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ACEC & AES MERGER WORKSHOP REPORT



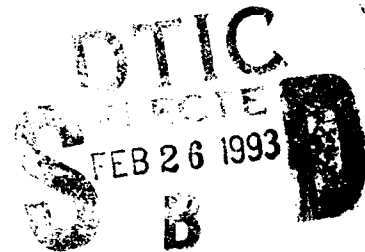
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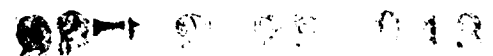
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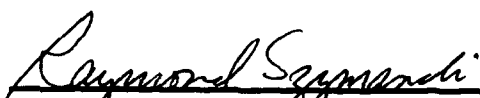
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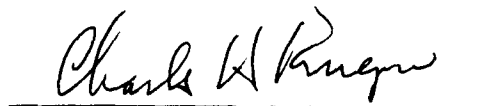
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| <p>This report summarizes the activities and results of the ACEC &amp; AES Merger Workshop which was conducted 22-24 January 1992. The purpose of the workshop was to discuss the issues pertinent to the merging of two distinct Ada compiler evaluation test suites. This report contains the recommendations provided by the participants and the supporting rationale for each recommendation. Also included is the presentation material used during the workshop and a list of the participants.</p> |  |   |  |  |  |  |  |
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## ACKNOWLEDGEMENTS

The author is indebted to all the Workshop participants for their accomplishments during this event which has produced a significant milestone in the Ada program. Because of the expertise and dedication of these individuals, the Workshop results have contributed substantially to the overall goals of the ACEC & AES Merger activity. Additionally, I extend my gratitude to George Robertson, Lloyd Stiles and their support staff at NCCOSC, San Diego, for hosting the Workshop and providing critical administrative and technical support. Special thanks also goes to Barbara Rhoads and Trudy Grube who patiently listened, recorded and transcribed the proceedings for use in developing this report.

## PREFACE

In June 1991, the Department of Defense of the United States of America (US DoD) and the United Kingdom Ministry of Defence (UK MOD) agreed to merge their respective Ada compiler evaluation test suites and produce a single, internationally available suite.

The development of the US suite, the Ada Compiler Evaluation Capability (ACEC), is managed by Mr. Raymond Szymanski of Wright Laboratory and was accomplished by Boeing Defense and Space Group Product Support Division, