A Bibliography of Externally Published Works by the SEI Engineering Techniques Program

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Review and Approval

This report has been reviewed and is approved for publication.

FOR THE COMMANDER

John S. Herman, Capt, USAF
SEI Joint Program Office

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A Bibliography of Externally Published Works by the SEI Engineering Techniques Program

Abstract: This bibliography lists works by the members of the Software Engineering Institute (SEI) Engineering Techniques Program that are not published or available from the SEI. The bibliography is organized by type of work (i.e., journal or magazine article, book, or proceedings). Indices are provided by author and targeted audience.

1 Introduction

This bibliography lists work by members of the Engineering Techniques Program that were published during their employment at the SEI, but are not available from the SEI.

The organization of the bibliography is by type of work (journal or magazine article, books in whole or in part, and work in proceedings). Within each of these categories, the organization is alphabetical by primary author. Each entry contains the name(s) of the author(s), title of the work, targeted audience, and publication information. Where available, abstracts are also included.

The primary focus of the Engineering Techniques Program is tools and methods that operate on and within the software process to control and improve it. Some of the subjects that are addressed in the works listed are:

- CASE tools, adoption, and integration
- code inspection
- computing research and direction
- configuration management
- domain analysis
- domain-specific architectures
- integrated software process environments (IPSEs)
- interactive video, multi-media, and virtual reality
- model-based engineering
- programming languages
- reuse
- software architectures
- software engineering as a discipline
- software engineering education
- software engineering environment integration
The target audiences were determined using the following definitions:

**Manager:** Senior managers responsible for leading software organizations to build higher quality software and to do it more productively.

**Practitioner:** Software professionals responsible for producing and maintaining better software.

**Educator:** Those responsible for improving software engineering education and training.

More information about the Software Engineering Institute is provided in Appendix A. Appendix B provides a listing of the members of the Engineering Techniques Program as of July 1992.

**Note:** To obtain copies of the publications listed in this document, contact your local libraries or the sources cited.
2 Journal and Magazine Articles


Audience: Manager

Abstract: The state of the practice in software engineering has not evolved fast enough to keep pace with the rising demand for increasingly larger, more sophisticated software systems and components. Today, software contractors are faced with numerous difficulties that prevent them from fulfilling the software needs of the market—difficulties that result in excessive costs for systems with reliability that is, in too many cases, questionable at best.


Audience: Practitioner

Abstract: A discussion of some of the issues of tool integration in an integrated project support environment (IPSE). A conceptual framework is proposed for analyzing and measuring aspects of integration in an IPSE.


Audience: Manager, Practitioner

Abstract: A detailed bibliography on tool integration in a software engineering environment. Contains summaries of over 20 pages that are important in this topic area.


Audience: Practitioner, Educator

Abstract: A digital video course on software technical reviews illustrates how virtual reality can be implemented today on a personal computer platform. The advantages of using a virtual environment for teaching code inspections are discussed, as are the implications of making that environment increasingly realistic.


Audience: Practitioner

**Audience:** Manager, Practitioner

**Abstract:** All too often would-be CASE implementors find that the costs of adopting a new CASE tool are much higher than they originally anticipated. This is because implementors often focus only on the direct CASE tool purchase cost, overlooking significant other costs — not only in dollars, but in terms of people and time. This article attempts to address the very practical issue of providing a complete basis for a realistic cost estimate for the adoption of a CASE. A summary of this article is organized into two tables: primary cost items and primary cost drivers. Many subjects discussed in this article lead to other significant CASE-related topics. These are addressed superficially, but pointers are supplied to more detailed information.


