann, Len Bass, Mark Klein, and Phil Bianco created the SEI Architecture Expert (ArchE) tool to scientifically evaluate a software architecture's ability to meet requirements. Bosch, a leading global supplier of technology and services in the areas of automotive and industrial technology, consumer goods, and building technology, played an active role in ArchE's development and provided financial support. Senior research engineer Charles Shelton from the Bosch Research and Technology Center (RTC) in Pittsburgh worked as an SEI resident affiliate helping develop ArchE's models and implementations.

In its initial implementation, ArchE, which can be downloaded from the SEI Web site, includes two qualities.

"Our Bosch RTC collaborators let the SEI know we were on the right track because of their successful real-world implementation during ArchE's development," says Bachmann. Shelton echoes that: "We were able to directly apply ArchE to Bosch RTC projects, such as automotive engineering and building security technologies, and see some initial benefit. The ArchE concept of using an expert system for architecture design is a unique approach that could greatly improve the quality and efficiency of software engineering, specifically in architecture design."

The SEI team members' goals included making it easy to add analytic capabilities about quality attributes to ArchE and working with a real example. By working with Bosch RTC, they accomplished both. Bianco says, "The collaboration was helpful because Charles provided a real sample of a system to test the tactics used in ArchE and was willing to add [analytic capability] to ArchE."

According to Shelton, "We have incorporated ArchE into internal research projects and are able to use it as a basis for further explorations in software architecture design." Bosch RTC researchers appreciate, says Shelton, "being able to use ArchE dynamically to observe how changing an architecture design affects the ability to satisfy requirements. We can use the tool to try out different architectural design choices and get immediate information on whether they work. This helps us quickly evaluate multiple designs."

ArchE helps architects avoid the risks associated with failure to meet quality-attribute requirements. As Shelton states, "The power of the ArchE concept lies in its ability to provide not only analysis of architecture designs, but also feedback and suggestions on how to improve a design." A new version of ArchE is planned to give architects the ability to add analytic capabilities, expanding its potential.

# Fighting Fires

## Helping the Wildland Fire Community Gain Control of a Complex Environment

When wildfires ravaged California in 2007, firefighters used all the tools available to control the blazes: axes, rakes, shovels, hoses, aircraft—and computers.

“The wildland fire community uses a variety of software systems and tools to do its work,” says John Cissel, program manager of the Joint Fire Science Program (JFSP), a U.S. interagency partnership. Examples include FSPro, which predicts the probability that a fire will reach a specific area; BlueSky, which can forecast ground concentrations of smoke; and Consume, which estimates fuel consumption, pollutant emissions, and heat release.

FSPro, BlueSky, and Consume are only a few of the decision-support tools used by fire professionals; JFSP has encouraged development of dozens of software tools over the last decade. And still there are more—by some counts, there may be 300 others. And that’s the problem.

“The proliferation of software tools has led to confusion among users,” says Cissel. “It was time to assess the tools available today and create a more effective environment for users to select tools appropriate to their needs and apply them in an integrated environment.”

“These tools have been developed independently, using different underlying mathematical models, software languages, hardware infrastructures, coding standards, data sets, architecture, and design assumptions,” explains Steve Palmquist of the SEI.

So the JFSP initiated a study of fire and fuel management tools and systems and sought help from the SEI. “We were looking for an independent voice to help strengthen the credibility of the recommendations,” says Cissel.

The SEI undertook the study with Palmquist as the project manager, Lisa Brownsword as the technical lead, Eileen Forrester in a technology-transfer role, and Phil Boxer as the principal analyst and developer of a projective analysis technique geared to complex systems.

“Our approach,” says Palmquist, “is not just technical. It has to be tied to user need.”

To understand the operational environment, the SEI team interviewed fire managers, fire incident commanders, natural resource professionals, and tool developers across the United States. “We’re learning many things about the underlying causes of the users’ problems,” says Brownsword, “that we must know to help frame the solutions.”

Boxer characterizes the current situation as a mismatch between supply and demand: “There is a push of tools from the developers and a pull of operational demand from the users, but there’s a gap between push and pull.”

Fires, notes Forrester, “create both technical and political complexity.” For example, fire managers must consider not only loss of life, landscape, and property, but also smoke’s effects on health, fire’s effects on climate and environment, and economic and policy outcomes.

These decision-making tools help fire managers balance the considerations in this complex environment, but only if the tools interoperate properly in a dynamically responsive system of systems. “Our goal is to help them be able to design, build, roll out, and maintain these complex systems of systems,” says Brownsword.

