Carnegie Mellon University
Software Engineering Institute

Quarterly Update

July–September 1993

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Software Engineering Institute

Quarterly Update

July—September 1993

Summary of Accomplishments

This section provides a summary of accomplishments from July—September 1993

The SEI hosted its annual **Software Engineering Symposium** 23-26 August 1993 at the David Lawrence Convention Center in Pittsburgh, Pennsylvania. The theme of the symposium was "The Business of Software Engineering: The Competitive Edge." This year's symposium had a broader focus than in past years, including increased participation from industry and government. The symposium also had 36 exhibitors this year, twice the number from last year's event. The final attendance figure for this year's symposium was 1288, an increase from last year's conference.

Software Capability Evaluation (SCE) Version 1.0 Implementation Guide was published this quarter. This guide was based on the material contained in a similar guide that was previously developed for a United States Air Force technical objectives and plans customer.

The Independent Risk Assessment Project (IRA) has **developed and published Version 0.1 of the Software Risk Evaluation** (SRE), and has continued to refine the definitions associated with the SRE and the IRA

The **Computer Emergency Response Team** hosted the 5th Forum of Incident Response and Security Teams (FIRST) Computer Security Incident Handling Workshop in St. Louis, Missouri. The workshop was attended by 140 individuals from government, university, and corporate organizations.

The **Managing Software Development** course will be offered during the fall semester at the SEI. This course will be offered to audiences at CMU and National Technological University (NTU). The course is an updated and expanded version of an earlier Academic Series course, "Software Project Management." The course is videotaped during presentation to CMU students and broadcast over satellite to NTU students. With an enrollment of 43, "Managing Software Development" is the largest class registered at NTU this semester.

The **Computer-Aided Software Engineering Environments Project** completed its work on the Navy's Next Generation Computing Resources Project Support Environment Standards Working Group Reference Model for environment services. This reference model provides a definition of the services that can be offered by a full working environment and offers a frame of reference for understanding existing environments.

The Software Process Measurement Project conducted a pilot offering of **"Engineering an Effective Software Measurement Program"** Workshop at Standard Systems Center (SSC), Gunter Air Force Base in August. The workshop was well received and attended by 35 SSC personnel representing the Quality Improvement Group and the program/project managers. The workshop was designed to formulate a software measurement installation plan for use as an end product.

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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.

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. Project members are formulating reliable measures of the software development process and products to guide and evaluate development. To expedite Department of Defense and industry transition, project members are actively working with professionals from industry, government, and academia in encouraging organizations to use quantitative methods to improve their software processes.

In August, the project conducted a pilot offering of "Engineering an Effective Software Measurement Program" Workshop at Standard Systems Center (SSC), Gunter Air Force Base. The workshop was well received and attended by 35 SSC personnel representing the Quality Improvement Group, and the program and project managers. The workshop was designed to formulate a software measurement installation plan for use as an end product.

Also during this period, two site visits were conducted in support of the measurement work at Army Materiel Command, Ft. Sill site in Lawton, Oklahoma. An SPM staff member has been working to assemble a policy, procedure, and standard for software measurement practices at Ft. Sill.

This quarter, three site visits were conducted in support of the Defense Information Systems Agency (DISA)/Center for Information Management technical objectives and plan. The site visits supported pilot efforts to use the SEI software measurement checklists at Columbus, Ohio; Battlecreek, Michigan; and Mechanicsburg, Pennsylvania. In addition, two working sessions were held at DISA in Washington D.C.

An SPM project member is leading a technical collaboration with IBM Federal Systems Center to develop guidelines for implementing software measures in conjunction with the key practices of the capability maturity model, further mapping the details of Levels 4 and 5. This project member also presented status of this collaboration at the SEI/IBM Semi-Annual Program Review.

Project members delivered the following presentations at the 1993 SEI Software Engineering Symposium:

- Integrated Process Tutorial
- Software Cost Estimating Initiative
- Siemens Case Study Effort
- Measuring the Benefits of Software Process Improvement
- Panel Session on Experiences in Using the SEI Measurement Definition Checklists

A project member delivered a presentation on the SEI Software Cost Estimating Initiative at the Software Life-Cycle Cost Model User's Group Meeting in Tyson's Corner, Virginia.

Anita Carleton, Bill Curtis, Larry Druffel, and Ronald Radice led panel sessions at the Cooperstown I Workshop entitled "Creating a National Vision and Force in Software Through Software Measurement." Results of the workshop will be briefed to Vice President Gore in the fourth quarter.

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 documentation, training, and practice are equivalent.

Project members are exploring process definition methods and techniques through collaboration with several SEI sponsors. Project members participate in process improvement activities at GTE and Naval Air Warfare Center through resident affiliates. Project members are also exploring advanced applications of process definition technology through the Advanced Research Projects Agency (ARPA)/Software Technology for Adaptable, Reliable Systems (STARS) Program.

