

STRATEGY FOR A SOFTWARE  
ENRICHED SOCIETY

# SEI Annual Report

>> FY 2005



Software Engineering Institute

Carnegie Mellon



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

The SEI advances software engineering and related disciplines to ensure the development and operation of systems with predictable and improved cost, schedule, and quality.

The stories that begin on page 10 exemplify how the SEI pursued its strategy to improve the practice of software engineering during the fiscal year ending September 30, 2005.



**Paul D. Nielsen**  
Director and Chief Executive Officer  
Software Engineering Institute

# Director's Message

Through the Create-Apply-Amplify cycle, we aim to realize our vision of leading the world to a software enriched society.

A Message from SEI Director and CEO Paul D. Nielsen

**A**t the Software Engineering Institute, 2005 was a pivotal year. We celebrated our first 20 years as an organization—and set the course for our future. The management team at the SEI worked hard on strategic planning even as we continued to increase our impact on the global software engineering community.

We validated our tried-and-true process of Create-Apply-Amplify as the basis for our research and transition of software engineering technology and management practices. We will continue to do unique research where we have the right talent—and we will reach out even more to the broader software engineering community to identify new techniques, new concepts, and new innovations that show promise. As part of this strategy, we led two probing studies to look at future research needs and trends in the areas of process research and ultra-large-scale systems. Both efforts involved many of the top international researchers from academia and industry.

We've partnered strongly with our key federal sponsors and their support organizations during this year. With the U.S. Department of Defense (DoD), we continue to improve our flagship process improvement model, the Capability Maturity Model Integration (CMMI) framework. During 2005 we applied Version 1.2 of the model in defense

organizations and used feedback from these pilots to refine the model, which will be released in 2006. We also began work on extensions of the model to help both acquisition and service organizations. In addition, more organizations, both defense and commercial, are adopting our Team Software Process, software architecture, and product line approaches to further improve their software practices.

Our partnership with the Department of Homeland Security (DHS) continues to improve network security for our country. Our CERT experts work closely with the DHS staff to address cyber threats including malicious code, insider threats, and the new rise in phishing. Although DHS leads these areas for the federal government, the SEI continues to support the DoD network-security community. The interests of DHS and DoD are tightly coupled, and we have been able to provide both agencies with great synergy and leverage.

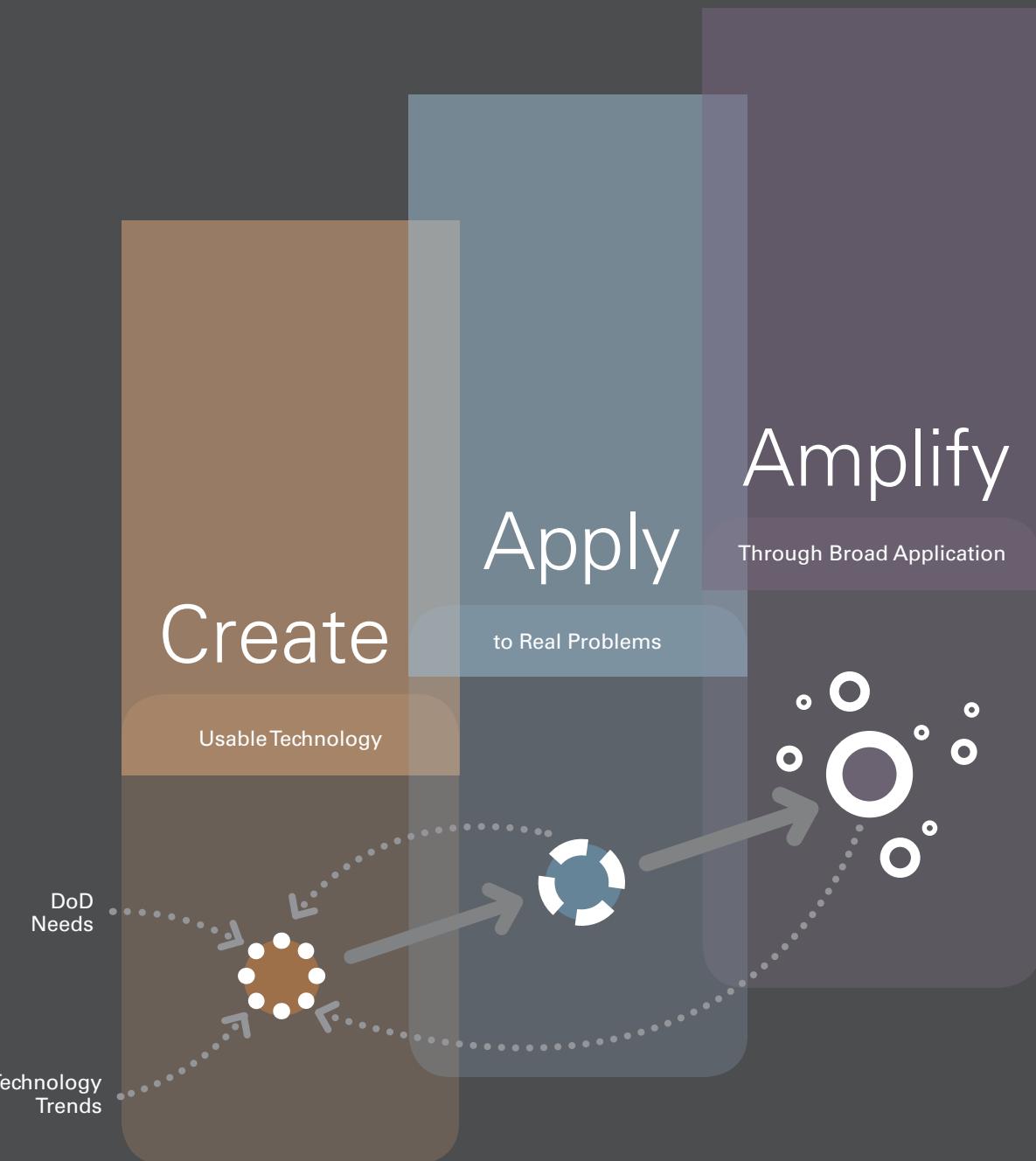
We are working to expand our influence and skills in the general area of the integration and interoperability of software-intensive systems, which addresses the trend toward systems of systems and service-oriented architectures, both important trends in the DoD and the general software community. And we are taking the first steps to address software engineering for high-performance computing—critical for modeling and simulation and scientific computing in the DoD, the Department of Energy, and the research community, and for software in which safety and mission assurance are paramount, such as in unmanned vehicles and medical systems.

Overall, software's influence on our lives and our security continues to grow, and the SEI will be there to enable software to enrich our society, to improve our security, and to enhance our quality of life. At the heart of all this work are the innovative men and women of the SEI and the global software community who make this happen. They are a true treasure.

A handwritten signature in black ink, appearing to read "Paul D. Nielsen".

# Strategy

The SEI achieves mission success and reaches its goals through technology innovation and transition. It does this by *creating* usable technologies, *applying* them to real problems, and *amplifying* their impact by accelerating broad adoption.

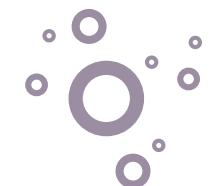


The SEI addresses significant and pervasive problems in software engineering and related disciplines by

- motivating research
- developing innovative new technologies
- identifying and fostering the development and improvement of emerging or underused technologies
- improving and adapting existing solutions

SEI technologies and solutions are suitable for all organizations that commission, build, or use systems that depend on software.

Collaborators: **innovators and researchers**  
**early adopters**



The SEI applies, validates, refines, and extends new and improved technologies and solutions in real-world government and commercial contexts. Application and validation insure effectiveness, applicability, and adoption potential.

