Carnegie Mellon University
Software Engineering Institute

Quarterly
Update

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April–June 1993

2Q 93

Carnegie Mellon University
Software Engineering Institute

Quarterly Update

April–June 1993

Summary of Accomplishments: 2Q93

The SEI will **host its annual Software Engineering Symposium** in Pittsburgh on 23-26 August. The theme of the symposium is "The Business of Software Engineering: The Competitive Edge."

The Transition Models project leader **presented a tutorial** entitled "Software Technology Transition." The tutorial was given at the National Software Engineering Process Group (SEPG) Meeting in April.

The Academic Education Project **published a set of educational materials**: *Lecture Notes on Engineering Measurement for Software Engineers* was released in June.

The Computer-Aided Software Engineering (CASE) Project **presented a CASE environments tutorial** at the Software Engineering Process Group Conference.

The Taxonomy-Based Questionnaire Project and Industry Risk Management Projects **combined to form the Risk Management Improvement Project**. The RMI Project is focused on improving the state of the practice of risk management in the Department of Defense (DoD) industrial community.

The Risk Management Improvement Project **published a technical report** entitled *Taxonomy-Based Risk Identification Method.*
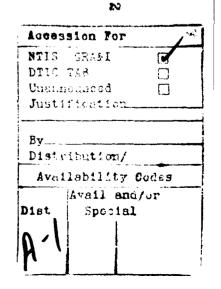
The Computer Emergency Response Team (CERT) **completed new releases of two tutorials**: "Internet Security for Managers" and "Internet Security for System and Network Administrators." These tutorials were presented at the first offering of the CERT Security Seminars.

Watts Humphrey **presented the keynote address** at the National SEPG Meeting, which was held in April.

Software Design Methods for Concurrent and Real-Time Systems became **the fifth book in the SEI Series in Software Engineering.**

In May, **18 students received master's in software engineering degrees** at the 1993 commencement ceremonies at Carnegie Mellon University.

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This section provides a summary of accomplishments from April–June 1993

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Software Process

The Software Process Program focuses on improving the process of software development. Projects within the program are assessing the actual practice of software engineering in the defense community, training organizations to gain management control over their software development processes, supporting the use of quantitative methods and measures as a basis for process improvement, and developing improved methods for software process management.

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Software Process Measurement

The objective of the Software Process Measurement (SPM) Project is to promote and improve the use of measurement in managing, acquiring, and supporting software systems. The project is formulating reliable measures of the software development process and products to guide and evaluate development. To expedite Department of Defense (DoD) and industry transition, the project is actively working with professionals from industry, government, and academia in encouraging organizations to use quantitative methods to improve their software processes.

This quarter, nondisclosure agreements were coordinated with participating organizations to examine their software cost estimating practices, methods, and data.

One site visit was conducted in support of the measurement effort at Standard Systems Center, Gunter Air Force Base. Project members continue further development and review of, and refinement to the measurement workshop. Site deliveries will take place at the end of July.

This quarter, two site visits were conducted in support of measurement work at Army Materiel Command (AMC), Ft. Sill site in Lawton, Oklahoma. In April, a project member presented a one-day tutorial, "Engineering an Effective Software Measurement Program," to the software engineering process group (SEPG) and process action team. In May, the measurement tutorial was presented at the AMC Ft. Sill Colloquium.

A project member conducted a site visit to the AMC Communications-Electronic Command (CECOM), Ft. Monmouth site to discuss measurement support activities. Project members have been working closely with the SEI Software Process Definition Project to integrate the process definition and process measurement workshops.

A site visit was conducted in support of the Naval Air Warfare Center (NAWC) technical objectives and plans effort this quarter. An SPM project member participated in a meeting with NAWC personnel and a representative from Naval Surface Warfare Center.

Project members completed materials for proposed presentations, panel discussions, and the integrated process improvement tutorial in preparation for the 1993 SEI Software Engineering Symposium, which will take place at the SEI in August.

The project leader represented the SEI at the Executive Metrics Panel Meeting, which was held in April. The project leader also provided a presentation entitled "Metrics for Software Projects—What, Why, and How" at the NRAD Software Process Improvement Working Group Meeting, which took place in June.

This quarter, project members presented a tutorial on measurement definition frameworks at the National SEPG Meeting, in April. Also this quarter, project members made presentations at the CECOM Software Measurement Working Group Meeting, which took place in May.

The SPM project was represented at the Train-the-Trainer course on Xerox Quality Training that took place this quarter.

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Software Process Definition

The objectives of the Software Process Definition Project are to establish the use of defined processes for the management and development of software as standard software engineering practice and to advance the capabilities required to define and automate the software process within an organization. A "defined process" means that a process is documented, supported by training, and practiced, and that the practice, training, and documentation are equivalent.

The project is exploring process definition methods and techniques through collaboration with several SEI sponsors including: Air Force Standard Systems Center; Gunter Air Force Base; Army Materiel Command at Picatinny Arsena; Redstone Arsenal; and Ft. Monmouth, Software Technology Support Center, and Air Force Materiel Command. The project is also exploring advanced applications of process definition technology through the Advanced Research Projects Agency Software Technology for Adaptable, Reliable Systems (STARS) Program.

Currently the project is developing a software process framework based on the CMM, guidelines for defining enactable processes, and a workshop on software process definition for SEPG members.

This quarter, the project completed the next version of the software process definition workshop "Defining Software Processes: Getting Started" and the second prototype version of "Software Process Framework."

During this quarter, project members conducted a three-day workshop on software process definition at Fort Monmouth. Follow-on activities will include support for the planning and development of process elements that address Ft. Monmouth's process improvement goals and objectives.

During this period the project conducted planning meetings with representatives from the National Oceanographic and Atmospheric Administration (NOAA) to discuss the possible application of the project's technical products within NOAA.

The Capability Maturity Model (CMM) Project maintains a model describing how organizations can improve their software process maturity. This model will be continuously updated with the state of the art as it evolves in software engineering, total quality management, and other relevant areas of improvement. It will elaborate on software development practices that provide clear strategies for capability maturity growth and improvement.

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Capability Maturity Model

Current work is focused on two fronts: standards activities and an "Introduction to the CMM" course. The introductory course is aimed at providing software process assessment and software capability evaluation teams with a working knowledge of CMM v1.1 and the concepts that will enable them to develop reliable, consistent key process area profiles and understand the process management problems that they encounter during a site visit. The course will also be of value to SEPG members who are doing software process improvement.