The California fires underscore the critical work that JFSP supports. “It’s gratifying to work on something of such importance,” says Forrester. “Because of the personal, economic, and environmental consequences of wildfires, this work ultimately benefits everyone.”

**Interagency Partnership**

The Joint Fire Science Program is a partnership of the U.S. Department of the Interior and U.S. Department of Agriculture. Participating agencies include the Bureau of Land Management, National Park Service, U.S. Fish and Wildlife Service, Bureau of Indian Affairs, U.S. Geological Survey, and the Forest Service.

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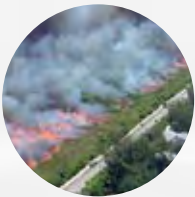
**Lisa Brownsword**

*Software Engineering Institute*

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**Steve Palmquist**

*Software Engineering Institute*



*J.N. "Ding" Darling National Wildlife Refuge, Sanibel, Fla.*

*Paul Ryan photo*



**John Cissel**

*Joint Fire Science Program*



**Eileen Forrester**

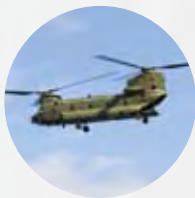
*Software Engineering Institute*

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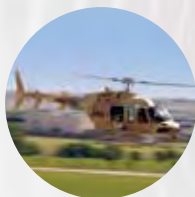
**Gary Chastek**  
*Software Engineering Institute*

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**Sholom Cohen**  
*Software Engineering Institute*



*Army helicopter CH-47D*



*Army helicopter ARH-70*



*Army helicopter AH-64*

# Software Product Lines

## Approach Helps Army Save Money and Reduce Time to Field

Mechanics have to be ready to fix more than 300 models of cars—each with its own unique and likely computerized circuitry. Although they don't have specialized training in any one model, they can repair almost any car within a few days—because they use a special diagnostics machine to help them.

What if the car were highly specialized—with complex, integrated components? What if it had a sticker price of over \$10 million? And what if having it out of service could mean the loss of human lives?

That's what U.S. Army field maintainers face every day on the battlefield. They must quickly diagnose and repair helicopters that break down—even if all they have is general knowledge about the particular model and limited resources. And at times they need the help of experts thousands of miles away.

The SEI has helped the Army address this need. First, the SEI identified the Army's Communications Electronics Command Life Cycle Management Command (CECOM LCMC) ability to meet those needs on the battlefield as a potential risk during an architecture evaluation based on the SEI Architecture Tradeoff Analysis Method® (ATAM®). Then, SEI staff members Sholom Cohen, Patrick Donohoe, and Gary Chastek helped the organization address that risk—through the Advanced Multiplex Test System (AMTS), a sophisticated diagnostic and maintenance system for military helicopters.

According to Cohen, “A helicopter breaks down in the field, but the field maintainers might have little knowledge about that model. The AMTS—like the car mechanic's diagnostics machine—guides them through some diagnostics, and they can use another CECOM project to collaborate with a maintenance expert located in the U.S. if they need additional help. The maintainer and expert can both look at the same diagnostic screenshot at the same time to figure out how to solve the problem.”

Because the Army followed the SEI's software product line approach when creating the AMTS, it will soon be shared across three products, and additional products are planned. Cohen says, “The product line approach is helping Army personnel save about 25 to 30 percent on each product they produce. They're going to reach their return on investment after producing only three to four products. And they can get them to field now in months instead of years.”

In addition to reducing costs, using a product line approach simplifies software maintenance and enhancement. “The fact that maintenance is easier allows the Army to increase the number of users dramatically—from 20 to probably hundreds of users—without worrying that the system won't be able to handle them,” Cohen says. “Errors will be fewer, and any that do happen can be fixed more easily than in a non-product-line approach, because the fix involves changing a small piece of code rather than an entire system.”

Right now, 15 Army aviation units are using the AMTS product line to meet the Army's battlefield needs in real time. Success is critical, and the outlook is good, says the AMTS project leader. “Overall, our funding has been tight, and we've been asked to do more with less money and fewer resources. The product line approach allows us to do exactly that.”

# Defining Software Acquisition

## Implementation and Integration Strategies for U.S. Satellite Program

When the United States Air Force undertook one of its most challenging military-satellite communication projects ever, it asked the Software Engineering Institute to help.

The Transformational Satellite Communications System (TSAT) program is creating the next generation of secure communications satellites—a network of advanced orbiters and ground stations that will provide the bandwidth needed for high-volume, Internet-like links across land, sea, and air forces deployed around the world. The SEI has collaborated with the Air Force on the space segment (developing what is essentially a router network in orbit) and the mission-operations segment—the ground stations tying it all together.