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 needed adjustments, technologies, and solutions
- the Amplify activities about needed adoption artifacts and strategies

Collaborators: **early adopters**

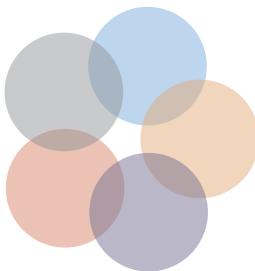
The SEI accelerates the adoption and impact of improvements in software engineering and related disciplines. The SEI encourages and supports the widespread adoption of new and improved technologies and solutions through

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

Collaborators: **engineers throughout the world**, through direct interaction with the SEI and with SEI Partners—organizations and individuals licensed by the SEI to deliver official SEI services

# Areas of Work

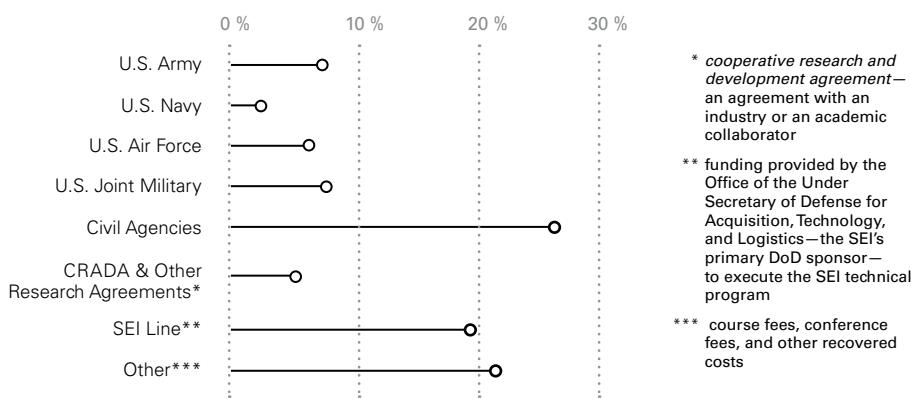
The SEI technical program, executed through the Create—Apply—Amplify strategy described on page 5, consists of five technical focus areas. The SEI also conducts new research into emerging topics in software and systems engineering.



**S**ince 1984, the Carnegie Mellon® Software Engineering Institute (SEI) has served the nation as a federally funded research and development center. The SEI staff has advanced software engineering principles and practices and has served as a national resource in software engineering, computer security, and process improvement. As part of Carnegie Mellon University, which is well known for its highly rated programs in computer science and engineering, the SEI operates at the leading edge of technical innovation.

## SEI Funding by Organization

In FY 2005, the SEI received \$92.7 million in funding from a variety of sources. The chart below shows the percentage of funding given by each organization.



The SEI program plan, conducted in the general areas described on page 7, is based on 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.

## Architecture, Product Lines, & Predictable Assembly

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.

## 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.

## 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.

## Process Improvement & 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.

## System Interoperability & Dependability

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



  
Create

Chuck Weinstock (right) is a senior member of the technical staff whose research focuses on the dependability of large software systems. SEI Fellow John Goodenough (left), is head of the SEI Performance-Critical Systems Initiative and leads SEI research with Weinstock on software assurance—the planned and systematic set of activities that ensures that software processes and products conform to requirements, standards, and procedures.

## Impact : FY 2005

The SEI improves software engineering and related practices through technology innovation, application, and transition. The stories in this section provide examples of important and noteworthy work conducted by SEI staff members in FY 2005.

## &gt;&gt; Catalyzing Research Collaborations

**S**ince 1984, the Software Engineering Institute (SEI) has operated at the nexus of government, industry, and academia as a national resource in software engineering and technology. To ensure objectivity, independence, and the ability to act as a trusted, neutral advocate of best software-engineering practices from a wide variety of sources, the SEI's DoD sponsor positioned the SEI to be administered by a university and chartered it as a federally funded research and development center (FFRDC). As stated by the SEI's sponsor in the SEI Core Statement of Work, "The SEI sponsor requires impartial analysis and advice, divorced from all conflicting interests—political, bureaucratic, and commercial—other than those of the U.S. public interest."

Because of its defined role in serving the public interest, the SEI is uniquely adept at organizing and catalyzing diverse groups of experts to solve challenging problems.

**Ultra-Large-Scale Systems**

One such problem is the escalating scale of mission-critical systems. Given the issues with today's software engineering, how can we build systems of the future that are likely to have billions of lines of code?

Claude M. Bolton, Jr., Assistant Secretary of the Army (Acquisition, Logistics, and Technology), posed this question to the SEI in 2004. The question led the SEI to initiate a research study in ultra-large-scale (ULS) systems: systems that exceed some critical limit of today's software engineering technology such as size, unboundedness, continuous requirements evolution, and continuous operation.



Linda Northrop, director of the SEI Product Line Systems Program, guides a team of software experts on the critical challenge of ultra-large-scale (ULS) systems. Participants gathered at the SEI in August 2005 to discuss and identify the organizing elements for a ULS technology roadmap: ULS system characteristics, technical challenge areas, and breakthrough research areas.



**Caroline Graettinger**  
Team Lead, International Process Research Consortium

Caroline Graettinger has been a senior member of the technical staff since 1999. Her research and development interests include management frameworks for the maturation and transition of software engineering methods, metrics for evaluating transition readiness, and the application of these to real-world programs of software-intensive-systems development.

**Assurance Cases**  
participating organizations:

Adelard  
Aspect Security  
Carnegie Mellon University  
City University of London  
Cyber Defense Agency  
Defence Science and Technology Laboratory  
Joint Research Centre of the European Commission  
MITRE Corporation  
Swedish Nuclear Power Inspectorate  
University of Illinois  
University of Missouri  
University of York

**IPRC** founding sponsors:

BAE Systems  
Robert Bosch, GmbH  
Florida IT Centers of Excellence  
Lockheed Martin Corporation  
Science Applications International Corporation  
TCS America  
University of Pittsburgh Medical Center

To meet this challenge, the SEI brought together software experts with a wide range of knowledge and expertise. The group held its first meeting in August 2005 at the SEI's main office in Pittsburgh. It is continuing its work and will publish its findings in 2006. The intended outcome of the study is the creation of a research agenda for ULS systems and a collaborative research network that works toward solving ULS problems.

**Assurance Cases**

In systems in which there is a high penalty for system failure, there is a significant need for assurance, especially where traditional testing approaches are difficult or costly to implement. Safety-case technology has long been used in Europe to provide confidence in the safety properties of systems. The SEI has recognized that safety-case technology can be applied to assuring other non-functional properties of systems such as security, reliability, and performance. The SEI refers to this adaptation of safety-case technology as "assurance cases."

To further the exploration and adoption of assurance cases in North America, the SEI hosted a three-day Assurance Case Workshop in June 2005 at the SEI's Washington office. It was attended by industry, government, and academic leaders from Europe and the United States. This by-invitation-only workshop, a follow-up to a workshop held in Florence, Italy, in 2004, focused on the development of assurance cases for security properties.

**International Process Research Consortium**

The SEI is also leading an exciting new venture in the field of software process research. Due in large part to the influences of the SEI, process improvement has become a global movement. By assembling the International Process Research Consortium (IPRC), the SEI has brought together a core team of distinguished experts in the field of process research from industry, government, and academia to explore the future of software process research and accelerate movement toward future process technologies.

The consortium assembled in a series of six workshops over the course of two years. At these workshops, consortium members created plausible scenarios to determine the likely nature of software, systems, and enterprises in 2015, and will now develop recommendations for how to invest in process research over the next 10 years. With the *Process Research Roadmap to 2015*, to be released in 2006, the IPRC will launch a series of working groups that will focus on the directed research identified in the roadmap.

## >> Achieving System-of-Systems Interoperability

T

Today, the U.S. Department of Defense (DoD) and other organizations increasingly expect their large-scale, software-intensive systems of systems to work together seamlessly.

To support a mission or business vision, each system must use information from and provide information to other systems—satellite ground-support and mission software must be integrated, radar systems must share flight-track information, and personnel and financial systems must interact.

To achieve the levels of interoperation they need, organizations must consider how systems are developed and acquired. The SEI System-of-Systems Interoperability Practices (SoSIP) form a foundation for this effort, particularly through a probe technique that identifies and characterizes factors that either enable or hinder interoperability. Using the SoSIP Probe, one large DoD organization found information bottlenecks and highlighted the communication paths needed to make informed decisions in a system of systems.