Currently, project members are developing a software process framework based on the capability maturity model (CMM) for software, guidelines for defining enactable processes, and a workshop on software process definition for software engineering process group members.

During this quarter, project members completed version 1.0 of "Software Process Definition Guide: Content of Enactable Software Process Definitions," began development of version 3.0 of the "Software Process Framework," and began working to make "Defining Software Processes: Getting Started" available to the public.

During this quarter, project members held two one-day workshops on software process improvement for Standard Systems Center (SSC) management. The workshop "Software Process Improvement: Getting Started" is a one-day introduction or refresher course on software process improvement. The workshop includes working sessions where participants identify common process-related root causes of software production problems and apply the principles and concepts from the class to prioritize process improvement goals.

Project members delivered a workshop on software process definition to program and project managers at SSC, and to the SSC Quality Improvement office. Following the workshop, a four-day working session was held to discuss and implement recommended changes to the SSC software engineering process. Recommendations were based on an evaluation of the SSC documented process against the project's CMM-based software process framework. This evaluation identified areas within the documented process where policies, standards, and processes were inconsistent with the CMM.

Project members are providing support to the ARPA/STARS demonstration projects and Process Technology Transition Affiliates (PTTAs). Project members are also providing limited technical support for the joint ARPA STARS/SEI process asset library (PAL), which is a joint effort between the SEI, an SEI resident affiliate from GTE, and several STARS prime contractors. Project members are also supporting the development of software processes for STARS demonstration projects and technology transition affiliates. This support provides early access to products being developed by the project and consulting support for planning, process design, and process development and review.

This quarter, project members updated the electronic version of the PAL that is available in the electronic repository, Asset Source for Software Engineering Technology. The update involved a restructuring to increase the number of electronic formats in which PAL assets are available. PAL assets can now be retrieved in Macbinary, Rich Text Format, BinHex, and Postscript. Tests of these formats were conducted to ensure that the files could be printed from Macintosh, IBM, and Sun platforms using at least one of the PAL electronic formats.

Capability Maturity Model

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.

The "Introduction to the CMM" 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 software engineering process group members who are doing software process improvement. This quarter, the course was pilot tested in an alpha version and will continue to undergo pilot testing as it is incrementally developed. The course is available on a limited basis during pilot testing. The target completion date for the course is February, 1994.

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. EM staff members manage the software process database and generate periodic reports on the status of software process maturity and results of software process improvement.

This quarter, EM staff members developed beta test versions of the auxiliary questionnaires. These questionnaires may be used in SPAs, software capability evaluations (SCE), mini-assessments, and other appraisal methods to capture consistent information to:

- Determine the organizational scope of SPAs and SCEs.
- Assist in selecting projects to include in a SPA or SCE.
- Develop the plan for the on-site period of SPAs and SCEs, and select those who will complete the maturity questionnaires for use in efficient appraisals.

Staff members from the EM and Software Process Definition Projects developed a survey that was completed by 339 people at the 1993 National Software Engineering Process Group (SEPG) Meeting. The survey addressed SEPG experiences and needs that the software process improvement (SPI) community perceives the SEI could address. Also, the survey was used to collect demographic data about the SPI community. The results of the survey will be summarized in a report that will be released in the fourth quarter.

This quarter, EM staff members collaborated with a resident affiliate from Pacific Bell and through a technical partnering agreement with Hewlett-Packard to complete alpha tests and plan beta tests for 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. A technical report describing the method will be released next quarter.

Software Process Assessment

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 capability maturity model (CMM) v1.1 as a framework; and help the organization initiate those improvements.

This quarter, SPA project members conducted two separate field exercises of the alpha2 version of the new CMM-based SPA method. Technical collaboration agreements were established with the Texas Instruments Defense Electronics and Systems Group, Dallas, Texas, and with the Electronic Data Systems Engineering Applications Development Division, Troy, Michigan. Assessment teams from both organizations were trained during the previous quarter in preparation for their on-site assessment periods. Both field exercises were successful and yielded valuable information for incorporation into the beta version of the assessment method and training.

At the 1993 SEI Software Engineering Symposium, a SPA project member participated in the development and delivery of the "Integrated Approach to Software Process Improvement" tutorial and delivered the presentation "Upgraded SPA: CMM-Based SPAs." Other SPA project members delivered the presentation "An Analysis of SEI Software Process Assessment Results."

This quarter, a SPA project member attended the International Standards Organization Software Process Improvement and Capability dEtermination (SPICE) meeting in Rome, Italy.

Software Capability Evaluation

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.

Software Capability Evaluation Version 1.5 Method Description was published this quarter. Work has immediately begun to update this document so that it includes capability maturity model (CMM) v1.1 concepts.