**Audience:** Practitioner, Educator


**Audience:** Practitioner


**Audience:** Practitioner


**Audience:** Practitioner, Educator

**Abstract:** This article attempts to standardize the use of many terms used in the software reuse literature. Three terms of particular interest — taxonomy, software reuse, and domain analysis — and some problems with their usage are discussed. The specific problems with these terms are generalized and several solutions are given, the most important being the introduction of the concept of using reuse process models to provide both context and an overall view of the potential areas of discourse in reuse. Several new terms are proposed for future use; definitions of existing terms that are meaningful in the context of software reuse are also included.
Audience: Practitioner, Educator

Audience: Manager, Practitioner, Educator
Abstract: As society's dependence on computing broadens, software engineering is being called upon to address new problems that raise new technical and nontechnical concerns. Aspirations and expectations for the application of computers appear to be unbounded, but present software development and support techniques will not be adequate to build computational systems that satisfy our expectations, even at very high cost. Each order-of-magnitude increase in the scale of the problems being solved leads to a new set of critical problems that require essentially new solutions. The next challenges for software engineering will deal with software as one of many elements in complex systems, which we call program-as-component, and with the role of software as an active participant in the software development process, which we call program-as-deputy.

Audience: Manager, Practitioner, Educator
Abstract: See Shaw86b, above.

Audience: Practitioner, Educator

Audience: Educator
Abstract: Just as some years are memorable for their wines, some years are memorable for their research. In software, 1968 was such a year. It was the year the software research community really started thinking systematically, even formally, about software structures.

Audience: Practitioner, Educator
Abstract: See Shaw89d, page 22.

**Audience:** Practitioner, Educator  
**Abstract:** See Shaw86b, page 5.


**Audience:** Manager, Practitioner, Educator  
**Abstract:** Can history provide at least a rough guide to the nature of the problems that face software engineering? An engineering discipline emerges from craftsmanship in two stages, Shaw has found. First, systematic production techniques and management methods turn craftsmanship into routine commercial production, as shown in the accompanying table. Later, the problems of production practice yield professional engineering practice. In an interview with Contributing Editor Ware Myers, Shaw described this process as it relates to software.


**Audience:** Manager, Practitioner, Educator  
**Abstract:** Software engineering is not yet a true engineering discipline, but it has the potential to become one. Older engineering fields offer glimpses of the character software engineering might have. The term "software engineering" was coined in 1968 as a statement of aspiration—a sort of rallying cry. That year NATO convened a workshop by that name to assess the state and prospects of software production. The resulting practice, however, differs significantly from the practice of older forms of engineering.

This paper examines the usual practice of engineering and the way it has evolved in other disciplines, considering two examples in depth. This provides a historical context for assessing the current practice of software production and setting out an agenda for attaining an engineering practice.


**Audience:** Educator  
**Abstract:** Information technology and computer science have not only reshaped computation, communication, and commerce; they have expanded the basic models and paradigms of many disciplines. Informatics education has obligations to all the communities that rely on information technology, not just computing professionals. Serving this extended audience well requires changes in the content and presentation of computing curricula. This paper sketches the coming needs for information processing and analyzes the populations that will require
informatics education. It considers curriculum requirements through two examples, one outside the traditional boundary of computer science and one inside.

Audience: Educator
Abstract: Hurrah for William A. Wulf's statement in opposition to separate undergraduate software engineering programs.

Audience: Manager, Practitioner
Abstract: This article discusses the background for environments and tools. It overviews the major types of tools and the place of tools within software development. It discusses some of the issues in the use of tools, such as integration and scalability, and the implications of tools for software development.

Audience: Practitioner
Abstract: This article discusses holographic and optical techniques to create real (in the optical sense) three dimensional interactive images. Interactive design criteria and human factors based visual fidelity issues are addressed.

Audience: Practitioner, Educator
Abstract: The need for technological solutions to learning in the software engineering field is increasing. The Advanced Learning Technologies Project (ALT) has developed a highly interactive, high-fidelity simulation of group process communication. The first course demonstrating these techniques is on the formal technical review known as code inspection. This article discusses technical aspects of ALT's system design.
3 Books in Part or in Whole


Audience: Educator
Abstract: Reflecting the structure and emerging needs of modern computer science, this book presents a comprehensive redesign of the traditional curriculum emphasizing: the integration of fundamental conceptual material with the best of current practical applications; the identification and reorganization of topics based on common themes into single new courses; and the specification of requirements for computer support needed to illustrate important points made in the courses described.