The SEI is helping define requirements and the system software architecture, estimating cost and size, analyzing potential software issues, participating in design reviews, and helping assess risks, including oversight of contractors.

“This project is exciting for everyone involved—the SEI and other research centers, the contractors, and the Air Force,” says Mary Ann Lapham, who coordinates the SEI’s involvement. “It marks another step in the DoD’s continuing adoption of software-intensive systems.”

“The SEI team has truly been the conscience of software on the TSAT program,” says Col. Jay Moody, TSAT deputy program director and the project’s chief systems engineer. “The Institute has provided detailed expertise in individual program segments, and is now helping the program with tools to avoid software pitfalls within the system.”

In 2007, the SEI team helped the government program office complete the system design review (SDR). The SDR is a foundation for all systems development to come, and it marked the first formal review of the overall program design. The SEI team reviewed defense contractors’ preliminary designs for each part of the system, analyzing the approaches and working with the contractors to resolve potential issues.

Much of what the SEI team does, Lapham says, is help the TSAT program plan for and deal with complexity. “We’re talking about more than five million lines of code,” she says.

Printed single-sided from a standard office printer, she notes, it would constitute a nearly 30-foot-tall stack of paper. “So just the sheer volume is impressive,” Lapham says, “without even beginning to think about documentation or any algorithms involved with the domain it will work in—space, networks, and communications.”

“The SEI has reiterated the importance of thorough, disciplined processes in managing the development of software-intensive systems,” Col. Moody says. “The Institute’s background and focus on large-systems development and acquisition complements the contributions of the entire integrated team. It’s been a good, productive collaboration.”

As the United States continues to move toward net-centric defense systems, programs like TSAT are the leading edge of a wave of software-intensive development. The SEI’s research and knowledge in creating complex systems will continue to benefit not only the Air Force, but the entire defense community.

“Dealing effectively with increasing complexity is absolutely vital to developing networked systems that provide U.S. warfighters with the winning edge,” says Col. Moody.

### **Straight Talk**

The SEI's experience—and straight talk—has benefited the Air Force in the TSAT program, according to Col. Jay Moody. “From them,” Col. Moody said of the SEI team, “I get unflinching views from people who have seen the best and worst of software practices on large, software-intensive programs.”



**Mary Ann Lapham**  
*Software Engineering Institute*



**Col. Jay Moody**  
**TSAT**

*Photo: U.S. Air Force*



*The Transformational Satellite Communications System Mission Operations System will provide network management for the TSAT system, providing network-centric interoperability between TSAT and the Department of Defense's Global Information Grid.*

*Image: U.S. Air Force*

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**Randy Trzeciak**

*Software Engineering Institute*

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**Dawn Cappelli**

*Software Engineering Institute*

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**Andy Moore**

*Software Engineering Institute*



# Insider Threat

## Multiple Collaborations Drive CERT's Approach to a Complex Security Challenge

One Friday night, an insider obtained unauthorized system-administrator access to his company's network, deleted information and applications from his company's servers, then stole 77 backup tapes, including those in off-site storage. The results were severe: the emergency services 911 address-lookup system did not function for a large geographic area until the system could be restored.

Dawn Cappelli's insider threat team from the SEI CERT Program tackles the problem posed by such attacks, which involve the misuse of organizations' networks, systems, or data by current or former staff or contractors to commit crimes that target individuals or affect the security of the organization's data, systems, or operations. But it's not just about technology. "We're also looking at complex behavioral facets to analyze the big picture," notes Cappelli. To that end, her team has collaborated with government organizations and thought leaders from diverse fields.

Initially, the team partnered with the Department of Defense Personnel Security Research Center (PERSEREC) to research insider incidents in the armed forces and defense agencies. It later joined behavioral psychologists in the U.S. Secret Service to examine approximately 150 incidents in critical-infrastructure sectors. Most recently, the team is again working with the Department of Defense; initial findings are detailed in the SEI technical report *Comparing Insider IT Sabotage and Espionage: A Model-Based Analysis*.

The team's research, which included interviews with victim organizations and attackers, enabled the team to create an extensive database that laid the foundation for new work. "Our early work generated a lot of statistics," observes Cappelli, "but we became concerned that people didn't grasp the nuances."

To better understand the problem and convey its complexity, the team turned to system dynamics, a simulation-modeling methodology for studying complex systems. Working with PERSEREC, CERT's technical specialists engaged experts from a variety of disciplines, including psychology, political science, history, counterintelligence, law enforcement, personnel security, and information security. Initially, the work focused on validating the effectiveness of the system-dynamics approach. "Once we validated the approach, the experts helped us bootstrap our own efforts," says team member Andy Moore. To date, the team has produced three insider-threat models: one representing insider IT sabotage, one capturing espionage cases, and a unified, abstracted model representing the similarities between the two.