The project's standards activities include both International Standards Organization (ISO) and DoD standards. This quarter, project members participated in the Harmonization Working Group for DOD-STD-2167A and DOD-STD-7935A, which is overseeing the development of MIL-STD-498 (also known as MIL-STD-SDD). Project members also participated in the newly formed Software Life Cycle Process functional working group in the Joint Logistics Command Computer Resources Management Group, which was organized to coordinate DoD standards on process and total life cycle of software.

The project continues to be active in the ISO Software Process Improvement and Capability Determination project. The SEI has been selected as one of the four technical centers for this effort and is responsible for coordinating U.S. activities. One of the CMM project members is the convener of the Task Group 10 for the U.S. Technical Advisory Group in ISO SC7, and has been nominated for product manager of the baseline practices guide, which will be the ISO equivalent of the CMM.

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Empirical Methods

The Empirical Methods (EM) Project develops, evaluates, and validates products (e.g., questionnaires, methods, and models) for use in baselining and measuring software process improvement.

Prototype process maturity questionnaires based on the CMM are being developed in conjunction with the release of the CMM v1.1. Usability testing and field testing of these maturity questionnaires (MQs) in the updated software process assessment (SPA) method began in March and will be completed next quarter. The MQs incorporated usability data collected from 388 people in 10 organizations during 1992 and in the first quarter of 1993. SPA associates are also supporting testing of the questionnaires.

This quarter, EM staff members developed detailed requirements for the next version of the auxiliary questionnaires. These questionnaires may be used in SPAs, SCEs, mini-assessments, and other appraisal methods to capture consistent information to

- Determine the scope of SPAs and SCEs.

- Help with selecting projects to include in a SPA or SCE.

- Develop the plan for the on-site period of SPAs and SCEs, and select the people completing the maturity questionnaires for use in efficient appraisals.

The questionnaires are also being field tested with the SPA method update.

Staff members from the EM and Software Process Definition projects staff developed a survey that was completed by 339 people at the 1993 National SEPG Meeting. The survey addresses SEPG experiences—needs that the software process improvement (SPI) community perceives the SEI could address—and demographic data about the SPI community. The results of the survey will be summarized in an SEPG report that will be released in the next quarter.

This quarter, EM staff members collaborated with a resident affiliate from Pacific Bell and through a technical partnering agreement with Hewlett-Packard to further develop an instant profile product. Instant profiling is a supplemental appraisal method to rapidly check software process improvement between SPAs. This joint product development effort began in early 1992 and resulted in pilot and division-wide implementation of instant profiling within Pacific Bell. Additional pilot testing and documentation of the method with Hewlett-Packard began this quarter and will continue through the end of 1993.

The Software Process Assessment (SPA) Project helps organizations improve their software development process by providing a structured method for assessing their current practice, as well as continuously improving the assessment method and ensuring its focus on organizational process improvement. The objectives of the assessment method are to understand an organization's current practices; identify key areas for improvement, utilizing the SEI process maturity model as a framework; and help the organization initiate those improvements.

This quarter, the SPA project made significant progress in the SPA Method Update effort by incorporating lessons learned from the initial field exercise into an updated assessment method The project also developed and delivered prototype versions of an introduction to CMM course and a SPA team training course. This is the first delivery of a CMM training course by the SEI and the first delivery of a SPA team training course using the new CMM questionnaire.

In addition, the project complete technical collaboration agreements with Hewlett-Packard and Texas Instruments that cover a range of assessment and improvement-related activities.

Project staff delivered invited presentations on SPA assessment results at the National SEPG Meeting and the 15th International Conference on Software Engineering.

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Software Process Assessment

The Software Capability Evaluation (SCE) Project defines, develops, and evolves an appraisal method that helps government acquisition organizations evaluate the capability of contractors to develop and maintain software. SCE is a method for evaluating the software process of an organization to gain insight into its software development capability. The project members document the method, train the software community in its use, develop guidance materials to support the use of the method, and pilot the method with users. Significant effort is also expended communicating with the software community about the SCE method.

The *Software Capability Evaluation Version 1.5 Method Description* was reviewed by the SCE Advisory Board and the SCE project members. More than 900 comments were received, incorporated, or resolved. The refinement of the document demonstrated the need for a reevaluation of the overall SCE product release schedule with respect to the other CMM products (CMM v1.1).

This quarter, a "concept map" of object diagrams for the Electronic Tool Assistant was completed. The work demonstrated the potential for a tutorial for SCE using Hypercard.

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Software Capability Evaluation

A module of SCE lessons learned material concerning the contract monitoring phase of acquisition was developed at the request of the General Services Administration 'GSA). This module was delivered to the GSA Trail Boss Program TB-2 class in May. Approximately 30 government executives attended.

The SCE Team Training course was delivered in April and June. Teams consisted of 48 individuals.

Direct support of the NOAA /Advanced Weather Interactive Processing System (AWIPS) pilot partner continues toward a "baseline SCE" on-site observation and lessons learned report. Contract modification text was commented on and refined for the client. The NOAA SCE team attended SCE Team Training in April. In addition to the normal SCE Team Training materials the team was provided the CMM v1.1. Periodic meetings discussing the mechanics of the SCE methodology, the provision of various sanitized example SCE on-site materials and SCE implementation topics have been routinely conducted at the NOAA offices. Discussions with both the NOAA Systems Program Office and the AWIPS program personnel concerning follow on SCE support and development work have been initiated.

The SCE Advisory Board met at the SEI in May. The Advisory Board has been active in providing recommendations to the SCE project. During this quarter, minutes from all four Advisory Board meetings were forwarded to the SCE Review Group for information and status.

The SCE project continued to support the Air Force Materiel Command working group chartered to investigate how current evaluation techniques (including SCE) might be merged into a single method. SCE product materials as well as consulting work have been provided. This group's efforts are coming to closure in the next quarter.

❏ ❏ ❏ ❏ ❏ ❏ ❏ *Concepts on Measuring the Benefits of Software Process Improvements*
Process Program CMU/SEI-93-TR-9
Reports
For information about obtaining copies of SEI reports, see page 33.
April–June 1993

Real-Time Distributed Systems

The goal of the Real-Time Systems Program is to improve the development of real-time distributed systems by integrating software engineering with systems engineering and reducing the risk associated with new technology.