The Carnegie-Mellon curriculum design, developed by eight leading computer scientists, is formulated to last for the next decade and to play a leadership role in computer science education. Specifically, the curriculum includes: a detailed descriptions of 30 new or revised computer science courses; requirements for a computer science major consisting of a small core of courses that allow for a variety of specializations within the major; courses offered by other departments that present material relevant to computer science.


Audience: Practitioner, Educator
Abstract: Over 350 pages describing requirements for a software engineering environment (SEE), an analysis of a number of existing SEEs, and an examination of some key issues in this field. The book makes use of the European Computer Manufacturers (ECMA) reference model for frameworks of a SEE as a basis for comparing HP SoftBench, ECMA PCTE, DEC's CIS, and IBM's AD/Cycle.


Audience: Manager, Practitioner
Abstract: The potential benefits of software reuse are well-known; thus the question arises "Why isn't software reuse more widely practiced?" A misconception about what is required to encourage effective levels of reuse has hindered reuse efforts in the past. It is not reason-
able to expect high levels of reuse to result from merely cataloging existing code and making it available. Software must be engineered for reuse (either initially or during some type of retry-fitting process), and new applications must plan for reuse. There are three approaches to software reuse that cover the spectrum from short-term to long-term: adaptive, parameterized, and engineered. Tool support can facilitate both the introduction and practice of software reuse.


Audience: Manager, Practitioner, Educator


Audience: Educator

Abstract: The discipline of software engineering is developing rapidly. Its practitioners must deal with an evolving collection of problems and with new technologies for dealing with those problems. Software engineering education must anticipate new problems and technologies, providing education in the enduring principles of the field in the context of the best current practice. Since changes in the discipline cannot be completely anticipated, software engineers must be able to assume responsibility for their own continuing professional development. This paper describes significant changes now taking place in the field of software engineering and proposes some goals and objectives for the professional education of software engineers.


Audience: Practitioner, Educator

Abstract: The major issues of modern software are its size and complexity, and its major problems involve finding effective techniques and tools for organization and maintenance. This paper traces the important ideas of modern programming languages to their roots in the problems and languages of the past decade and shows how these modern languages respond to contemporary problems in software development. Modern programming's key concept for controlling complexity is abstraction—that is, selective emphasis on detail; new developments in programming languages provide ways to support and exploit abstraction techniques.

**Audience:** Practitioner, Educator

**Abstract:** See Shaw87b, page 9


**Audience:** Practitioner, Educator

**Abstract:** Software needs now strain the design limits of traditional programming languages. Modern application needs are not satisfied by traditional programming languages, which evolved in response to systems programming needs. Current programming language research focuses on incremental improvements, not on major changes to the nature of software development. But major breakthroughs are needed in two areas:

1. Non-programmers dominate modern computer use. Low computing costs have enabled a wide spectrum of application, and end users who are not programmers need to control their own computations. Order-of-magnitude increases in service require substantial shifts of technology. Computer users are interested in results, not in programming; software must reflect this.

2. Requirements for large complex software systems exceed our production ability. Growth of demand is greater than growth in capacity, and system requirements exceed the scope of conventional languages. Software lacks a true engineering base. Language concepts can support a design level above the algorithm/data structure level and contribute to an engineering discipline.

Programming language designers must look beyond the traditional systems programming domain and tackle problems of special-purpose software and system-level software design.


**Audience:** Practitioner, Educator

**Abstract:** See Shaw87b, page 9.

Audience: Manager, Practitioner

Abstract: This report summarizes a workshop held last February under the sponsorship of the Computer Science and Technology Board of the National Research Council. The Computer Science and Technology Board set out to examine the problems of producing large complex software systems. The problems most frequently cited are those of cost overruns, schedule overruns, and software that fails to perform either to its requirement or to its intended function. But as we organized the workshop, we broadened our definition of the problem to include the opportunity costs of software that could not be created because software production capabilities were not up to the task of its creation.