This quarter, *Software Capability Evaluation (SCE) Version 1.0 Implementation Guide* was published. This guide was based on the material contained in a similar guide that was previously developed for a United States Air Force technical objectives and plan customer. Approximately 90 copies of the guide were forwarded to government and industry personnel who requested to receive it upon publication. Efforts to update this document to the CMM v1.1 have also been begun.

This quarter, SCE project members delivered a 4-team SCE team training class to 24 people. The SCE Overview Seminar was delivered at a customer site and was offered once at the SEI. The 2-hour "Introduction to SCE" module was delivered to the Defense Systems Acquisition Course, Management of Software Acquisition Course in Fort Belvoir, Virginia.

An SCE on-site was performed at Planning Research Corporation in Reston, Virginia, as part of the SCE pilot program with the National Oceanographic and Atmospheric Sciences Agency (NOAA) Advanced Weather Interactive Processing System program. Final preparations for the pilot program were completed this quarter.

Project members made two presentations at the 1993 Software Engineering Symposium: "Software Capability Evaluation: A Method Description" and "Use of the SCE Method in a Contract Monitoring Application: Lessons Learned."

The SCE Advisory Board met in July and September. SCE documents, listings from databases tracking issues, recommendations, decisions, and action items were reviewed and positive outbriefings were received.

This quarter, a study of SCE use with the United States Army was completed; the results are being analyzed for suitability of publication and for replicating the study in other Department of Defense organizations.

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Software Process Reports

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Concepts on Measuring the Benefits of Software Process Improvements
CMU/SEI-93-TR-9

Establishing a Software Measurement Process
CMU/SEI-93-TR-16

Software Capability Evaluation (SCE) Version 1.5 Method Description
CMU/SEI-93-TR-17

Software Capability Evaluation (SCE) Version 1.0 Implementation Guide
CMU/SEI-93-TR-18

A Software Process Framework for the SEI Capability Maturity Model: Repeatable Level
CMU/SEI-93-SR-7

For information about how to obtain copies of SEI reports, please turn to page 35.

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.

Engineering Maturity Model

This effort is a feasibility study that focuses on the development of an engineering maturity model (EMM) to complement the capability maturity model (CMM). While the CMM aims to stimulate the evolution of organizations to a continuously improving, controlled state, the EMM seeks to stimulate the evolution of product engineering practices used to predict and control properties of software artifacts. While the CMM is typically used to evaluate the maturity of organizations, the EMM will be used to determine how practices can best be improved to gain better predictability and control over properties of software systems.

This quarter, project members produced two drafts of a white paper that describes an EMM framework. Although the general framework was established, it has yet to be applied in depth to specific software engineering domains and specific artifact properties. In the next quarter, project members will produce a final version of the white paper as a technical report and will begin further work to explore the utility of the model.

Ada 9X — Review

The SEI is supporting the revision of the Ada programming 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 ongoing 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.

Dependable Real-Time Software Systems

The goal of the Dependable Real-Time Software Systems Project is to develop a reusable and generalizable software architecture to support software evolution in mission-critical systems.

The Navy's Next Generation Computing Resource Program has developed a technical objectives and plan with the SEI to lead the development of a new high-performance real-time network standard based on the asynchronous transfer mode network standard.

The project's cooperation with MITRE on airborne radar continues. During a MITRE review in July, this cooperative work was ranked as one of the best at MITRE. Furthermore, a manager from the Advanced Research Projects Agency suggested that MITRE and the SEI submit a joint proposal to further this work.

The project gave its first successful demonstration at the 1993 Software Engineering Symposium in August. Project members demonstrated:

- The reusability of the project's software architecture, design, and implementation, using two well-known sample control problems: the ball and beam device and the inverted pendulum device. Both are unstable without active computer control.

- The ability to introduce new software online to improve control performance without the need to shut down the device.

- The robustness of the project's software, by inviting the audience to insert software bugs of their choice into the new software. Although some admirable attempts were made, no one has broken the system.

To the best knowledge of the project's members, this was the first such demonstration in the world.

This quarter, "A Systematic Approach to Design Distributed Real-Time Systems" was published in *IEEE Computer.* Also, a project member was elected to be a full member of International Federation of Information Processing Working Group 10.4 on Dependable Computing and Fault Tolerance.

The paper, "Distributed System Design Using Generalized Rate Monotonic Theory," published in the *1992 Proceedings of the 2nd International Conference on Automation, Robotics, and Computer Vision*, was selected by the conference committee as one of best innovative papers. An updated version will be published again in a special issue of the *Journal of Integrated Computer-Aid Engineering* in 1993.

Real-Time Simulators

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 supported the development of several Air Force simulator programs, including the Simulator for Electronic Combat Training and the F22 Simulator.

Project members also transitioned the main concepts of structural modeling to a broader audience. Project members are continuing to develop the structural modeling guidebook.

Project members wrote a Carnegie Mellon University (CMU) School of Computer Science technical report on the use of general architectural concepts to evaluate user interface architectures. This report was prepared jointly with the Evolutionary Development Life Cycle Project within the Robotics Institute at CMU.