This effort is a feasibility study that focuses on the development of an engineering maturity model to complement the capability maturity model. In particular, work has focused on producing a white paper describing a generic notion of a maturity model and how this notion can be applied productively to product engineering practices and the scientific knowledge that is embodied in these practices. Significant progress was made in articulating the issues that need to be addressed by a product engineering maturity model, but much work remains to achieve general agreement on the nature and content of such a model.

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Engineering Maturity Model Project

The SEI is supporting the revision of the Ada progr mming language in a variety of ways. One member of the technical staff is a participant in the Ada 9X Distinguished Reviewers Group, which is responsible for reviewing the ongoir ' revision work. This group meets periodically to review the progress of the revision. Another staff member chairs the Ada Compiler Validation Capability Review Team, which is responsible for reviewing the direction and content of the test suite that will be used to validate Ada 9X compilers. The SEI also supports outside experts who participate in the Ada 9X effort as distinguished reviewers and as Ada Compiler Validation Capability Review Team members. Finally, the SEI provides electronic mailing facilities to the Ada 9X project and to the Ada Joint Program Office, facilitating communication among the various groups interested in the Ada standard and its revision.

This quarter, meetings of both review groups were held, and documents pertaining to the efforts were reviewed.

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Ada 9X — Review

The Dependable Real-Time Software Project addresses the need for predictability and dependability in embedded computing applications. Examples of embedded computing applications are distributed process control for advanced manufacturing, multimedia high-performance networks, medical equipment, and defense systems.

This quarter, project members demonstrated software fault tolerance experimentally, using a refined version of the simplex software architecture and rate monotonic analysis (RMA) to control multiple unstable devices. Project members demonstrated that under the control of simple and reliable software, an unstable device can improve its control performance if new and improved software is added to the system. During this quarter, project members investigated the issues and improved the fault coverage and performance of the system. Project members will present a demonstration at the SEI Software Engineering Symposium.

The Navy Next Generation Computing Resources (NGCR) asked the project to lead the standardization effort for the Navy's next generation high-performance network for mission-critical applications. The technical objectives and plans contract is expected to begin in July. Project members also continue to make progress in the further development of RMA for use in distributed systems.

Members of the Dependability Working Group and Software Dependability Working Group met with representatives of the National Institute of Standards and Technology, the National Science Foundation, and the MITRE Corporation to initiate talks regarding establishment of a permanently funded National Center for Dependable Systems. A project member attended the meeting as a member of both working groups.

Real-time simulators, especially flight simulators, have traditionally used a software architecture that is optimized for efficiency. The focus on efficiency has complicated the achievement of certain types of functionality and has caused severe problems in maintaining and modifying software. Understanding the design tradeoffs involved in emphasizing certain non-functional qualities like the ability to maintain and modify will enable designers to develop model software architectures that satisfy these qualities, thereby improving the process of developing real-time simulators.

The goals of the Real-Time Simulators Project are to

- Extend, validate, and document flight simulator and other real-time simulator architectures in a format that is accessible to practitioners and acquisition personnel.

- Understand and codify the relationship between non-functional quality goals and software architectures.

This quarter, project members restructured a guidebook on the air vehicle portion of flight simulators for the Air Force Aeronautical Systems Center Program Office for Simulators and Training. The guidebook will contain seven chapters and several appendices, which will provide examples produced from the development of the T39A trainer. The remainder of the guidebook will be completed in 1993.

Project members also supported the development of several Air Force simulator programs, including the Simulator for Electronic Combat Training and the Special Operations Forces Aircrew Training System. Both programs use structural modeling and have collaborated on extensions to the technology.

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Open Systems Architectures

The purpose of the Open Systems Architectures Project is to assist in the transition of systems to an open architecture. In the past, many systems have been based on proprietary components; there is now a strong trend to move to systems that are based on open components, particularly those based on formal standards such as the American National Standards Institute and the International Organization for Standardization. It is important to note, however, that there are issues that must be addressed in development of open systems for the mission-critical domain. Hence, another goal of the project is to identify these issues and seek solutions to problems.

This quarter, project members supported the Institute of Electrical and Electronic Engineers 1003 Portable Operating System Interface (POSIX) standards effort. This work is supported by the Navy NGCR Program. A new working group in POSIX was recently formed, entitled "Real-Time Distributed Systems Communications" (POSIX .21). The working group seeks to develop a language-independent specification and an Ada language binding that is suitable for the real-time domain. Project members are chair and co-technical editor for this group. Project members are working with a team of approximately eight industry firms on a joint concept development for the Advanced Research

Projects Agency Technology Conversion Program. The project has also concluded a technical collaboration agreement with Texas Instruments. The areas of work include strategies for open systems in the hard real-time domain, work on an open systems handbook, and modeling tools for distributed systems.

Project members support the Master of Software Engineering program at Carnegie Mellon University. The project leader has worked with one student in a reading course in real-time distributed systems. A student is currently working with project members to develop a formal specification (using the Z language) for a subset of the POSIX .21 interface. This is a collaborative effort with another project at the SEI.

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Transition Models

The Transition Models Project is developing a set of methods and supporting materials such as guidelines and checklists for planning and implementing software technology transition. These materials will be used by software technology producers and consumers both inside and outside the SEI.

Transition Models staff members provide other SEI staff—including management—with education and training on technology transition concepts and approaches. Additionally, project members provide limited consulting on software technology transition to members of SEI constituencies, and maintain contact with researchers and others interested in technology transition from business, government, and academic domains.

This quarter, planning continued for the International Working Conference on Diffusion, Transfer, and Implementation of Information Technology. The conference is sponsored by the International Federation of Information Processing Technical Committee 8 (Information Systems), in cooperation with the SEI and the Institute for Electrical and Electronic Engineers (IEEE) Computer Society Technical Committee on Software Engineering. The SEI is the host organization. The program committee, chaired by the Transition Models project leader, represents a wide range of researchers and practitioners in software and information technology transition. The committee met twice this quarter by teleconference to discuss the reviewing process for papers and position statements, possible invited speakers, and to review the submissions.

Project members continued to work on the conceptual framework by investigating how the commercialization process supports software technology transition.

This quarter, a project member attended the Ben Franklin Challenge Grant Workshop in March and two project members attended the conference entitled "From Lab to Market." Also this quarter, two project members attended the Federal Labs Consortium Conference, which took place in Pittsburgh.