Audience: Practitioner

Abstract: Accessing massive multimedia databases will require multiple representations of those databases. Initial access may be through visual representations of the database. However, traversing numerous levels of tree-like structures will quickly find the user lost. Simple database queries may overwhelm users with information.

To overcome these problems, the Advanced Learning Technologies Project at Carnegie Mellon University's Software Engineering Institute embeds in multimedia objects the knowledge of the content of those objects over several dimensions. With this model, variable granularity knowledge about the domain, content, image structure, and the appropriate use of content and image is embedded with the object. In ALT, a rule base acts as a visual director, making a judgment on what image to display and how to manipulate it. This provides the ability to present disparate text, audio, images, and video intelligently in response to users' needs. This chapter discusses these techniques and provides examples of objective and subjective knowledge types for multimedia objects.
4 Work in Proceedings


Audience: Practitioner, Educator


Audience: Practitioner, Educator


Audience: Practitioner, Educator

Abstract: The Software Engineering Institute is creating one of the first training applications using Intel's Digital Video Interactive (DVI) technology. This application is a course on code inspections, a formal technical review process noted for its importance to software quality by organizations such as IBM and AT&T Bell Laboratories. In addition to incorporating many new design techniques made possible by digital video, the course also includes a hypertext tool, menu-based natural language interface, and an expert system. The design and development of this course are discussed, with primary focus on those aspects of the course that are uniquely suited to the DVI medium. New interactive digital video technologies, such as DVI, CD-I, and hybrid analog and digital videodiscs, are just beginning to become commercially available. This paper communicates some lessons learned in the development of one course that future interactive digital video developers may find useful.


Audience: Educator

Abstract: Software engineers need practical training in addition to classroom lectures to obtain the knowledge and skills necessary to succeed in industry. This training is provided by laboratories in other engineering disciplines. Such laboratories have been implemented as computer-based interactive video courses in the past, with numerous advantages. Based on this success, an interactive video course was created for use as a "code inspection laboratory," in which the skills of preparing for and participating in code inspections are learned and
practiced. This paper summarizes the anecdotal feedback and usage data from 120 students who used the course over the past two years. Lessons learned from these experiences are discussed, with implications for the development of future interactive video software engineering laboratories.

Audience: Practitioner
Abstract: Locating resources in a collection of reusable software requires integration of management and retrieval methods. The maintainer of the collection will need different operations and modes of access from an application developer using the collection. Users of the collection will want access to it at different phases of the life cycle. Finally, users will have expertise in different application domains, but may desire access to the same information.

This paper briefly examines methods for managing and locating reusable resources. These methods include both attribute- and facet-based information retrieval. The paper also introduces a new method to support search and retrieval that captures information specific to an end-user application (both requirements and design) and matches that information to resources in the library. Integration of these approaches is essential for successful reuse-based software development.

Audience: Practitioner, Manager
Abstract: The adoption of reuse into software development will include the definition of new products and processes. On the product side, we must identify the form of deliverables that can support reuse; on the process side, we must identify the approach needed to develop and apply those products. This paper examines the processes and products that can lead to successful reuse. The first process, one widely used today, is to adapt an existing system to meet a new set of requirements. The second, a relatively new practice, identifies families of programs, providing support for parameterization of commonality and customization for unique requirements. The third process is a reuse-based engineering approach to discover and exploit commonality in software systems as the basis for software development.

Audience: Practitioner, Educator
Audience: Practitioner, Educator

Audience: Manager, Practitioner, Educator

Audience: Practitioner

Audience: Manager, Practitioner, Educator

Audience: Manager, Practitioner, Educator

Audience: Manager, Practitioner, Educator

Audience: Manager, Practitioner, Educator

Audience: Practitioner, Educator
**Abstract:** We have been observing the design methods of software practitioners and engineers in other disciplines and have noticed differences. The most notable difference is the lack of models available to the software practitioner. We have reached several conclusions as a result of our observations and work:

- What is currently being called software engineering is not really engineering in the traditional sense
- There are important lessons about the design process to be learned from traditional engineering disciplines
- The application of one of the key concepts in engineering, the process of modeling, has the potential for high payoff.