In addition, the SEI Service-Oriented Migration and Reuse Technique (SMART) effectively gathers information to produce a service-migration strategy. Developed in collaboration with the U.S. Army's information technologies and integrated systems center, SMART reveals whether legacy systems can be used as services in an interoperable service-oriented architecture (SOA).

The SEI also investigated obstacles to system-of-systems interoperability in system acquisition. In the SEI-led Future Force Workshop, representatives from U.S. Army acquisition organizations identified how individual systems' program-management strategies need to account for the total system-of-systems perspective.

Finally, to capture current best practices and point to promising approaches, the SEI published a Web-based *Guide to Interoperability* in 2005. Initiated by the SEI, the guide is designed to include contributions from those who are planning, constructing, and maintaining interoperable systems of systems.



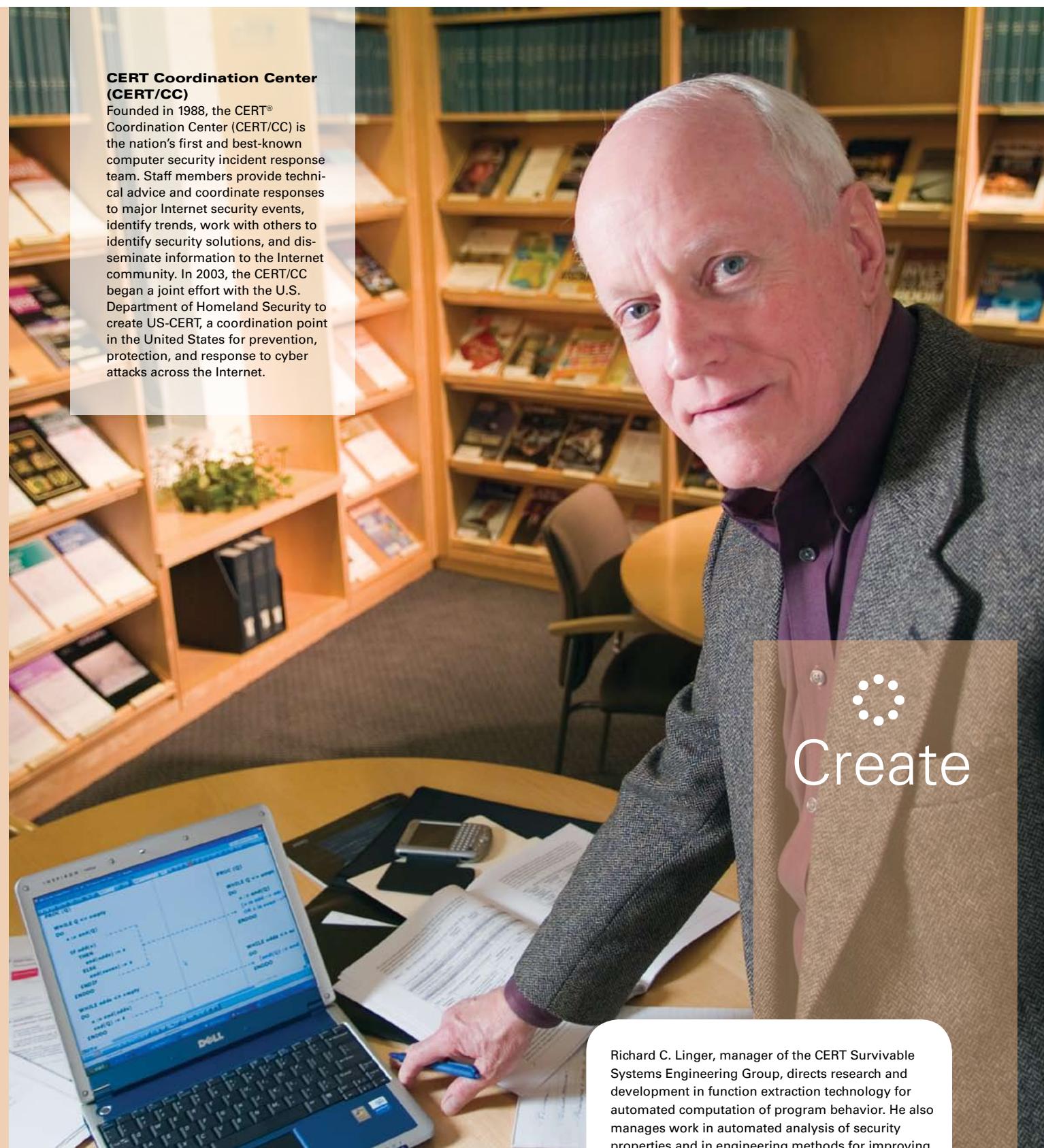
Patricia Oberndorf, director of the SEI Dynamic Systems Program, works with Dennis Smith on research into system-of-systems interoperability. This work is essential for the integration of large military systems as well as e-business, mergers and acquisitions, and communications between embedded devices in commercial systems.

## >> Improving Enterprise Security Processes

The technical and environmental complexity of today's organizations and the ever-increasing dependence on technology make managing security a challenge. Added to this complexity are vulnerabilities in mission-critical products and the external and internal threats to which organizations are subjected daily. In today's environment, organizations can no longer manage security effectively as a stand-alone discipline. Because security is a business problem, organizations must direct many of their core competencies to work together to provide effective solutions. To sustain success, security at an enterprise level requires that organizations move toward a security-management process that is strategic, systematic, and repeatable—efficient at using the organization's resources and effective at consistently meeting security goals.

Capitalizing on the SEI's unique expertise in both process improvement and security, researchers from the CERT Survivable Enterprise Management team are developing tools, technologies, and methods for improving security processes. In FY 2005, they began work on a framework called Process Improvement for Security Management, a set of enterprise capabilities that collectively define the security process. These are capabilities that are essential for achieving operational resiliency—the ability to adapt to and manage risks that emanate from day-to-day operations. An organization that has resilient operations is able to cope systematically and transparently with disruptive events so that its overall ability to meet its mission is not affected.

The CERT researchers were approached by members of the Financial Services Technology Consortium (FSTC) who had read CERT reports on resiliency and enterprise security management. The FSTC was seeking a way to help the banking and financial industry develop a model for benchmarking their business continuity and resiliency activities against their peers and in the hopes of satisfying regulatory compliance. In addition, they wanted a standardized means for assessing the resiliency of upstream and downstream business partners to ensure that their business processes exhibit end-to-end resiliency. The researchers began collaborating with the FSTC in the development of the framework and held three workshops in FY 2005 for exploration and data gathering. Their goal is to have a first draft of the framework ready for publication by September 2006.



## >> Untangling Malicious Code with Function Extraction Technology

Because malicious code—code designed to damage or disrupt a system—employs increasingly sophisticated intrusion strategies, analysts must understand all possible behaviors of the code to develop effective responses. While current software engineering tools can provide useful information about specific cases of behavior of malicious code, precise means for viewing all cases of behavior are lacking. To help address this need, CERT is developing the emerging technology of function extraction (FX). The initial goal of this project is to develop a system that computes the behavior of malicious assembly language code to the maximum extent possible, to help security analysts quickly determine intruder objectives and strategies. Beyond malicious-code analysis, FX technology can be applied to analyze the behavior of any software during development or acquisition.

In FY 2005, CERT researchers completed an initial version of the Function Extraction for Malicious Code (FX/MC) system. This version transforms malicious code's intentionally confusing control flow into a readable, structured form for faster understanding and analysis and provides a foundation for calculating behavior. In addition, CERT researchers conducted a rigorous experiment to compare traditional manual methods of program reading and inspection with use of FX automation. Experienced programmers were divided into a control group using traditional techniques and an experimental group using an FX prototype. Each group answered questions dealing with comprehension and verification of three Java programs. Results showed remarkable productivity improvement for the FX group: for the most complex program, the experimental group produced four times more correct answers to the questions in one-fourth of the time.

FX/MC is expected to help analysts to quickly determine intruder strategies by providing precise information on the structure and function of malicious code, enabling them to limit the harm it does to networked systems.