In April, the project leader supported the Defense Information Technology Services Organization meeting with a mini-tutorial on software technology transition. The project leader also worked with two SEI groups to facilitate a workshop with the Air Force on the technology of technology transition that took place in April. The workshop focused on Air Force strategies for software technology transition.

The project leader presented a tutorial, "Software Technology Transition," at the Software Engineering Process Group National Meeting in April. The tutorial was attended by about 125 people, several of whom expressed interest in possible collaboration with the Transition Models Project. In the evening, 30 people attended an informal case study exercise.

The project leader attended the 15th International Conference on Software Engineering. The project leader also attended the inaugural meeting of a new technology transfer subcommittee of the IEEE Computer Society Technical Committee on Software Engineering.

Performance and Ada Style for the AN/BSY-2 Submarine Combat System
CMU/SEI-93-TR-32

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Real-Time Distributed Systems Reports

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For information about obtaining copies of SEI reports, see page 33.

Software Engineering Techniques

The goal of the Software Engineering Techniques Program is to improve effectiveness and efficiency in engineering and reengineering of large software-intensive systems through increased use of engineering knowledge. We envision this to be accomplished through systematic application of models supported by methods and tools.

The program consists of three projects. The Computer-Aided Software Engineering (CASE) Environments Project focuses on automation of the software engineering processes and addresses issues of engineering and adoption of environments. The Application of Software Models Project addresses the systematic creation and use of models in application engineering. The Software Engineering Information Modeling Project addresses issues of capturing, representing, and making accessible increasing amounts of engineering information ranging from requirements elicitation and system understanding to engineering knowledge typically found in handbooks.

The goal of the Application of Software Models Project is to address the systematic creation and application of models in application engineering. These models form a codified technology base of engineering knowledge. Software engineers use this technology base to support

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Application of Software Models

- Analysis of customers' needs.

- Synthesis of solutions based on recognized commonalities or on variations from previous solutions.

- Reuse and reengineering of legacy software.

The approach to developing software applications is a component of the model-based software engineering approach being promoted by the Engineering Techniques Program.

This quarter, the project continued transition work with the following organizations:

- **Strategic/Theatre Army Command and Control System.** Project members are working with Computer Sciences Corporation McLean, the contractor for this system, to incorporate the project's movement control system.

- **Army Tactical Command and Control System.** Project members are working with the program executive officer for command and control to extend the movement control system to incorporate a geographical information system and automatic deconfliction.

- **Department of Army Movement Management System.** Project members are working with the program office to incorporate the movement control system as a fielded product.

The project continued to support the Joint Modeling and Simulation System (J-MASS). Project members developed models for J-MASS to assure compliance with the software development plan guidelines. The results of this review were presented at a J-MASS meeting.

Two project members delivered the domain analysis tutorial to the AT&T Transmission Systems Business Unit. Project members are continuing discussions with AT&T to determine follow-on opportunities. Project members also delivered the tutorial to a National Institute of Standards and Technology (NIST) project that is performing a domain analysis using the SEI feature-oriented domain analysis method. Under a technical objectives and plans arrangement with NIST, the results of their domain analysis will be reviewed.

Project members are working with the U.S. Air Force Academy to develop a training curriculum that will cover model-based software engineering. The product will be delivered to the SEI Educational Training and Review Board for review and instructional design. The goal is to begin delivery of these courses in 1994.

The project coordinated a joint SEI-Lincoln Labs concept development to support radar simulations drawing on Lincoln Labs expertise in radar systems and SEI expertise in modeling and simulation systems. The activity will also coordinate with J-MASS and other modeling and simulation efforts. The joint work included a brief report on the collaboration.

The Software Engineering Information Modeling Project is investigating the creation, maintenance, and use of models critical to software engineering. The project is conducting research into the techniques and tools that will improve a software engineer's ability to capture, represent, and access reusable software engineering information, knowledge, and models. Work continues on developing pilot technology that facilitates access to software engineering information, initially focusing on the improvement of requirements capture and analysis. A first set of tools for associating and synchronizing video, audio, and their text transcripts has been developed.

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Software Engineering Information Modeling

This quarter, the project continued its joint effort with Texas Instruments to develop multimedia engineering experience modules. The creation of these modules will be based on ongoing project work to develop multimedia knowledge representation techniques. The first series of modules was captured with multiple isolated cameras in the SEI video studio during this quarter. The second series will be captured next quarter with decomposition and indexing to follow. The video/text synchronizing tools will be alpha tested on this data.

This quarter, project members continued to work with the Naval Supply Systems Command on a technical objectives and plans project entitled "Research and Development of Advanced Technology in Support of the Naval Supply Systems Command." Project members provided technical support for system requirement determination and evaluation of process, knowledge, and data requirements to automatically convert hardcopy engineering drawings into computer models. Project members attended two progress reviews with the Naval Supply Systems Command contractor, Mantech, at the Fairmont, West Virginia facility.

The project leader attended two Advanced Research Projects Agency Information Sciences and Technology study group meetings on educational requirements of the National Information Infrastructure. He also attended a National Research Council Computer Science and Telecommunications Board Colloquium, "Keeping the U.S. Computer and Communications Industry Competitive: Convergence of Computing, Communications, and Entertainment."

The Computer-Aided Software Engineering (CASE) Environments Project addresses the problem that, while a large number of software tools and integrating frameworks are currently available, there is not clear evidence to determine the precise impact of tools on productivity and quality. In addition, the integration of different tools is problematic, and the organizational issues for adopting technology and the support of tools for an organization's software development process are not well understood or generally agreed upon.

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CASE Environments

This overall problem is addressed through three general approaches:

1. Developing conceptual frameworks to understand tool integration and tool adoption from the perspectives of technical mechanisms, users services, and organizational processes.

2. Viewing both integration and adoption as design activities that require an analysis of the current state, and a coherent process to move to a desired state.

3. Verifying the conceptual frameworks through small-scale experiments.

This quarter, project members developed several significant new experiments on tool integration. These experiments examined how different control integration mechanisms operate together and how control integration and data integration provide complementary solutions to the integration issue. A paper on practical experiences with tool integration has been accepted for presentation at the annual Portable Common Tool Environment Conference (PCTE '93).

An investigation into the state of the practice of CASE integration has been completed. This investigation showed a discrepancy between the state of the art and the state of the practice. A paper on this effort has been accepted for presentation at SEE '93.