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 Next Generation Computing Resource 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. At the last POSIX meeting, the working group reached an agreement on top-level requirements for the standard. The Institute of Electrical and Electronic Engineers (IEEE) has requested permission to publish the requirements document as part of its Emerging Practices Series. IEEE has also requested permission to distribute a brief document entitled "Beginner's Guide to POSIX" that was developed by project members.

Project members have begun to work on an externally supported effort to develop a prototype course for high-level managers in the area of open systems. The course is modular in content and, in addition to basic principles of open systems, includes emphasis on real-time distributed systems. This work is done in collaboration with staff members from the Software Engineering Techniques Program.

Project members continue to support the Master of Software Engineering Program at Carnegie Mellon University. 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 work was presented at the last POSIX meeting and a paper was submitted to a requirements engineering conference. An interesting aspect of the work is the ability to delineate different classes of issues associated with the development of a formal specification and then to state them in terms of Z. This is a collaborative effort with another project at the SEI.

Transition Models

The goals of the Transition Models project are to determine and demonstrate a systematic, predictable, and replicable process for software technology transition. Work includes development and evolution of a conceptual framework; development and dissemination of guidance for general transition planning and for introducing new software technologies within organizations; and case studies of the transition of immature software technologies. Transition Models project customers include internal SEI staff as well as members of the SEI constituencies. Project members also maintain contact with researchers and others interested in software technology transition from business, government, and academic domains.

This quarter, a project member reviewed the draft proposal for the National Technology Transfer Center and the Technology Transfer Committee of the Council of Consortia. This proposal involves building a hypermedia inventory of knowledge and practice associated with technology transfer.

Eighty participants have registered for the upcoming 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) with the cooperation of Technical Committee 2 (Software Theory and Practice). The SEI is hosting the conference and the preliminary program has been distributed to participants.

A technical paper, "From Theory to Practice: Technology Transition to the SEI," was accepted for presentation in the mini track, Issues in Technology Transfer, of the Hawaii International Conference on Systems Sciences.

A project member presented a tutorial, "Managing Technology Transition as a Project," at the 1993 SEI Software Engineering Symposium.

Real-Time Distributed Systems Reports

July—September 1993

Structural Modeling: An Application Framework and Development Process for Flight Simulators
CMU/SEI-93-TR-14

Dependable Software Technology Exchange
CMU/SEI-93-SR-4
This report is available in electronic format via anonymous file transfer protocol (FTP).

For information about how to obtain copies of SEI reports, please turn to page 35.

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. Project members 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.

Application of Software Models

For systematic software reuse, organizations must invest in evolving a core competence in software modeling. This core competence involves modeling the common capabilities of software applications within a product family, and developing a generic design founded on a software/hardware architectural model. As an organization enriches its software assets with models, the process for developing or evolving software applications will become more an engineering change activity of mapping from needs to software solutions than a synthesis activity of building from scratch.

The Application of Software Models (ASM) Project is developing the technology, engineering process, organization structure, and transition planning involved in building and applying a core competence in software modeling. The activities of this project are based on the combined experience of the project members in domain modeling, software architecture, composition of systems via the application of models, design for and with reuse, and other key supporting techniques. The application of these techniques leads to the systematic creation and application of models, which form a codified technology base of engineering knowledge. The SEI has produced abstract models such as those which form the Feature-Oriented Domain Analysis (FODA) method, the Object Connection Update model, and the Object Connection Architecture model. The project also uses abstract models created by other organizations.

Through collaboration with technical objectives and plan sponsors, the project has used abstract models as a basis for creating concrete models through domain engineering and is applying these models in the creation of applications. The primary sponsors during this quarter include:

- Army Communications and Electronics Command (CECOM)
- Joint Modeling and Simulation Systems (JMASS)
- Ballistic Missile Defense Office (BMDO)
- The United States Navy
- National Institute of Standards and Technology (NIST)

CECOM is involved in the development of a domain analysis technique and its application in creating a domain model of Army movement control, a tactical decision aid supporting command and control.

Representatives from JMASS are responsible for applying the Object Connection Update model for design of friendly and threat models.

BMDO is using abstract models as a means of evaluating the BMDO Information Architecture and its ability to support system definition of Battle Management/Command Control and Communication applications.

Navy personnel are creating concrete models to support the development of weapon system trainers. The ASM Project provided a report to be used by the Navy for assessing possible contractors in the areas of software development environment, software size and productivity metrics, and the software development plan. Project members used SEI recommended practices in Model-Based Software Engineering (MBSE), computer-aided software engineering (CASE)/tool adoption and metrics to prepare this report. Project members also delivered a report on Technical Performance Measures for the high-risk areas in software development.

NIST is applying the FODA method for developing a model of network management systems software.