This report describes our experience and successes with modeling.

**Audience:** Practitioner, Educator

**Abstract:** The software architectures engineering effort at the SEI has developed engineering modeling techniques that both reduce the complexity of software for domain-specific computer systems and result in systems that are easier to build and maintain. These techniques allow maximum freedom for system developers to apply their domain expertise to software.

We have applied these techniques to several types of applications, including training simulators operating in real time, engineering simulators operating in non-real time, and real-time embedded computer systems. Our modeling techniques result in software that mirrors both the complexity of the application and the domain knowledge requirements. We submit that the proper measure of software complexity reflects neither the number of software component units nor the code count, but the locus of and amount of domain knowledge. As a result of using these techniques, domain knowledge is isolated by fields of engineering expertise and removed from the concern of the software engineer. In this paper, we describe kinds of domain expertise, describe engineering by domains, and provide relevant examples of software developed for simulator applications using the techniques.


**Audience:** Practitioner, Educator

**Abstract:** This paper describes a model for the engineering of products and some implications for the model. The concepts are from typical engineering disciplines. Supporting material can be found in many standard engineering texts.


**Audience:** Practitioner, Educator


**Audience:** Practitioner, Educator

**Audience:** Manager, Practitioner, Educator


**Audience:** Educator

**Abstract:** As software systems grow in size and complexity their design problem extends beyond algorithms and data structures to issues of system design. This area receives little or no treatment in existing computer science curricula. Although courses about specific systems are usually available, there is no systematic treatment of the organizations used to assemble components into systems. These issues—the *software architecture* level of software design—are the subject of a new course that we taught for the first time in Spring 1992.

This paper describes the motivation for the course, the content and structure of the current version, and our plans for improving the next version.


**Audience:** Practitioner


**Audience:** Practitioner


**Audience:** Practitioner


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Audience: Practitioner

**Audience:** Practitioner

**Abstract:** In general, the software systems planned for the next five to ten years are expected to be far larger, or far more complex, than anything successfully built to date. When we review the success rate for current large-scale systems, we conclude that the traditional ways of building such systems are unlikely to deliver well-engineered systems of the projected scale.

Our experience helping to build systems in several important areas (flight simulators and training devices, command and control systems, MIS systems, embedded missile seeker systems) has convinced us that unless software development becomes more oriented to traditional engineering practice, most of the major problems related to software development will remain. Software engineering has much to gain by emulating the practices of systems engineering where there has been a way of designing the systems while maintaining a clear separation of domain expertise needed to produce each system component.


**Audience:** Practitioner


**Audience:** Practitioner


**Audience:** Practitioner

**Abstract:** There are problems with the use of many of the terms used in software engineering when applied specifically to reuse. Three terms of particular interest, taxonomy, software reuse, and domain analysis and some problems with their usage are discussed. The specific problems with these terms are generalized and several solutions are given, the most important being the introduction of the concept of a reuse process model to provide context and an overall view of the potential areas of discourse in reuse. Several new terms are proposed for future use as well as definitions of existing terms that are meaningful in the context of software reuse.
Audience: Practitioner

Abstract: This paper briefly describes a specific portion of recent work performed by the domain-specific software architectures efforts at the SEI-the development and use of a model solution for message translation and validation in the C3I domain. Based on this experience and our involvement with programs in the C3I domain, future considerations are described. These considerations involve identifying potential models within a domain and making recommendations for developing and documenting model solutions that will enable the models to be reused.


Audience: Practitioner

Abstract: See Plinta89a, page 20.


Audience: Practitioner

Abstract: This paper provides guidance for identifying candidate architectures based on the author's experience. Two approaches to finding an architecture for an application area are discussed: an archeological approach and a contextual approach.