"The models have been well received," notes team member Randy Trzeciak. "They help people quickly comprehend the problem as well as possible mitigation strategies."

The CERT team is the first to focus on both technical and behavioral aspects of actual insider compromises. And the team's models are the first to convey the complete picture of the insider-threat problem—the complex interactions, relative degree of risk, and unintended consequences of policies, practices, technology, insider psychological issues, and organizational culture over time. PERSEREC's Lynn Fischer concurs. "We have made significant progress in the development of a theoretical framework that includes environmental, organizational, psychological, and technical variables in the workplace and their interrelationships. I see this as a significant breakthrough because current personnel-security programs focus almost exclusively on the past behaviors of employees divorced from the environment in which they work."

"Our team is committed to this. We have a passion for studying insider threat," says Cappelli.

# University Collaborations

## Bringing SEI Knowledge to the Global Software Industry

Nearly 10,000 miles apart and on opposite sides of the globe, Monterrey, Mexico, and Johannesburg, South Africa, do not seem to have much in common. However, Johannesburg and Monterrey are leading their countries' efforts in software engineering through education by bringing SEI technologies into the curriculum at leading universities.

In an effort to equip its workforce to compete in the global software industry, the Mexican government began its push to bring the SEI Team Software Process<sup>SM</sup> (TSP<sup>SM</sup>) methodology to software development in Mexico in March 2006. One of Mexico's leading universities—Instituto Tecnológico y de Estudios Superiores de Monterrey, or Tec de Monterrey—was the starting point for this effort. With support from the SEI, Tec de Monterrey, and the Mexican government, Mexico's TSP initiative saw the launch of its first TSP teams in December 2006.

Rafael Salazar, director of the Mexican TSP Initiative at Tec de Monterrey and an SEI-authorized TSP instructor and coach, sees the national TSP initiative as a vital part of Mexico's efforts to compete in the global software industry. "TSP and PSP are going to catapult what we're doing in Mexico. We have already embraced CMMI. TSP and PSP are what we need for developers," he says. The 74 Mexican professionals who became SEI-certified PSP developers during the first phase of Mexico's TSP initiative form the core of the qualified workforce Mexico is building.

The story is similar for the Johannesburg Centre for Software Engineering (JCSE), located at the Witwatersrand University in South Africa's largest city. In the 1990s, the South African government turned to the IT sector to sustain and expand its economy. As the South African IT industry grew, Professor Barry Dwolatzky, CEO and director of the JCSE, saw the need for CMMI. "South Africa's software industry suddenly found itself competing with some of the best IT companies in the world. Quality and process maturity became a major problem. We needed to bring our IT skills and practices up to the highest level," says Dwolatzky.

In 2007, activity surrounding the JCSE's CMMI initiative boomed. South Africans completed CMMI instructor training and Standard CMMI Assessment Method for Process Improvement (SCAMPI<sup>SM</sup>) team-leader training, and a CMMI in Africa Symposium was held in Johannesburg. SEI staff members Kristi Keeler and Brian Larman taught the intermediate CMMI course to attendees from a diverse set of backgrounds in South Africa. With its academic connection, the JCSE is an ideal provider of CMMI training. "As we teach CMMI, it becomes part of the intrinsic way people do business," says Keeler. Making CMMI part of routine business practices, Dwolatzky believes, will help South Africa's workforce compete in the global software industry.

Both countries are already seeing pilots of projects that use SEI technologies. In Mexico, pilot projects using TSP are under way at Softtek and IBM Mexico. In South Africa, nine pilot projects using CMMI have begun at companies that include First National Bank, IBM, and Fujitsu Services. Tec de Monterrey and the JCSE remain at the forefront of the efforts to bring SEI technologies to their countries' industries. "Being linked to universities keeps the SEI informed and keeps the research areas refreshed," says Keeler.

**Improving Processes with  
CMMI, TSP, and PSP**

The Capability Maturity Model Integration (CMMI) methodology is a process improvement approach that provides organizations with the essential elements of effective processes. CMMI is being adopted by organizations in North America, Europe, Asia, Australia, South America, and Africa.

The Team Software Process (TSP) method can enable organizations to dramatically improve software development teams' productivity and reduce defects, costs, schedule deviations, and time to market. TSP works in conjunction with the Personal Software Process<sup>SM</sup> (PSP<sup>SM</sup>) method, through which individual engineers can measure and enhance their performances. The term "TSP" generally refers to the two processes as they are practiced in tandem. Both were created as a way to bring CMMI principles to teams and individuals.