Project members presented a paper on the state of environment integration at the International Conference on Software Engineering (ICSE 14). Project members presented another paper on configuration management and software maintenance at the Software Configuration Management (SCM '93) Workshop

Project members presented a CASE environments tutorial at the Software Engineering Process Group Conference and gave a presentation on PCTE at the U.S. Army Software Development Conference.

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Software Engineering Techniques Reports

April–June 1993

An Overview of PCTE: A Basis for a Portable Common Tool Environment
CMU/SEI-93-TR-1

Software Architecture for Shared Information Systems
CMU/SEI-93-TR-3

Process-Centered Development Environments: An Exploration of Issues
CMU/ESI-93-TR-4

Reengineering: An Engineering Problem
CMU/SEI-93-SR-5

For information about obtaining copies of SEI reports, see page 33.

Software Risk Management

The objective of the Software Risk Management Program is to improve the management of risks that arise in the development of software-intensive systems. Project members are assessing the state of the practice of software risk management, developing methods and processes to improve the state of the practice, and transitioning these methods and processes into practice.

The goal of the Government Risk Management Project is to help government program managers become effective risk managers. The project will enhance the capability of government agencies to successfully manage system acquisition by:

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Government Risk Management

1. Improving software engineering methods through the application of a software risk management discipline.

2. Fostering the concept of team risk management.

The scope of this project is to develop and transition into practice a comprehensive set of software risk management products that are aimed at serving program managers' needs for effective support in managing the acquisition and development of large, software-intensive systems. The risk management product set will focus on issues of modeling acquisition processes, developing risk management methods to support these processes, and improving communications about risk within government and between government and its industrial contractor base. The primary emphasis is on enhancing the capability of the customer and supplier team to manage risks in software development.

This quarter, a project team completed two baseline risk assessments: one for the contractor and the other for the government program management organization. A project sub-team initiated risk mitigation planning and continuous risk management with the contractor.

The project conducted a Joint Management Comparison Risk Ranking (CRR), which combines the results of the two baseline assessments at contractor and government programs into a single list. The respective program managers rank order and accept action responsibility for specific critical risks to the program. This Joint CRR will be updated in joint session on a quarterly basis.

The project proposed a strategic partnership agreement with an Air Force program and continued work on a technical objectives and plans agreement to be completed during next quarter.

A project team completed a risk assessment with the National Oceanographic and Atmospheric Sciences Agency, and is currently developing a strategic plan for a follow-on Team Risk Management Strategic Partnership.

The project leader presented technical program details to technical staff members of the Nuclear Regulatory Commission. This concluded a series of technical interchanges with the SEI that were successful for the sponsor.

The project pursued potential collaboration with the MITRE Corporation with the objectives of (1) enhancing wider transition of SEI risk management methods, and (2) improving risk management in acquisition through collaborative development/transition with MITRE.

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Risk Management Improvement

The Risk Management Improvement Project (RMI) is the new name of the combined Taxonomy-Based Questionnaire Project and Industry Risk Management Project. The RMI Project is focused on improving the state of the practice of risk management in the Department of Defense (DoD) industrial community. The strategy of the RMI Project is to work in a collaborative manner with key industrial companies to develop, test, and transition risk management methods for the development of software-dependent systems.

The goal of the risk taxonomy portion of the RMI project is to develop the taxonomy-based questionnaire and supporting methods so that both industry and government can easily integrate the methods into their daily risk management process.

Project members are signing technical collaboration agreements (TCAs) with several companies that fit into the overall project strategy. The TCAs will outline tasks that will further the work RMI is doing in developing risk management methods. The companies will participate in the development of the methods by providing a project that will be used as a testbed for the methods and tools. As part of the collaborative agreement, each company will critique RMI methods and offer suggestions for process improvement.

The field testing of the taxonomy-based risk identification method was concluded this quarter with an assessment of a client project in April. Further work is being done to develop phase-sensitive and domain-sensitive taxonomy-based questionnaires. Although the questionnaire variance from phase to phase and from domain to domain is small, it is significant in identifying software technical risk. The structure of the taxonomy-based questionnaire will remain unchanged over the variation of the questionnaire. The taxonomy-based risk identification method will be integrated into methods to establish a baseline of risks for a project.

The half-day "Introduction to Risk Management" tutorial was given at the National Software Engineering Process Group Meeting in April. A presentation on the taxonomy-based risk identification method was given at the Los Angeles area Software Process Improvement Network meeting in June.

The technical report entitled *Taxonomy-Based Risk Identification Method* was published in June and serves as the second quarter deliverable of the Risk Program. The taxonomy-based risk identification method uses the taxonomy-based questionnaire as the principal instrument for identifying risks.

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Independent Risk Assessment

The goal of the Independent Risk Assessment (IRA) Project is to assist government acquisition, program management, software development, and software support managers and offices in the execution of risk management within their spheres of interest. The over-arching focus of the IRA Project is, therefore, on the acquisition life cycle and process and how risk management affects this focus arena.

The scope of the IRA Project is to develop and transition a set of methodologies and tools that will accomplish the stated goals. The IRA Project is operating under a strategy of providing its product set principally through integration of risk management products that have been developed over the past few years and applying the resulting product set throughout the acquisition community. The IRA Project is complementary to other projects within the Risk Management Program by providing the initial, broad-scale approach within the SEI sponsor environment and multiple sources of interest in other, more detailed, risk management mechanisms. The initial Risk Management Program product that is being integrated by the IRA Project is the risk taxonomy and questionnaire.

Under the auspices of the IRA Project, the Risk Management Program has also included the execution of the independent risk assessments that the institute has been called upon to perform for various programs from time to time over the years. This approach, which is formally entitled the "SEI Independent Risk Assessment," includes the core functionality of the product set that is also being provided to the sponsor organizations. The project will also expand the initial product set by ascertaining the feasibility of applying cost and schedule and predictability in the product set.

This quarter, project members produced the initial product set that was delivered to the DoD, Office of the Director, Defense Research and Engineering, Software Action Plan Working Group, on April 30, 1993. The deliverable, published as Version 0.1, included the risk taxonomy, questionnaire, and the methodology for applying them in a software developer's environment.

With the deliverable of the IRA Version 0.1, project members commenced the follow-up verification and validation activities with a risk assessment on a government contractor's software-intensive project. The IRA methodology was well received and surfaced the appropriate risks associated with the project, while at the same time provided focus and clarity on those issues that had never been possible before the use of such a disciplined approach.