Audience: Manager, Practitioner


Audience: Practitioner, Educator

**Audience:** Practitioner

**Abstract:** Interactive user interfaces depend critically on underlying computing system facilities for input and output. However, most computing systems still have input-output facilities designed for batch processing. These facilities are not adequate for interfaces that rely on graphical output, interactive input, or software constructed with modern methodologies. This paper details the deficiencies of batch-style input-output for modern interactive systems, presents a new model for input-output that overcomes these deficiencies, and suggests software organizations to take advantage of the new model.


**Audience:** Practitioner

**Abstract:** Formal specifications customarily deal exclusively with the domain of functional properties of software. However, other domains are of interest to software designers and developers. Two particular areas of concern for practical software development are not yet well served by formal specifications. This paper raises issues about how these areas might be better served.


**Audience:** Practitioner

**Abstract:** See Shaw85a, page 21.


**Audience:** Practitioner, Educator

**Abstract:** See Shaw86b, page 5.


**Audience:** Educator

**Abstract:** In the past year or two, software reuse has gained fresh attention as a technique for dealing with some of the problems of software development and maintenance. Unfortunately, much of the acclaim is uncritical, the subject is more complex that many of its advo-
cates realize, and thirty years of indifferently successful history is often ignored. As a result, "software reuse" is in danger of becoming the empty buzzword of the late 1980s.

This paper sharpens the focus on the problems that software reuse might solve and how it might do so, and proposes some structure for the subject area in order to bring out some of the (very different) concerns of various projects and to make objective comparisons of different techniques possible.


Audience: Practitioner, Educator

Abstract: Software now accounts for most of the cost of computer-based systems. Over the past thirty years, abstraction techniques such as high-level programming languages and abstract data types have improved our ability to develop software. However, the increasing size and complexity of software systems have introduced new problems that are not solved by the current techniques. These problems involve the system-level design of software in which the important decisions are concerned with the kinds of modules and subsystems to use and the way these modules and subsystems are organized. This level of organization, the software architecture level, requires new kinds of abstractions. These new abstractions will capture essential properties of major subsystems and the ways they interact.


Audience: Educator

Abstract: See Shaw89b, page 5.


Audience: Practitioner, Educator

Abstract: Over the past thirty years, abstraction techniques such as high-level programming languages and abstract data types have improved our ability to specify and develop software. However, the increasing size and complexity of software systems have introduced new problems that are not solved by the current techniques. These new problems involve the system-level design of software in which the important decisions are concerned with the kinds of modules and subsystems to use and the way these modules and subsystems are organized. This level of organization, the software architecture level, requires new kinds of abstractions that capture essential properties of
major subsystems and the ways they interact. This paper discusses classical system organizations, the building blocks from which they are constructed, and a programming-language approach to specification.

Audience: Practitioner, Educator

Audience: Practitioner, Educator
Abstract: Hardware design is carried out at several different levels, with different issues, models, and design strategies at each level. The same situation is true for software, except that the distinctions among levels—or even the existence of distinct levels—is not as widely recognized. A delivered software system should consist of a model for each of these levels, each expressed in some appropriate language.

Audience: Practitioner
Abstract: Domain analysis for reuse is a topic of much current interest and study. While there are several variations of domain analysis, they are usually characterized by their emphasis on application dependencies. This position paper describes architectural analysis which is a type of analysis for furthering our understanding of software architectures. It attempts to raise the abstraction level of design elements and, thereby, emphasizes domain independence. Although architectural analysis and domain analysis for reuse have different processes and goals, they are closely related and support one another. This mutual support is identified and examined.

Audience: Educator
Abstract: The software engineering course provides undergraduates with an opportunity to learn something about real-world software development. Since software engineering is far from being a mature engineering discipline, it is not possible to define a completely satisfactory syllabus. Content with a sound basis is in short supply, and the material most often taught is at high risk of becoming obsolete within a
few years.

Undergraduate software engineering courses are now offered in more than a hundred universities. Although three textbooks dominate the market, there is not yet consensus on the scope and form of the course. The two major decisions an instructor faces are the balance between technical and management topics and the relation between the lecture and project components. We discuss these two decisions, with support from sample syllabi and survey data on course offerings in the United States and Canada. We also offer some advice on the management of a project-oriented course.