  
Apply

## >> Discussing Software Engineering with Senior U.S. Army Leaders

**P**art of the SEI's core purpose is to provide technical leadership so that the DoD can acquire and sustain its systems with predictable and improved software cost, schedule, and quality.

During FY 2005, Lieutenant General Joseph Yakovac, the Military Deputy (MILDEP) to the Assistant Secretary of the Army (Acquisition, Logistics, and Technology) asked the SEI for a course on critical factors in software engineering, factors that Army leaders should know about as they oversee acquisition programs.

In response, the SEI created the Senior Leader Education Program—an opportunity for the MILDEP, program executive officers, chief engineers, program managers, and product managers in the Army to learn from SEI experts and from each other.

“Software is everywhere now. The Army is increasingly dependent on the ability of every soldier and piece of equipment on the battlefield to be part of a network,” said Ceci Albert, the SEI’s Army chief engineer. “We provide a backdrop for Lieutenant General Yakovac and his leadership team to raise and discuss software-related issues.”

The Senior Leader Education Program is composed of presentations from SEI managers and thought leaders in the areas of software process, architecture, cost and schedule, assurance, and interoperability. In addition there have been presentations from Carnegie Mellon University and Army guest speakers, discussions, and social activities.

Lieutenant General Yakovac and his staff praised both the technical content of the program and the opportunity it provided for program executive officers to network and share ideas and solutions.



## >> Assessing Federal Computer Network Defenses

**C**omputer security incident response teams (CSIRTs) are filling a crucial role in agency incident response plans and the defense of networks at federal, state, and local government agencies. To help these teams ensure that they are providing needed services effectively, members of the CERT CSIRT Development team have developed a set of computer network defense (CND) performance metrics. These metrics are derived from the Department of Defense (DoD) 8530 Directive and Instruction for Certification and Accreditation of Computer Network Defense Service Providers. This derived set of metrics is funded by the US-CERT (the United States Computer Emergency Readiness Team, a joint effort of the SEI’s CERT program and the Department of Homeland Security’s National Cyber Security Division) and will support the need for consistency in evaluating computer network defense service provider operations that exist in DoD, federal, civilian, and state agencies. This work directly supports the Department of Homeland Security’s National Cyber Security Division in its mission to implement the President’s National Strategy to Secure Cyberspace.

CND services are those that are essential for protecting agencies’ computing environments, detecting suspicious activity, responding to threats and incidents, and sustaining incident management operations. The CSIRT Development team described a set of incident management capabilities supporting the *protect, detect, respond, and sustain* services in its report *Defining Incident Management Processes for CSIRTs: A Work in Progress*. More information about CSIRTs in general has been provided in a technical report entitled *State of the Practice of Computer Security Incident Response Teams (CSIRTs)*.

The CSIRT Development team has piloted a beta version of an assessment method that enables CSIRTs to benchmark their performance against the CND metrics. The method describes activities, controls, and success factors associated with each metric along with cross-references to related DoD 8530 metrics and federal regulations. The metrics are prioritized to indicate the relative importance or criticality of specific CND activities to a successful incident management capability. CSIRT Development team staff members have planned three additional pilots for FY 2006.

The metrics will help assure U.S. government agency system owners, data owners, and operators that CND services are delivered with a high standard of quality and acceptable levels of risk.

Georgia Killcrece, Mark Zajicek, David Mundie, and Audrey Dorofee (left to right) are part of a team of researchers developing a set of performance metrics for computer network defense teams in government agencies.



## >> Supporting DoD Acquisition with SEI Tools and Methods

**T**actical Data Links (TDLs) provide real-time battlefield data about enemy positions and movements among various sensors, weapons platforms, aircraft, and other vehicles. The Common Link Integration Processing (CLIP) Program is a joint U.S. Air Force and Navy effort to acquire software that allows platforms without a TDL integration solution and platforms with different TDLs to communicate.

CLIP adopted a novel approach to acquisition that—from the request-for-proposal (RFP) stage—identified the significant software architecture attributes, such as portability, scalability, extensibility, interoperability, and modifiability, that must be considered in the requirements and design phases of the software program.

To support this approach, the SEI is conducting SEI Quality Attribute Workshops (QAWs) and a series of software architecture evaluations using the SEI Architecture Tradeoff Analysis Method® (ATAM®) evaluation process with the Air Force–Navy acquisition team. An SEI QAW is a facilitated method for discovering the driving quality characteristics of a system, while an SEI ATAM is a complementary analysis method that is useful for identifying risks, sensitivities, and tradeoffs associated with how well an architecture can achieve specific quality attributes.

The first QAW in 2003 generated a prioritized set of technical attributes that contributed to the technical evaluation criteria in the RFP. A second QAW in 2005 included the contractor, Northrop Grumman, to develop scenarios to guide the software architecture development toward the system's desired qualities.

The SEI also supports process improvement in the CLIP Program by providing Capability Maturity Model® Integration (CMMI®) training and leading Standard CMMI Assessment Method for Process Improvement (SCAMPI<sup>SM</sup>) Class B assessments.

*"The CLIP Program took a proactive approach toward quality attributes and was one of the first DoD acquisitions to specify requirements for Quality Attribute Workshops, an Architecture Tradeoff Analysis Method analysis, and a software architecture description template in its request for proposal and then in the awarded contract."* — Tim Morrow, technical lead, CLIP, and member of the technical staff, SEI Acquisition Support Program



Brian Gallagher (left) directs the SEI Acquisition Support Program, which builds teams to support the DoD software acquisition community. He and Joseph Elm (right), who supports software acquisition practices for the armed services, are working with General Motors Corporation on the codevelopment of what will eventually become the new CMMI for Acquisition model.

## >> Expanding the Application of the CMMI Framework

**T**he SEI continues to expand its CMMI Product Suite. CMMI is a process improvement approach that helps organizations continuously improve the performance of their processes in the areas of product and service development, maintenance, and acquisition. In FY 2005, SEI staff members, together with the CMMI Steering Group (representatives from government and industry who provide guidance regarding the development, maintenance, and enhancement of the CMMI Product Suite), started work on two new CMMI projects.

The SEI and General Motors Corporation, in coordination with the CMMI Steering Group, began a joint effort to create a new business process improvement model for companies looking to source information technology capabilities from third-party suppliers. The SEI and GM will codevelop the initial model, which will be based on CMMI and the existing CMMI Acquisition Module, for pilot use by government and industry organizations. Additional government and industry stakeholders will review and further develop this initial model, and then it will be submitted for approval to the CMMI Steering Group. Once approved, it will be added to the CMMI Product Suite as the *CMMI for Acquisition* model.

With the approval of the CMMI Steering Group and endorsement from the NDIA Systems Engineering Division (the industry sponsor of CMMI), a team began work on a CMMI for Services model in August 2005. The CMMI for Services team defines a service as a product whose primary value is delivered to a customer or end user in a form that is intangible, non-storable, and dependent on the direct application of labor. The purpose of the model is to let the current users of CMMI get the same results and benefits in their service-deployment efforts that they currently enjoy in their development efforts. The CMMI for Services team is led by Northrop Grumman, and it includes participants from the SEI, The Boeing Company, Lockheed Martin, Raytheon, SAIC, SRA, and Systems and Software Consortium (SSCI).

## >> Supporting Architecture Technology at Raytheon and Siemens

The SEI helps acquirers and developers adopt effective practices in software architecture. Users of these practices can exert greater control over quality attributes such as usability, reliability, security, modifiability, and performance and better understand the tradeoffs among them. Two companies that have benefited from SEI work in software architectures are Raytheon and Siemens.

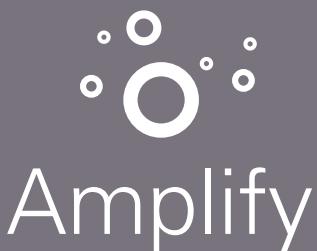
During FY 2005, senior architects at Raytheon have continued to take courses in the SEI Software Architecture Curriculum as part of Raytheon's internal Certified Architect program. The Raytheon Enterprise Architecture Process (REAP), Raytheon's standards-based approach to architecting customer systems, unifies several well-established industry and government standards including the SEI Quality Attribute Workshops, conducted before the development of an architecture to elicit quality-attribute goals and architecture-development plans, and the SEI Architecture Tradeoff Analysis Method® (ATAM®) evaluation process. REAP adapts the core concepts of QAWs and the ATAM in the development of its enterprise and systems architectures.

and Siemens' close relationship with the SEI has also included participation in the SEI Affiliate Program, in which sponsoring organizations contribute staff members to collaborate on SEI work in specific technology domains. Siemens employee Matt Bass began an assignment at the SEI in 2005, exploring how architectures can be designed for distributed-development teams to implement software systems.