The ASM Project is currently developing a set of support services, training and documentation for organizations wishing to develop a software modeling competence. Currently in place are:

- An overview briefing describing the evolution to MBSE.
- An overview briefing on abstract and concrete models to support design.
- A multi-day tutorial/workshop on domain analysis.

ASM project members attended the American Institute of Aeronautics and Astronautics Workshop on Satellite Autonomy at Philips Lab, Kirtland Air Force Base.

Project members made presentations at the 1993 SEI Software Engineering Symposium, and met with personnel from the Air Force Software Technology for Adaptable, Reliable Systems demonstration project for a two-day information exchange.

Software Engineering Information Modeling

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.

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 second series of modules was captured with multiple isolated cameras in the SEI video studio during this quarter. The decomposition and indexing of the modules has begun. The first prototype of AMORE (Advanced Multimedia Organizer for Requirements Elicitation) was demonstrated at the 1993 SEI Software Engineering Symposium in Pittsburgh, Pennsylvania, in August.

Also this quarter, project members continued to work with the Naval Supply Systems Command on a technical objectives and plan 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 a critical design review with Mantech, the Naval Supply Systems Command contractor.

The project leader attended the Advanced Research Projects Agency Summer Study meeting on educational requirements of the National Information Infrastructure and was appointed to the editorial board for the Institute of Electrical and Electronic Engineers Computer Society multimedia computing magazine.

CASE Environments

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, generally 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.

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 which 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, CASE project members continued experiments on tool integration. These experiments have examined how different control integration mechanisms operate together, and how control integration and data integration provide complementary solutions to the integration issue.

The project completed its work on the Navy's Next Generation Computing Resources Project Support Environment Standards Working Group Reference Model for environment services. This reference model provides a definition of the services that can be offered by a full working environment and offers a frame of reference for understanding existing environments.

Project members have participated with the Institute of Electrical and Electronic Engineers and the International Standards Organization on SC7 in developing a standard practice for CASE adoption. This group is using work from the project as a baseline document for a standard practice on CASE adoption.

Project members delivered a tutorial on CASE Integration and Adoption at the 1993 SEI Software Engineering Conference. In addition, project members delivered five papers that highlighted project work on environment integration, CASE adoption, configuration management, and the programming support environments reference model. In addition, the project sponsored a talk by Maureen Judd of IBM at the conference.

Process-Centered Development Environments: An Exploration of Issues
CMU/SEI-93-TR-4
This report is available in electronic format via anonymous file transfer protocol (FTP).

Safety-Critical Software: Status Report and Annotated Bibliography
CMU/SEI-93-TR-5
This report is available in electronic format via anonymous file transfer protocol (FTP).

A Case Study in Software Maintenance
CMU/SEI-93-TR-8
This report is available in electronic format via anonymous file transfer protocol (FTP).

Integrating 001 Tool Support into the Feature-Oriented Domain Analysis Methodology
CMU/SEI-93-TR-11

AMORE: The Advanced Multimedia Organizer for Requirements Elicitation
CMU/SEI-93-TR-12
This report is available in electronic format via anonymous file transfer protocol (FTP).

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Software Engineering Techniques Reports

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An Investigation into the State of the Practice of CASE Tool Integration
CMU/SEI-93-TR-15

Reengineering: An Engineering Problem
CMU/SEI-93-SR-5
This report is available in electronic format via anonymous file transfer protocol (FTP).

For information about how to obtain copies of SEI reports, please turn to page 35.

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.

Team Risk Management

The goal of the Team Risk Management Project is to establish a cooperative working environment throughout all levels of the program that gives everyone in the program the ability and motivation to notice and handle risks before they become problems. To reflect this emphasis, the project name has changed from Government Risk Management to its current name, Team Risk Management. The project will work toward its goal by developing a framework for acquisition that fosters cooperation and partnering through cooperative or team processes, explicit methods to structure and sustain the processes, and supporting tools to aid the practitioners and managers.

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 team risk management product set will focus on issues of modeling acquisition processes, developing team risk management methods to support these processes, and improving communications about risk within government and between government and industry program offices. The primary emphasis is on enhancing the capability of the customer and supplier to manage risks as a team in software development.

This quarter, the project team continued on-line work with the Navy program office and its contractor to develop the partner relationship to jointly manage risks. Action plans are evolving strategies to mitigate the risks identified and a mechanism to continuously identify new risks has been put in place.

The project presented the team risk management concept at the 1993 SEI Software Engineering Symposium and published the concept in a report to the Navy Program Executive Officer, a Risk Program strategic partner.

The project team completed its planning activity with the National Oceanographic and Atmospheric Administration System Program Office, producing a five-year plan for National Oceanographic and Atmospheric Sciences software acquisition and development improvement.

The project team coordinated the technical objectives and plan agreement to start work with the Air Force Follow-on Early Warning System in team risk management.