**Kristi Keeler**  
*Software Engineering Institute*



*Lance Stewart, Barry Dwolatzky,  
Kristi Keeler, Brian Larman*



*August 2007 Intermediate  
Concepts of CMMI course,  
Johannesburg, South Africa*

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**Dan Plakosh**

*Software Engineering Institute*

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**Gabriel Moreno**

*Software Engineering Institute*

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**Scott Hissam**

*Software Engineering Institute*



**Marcin Stelmarczyk**  
*ABB*



**Isak Savo**  
*ABB*



**Saman Hadiani**  
*ABB*

# Predictability by Construction

## Improving Confidence in the Quality of a Product

ABB, a manufacturer of power and automation technologies with headquarters in Sweden, needed a software engineering technology that would ensure that its software and system product lines—which include power, robotics, and process automation—could be customized by third parties while not compromising the governmental and industrial quality standards to which they were built.

ABB's work with the Predictable Assembly from Certifiable Components (PACC) team at the SEI, which conducts research in achieving predictability by construction, will improve ABB's ability to quantify its confidence in the quality of its products.

“In short, predictability by construction means taking what you know about the software components of a system—its certified, trusted behavior—and from that predicting how that overall system will behave,” explains Kurt Wallnau, PACC team lead. “What makes our work unique is that we provide the means to have measurable trust in all of this—real, quantifiable, measurable trust.”

Partnering with the PACC team will allow ABB to put in place a system to ensure that once a product or service is delivered, any user-customized configurations will hold up to quality tests that ABB had already put in place, explains PACC team member Scott Hissam, who worked on the initiative along with Wallnau and the SEI's Gabriel Moreno and Dan Plakosh.

The collaboration with ABB began as a result of an SEI research and development project on predictable assembly, which was partially funded by ABB.

In 2006 and 2007, ABB and the SEI applied the key ideas developed in the lab to a release of ABB production software. The intent was to demonstrate, in a product setting, the feasibility and effectiveness of the PACC approach. But first, both teams had to develop a mutual understanding of product and software engineering technology while, at the same time, contending with cultural and language differences.

After several trips by ABB and the SEI across the Atlantic, the ABB engineers—Marcin Stelmarczyk, Saman Hadiani, and Isak Savo—began an extended stay at SEI headquarters to initiate prototype development. The PACC team then constructed a minilab on-site in Pittsburgh replicating the ABB system in Sweden.

The 2006-07 work resulted in a foundation for tools and techniques that can be integrated into ABB's development environment, architecture, and production software. The results will improve the methods used by ABB to quantify the quality and predictability of its software. This assurance will also improve the methods used by ABB to predict whether a given configuration of systems will violate critical performance requirements.

“The frequent visits, the intense period of travel between the groups, established the personal relationships and expectations. It helps when working remotely,” says Magnus Larsson, manager for industrial software systems at ABB in Vasteras, Sweden.

Although both teams continue to work together, the most beneficial outcome to date has been the development of a system that would allow ABB to predict real-time performance of products.

“What we needed was the technology for doing predictions in real-time systems so that we could predict performance behavior,” explains Larsson.

# High Maturity

## Using Quantitative Indicators to Stay on Track

For many organizations, achieving and maintaining CMMI high-maturity practices is a hard-earned goal. For Warner Robins Air Logistics Center Software Maintenance Group, it was a step toward a richer, deeper application of best practices through close collaboration with the SEI. The Software Maintenance Group provides technical expertise to develop, maintain, and enhance systems by sustaining software vital to the mission, operation, and sustainment of weapon systems, airborne electronics, electronic warfare, space communications, and support equipment.

“The implementation of any improvement model is dynamic, and CMMI is no exception,” says Bob Stoddard, a member of the SEI staff who has been working closely with the Software Maintenance Group. “Technology is always changing, and best practices are constantly being refined. The Software Maintenance Group put together a plan for continual improvement that includes an ongoing collaboration with the SEI.”

Immediately after achieving its most recent Maturity Level 5 rating, the Software Maintenance Group began expanding its implementation of CMMI. The group arranged to have Stoddard on-site for coaching one week per month throughout most of the year. CMMI training and coaching were extended from a handful of software-engineering process specialists to dozens of other leaders, including measurement specialists, strategic planners, and squadron directors. By working with more people in a wider variety of organizational roles, Stoddard helped the Software Maintenance Group target new areas of improvement with a variety of industry-proven implementations of CMMI practices, including Six Sigma techniques.