The IRA Project is sponsoring a panel session on lessons learned from risk assessments that will be presented at the Annual SEI Symposium in August.

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**SEI Risk
Reports**

April–June 1993

Taxonomy-Based Risk Identification
CMU/SEI-93-TR-6

SEI Services

SEI Services works with other groups in the SEI to develop, deliver, and transition services that support the efforts of SEI clients to improve their ability to define, develop, maintain, and operate software-intensive systems. To accelerate the widespread adoption of effective software practices, SEI Services works with client organizations that are influential leaders in the software community, promotes the development of infrastructures that support the adoption of improved practices, and transitions capabilities to government and commercial associates for use with their client organizations.

The Computer Emergency Response Team (CERT) was formed by the Defense Advanced Research Agency in November 1988 in response to the needs exhibited during an Internet security incident. The CERT charter is to work with the Internet community to facilitate its response to computer security events involving Internet hosts, to take practice steps to raise the community's awareness of computer security issues, and to conduct research targeted at improving the security of existing systems.

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Computer Emergency Response Team

The CERT Frequently Asked Questions (FAQ) document was approved for public release by the SEI Joint Program Office. The FAQ provides basic information about the CERT, its function, and the type of information that is available from CERT. Topics include CERT advisories, available courses and workshops, recommended books and articles, information available by file transfer protocol (FTP), mailing lists and newsgroups, and what kind of information to provide when a site experiences an intrusion. The FAQ is now being used in responding to callers; it is also available via anonymous FTP from the cert.org system.

This quarter, new releases of two tutorials were completed: "Internet Security for Managers" and "Internet Security for System and Network Administrators." The tutorials were presented at the first offering of CERT Security Seminars in June. The courses were attended by 107 people.

CERT hosted its first Invited Vendor Workshop in May. Nineteen representatives from nine major information technology corporations attended. The purpose of this event was to discuss issues of mutual interest to the CERT and the vendor community.

At the annual Information System Security Association (ISSA) conference, the CERT manager was installed as ISSA international vice president.

A CERT staff member taught a class for a course entitled "Emerging Technologies," sponsored by the Information Networking Institute of Carnegie Mellon University. The topic was Internet Security Issues and CERT.

CERT members spoke at the following events this quarter:

- **EDP Auditor's Association Annual Conference on Computer, Audit, and Control.** The audience for the CERT presentation consisted of 45 audit managers and information security professionals.

- **IPACRI (the Italian equivalent of the American Bankers Association) (Rome, Italy).** The plenary address presented the CERT concept and experiences. The talk was simultaneously translated for the attendees, who represented the Italian banking, insurance, and telecommunications industries.

- **National Aeronautics and Space Administration Science Internet/Catalog Interoperability Workshop (San Diego).** A CERT staff member gave a briefing on Internet security as part of an invited panel.

- **Association for Women in Computing.** More than 20 attendees received a CERT presentation at a Pittsburgh chapter meeting on May 17. The presentation generated questions about Internet connectivity, and what we see exploited and what recommendations we make.

- **USENIX Conference (Cincinnati, Ohio).** A CERT member chaired a session on security and a birds-of-a-feather session on network security and CERT.

CERT experienced approximately a 16 percent increase in electronic mail sent to the cert@cert.org alias in the first five months of this year over the comparable five month period in 1992. CERT also published 4 CERT Advisories this quarter.

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Organization Capability Development

The Organization Capability Development function supports SEI clients' software process improvement efforts by helping them develop the capability to manage the organizational aspects of improvement at their sites. Services include organizational assessment, vision setting and dissemination, strategic planning, transition infrastructure development, executive consulting, cross-functional team development, managing technological change, and consulting skills for software engineering process groups (SEPGs). The goal of the function is to provide to clients the self-sustaining capability of managing their own long-term improvement.

The "Managing Technological Change" course was presented twice this quarter. The first offering was to the Dallas Software Process Improvement Network (SPIN), which included Texas Instruments, DSC Communications Corporation, and Electronic Data Systems. The second was to the Embedded Computer Resources Support Improvement Program at Peterson Air Force Base (AFB).

The first meeting for trainer certification for the "Managing Technological Change" course was offered in May. Follow-up activities include co-teaching with participants to ensure success in the transition.

The Consulting Skills Workshop was held for Air Force Materiel Command at Tinker AFB and for the public at the SEI.

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Improvement Planning and Organizing

The Improvement Planning and Organizing (IPO) function focuses activities with SEI clients who seek long-term support for their software process improvement efforts. IPO was formed to address needs for integrated software process improvement programs that include: understanding the principles of how to effectively launch and sustain continuous software process improvement; and integrating assessments, organizational dynamics, the maturity model, process definitions, and improvement metrics into a plan. IPO members provide support in planning and organizing continuous software process improvement programs including: using business and case histories in software process improvement to illustrate benefits achieved; promoting and launching software process improvement programs; and coordinating clients' activities with the work of different SEI projects.

The National SEPG Meeting took place in April. This annual event was co-hosted by the SEI and the Southern California SPIN. The 536 attendees represented more than 70 percent growth from the 1992 meeting attendance of 380. The meeting provides a forum for software practitioners to share lessons learned, collect best practices, hear about new SEI developments, and showcase their accomplishments. Highlights included 12 tutorials on such topics as the capability maturity model, planning a process improvement program, defining software measures, and formal inspections. Watts Humphrey gave the keynote address at the National SEPG Meeting; Larry Druffel and Barry Boehm both gave luncheon speeches. Sessions were offered in two tracks: one for beginning practitioners and one for advanced practitioners.

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Technical Assistance

The Technical Assistance (TA) function focuses on transitioning technologies from the SEI to software practitioners and program managers. TA staff members serve as a bridge between SEI clients and technology groups to minimize the effort and time required to successfully transition, adopt, and institutionalize emerging technologies and methods. Staff members administer technical objectives and plans efforts involving the transition of software risk identification and analysis, SCE, software process definition, software environments, software architectures, and software project management training.

A TA staff member participated in a red team review of the Air Force Combat Ammunition System (CAS), at the request of the Air Force Program Executive Officer for Management Information Systems. MITRE Corporation and Air Force members also participated. The results were well received by the Program Executive Officer and Program Director, who were in the process of making critical CAS decisions.