Risk Management Improvement

The Risk Management Improvement (RMI) Project is focused on improving the state of practice of software risk management in the development of software-dependent systems in the Department of Defense (DoD) industrial community as well as in the commercial community. The strategy 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 RMI Project is to develop risk management methods that can be used on a regular basis by projects developing software-dependent systems. To do this, the RMI Project is developing material for training companies and appropriate third party groups such that they can apply the risk management methods, processes, and tools without the aid of the SEI Risk Program personnel.

The Risk Program's risk management paradigm is the framework in which the risk management practices are being developed. The work done by the Taxonomy project in developing a risk identification mechanism is being integrated into a risk evaluation process. Risk evaluation will be the method by which a project's baseline of risks will be established. Methods are being developed for risk identification, analysis, planning, tracking, control, and communication. Through collaboration with selected DoD industrial firms, these methods will be tested and improved. When the methods are stabilized, that is, when the method has been field proven, the methods will be disseminated throughout the software development community to improve the state of practice of managing risks. To accomplish this, project members have signed technical collaboration agreements (TCAs) with companies that fit into the RMI Project's overall strategy. The TCAs describe tasks to be accomplished to further the work the RMI Project is doing in developing risk management methods. The companies

are participating in the development of the methods by providing pilot projects to be used as the test bed for prototyping the methods and tools. As part of the collaborative agreement the companies will critique the RMI Project's methods and offer suggestions for process improvement.

The products of the RMI Project are the methods supporting a risk assessment process, which identifies project-specific risks and mitigation plans to control the identified risks, and the training course to train industry to conduct risk assessments.

This quarter, project members focused on developing analysis methods to determine the impact of the identified risks on the project in preparation for planning the mitigation strategies. These methods are being field tested on the pilot projects of our TCA companies as well as other companies as the opportunities are presented. The field tests will provide data not only to improve the processes but also to prove the effectiveness of the methods. The project leader presented the Taxonomy-Based Questionnaire in a plenary session at the 1993 SEI Software Engineering Symposium in August. The half day tutorial "Introduction to Risk Management" was given in a session preceding the Symposium. The RMI Project also sponsored a panel of industry personnel who have firsthand experience with the taxonomy-based risk identification methods.

Independent Risk Assessment

The Independent Risk Assessment (IRA) Project has achieved noted success in attaining its goal of assisting government acquisition activities, program management, and software development, as well as assisting software support managers and offices in the execution of risk management within their applicable spheres of interest. The principal focus of the IRA Project is, therefore, aimed at the acquisition life cycle.

The IRA Project has developed and published Version 0.1 of the Software Risk Evaluation (SRE), and has continued to refine the definitions associated with the SRE and the IRA. The SRE has been under review by the originating Department of Defense office and other service and agency representatives since its publication in April. Additional SRE events conducted by IRA project members have aided in refining the SRE and will be incorporated in the upcoming delivery of the SRE Version 0.2.

IRA project members sponsored a panel at the 1993 SEI Software Engineering Symposium. The panel included individuals critical to the transition of this risk management technique into the broader usage across the acquisition community. These individuals provided support for the overall Risk Program while addressing their perspectives of the use of risk management techniques in their respective areas of expertise.

Preparation is underway to take a leading role in the upcoming SEI Risk Symposium and the Air Force Materiel Command, Software Technology Conference.

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Software Risk Management Reports

July—September 1993

Taxonomy-Based Risk Identification
CMU/SEI-93-TR-6
This report is available in electronic format via anonymous file transfer protocol (FTP).

For information about how to obtain copies of SEI reports, please turn to page 35.

SEI Products

With the goal of helping end-users help themselves, SEI Education Products works with other groups in the SEI to develop an integrated set of educational products and services for managers, practitioners, and educators. The program 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.

Curriculum Research

The Curriculum Research Project (formerly called 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. Project members are 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.

This quarter, the project leader presented a lecture entitled "The Current State of Certification and Licensing of Software Engineers" at the 1993 SEI Software Engineering Symposium. The lecture described the certification requirements of two organizations that currently offer certification of professionals in the software field: the Institute for the Certification of Computer Professionals and the American Society for Quality Control. Also discussed were the implications of U.S. equal employment opportunity laws with respect to certification as a condition of employment, the rationale for requiring licensing, and recent activities in the area of licensing.

Academic Education

The Academic Education Project (formerly the Master of Software Engineering Project) focuses primarily on software engineering education at the graduate level. The project cooperates with the School of Computer Science at Carnegie Mellon University (CMU) in offering a 16-month master's degree program in software engineering. The core of the program is based on the SEI curriculum recommendations for MSE programs. The Academic Education Project also produces the Academic Series, a set of video-based graduate-level courses on software engineering, and educational materials that support the teaching of software engineering topics.