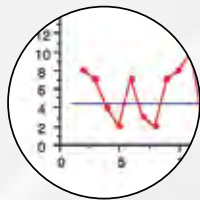
They began by tackling the difficulty of predicting costs, schedules, and several other performance outcomes. Stoddard coached them to initially develop several statistical process-performance models to predict these outcomes based on factors the organization could control, such as work product size, complexity, risk codes, and average domain experience. In addition, they created numerous charts to help them track and visualize their leading indicators, providing them early warning of process-performance issues. Six Sigma simulation and optimization techniques were used to determine how to use leading indicators to improve performance. This approach identified potential efficiencies for some tasks.

By targeting cost and schedule issues for improvement, the Software Maintenance Group was able to statistically demonstrate improvements in both cost and schedule variance by comparing results before and after CMMI high maturity. The process-performance models and baselines are expected to support future improvements surrounding reduced internal rework, shorter cycle times, lowered costs, and fewer schedule crunches.

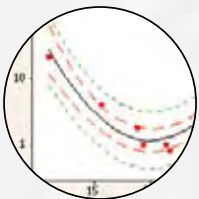
The Software Maintenance Group continues to work on new improvement techniques. Most recently, Stoddard has been leading them through an innovative process to define their vision and goals for how the organization contributes to the goals of the Air Force and the Department of Defense. Through this process, the Software Maintenance Group is identifying new goals that will help to achieve the success articulated in its vision.

“This collaboration has helped our group better understand high-maturity practices from a consultant who has actual experience implementing these practices in industry,” says Millee Sapp, the Software Maintenance Group’s software engineering process group lead. “It also helps the SEI understand the challenges that our organization experiences implementing CMMI.”

**Bob Stoddard**  
Software Engineering Institute



*Control charts help statistically manage critical processes.*



*Process performance models predict outcomes based on critical process attributes.*

# Technology Transition Activities

As part of its Amplify strategy, the SEI works with the software engineering community and organizations dependent on software to encourage and support the widespread adoption of new and improved technologies and solutions.

## SEI Partner Network

The SEI Partner Network consists of organizations and individuals trained and authorized or certified by the SEI to deliver official SEI services worldwide. The SEI works with its partners to ensure that the highest standard of professional conduct is exhibited.

Organizations that engage SEI Partners for training and education, consulting, or appraisal services can have confidence in the quality of the service and the integrity of the provider.

SEI Partners provide training and education in software process improvement through the Capability Maturity Model Integration (CMMI), People Capability Maturity Model (PCMM), Personal Software Process (PSP), and Team Software Process (TSP) methodologies as well as in software architecture, software measurement and analysis, and network security and survivability.

In FY 2007, the SEI Partner Network consisted of 350 partner organizations and 2,104 authorized and certified individuals.

[www.sei.cmu.edu/partners](http://www.sei.cmu.edu/partners)



## SEI Membership

SEI Membership is a business and knowledge network that connects the SEI with software and systems engineering leaders in government, industry, and academia throughout the world. SEI Members include CEOs, directors, and managers from Fortune 500 companies and prominent government organizations, as well as front-line software engineers, programmers, testers, and developers from startup organizations.

SEI Membership is designed for software engineering professionals who are interested in priority access to SEI technologies and events that support the transition of software engineering standards and best practices. The SEI is the only one of the 37 U.S. federally funded research and development centers (FFRDCs) that offers membership to the public.

In FY 2007, SEI Membership had more than 1,400 members across 36 countries worldwide.

[www.sei.cmu.edu/membership](http://www.sei.cmu.edu/membership)

### SEI Conferences and Events

The SEI sponsors and co-sponsors many conferences, workshops, and user-group meetings. These events represent technical work and research in the areas of process improvement, software architecture and product lines, security, acquisition, dependability, and interoperability.

In FY 2007, SEI events drew nearly 4,300 attendees from around the world.

The SEI continued its sponsorship of the SEPG Conference Series which includes the original SEPG North America conference and SEPG conferences held in Australia, Europe, and Latin America. The SEI served as primary sponsor of the Software Architecture Technology User Network (SATURN) workshop, the FloCon<sup>SM</sup> workshop, and the TSP Symposium. The SEI also continued to serve as host of the U.S. Army's quarterly Senior Leader Education Program that more than 170 individuals have attended since its inception.