A staff member participated in a review team for the Peace Shield for the Air Force Program Executive Officer for Command, Control and Communications. The review team was headed by the Secretary of the Air Force for Acquisition and included representatives from MITRE and the Air Force. The results provided information to validate the credibility of the contractor's critical design review approach.

SEI Products

With the goal of helping end-users help themselves, SEI Products works with other groups in the SEI to develop an integrated set of products and services for managers, practitioners, and educators. SEI Products ensures that the results of SEI work are in a form that the software community can easily and effectively use to improve software practice and that educators can use to improve software engineering.

The Academic Education Project focuses on the long-term development of a highly qualified work force. The project promotes and accelerates the development of software engineering as an academic discipline. The project is developing model curricula and promoting the establishment and growth of software engineering programs, as well as working to increase the amount of software engineering content in computer science programs. The project produces educational materials that support the teaching of software engineering in universities.

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Academic Education

The Academic Education Project published a set of educational materials, *Lecture Notes on Engineering Measurement for Software Engineers, which* was released in June. These materials provide information for instructors who plan to introduce the subject of measurement into their software engineering or computer science courses. The package includes instructor's guidelines, student handouts, transparency masters, and checklists that were published by the SEI Software Measurement Project last year.

Software Design Methods for Concurrent and Real-Time Systems, by Hassan Gomaa, became the fifth book in the SEI Series in Software Engineering, published by Addison-Wesley Publishing Company. In the book, Gomaa outlines the characteristics of concurrent, real-time, and distributed systems and describes the concepts most important in their design. He surveys and compares a range of applicable design methods, elaborates on two object-oriented methods, and describes a practical approach for applying real-time scheduling theory to analyze performance.

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Master of Software
Engineering

In response to industry's growing demand for skilled software developers, Carnegie Mellon University (CMU) offers a 16-month master's degree program in software engineering. The program is a cooperative effort of the CMU School of Computer Science and the SEI. The core of the program is based on the SEI curriculum recommendations for master's in software engineering (MSE) programs. The MSE Project also produces the Academic Series, a set of video-based graduate-level courses on software engineering.

In May, 18 students received MSE degrees at the 1993 commencement ceremonies at CMU. This is the second group to graduate from the CMU MSE program. The program admitted 14 new students for the fall of 1993.

The MSE Project acquired a contract from the Defense Informations Systems Agency through the University of Houston, Clear Lake to produce three courses on software reuse. The courses are described below.

• **Reuse Training for Executives.** This course is intended for senior managers of organizations that procure or develop systems with a major software component. The course is also appropriate for line managers who support reuse. Topics include quantifiable benefits of reuse, inhibitors to reuse and how to remove them, investment in reuse, and reuse in practice.

• **Developing Reusable Software.** This course provides a detailed technical description of component-based software development. Topics include fundamentals such as component acquisition, component storage and retrieval, and reverse engineering. The course also deals with component-level considerations and component integration issues. The underlying programming technology in the course focuses on the Ada language.

• **Managing the Software Reuse Effort.** This course is intended for line managers. The course addresses the process, organizational, and technical aspects of reuse; it emphasizes the overall benefits of systematic software reuse and the investments of time, resources, and management that are needed to obtain those benefits.

The SEI sold 23 copies of Academic Series courses this quarter.

In addition, National Technological University broadcast the Academic Series course "Software Creation and Maintenance" by satellite.

The Continuing Education Project interacts with industry and government to increase the availability of high-quality educational opportunities for software practitioners and executives. The project produces the Continuing Education Series and the Technology Series. The Continuing Education Series provides video-based courses designed for clients' in-house education, and executive offerings designed for decision makers involved in improvement efforts. The Technology Series provides stand-alone presentations that promote awareness of emerging issues and leading-edge technologies.

The eighth public offering of "Software: Profit through Process Improvement" was held at the SEI in May. This overview course for executives was attended by 18 students. In addition, the SEI instructor presented a full-day tutorial, based on course material, at the National SEPG Meeting in April. On April 28, he gave an invited presentation (a 5-hour derivative of course material) to 10 executives of SEMATECH for their President's Day program.

The seventh public offering of the executive course, "Software Quality Improvement," was held at the SEI in June.

In May, a third course in the executive curriculum, "Software Productivity Improvement," was presented.

Development was completed on a new course for executives, "Software Risk Management." This three-day course presents fundamental concepts and techniques that will help executives manage the risks inherent in building complex, software-intensive systems. During the course, participants create plans for incorporating software risk management into their organizations. The course was presented for the first time on June 29 to July 1.

A set of 38 videotapes and other course materials from the Continuing Education Series practitioner course, "Software Project Management," were purchased by McLean Air Force Base and by the Department of Agriculture. Three videotapes from the "Software Requirements Engineering" course were purchased by American Management Systems, Inc.

During this quarter, 26 Technology Series videotapes were sold.

Lecture Notes on Engineering Measurement for Software Engineers
CMU/SEI-93-EM-9

For information about obtaining copies of SEI reports, see page 33.

Technology Transition Initiative

The Process Research Project investigates the factors that limit software development performance by conducting research on the use of software process principles by individuals and small teams. This research is seeking insight into the processes, tools, and methods that will be most helpful in improving the performance of software engineering professionals.

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Process Research

The Process Research Project continues to explore the use of statistical process management methods by individual software practitioners. Early work has demonstrated the potential value of such methods in improving the quality, productivity, and predictability of their work. With the completion of milestone 1 in the first quarter, the project has moved from the early exploratory phase to addressing the feasibility of more general application of the personal software process (PSP) method. Principle emphasis has thus moved to working with academic and industrial groups. Because of the substantial changes required in individual and management attitudes and practices, it is expected that both academic and industrial adoption of the method will be slow. Work is thus underway with several groups with the objective of gaining usage experience from some of them during 1993 and 1994.

The principal focus of the industry activities has been with Siemens Research of Princeton, New Jersey and Advanced Information Systems (AIS) of Peoria, Illinois. Siemens has completed the preparatory work and is ready to begin using their tailored version of the PSP. AIS has similarly made considerable progress and has started using the PSP on one project. A meeting was held with this group in June. As expected, both groups are making slow but steady progress. While several other industrial groups have expressed interest in the PSP work, nothing has been arranged.

The principal project focus is now on preparing a graduate course on the PSP. The project leader will give this course at Carnegie Mellon University starting in January, 1994. This course has been discussed with several academic groups. In addition, professors at two universities, University of Massachusetts and McGill, have agreed to teach the material. Since there is no published text on this material, the project has committed to make text and lecture draft material available to support them. They have both agreed to provide data on the students' work and course results to the project.