"Managing Software Development" will be offered during the fall semester at the SEI. This course will be offered to audiences at CMU and National Technological University (NTU). The course is an updated and expanded version of an earlier Academic Series course, "Software Project Management." The course is videotaped during presentation to CMU students and broadcast over satellite to NTU students. With an enrollment of 43, "Managing Software Development "is the largest class registered at NTU this semester.

Professional Education

The Professional Education Project (formerly called 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 video-based course materials designed for practitioners' in-house education, and executive offerings designed for decision makers involved in improvement efforts.

A course for executives, "Software Quality Improvement," was offered at the SEI to 35 students at Tinker Air Force Base (AFB) and to 35 students from Army Materiel Command at Fort Leavenworth, Kansas.

The executive course "Software Productivity Improvement" was taught in September to students from the Air Force Intelligence Command, Defense Information Systems Agency/Center for Information Management, Salomon Brothers, and UNISYS Brazil. Also participating was an SEI resident affiliate from the National Security Agency.

Hughes Training Inc. in Herndon, Virginia and PARAMAX each purchased one videotape from the practitioner course "Software Project Management." A complete set of course materials was purchased by McClellan AFB, Huntington District Corps of Engineers, and Kelly AFB.

Science Applications International Corporation purchased 10 videotapes from the practitioner course "Software Requirements Engineering." This quarter, 115 videotapes (23 copies of five lectures) were sold to Army Training and Doctrine Command; one videotape to Lawrence Livermore Laboratory; and one complete set of course materials to Huntington Corps of Engineers.

The project released three new Technology Series videotapes focusing on risk management: *Risk Management Culture* by Robert J. Kirkpatrick, *Motivation for Software Risk Management* by Robert N. Charette, and *Up the Down Escalator: A Dynamic Three-Dimensional Model for Managing Risk* by Robert N. Charette. These stand-alone videotapes are by-products of "Software Risk Management," a course for executives.

During this quarter, a total of 32 Technology Series videotapes were sold.

Lecture Notes on Engineering Measurement for Software Engineers
CMU/SEI-93-EM-9
This report is available in electronic format via anonymous file transfer protocol (FTP).

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SEI Products
Reports

July—September 1993

For information about how to obtain copies of SEI reports, please turn to page 35.

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.

Computer Emergency Response Team

The Computer Emergency Response Team (CERT) was formed by the Advanced Research Projects Agency (ARPA) (then called the Defense Advanced Research Projects 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 practical steps to raise the community's awareness of computer security issues, and to conduct research targeted at improving the security of existing systems.

This quarter, the CERT published a revised version of "Anonymous File Transfer Protocol (FTP) Configuration Guidelines" document. This document helps system administrators configure anonymous FTP capabilities in a way that minimizes unintended use of services or resources.

The CERT published one updated advisory and four new advisories this quarter:

CA-93:09a.SunOS.expreserve.vulnerability (updated)
CA-93:10.anonymous.FTP.activity (new)
CA-93:11.UMN.UNIX.gopher.vulnerability (new)
CA-93:12.Novell.LOGIN.EXE.vulnerability (new)
CA-93:13.SCO.Home.Directory.Vulnerability (new)

The CERT hosted the 5th Forum of Incident Response and Security Teams (FIRST) Computer Security Incident Handling Workshop in St. Louis, Missouri. The workshop was attended by 140 individuals from government, university, and corporate organizations.

At the workshop, CERT members gave presentations, held panel discussions, and conducted an "incident handling" role playing exercise designed to help participants develop an awareness of the many issues encountered when handling a complex incident. For the first time, CERT members fully exercised CERT's capability for remote operations of its incident response capabilities, which includes policies and procedures for physical security, encryption, backups, and disposal of sensitive materials. The transition to remote operations was transparent to CERT constituents, and even to members of other incident response teams who attended the workshop. Law enforcement representatives and response team representatives were given an out-of-hours guided tour of the remote operations suite and provided positive feedback on the physical security and working environment.

In July, several CERT staff met with members of the team working on providing Internet services to the Executive Office of the President. The purpose of the meeting was to explain CERT's purpose and to consider how CERT might support the team's activities.

CERT staff met with members of the U.S. House of Representatives House Information Systems (HIS) group in Washington, D.C. in August. CERT personnel provided two days of instruction to 30-plus members of the HIS staff on network security issues.

A CERT staff member participated in the Internet Engineering Task Force meeting in July. While there, meetings took place between CERT staff, the CERT-NL group, and a representative from the newly forming DFN-CERT. They discussed the procedures for handling incidents, vulnerability reports, and advisories. A meeting with a representative of the DFN-CERT was particularly beneficial since it provided an opportunity to have in-depth discussions about how they were planning to operate.

CERT staff members attended the Open Software Foundation (OSF) meeting of the Security Special Interest Group, held in July in Cupertino, California. In addition to formal presentations, there was much discussion concerning how CERT will be handling vulnerability reports related to OSF software.