“When we first looked at the SEI analysis methodologies, they were in a form that was sufficiently mature and real-world tested to enable us to adapt them as subprocesses within REAP.” — Rolf Siegers, chief architect, Garland Engineering Center, Raytheon Company

The SEI works closely with organizations to pilot methodologies such as an Architecture Improvement Workshop, which helps these organizations improve the quality of their software architectures and reduce risk. Mark Klein (left), a senior member of the technical staff, is one of the developers of such methodologies.





## >> Celebrating Lifetime Achievement

**O**n March 14, 2005, Watts S. Humphrey, a fellow of the SEI, received the National Medal of Technology from President George W. Bush at a ceremony at the White House.

The National Medal of Technology is given in recognition of outstanding contributions to the nation's economic, environmental, and social well-being through the development and commercialization of technology products, processes, and concepts; technological innovation; and development of the nation's technological expertise. Humphrey was recognized for his leadership, inspiration, and dedication to software engineers and software development organizations in industry, academia, the U.S. government, and other organizations worldwide.

Humphrey was instrumental in the development of the Capability Maturity Model® for Software, a collection of best software engineering practices that has been used by thousands of organizations throughout the world to improve their software development practices. Humphrey also initiated and led the development and introduction of the Personal Software Process<sup>SM</sup> and the Team Software Process<sup>SM</sup>, methods that improve the work life of individual software engineers and their teams.

Humphrey is the author of nine books, including seven in the Addison-Wesley SEI Series in Software Engineering. *PSP: A Self-Improvement Process for Software Engineers*, and *TSP: Leading A Development Team* were published in 2005.



SEI Fellow Watts S. Humphrey receives the National Medal of Technology at the White House on March 14, 2005. Humphrey is credited with inspiring the development of the Capability Maturity Model for Software and with developing the Personal Software Process and Team Software Process, two methods for improving the way software engineers and teams build high-quality software.

"We have found that by applying to software the principles that made the industrial revolution possible, software engineering teams can achieve improvements in quality, predictability, and productivity that exceed our wildest dreams. We call this intellectualization; and if industrialization was the great achievement of the 20th century, intellectualization is the great challenge of the 21st century."

—Watts S. Humphrey

"With analysis and integration tools, AADL will provide a strong foundation for rapid, predictable, computer-based system design, development, and evolution. It will be used to reduce program risk, rework, and integration costs and add a powerful mechanism for lifecycle system modernization."

—Bruce Lewis, chairman of the SAE AS-2C AADL Subcommittee, experimental developer, U.S. Army RD&E Command

## >> Using AADL to Engineer Reliable Systems

**F**or embedded software systems—such as the ATM on the corner or the guidance system in a fighter plane—reliability, safety, and performance are critical. Yet, software architects have been largely unable to assess early in the design process the impact of decisions about those properties, if at all.

Developed under the auspices of the Society of Automotive Engineers (SAE) and published in November 2004, the Architecture Analysis and Design Language (AADL) standard provides architects with a common language precise enough to specify and analyze embedded real-time systems long before integration time. Peter Feiler, senior member of the technical staff at the SEI, was technical lead, author, and co-editor of the AADL standard.

The AADL standard gives users the ability to model architectures textually and graphically and to exchange models via the industry-standard XML format with other analysis tools. The standard already has widespread application in fields that use real-time engineering practices, including avionics, robotics, and the aerospace and automotive industries. Organizations such as the U.S. Army, Honeywell, Rockwell-Collins, Lockheed Martin, General Dynamics, Airbus, the European Space Agency, Axlog, Dassault, EADS, Ford, and Toyota are voting members of the standard subcommittee and are actively investigating incorporating or extending it.

To encourage its adoption, the AADL standard supports open-source tool development and integration with commercial modeling tools, including UML-based tools through its XML interchange format. The SEI and Airbus have developed open-source tools, and commercial tools are emerging.

The SEI currently is helping organizations understand how to apply the standard in their development processes by holding workshops and developing training materials and a public course, Model-Based Engineering with SAE AADL.

### Peter Feiler

*Senior Member of the Technical Staff*

Peter Feiler is the technical lead and author of the SAE AS-2C Architecture Analysis & Design Language (AADL) standard. His research interests include dependable real-time systems, architecture languages for embedded systems, and predictable system analysis and engineering.



## >> Outreach Activities Extend the SEI's Impact

**A** core element of the SEI mission is to broadly disseminate software engineering knowledge and methods to improve the state of the practice of software engineering worldwide. The SEI helps organizations and individuals implement its practices and technologies through education and global collaboration.

### SEI Certificates and Certifications

The SEI offers individuals official recognition of their skills and expertise through SEI certificates and certifications. The SEI awards certificates to individuals who have completed a series of courses in a particular discipline. Certifications are awarded to individuals who complete a series of courses and then also successfully pass an assessment based on industry standards.

Last year, the SEI developed and began pilot testing the examination for its SEI-Certified Personal Software Process (PSP) Developer certification. This program awarded certification to 39 developers during alpha testing in FY 2005. The certification is now publicly available to those who successfully pass the certification exam, which is offered at 250 testing centers worldwide.

In addition to the PSP Developer certification, the SEI offers the CERT-Certified Computer Security Incident Handler (CSIH) certification program for incident-handling professionals, computer security incident response team (CSIRT) technical staff, system and network administrators, incident-handling trainers and educators, and individuals who want to enter the incident-handling field.

*In 2005, SEI Partner organizations provided training and services in*

software process improvement, through Capability Maturity Model Integration (CMMI), People Capability Maturity Model (People CMM), Personal Software Process (PSP) and Team Software Process (TSP) training curricula, appraisals, and methods of practice

software architecture, through training curricula and methods of practice

software measurement and analysis, through training curricula and methods of practice

network security and survivability, through the CERT suite of courses

### 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. These services include courses, consulting methods, and management processes that aid in the implementation of the SEI's software engineering technologies. Partners who deliver SEI services are trained and evaluated by the SEI to ensure that they have the necessary knowledge and skills. In 2005, the SEI Partner Network consisted of 257 partner organizations and 1,773 authorized and certified individuals. The online SEI Partner directory extended the availability of SEI services delivered through Partner organizations by making Partner information readily available to those seeking training in SEI methods, processes, and technologies.

### Membership Program

The SEI Membership Program, now in its 13th year, fosters the relationship between the SEI and the software engineering community. In FY 2005, the program had 1,988 members worldwide. Members are leaders in software engineering and include CEOs, directors, and managers from business, industry, and prominent government organizations. The program provides software engineering leaders priority access to SEI technologies and events that support the transition of software engineering standards and best practices. SEI membership provides members with many opportunities to advance, network, and learn through collaboration with the SEI and each other. Many members have used their SEI memberships to increase their professional standing and affiliations.

### Conferences

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 of systems. Each year, these events draw more than 3,600 attendees from around the world.

### Education and Training

SEI Education and Training helps bring SEI technologies and best practices into widespread use. In 2005, SEI Education and Training offered 262 courses in process improvement, information



The SEPG Conference is the world's leading conference and exhibit showcase for software and systems engineering process. The conference brings together international representatives from government, industry, and academia for a global perspective on process improvement activities and results.