This quarter, the project leader met with representatives from the Defense Information System Agency Executive Panel Roundtable Discussion to assess the SEI core metrics initiatives and the Institute of Electrical and Electronic Engineers (IEEE) metrics standardization efforts.

The project leader also visited Paramax in Houston, Texas, to discuss their possible use of the PSP method. He also visited the Hughes Aircraft Corporation's Ground Systems Group to review their metrics and process improvement activities.

This quarter, the project leader presented the keynote address at the 5th Software Engineering Process Group meeting. The topic was software process improvement.

In addition, the project leader delivered a talk on software process improvement at the IBM Annual Software Conference on Process Improvement.

This quarter, the project leader announced the IEEE/SEI Award for Software Process Achievement at the 15th annual International Conference on Software Engineering.

Program Development

The vision of the Program Development Division (PDD) is to serve customer needs by being the voice of the customer to the SEI and the voice of the SEI to the customer. The PDD mission is to understand the key requirements of SEI customers, translate these into responsive SEI program specifications consistent with the SEI mission, and facilitate the effective transition of best software engineering practice into use.

PDD accelerates the transition of new SEI software technologies and methods by disseminating information, providing mechanisms for collaboration and technology exchange, and offering customers the opportunity to participate in technical interchange meetings, workshops, and educational offerings. Efforts used to facilitate this transition include the Customer Relations information line, the subscriber program, the resident affiliate program, events such as the annual SEI Software Engineering Symposium and Visitor's Days, and distribution partners.

The subscriber program, in effect since January 1992, is open to any individual with a U.S. mailing address. Subscribers receive regular publications such as *Bridge* and the *Annual Technical Review*, a discount at the annual SEI Software Engineering Symposium, a 10% discount on all SEI technical reports ordered through Research Access, Inc., invitations to selected SEI events (e.g., the annual SEI Symposium), and first notification of SEI course offerings. The 1993 fee for subscribers is $100 per individual per year. The fee is subject to change in 1994, as the benefits are reviewed and amended.

Visitor's Day is hosted by the SEI three times a year to familiarize software practitioners, managers, and educators with the SEI. The next two Visitor's Days are scheduled to take place on 18 November 1993 and 3 March 1994. Visitors must pre-register; walk-ins will not be accommodated. Registration forms are available from Customer Relations (see page 33 for more information).

The SEI will host its annual Software Engineering Symposium on 23-26 August 1993 at the David Lawrence Convention Center in Pittsburgh, Pennsylvania. The theme of the symposium is "The Business of Software Engineering: The Competitive Edge." This year's symposium will have a broader focus than in past

years. The symposium will showcase a variety of topics that are important to corporate and government organizations dependent on software engineering. The topics selected will help software managers and practitioners respond better to competition and the changing environment.

For registration information, contact:

Events
Software Engineering Institute
Carnegie Mellon University
Pittsburgh, PA 15213-3890
Phone: (412) 268-7388
FAX: (412) 268-7401

The following organizations sponsored resident affiliates in the second quarter of 1993:

Industry
Computer Sciences Corporation

GTE Government Systems

IBM Federal Systems Company, Houston

Pacific Bell

Siemens

Texas Instruments Process, Inc.

Government

Air Force   Electronic Systems Center

Navy   Naval Air Warfare Center

Naval Surface Warfare Center

Other DoD   National Security Agency

Academia   Madrid Polytechnic University

How to Get Additional Information

For information about purchasing SEI publications, contact one of the following organizations:

RAI   Research Access Inc.
800 Vinial Street
Pittsburgh, PA 15212
Telephone: 1-800-685-6510
FAX: (412) 682-2994

NTIS   National Technical Information Service
U.S. Department of Commerce
Springfield, VA 22161-2103
Telephone: (703) 487-4600

DTIC   Defense Technical Information Center
ATTN: FDRA Cameron Station
Alexandria, VA 22304-6145
Telephone: (703) 274-7633

Some—not all—SEI documents are available electronically. Send electronic mail to info-manage@sei.cmu.edu for information about obtaining documents via anonymous file transfer protocol (FTP) on the Internet. Be certain to include your telephone number in the event that we have difficulty contacting you by electronic mail.

For information about the subscriber program and other SEI offerings, contact:

SEI   Software Engineering Institute
ATTN: Customer Relations
Carnegie Mellon University
Pittsburgh, PA 15213-3890
(412) 268-5800
Internet: customer-relations@sei.cmu.edu

List of Acronyms

AFB	Air Force Base
AIS	Advanced Information Systems
AMC	Army Materiel Command
AWIPS	Advanced Weather Interactive Processing System
CAS	Combat Ammunition System
CASE	Computer-Aided Software Engineering
CECOM	Communications-Electronic Command
CERT	Computer Emergency Response Team
CMM	Capability Maturity Model
CMU	Carnegie Mellon University
CRR	Comparison Risk Ranking
DoD	Department of Defense
EM	Empirical Methods
FAQ	Frequently Asked Questions
FODA	Feature-Oriented Domain Analysis
FTP	file transfer protocol
GSA	General Services Administration
ICSE	International Conference on Software Engineering
IEEE	Institute for Electrical and Electronic Engineers
IFIP	International Federation of Information Processing
IPO	Improvement Planning and Organizing
IRA	Independent Risk Assessment
ISO	International Standards Organization
ISSA	Information System Security Association

JLC	Joint Logistics Commanda
J-MASS	Joint Modeling and Simulation System
MQ	maturity questionnaires
MSE	master's in software engineering
NAWC	Naval Air Warfare Center
NGCR	Next Generation Computing Resources
NIST	National Standards and Technology
PCTE	Portable Common Tool Environment Conference
PDD	Program Development Division
POSIX	Portable Operating System Interface
PSP	personal software process
RMA	rate monotonic analysis
RMI	Risk Management Improvement
SCE	Software Capability Evaluation
SCM	Software Configuration Management
SEPG	software engineering process groups
SPA	software process assessment
SPI	software process improvement
SPICE	Software Process Improvement and Capability dEtermination
SPIN	Software Process Improvement Network
SPM	Software Process Measurement
STARS	Software Technology for Adaptable, Reliable Systems
TA	Technical Assistance
TCA	technical collaboration agreements