This quarter, CERT staff members attended the invitational National Institute of Standards and Technology (NIST) Workshop on Information Security Training and Education Needs, held in July in Gaithersburg, Maryland. At this government/industry workshop, approximately 60 IT security professionals focused on three fundamental areas:

1. Security education, awareness, and training for users, operations staff and management.

2. The knowledge base that serves as the foundation for security training, curricula, and testing.

3. Professional development and career field definition for IT security practitioners.

In July, a CERT staff member presented "CERT Incident Response" at JvNCnet Security Workshop, which was held in Princeton, New Jersey.

CERT staff members attended INET '93 (International Networking Conference), which was held in August in San Francisco, California. The paper, "CERT Incident Handling and the Internet," focused on the benefits of the Internet with CERT incident handling as the operational example.

CERT personnel attended the 1993 SEI Software Engineering Symposium, held in August in Pittsburgh, Pennsylvania. The CERT manager gave a plenary presentation on CERT. A CERT staff member presented the tutorial "Network Security for Managers."

Organization Capability Development

The Organization Capability Development (OCD) 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. The goal of the function is to provide to clients the self-sustaining capability of managing their own long-term improvement.

This quarter, the SEI "Managing Technological Change" course was presented to the Software Technology Support Center in Ogden, Utah, to Siemens in Munich, Germany, and to the public.

The executive overview of "Managing Technological Change" was presented to a total of 160 managers, from Defense Communications System Communications, Peterson AFB, the Software Technology for Adaptable, Reliable Systems Program, Texas Instruments, Union Switch and Signal, Unisys, and Warner Robins AFB.

The Consulting Skills Workshop was held twice this quarter, once at the Software Technology Support Center in Ogden, Utah and once at Peterson AFB.

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.

Process Research

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The Process Research Project continues to explore the use of statistical process management methods by individual software practitioners and small teams. 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 the personal software process (PSP) method. Primary 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 these methods 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 of Peoria, Illinois. Siemens completed the preparatory work and began using their tailored version of the PSP. During this quarter, project members met with Siemens personnel to assist them in defining a team process for the overall project and to tailor individual team member personal processes.

Work continued on preparing graduate course materials on the PSP. Materials on the first 9 textbook chapters and lectures have been completed and provided to professors at the University of Massachusetts and Howard University in Washington, D.C. Classes have started at Howard, with 20 students registered. At the University of Massachusetts, classes start in mid-September. The project has committed to make the balance of the text and lecture draft material available by early October. Both professors agreed to provide the project with data on the students' work and course results.

This quarter, the project leader visited Medtronics Corporation in Minneapolis, Minnesota and reviewed their process improvement status and plans. The project leader also participated in SEI Process Program Advisory Board meetings in July and September.

This quarter, the project leader attended a software process improvement conference and reviewed the software process improvement work at several laboratories of the Philips Corporation in Holland.

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 for 3 March 1994 and 26 May 1994. Visitors must pre-register; walk-ins will not be accommodated. Registration forms are available from Customer Relations. (See page 35 for more information.)

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

years, including increased participation from industry and government. The symposium also had 36 exhibitors this year, twice the number from last year's event. The final attendance figure for this year's symposium was 1288, an increase from last year's conference.

As of 30 September, the SEI has 25 signed technical collaboration agreements (TCA). A technical collaboration is a fixed-duration, well-defined collaborative relationship between one or more SEI projects and one or more industry partners. This form of collaboration involves a mutual commitment of resources to generate a demonstrable product. The organizations with the signed TCAs are Citicorp Services; Harris; Hewlett-Packard; Electronic Data Systems; Hughes Aircraft; IBM FSC; Logicon, Inc.; Master Systems; Northrop; Process Enhancement Partnerships, Inc.; Siemens Corporate Research; Texas Instruments; University of Southern California Center for Software Engineering. There are 11 TCAs in progress.

As of 30 September, the SEI has signed strategic collaboration agreements with 4 strategic partners. A strategic collaboration is a long-term, corporate-level relationship between the SEI and an industry organization. The relationship is characterized by a mutual statement of strategic intent and goals, and by the existence of a historical, multi-year association through resident affiliate sponsorship, masters of software engineering sponsorship, or several technical or other forms of collaboration. The strategic partners currently are Hewlett-Packard, Hughes Aircraft, IBM Federal Systems Company, and Texas Instruments.

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

Industry	Computer Sciences Corporation
	GTE Government Systems
	Hughes Aircraft Company
	IBM Federal Systems Company, Houston
	Pacific Bell
	Process, Inc.
	Siemens Corporate Research
	Texas Instruments
Government	
Air Force	Electronic Systems Center
Navy	Naval Air Warfare Center
Other DoD	National Security Agency
	Defense Contract Management Command
Academic	Madrid Polytechnic University

How to Get Additional Information

How to Order SEI Publications

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

How to Obtain Copies of Electronic Documents

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.

How to Get Additional Information

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`