*The SEI offered the following certificates and certifications in 2005:*

SEI Certificate in Software Engineering Process Management

SEI Certificate in Software Process Improvement Implementation

SEI Certificate in CMMI

SEI Certificate in Personal Software Process (PSP) for CMMI

SEI Software Product Line Professional Certificate

SEI Product Line Technical Probe Team Member Certificate

SEI Product Line Technical Probe Leader Certificate

SEI Software Architecture Professional Certificate

SEI ATAM Evaluator Certificate

SEI ATAM Lead Evaluator Certificate

SEI-Certified PSP Developer Certification

CERT-Certified Computer Security Incident Handler Certification

### Academic Initiative

Through a pilot project, the SEI launched a new course-delivery model—the SEI Blended Learning Model—that will offer software and systems engineers worldwide access to SEI public courses through the Internet. SEI Blended Learning combines the traditional classroom delivery of SEI public courses with Internet-based distance learning, while providing access to SEI-authorized instructors, SEI experts, course curricula, and exams. The model, which was piloted using instruction in the Personal Software Process (PSP), is based on the expert teaching of the SEI and delivery mechanisms of iCarnegie, an educational affiliate of Carnegie Mellon University and provider of modern, world-class software and systems-development curricula. SEI Blended Learning is one part of an SEI academic initiative that targets working professionals.

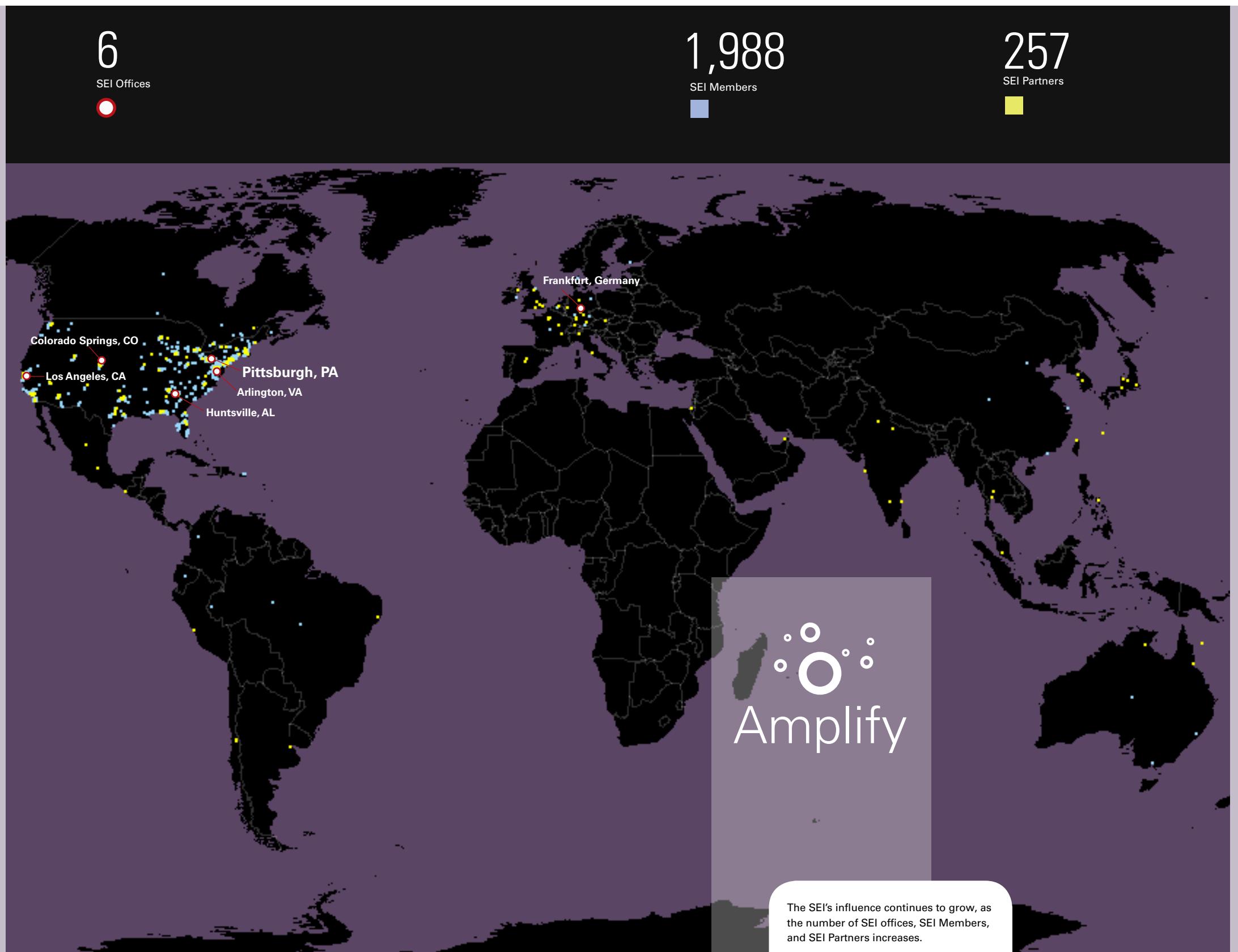
## &gt;&gt; Growing in Global Influence

The SEI expanded its global influence in FY 2005, ensuring that SEI services, training, and research are readily available worldwide. The SEI office in Frankfurt, Germany continues to lead software engineering partnership efforts in its third year of operation. In addition to working with leading European organizations such as Bosch, Siemens, and BAE Systems, the SEI European office added three new training facilities in Copenhagen, Denmark; Rome, Italy; and Madrid, Spain. "The SEI works to efficiently integrate technologies to ensure that software is the safest, most secure component of software-determined systems," said Geir Fagerhus, director of the SEI European office. "With employees and consultants from Germany, Switzerland, the Netherlands, the United Kingdom, Ireland, Poland, and Sweden, we represent a cross-section of the new Europe, and we plan to add employees in and from as many European countries as possible to ensure that the SEI represents the European industrial community. We further this strategy by actively seeking additional SEI Partners throughout Europe as well as collaborating with leading researchers."

In December, the SEI and the Qatar Supreme Council of Information and Communications Technology announced a partnership to establish Qatar CERT (Q-CERT). Q-CERT will serve as the national organization to conduct and coordinate the comprehensive set of cybersecurity activities that will be needed to protect Qatar's critical infrastructures.

Last year, the SEI signed a memorandum of understanding with Multimedia Development Corporation (MDC), whose mission is "to realise Malaysia as a global hub and preferred location for information and communication technology and multimedia innovations, services and operations." In the memorandum, the MDC committed to collaborate with the SEI to improve the state of process improvement education and training and to promote software process improvement in Malaysia.

The success of FY 2005's worldwide SEPG conferences also demonstrated that the SEI's software and systems process improvement initiatives are taking hold in the global market. The SEPG Latin America conference was held in November in 2004 Guadalajara, Mexico. This year's conference theme was "Process Improvement: Key to Global Software Success," and almost 40 presentations and tutorials, given by both SEI staff and software and systems process improvement professionals from central and south America, reflected the region's commitment to process. The European SEPG conference, held in London in June 2005, boasted more than 80 presentations, tutorials, and workshops, as well as an exhibition area. The third SEPG Australia conference was held in Sydney in September 2005 and featured SEI director and CEO Paul Nielsen as a keynote speaker.



# Leadership, Management, & Staff



## SEI Director's Office

The SEI Director's Office ensures the smooth, efficient operation of the SEI. Director Paul Nielsen, right, 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.

## 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.



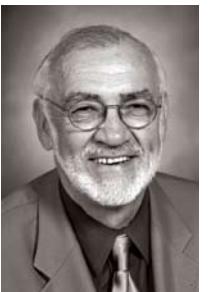
**Christine Davis**  
Chair, Board of  
Visitors; Consultant;  
Former Executive Vice  
President, Raytheon  
Systems Company



**Barry Boehm**  
TRW Professor of  
Software Engineering,  
University of  
Southern California;  
Director, University of  
Southern California  
Center for Software  
Engineering



**William Bowes**  
Vice Admiral, USN  
(Ret.); Consultant;  
Former Commander,  
Naval Air Systems  
Command, and  
Principal Deputy  
Assistant Secretary of  
the Navy for Research,  
Development and  
Acquisition



**Gil Decker**  
Consultant;  
Former Executive  
Vice President of  
Engineering and  
Production, Walt  
Disney Imagineering



**Philip Dowd**  
Private Investor;  
Former Senior Vice  
President, SunGard  
Data Systems;  
Trustee, Carnegie  
Mellon University



**John Gilligan**  
Vice President and  
Deputy Director,  
Defense Sector, SRA  
International, Inc.



**Dave McCurdy**  
President and CEO,  
Electronic Industries  
Alliance



**Alan McLaughlin**  
Consultant; Former  
Assistant Director,  
MIT Lincoln  
Laboratory



**Michael Reiter**  
Professor of Electrical  
and Computer  
Engineering and  
Computer Science,  
Carnegie Mellon  
University



**Donald Stitzenberg**  
President, CBA  
Associates;  
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.



**SEI Staff**

The SEI continues to attract top talent to implement its expanding objectives, increasing its staff by a third over the past four years. Members of the technical staff (MTS) 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, academia, and the military.