[www.sei.cmu.edu/events](http://www.sei.cmu.edu/events)



### SEI Education and Training

Through the SEI's Education and Training initiative, the institute helps bring SEI technologies and best practices into widespread use. In FY 2007, the SEI offered 321 courses in the United States and internationally in the areas of software architecture, software product lines, security, acquisition management, organizational management development, model-based engineering, and process management. In addition, the SEI offers customer on-site training and educational opportunities.

In FY 2007, the SEI trained 5,816 individuals from government, industry, and academia while SEI Partners trained 16,273 individuals, bringing the total number of individuals trained worldwide by the SEI and its Partners to 22,089.

The SEI Credentials Program helps organizations put in place the best practices for designing high-quality software and protecting networked systems. The SEI offers certificates and certification programs that help individuals develop expertise in specific areas of computer-security incident handling, software engineering process management, software architecture, and software product lines. In FY 2007, 264 professional certificates and 286 certifications were awarded.

[www.sei.cmu.edu/products/courses](http://www.sei.cmu.edu/products/courses)

[www.sei.cmu.edu/credentials](http://www.sei.cmu.edu/credentials)

[www.sei.cmu.edu/certification](http://www.sei.cmu.edu/certification)

### SEI Affiliate Program

Through the SEI Affiliate Program, sponsoring organizations contribute technical staff members to the SEI's ongoing effort to define superior software engineering practices. Affiliates lend their technical knowledge and experience to the SEI teams investigating specific technology domains. Participation in the Affiliate Program is intended to immerse affiliates in the inquiry and exploration of new tools and methods that promise increased productivity, predictable schedules, fewer defects, and decreased costs. In FY 2007, 18 affiliates were working on projects with the SEI.

[www.sei.cmu.edu/collaborating/affiliates](http://www.sei.cmu.edu/collaborating/affiliates)





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**Paul D. Nielsen**

*Director and*

*Chief Executive Officer*

Before joining the SEI in 2004, Nielsen served in the U.S. Air Force, retiring as a major general after 32 years of distinguished service in various jobs at headquarters level and in the field. Most recently, he served as commander of the Air Force Research Laboratory, Wright-Patterson Air Force Base, Ohio, where he managed the Air Force's science and technology budget of more than \$3 billion annually.

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**Clyde G. Chittister**

*Chief Operating Officer*

Chittister joined the SEI in 1985 and has held several senior management positions. He initiated and managed the Ada-Based Software Engineering Program, the Systems Program, and the Software Risk Management Program. He also managed the Industry Sector, which focused on establishing and building relationships between the SEI and industry clients.

# Leadership, Management, & Staff

## **SEI Director's Office**

The SEI Director's Office ensures the smooth, efficient operation of the SEI. Director and Chief Executive Officer Paul Nielsen and Chief Operating Officer Clyde Chittister build strong, collaborative relationships with leaders in government, industry, and academia, communicating the SEI's vision for software engineering.

## **SEI Board of Visitors**

The SEI's Board of Visitors advises the Carnegie Mellon University president and provost and the SEI director on the SEI's plans and operations. The board monitors SEI activities, provides reports to the president and provost, and makes recommendations for improvement.

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Former Executive Vice President,  
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Center for Software Engineering

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Former Commander, Naval Air  
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Trustee, Carnegie Mellon University

## SEI Management Team

The SEI management team leads the SEI by setting and executing SEI strategies, goals, and priorities and demonstrating the SEI core values of impact, excellence, and integrity.



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*Director, Financial and  
Business Services*



**Patricia Oberndorf**  
*Director, Dynamic Systems*



**Sally Cunningham**  
*Director, Technology  
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**David Thompson**  
*Director, Information Technology*



**Richard Pethia**  
*Director, Networked  
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**John Bramer**  
*Director, Program Integration*