Audience: Educator


Audience: Practitioner, Educator
Abstract: The current practice of software engineering bears only slight resemblance to the usual standards of engineering practice. This is in part a consequence of the immaturity of the field, but it also results from the failure of software engineering education to instill an engineering mindset in students. This position paper discusses the character of engineering practice with special emphasis on the routine use of reference materials; based on this characterization, it suggests ways software engineering education could better support good engineering practice.


Audience: Educator
Abstract: See Shaw91b, page 11.


Audience: Practitioner
Abstract: Software designers use a variety of structural patterns to specify system architectures. These patterns, or idioms, are currently
used informally and imprecisely. Nevertheless, they provide a useful, broadly shared vocabulary. In practice, a given design often relies on several patterns. This paper reviews some common architectural idioms, shows several ways in which they are used heterogeneously, and discusses the benefits of making these idioms and their combinations more explicit and precise.


**Audience: Practitioner, Educator**

**Abstract:** It is a prime tenet of most programming language design that "higher-level" languages are a good thing — indeed the higher the level, the better. The assumption is that the higher the level of the language — the more abstract the abstractions — the greater the leverage provided to the programmer. Language designers usually ensure that the higher-level constructs capture their intention by completely specifying the associated semantics.

A decade ago, we challenged the "higher-level is better" assumption. The paper in which we did this has largely been ignored. In fact we see this apparently benign assumption as aggressively interfering with good application design. Unfortunately, the consequences of blind adherence to this tenet are spreading in both current language proposals and larger system designs. This paper re-examines the claim that "higher-level" is better and the counter-claim that "higher-level" constructs interfere with software development when they preempt the developer’s design prerogatives. The starting point for discussion is our earlier paper, "Toward Relaxing Assumptions in Languages and Their Implementations".


**Audience: Practitioner**

**Abstract:** It is difficult to move through information that has an intrinsic and essentially fixed temporal element such as video. While detailed indexing of video can help, users often wish to peruse video much as they flip through the pages of a book. This paper highlights two techniques developed for the Advanced Learning Technologies Project that will facilitate such searches. First, detailed, embedded knowledge of the video information will allow for scans by various views, such as by content area or depth of information. Second, partitioning multimedia data into smaller objects reduces bandwidth problems associated with accessing central data in large video files. Concatenation of logically contiguous files allows for seamless, continuous play of long sequences.

Audience: Practitioner, Educator

Abstract: Using empirical and anecdotal data this paper discusses virtual reality interface design and testing including methods of navigation (both physical and information spaces), natural language interfaces, and image composition. Fidelity issues from high level design of virtual worlds to image resolution and frame rate are discussed.


Audience: Practitioner

Abstract: The software architectures engineering effort has been developing ideas about software architectures and model-based design issues for several years. During this period, both models and architectures (assemblages of models) have been developed for several projects. This article discusses the transition of an existing model to a new application area and the architecture that resulted.
5 Acknowledgments

Many thanks to all the authors listed for their assistance and contributions toward the creation of this bibliography. In addition, special thanks go to those who reviewed this work, in particular, Dan Bidwa, Mike Christel, Tim Herren, Fred Long, Jeff Stewart, Judy Vernick, Jim Withney, and especially to the technical writer/editor, Sandra Bond, for her expertise and guidance.
Appendix A  Information about the Software Engineering Institute

For more information about the Software Engineering Institute, or to obtain a copy of the current version of "SEI Reports: Annotated Listing" (a listing of SEI reports that are available for public distribution), contact:

Kristine Peebles
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Appendix B  Members of the SEI Engineering Techniques Program as of July 1992

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Michael Caldwell*
Michael Christel
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Sholom Cohen
Susan Dart
Jane Walter DeSimone
Richard D'Impolito
Peter Feiler
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Sandy Brenner and Gibbie Hart

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