Robert Seacord (fourth from left) with SEI staff members who contributed to the development of his book *Secure Coding in C and C++*, which was published by Addison-Wesley in September 2005.



# Key Publications

A sampling of the articles, books, guides, papers, and reports published by SEI staff in FY 2005. A complete list is available online at

>> [www.sei.cmu.edu/publications-2005.html](http://www.sei.cmu.edu/publications-2005.html)

## journal articles

- Clements, P.; Jones, L.; Northrop, L.; & McGregor, J. **Project Management in a Software Product Line Organization.** *IEEE Software* 22, 5 (September-October 2005): 54–62.
- Greenhouse, A.; Halloran, T. J.; & Scherlis, W. L. **Observations on the Assured Evolution of Concurrent Java Programs.** *Science of Computer Programming* 58, 3: 384–411.
- Kazman, R.; Bass, L.; Klein, M.; Lattanze, T.; & Northrop, L. **A Basis for Analyzing Software Architecture Analysis Methods.** *Software Quality Journal* 13, 4 (December 2005): 329–355.
- Lewis, G.; Morris, E.; & Smith, D. **Migration of Legacy Components to Service-Oriented Architectures.** *The DoD Software Tech News* 8, 3 (October 2005).
- Mead, N. R. & McGraw, G. **A Portal for Software Security.** *IEEE Security & Privacy* 2, 4 (July-August 2005): 75–79.

## books

- Humphrey, W. S. **PSP: A Self-Improvement Process for Engineers.** Boston, MA: Addison-Wesley Professional, 2005.
- Humphrey, W. S. **TSP: Leading a Development Team.** Boston, MA: Addison-Wesley Professional, 2005.
- Mirkovic, J.; Dietrich, S.; Dittrich, D.; & Reicher, P. **Internet Denial of Service: Attack and Defense Mechanisms.** Indianapolis, Indiana: Prentice Hall PTR, 2004.
- Seacord, R. C. **Secure Coding in C and C++.** Boston, MA: Addison-Wesley, 2005.

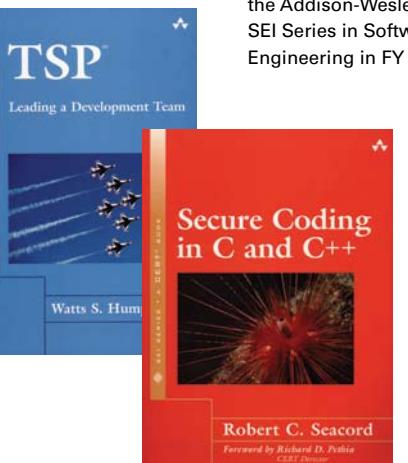
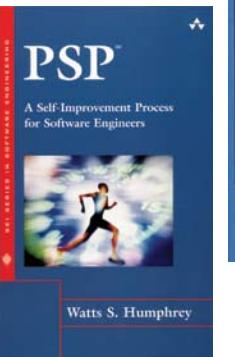
## guides

- Feiler, P. & Greenhouse, A. **OSATE Plug-in Development Guide.** 2005. ([www.aadl.info](http://www.aadl.info))
- Nolan, R.; O'Sullivan, C.; Branson, J.; & Waits, C. **First Responders Guide to Computer Forensics.** 2005.
- SEI Staff. **Guide to Interoperability.** 2005. ([www.sei.cmu.edu/isis/guide/isis-guide.htm](http://www.sei.cmu.edu/isis/guide/isis-guide.htm))

## conference papers

- Chaki, S.; Clarke, E.; Sharygina, N.; & Sinha, N. **Dynamic Component Substitutability Analysis.** *Proceedings of Formal Methods 2005.* Newcastle upon Tyne, UK, July 18–22, 2005.
- Chaki, S.; Clarke, E.; Sinha, N.; & Thati, P. **Automated Assume-Guarantee Reasoning for Simulation Conformance.** *Proceedings of 17th International Conference on Computer Aided Verification (CAV).* Edinburgh, Scotland, UK, July 6–10, 2005. Berlin, Germany: Springer-Verlag, Lecture Notes in Computer Science.
- Chaki, S.; Ivers, J.; Sharygina, N.; & Wallnau, K. **The ComForT Reasoning Framework.** *Proceedings of 17th International Conference on Computer Aided Verification (CAV).* Edinburgh, Scotland, UK, July 6–10, 2005. Berlin, Germany: Springer-Verlag, Lecture Notes in Computer Science.
- Kumar, R.; Krogh, B. H.; & Feiler, P. H. **An Ontology-based Approach to Heterogeneous Verification of Embedded Control Systems.** *Proceedings of 8th International Workshop on Hybrid Systems: Computation and Control (HSCC 2005).* Zurich, Switzerland, March 9–11, 2005.
- Bergey, J.; Dietrich, S.; Firesmith, D.; Forrester, E.; Jordan, A.; Kazman, R.; Lewis, G.; Lipson, H.; Mead, N.; Morris, E.; O'Brien, L.; Siviy, J.; Smith, D.; & Woody, C. **Results of SEI Independent Research and Development Projects and Report on Emerging Technologies and Technology Trends** (CMU/SEI-2004-TR-018).
- Bernard, T.; Gallagher, B.; Bate, R.; & Wilson, H. **CMMI Acquisition Module (CMMI-AM)** (CMU/SEI-2005-TR-011).

The SEI amplifies the results of its work throughout the world by making its reports available in PDF format on the SEI Web site. In FY 2005, there were 1,910,707 downloads of SEI reports.



Books published in the Addison-Wesley SEI Series in Software Engineering in FY 2005

# Opportunities

Thank you for your interest in the FY 2005 Software Engineering Institute Annual Report. Below are more opportunities to connect with the SEI.