**Linda Northrop**  
*Director, Product Line Systems*



**Jack Nicholas**  
*Acting Director, Administration*



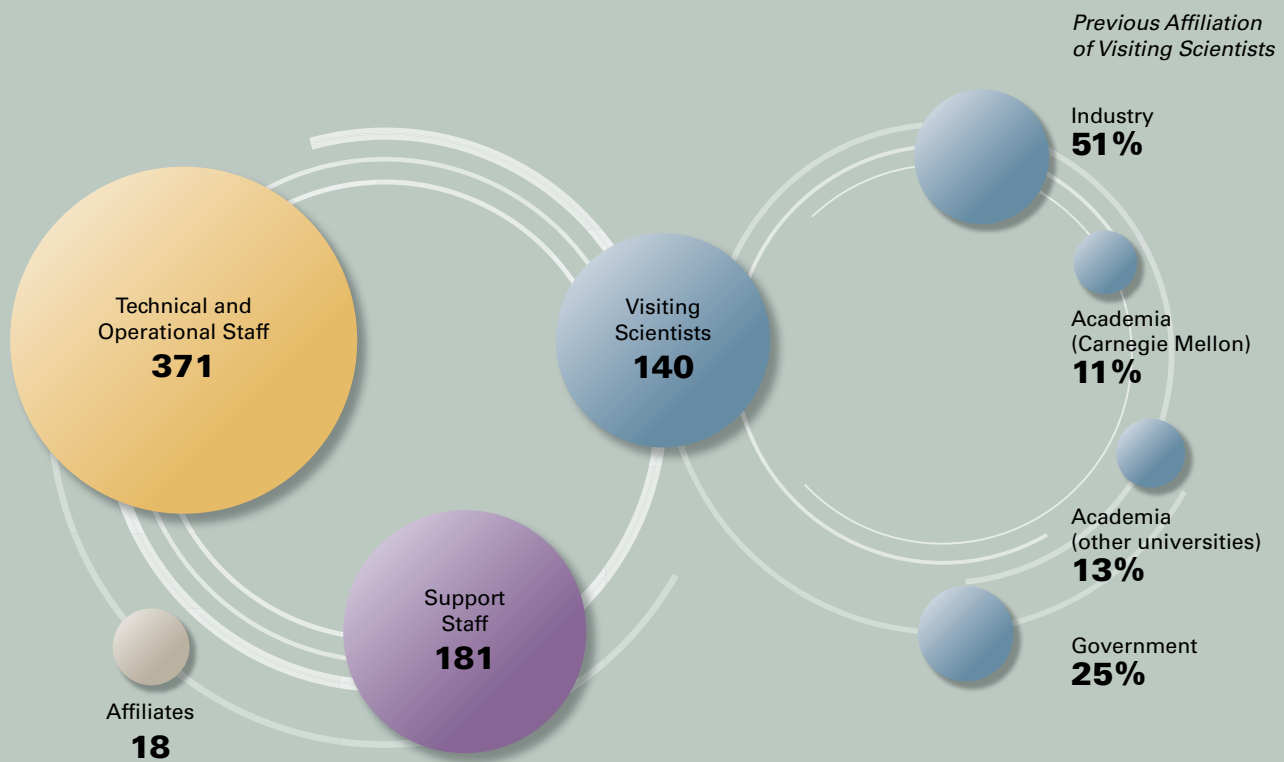
**Brian Gallagher**  
*Director, Acquisition Support*



**William Peterson**  
*Director, Software Engineering  
Process Management*

# SEI Staff

The SEI attracts top talent to implement its expanding objectives, increasing its staff by a third over the past four years. Staff members are permanent, full-time employees; affiliates are professionals sponsored by their home organizations to work on SEI technical projects; visiting scientists are temporary SEI employees from government, industry, and academia.



# Key Publications

## Reports

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# Opportunities to Work With the SEI

Congress established the SEI in 1984 because software is vital to the national interest. By working with the SEI, organizations benefit from more than two decades of government investment and participation from organizations worldwide in advancing the practice of software engineering.

The SEI creates, tests, refines, and disseminates a broad range of technologies and management techniques. These techniques enable organizations to improve the results of software projects, the quality and behavior of software systems, and the security and survivability of networked systems.

As an applied research and development center, the SEI brings immediate benefits to its research partners and long-term benefits to organizations that depend on software. The tools and methods developed by the SEI and its research partners are applied daily in organizations throughout the world.

## **How the SEI Works with Government and Industry**

SEI staff members help the U.S. Department of Defense (DoD) and other government agencies solve software engineering and acquisition problems. SEI direct support is funded through task orders for government work. Engagements with the SEI are of particular benefit to government program managers, program executive officers, and senior acquisition executives, particularly those with long-range programs that will benefit from strategic improvements that the SEI fosters.

The SEI has a well-established process for contracting with government agencies and will work with an organization to meet its needs. This process is described in more detail at [www.sei.cmu.edu/collaborating/contracting.html](http://www.sei.cmu.edu/collaborating/contracting.html).

The SEI works with commercial organizations that want to develop a strategic advantage by rapidly applying improved software engineering technology. The SEI works with organizations that want to combine their expertise with the SEI's expertise to mature new technology for the benefit of the entire software industry. The SEI also supports a select group called SEI Partners, which are organizations and individuals that are trained and licensed by the SEI to deliver SEI products and services.

To determine how to put the SEI to work for your organization, contact SEI Customer Relations at [customer-relations@sei.cmu.edu](mailto:customer-relations@sei.cmu.edu).

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