- Blanchette, S. **U.S. Army Acquisition – The Program Executive Officer Perspective** (CMU/SEI-2005-SR-002).
- Blanchette, S. & Keeler, K. **Self-Assessment and the CMMI-AM – A Guide for Government Program Managers** (CMU/SEI-2005-TN-004).
- Caralli, R. **Managing for Enterprise Security** (CMU/SEI-2004-TN-046).
- Carney, D.; Fisher, D.; Morris, E.; & Place, P. **Some Current Approaches to Interoperability** (CMU/SEI-2005-TN-033).
- Carney, D.; Fisher, D.; & Place, P. **Topics in Interoperability: System-of-Systems Evolution** (CMU/SEI-2005-TN-002).
- Clements, P. **Comparing the SEI's Views and Beyond Approach for Documenting Software Architectures with ANSI-IEEE 1471-2000** (CMU/SEI-2005-TN-017).
- Clements, P.; Bergey, J.; & Mason, D. **Using the SEI Architecture Tradeoff Analysis Method to Evaluate WIN-T: A Case Study** (CMU/SEI-2005-TN-027).
- Clements, P.; Cohen, S.; & McGregor, J. **The Structured Intuitive Model for Product Line Economics (SIMPLE)** (CMU/SEI-2005-TN-003).
- Elm, J. **Designing for Reuse of Configurable Logic** (CMU/SEI-2005-TR-016).
- Gallagher, B. P.; Case, P. J.; Creel, R. C.; Kushner, S.; & Williams, R. C. **A Taxonomy of Operational Risks** (CMU/SEI-2005-TN-036).
- Gordon, D.; Stehney, T.; Wattas, N.; & Yu, E. **Quality Requirements Engineering (SQUARE): Case Study on Asset Management System, Phase II** (CMU/SEI-2005-SR-005).
- Hevner, A.; Linger, R.; Collins, R.; Pleszkoch, M.; Prowell, S.; & Walton, G. **The Impact of Function Extraction Technology on Next-Generation Software Engineering** (CMU/SEI-2005-TR-015).
- Jones, L. & Northrop, L. **Product Line Adoption in a CMMI Environment** (CMU/SEI-2005-TN-028).
- Kasunic, M. **Designing an Effective Survey** (CMU/SEI-2005-HB-004).
- Lami, G. **QuARS: A Tool for Analyzing Requirements** (CMU/SEI-2005-TR-014).
- Lewis, G.; Morris, E.; O'Brien, L.; Smith, D.; & Wrage, L. **SMART: The Service-Oriented Migration and Reuse Technique** (CMU/SEI-2005-TN-029).
- Lewis, G. & Wrage, L. **Approaches to Constructive Interoperability** (CMU/SEI-2004-TR-020).
- Lewis, G. & Wrage, L. **A Process for Context-Based Technology Evaluation** (CMU/SEI-2005-TN-025).
- Lewis, G. & Wrage, L. **Model Problems in Technologies for Interoperability: Model-Driven Architecture** (CMU/SEI-2005-TN-022).
- Marz, T. **Integrated Diagnostics: Operational Missions, Diagnostic Types, Characteristics, and Capability Gaps** (CMU/SEI-2005-TN-035).
- McHale, J. & Wall, D. **Mapping TSP to CMMI** (CMU/SEI-2004-TR-014).
- Mead, N. R.; Hough, E.; & Stehney, T. **Security Quality Requirements Engineering (SQUARE) Methodology** (CMU/SEI-2005-TR-009).
- Meyers, C.; Monarch, I.; Levine, L.; & Smith, J. **Including Interoperability in the Acquisition Process** (CMU/SEI-2005-TR-004).
- Novak, W. E., ed. **Software Acquisition Planning Guidelines** (CMU/SEI-2005-HB-006).
- O'Brien, L.; Bass, L.; & Merson, P. **Quality Attributes and Service-Oriented Architectures** (CMU/SEI-2005-TN-014).
- Pomeroy-Huff, M.; Mullaney, J.; Cannon, R.; & Sebern, M. **The Personal Software Process (PSP) Body of Knowledge, Version 1.0** (CMU/SEI-2005-SR-003).
- Seacord, R. & Householder, A. **A Structured Approach to Classifying Security Vulnerabilities** (CMU/SEI-2005-TN-003).
- Siviy, J.; Wrubel, E.; Curtis, P.; & Callison, R. **Anticipated Availability of Software Engineers to Meet DoD Future Program Needs** (CMU/SEI-2005-SR-013).
- Smith, J. D. II & Meyers, B. C. **Exploring Programmatic Interoperability: Army Future Force Workshop** (CMU/SEI-2005-TN-042).

## Want a free, platinum membership to the Software Engineering Information Repository?

Fill out our [online survey](#) to let us know how we can improve the SEI Annual Report in future editions, and gain access to the SEI's online repository about software engineering.

>> [www.sei.cmu.edu/survey/ar](http://www.sei.cmu.edu/survey/ar)

## Want to find out more about the SEI?

Contact us today for a free copy of our **Guide to Products and Services**, a complete catalog of all the SEI's tools and methods, services, courses, conferences, credentials, books, and opportunities to collaborate with the SEI on research.

Software Engineering Institute / Customer Relations  
Carnegie Mellon University, Pittsburgh, PA 15213-3890  
1-888-201-4479  
[customer-relations@sei.cmu.edu](mailto:customer-relations@sei.cmu.edu)

See the **Guide to Products and Services** online at  
>> [www.sei.cmu.edu/publications](http://www.sei.cmu.edu/publications)

## Interested in being part of a growing, world-class team?

The SEI seeks candidates for its technical engineering and business divisions. Contact our Human Resources department to learn the benefits of working at the SEI.

>> [www.sei.cmu.edu/about/employment/employment.html](http://www.sei.cmu.edu/about/employment/employment.html)

**Editorial Direction**

Pamela Curtis  
Lauren Heinz  
William Pollak

**Editorial Staff**

Hollen Barmer  
Keith Kost  
Richard Lynch  
Bill McSteen  
John Morley  
Bill Thomas  
Laine Towey  
Barbara White

**Design**

Jennifer Z. McNulty,  
StudioLuxe

**Photography**

Tim Kaulen and  
Stephen Baden,  
Photography &  
Graphic Services  
at Mellon Institute

**Production Editor**

David Gregg

**Web Design**

Sharon West  
Barbara White

**Digital**

**Specialization**  
Melissa Neely  
Sharon West

**Copyrights**

Carnegie Mellon University SEI-authored documents are sponsored by the U.S. Department of Defense under Contract FA8721-05-C-0003. Carnegie Mellon University retains copyrights in all material produced under this contract. The U.S. Government retains a non-exclusive, royalty-free license to publish or reproduce these documents, or allow others to do so, for U.S. Government purposes only pursuant to the copyright license under the contract clause at 252-227-7013.

For information and guidelines regarding permission to use specific copyrighted materials owned by Carnegie Mellon University (e.g., text and images) see Permissions at [www.sei.cmu.edu/about/legal-permissions.html](http://www.sei.cmu.edu/about/legal-permissions.html). If you do not find the copyright information you need, please consult your legal counsel for advice.

**Trademarks and Service Marks**

Carnegie Mellon Software Engineering Institute (stylized), Carnegie Mellon Software Engineering Institute (and design), and the stylized hexagon are trademarks of Carnegie Mellon University.

® Architecture Tradeoff Analysis Method; ATAM, Capability Maturity Model, Capability Maturity Modeling, Carnegie Mellon, CERT, CERT Coordination Center, CMM, CMMI, and OCTAVE are registered in the U.S. Patent and Trademark Office by Carnegie Mellon University.

SM CMM Integration; COTS Usage Risk Evaluation; CURE; EPIC; Evolutionary Process for Integrating COTS-Based Systems; FloCon; Framework for Software Product Line Practice; IDEAL; Interim Profile; OAR; Operationally Critical Threat, Asset, and Vulnerability Evaluation; Options Analysis for Reengineering; Personal Software Process; PLTP; Product Line Technical Probe; PSP; SCAMPI; SCAMPI Lead Appraiser; SEPG; Team Software Process; and TSP are service marks of Carnegie Mellon University.

For information and guidelines regarding the proper referential use of Carnegie Mellon University service marks and trademarks, see Trademarks, Registration, and Service Marks at [www.sei.cmu.edu/about/legal-trademarks.html](http://www.sei.cmu.edu/about/legal-trademarks.html).

A **PDF version** of this report can be downloaded from

**>> [www.sei.cmu.edu/annual-report](http://www.sei.cmu.edu/annual-report)**

**Software Engineering Institute**

Carnegie Mellon University  
4500 Fifth Avenue  
Pittsburgh, PA 15213-3890

Phone: 412-268-7700  
Toll-free: 1-888-201-4479  
Fax: 412-268-5758  
[www.sei.cmu.edu](http://www.sei.cmu.edu)  
[customer-relations@sei.cmu.edu](mailto:customer-relations@sei.cmu.edu)

**SEI Europe**

An der Welle 4  
Reception Level 1  
60322 Frankfurt  
Germany

**SEI Huntsville**

AMSAM-BA  
Building 6263  
Redstone Arsenal, AL 35898

**SEI Washington, DC**

NRECA Building  
Suite 200  
4301 Wilson Boulevard  
Arlington, VA 22203

**SEI Los Angeles**

400 Continental Boulevard  
6th Floor  
El Segundo, CA 90245

**SEI Colorado Springs**

1155 Kelly Johnson Boulevard  
Suite 111  
Colorado Springs, CO 80920

>> [www.sei.cmu.edu/annual-report](http://www.sei.cmu.edu/annual-report)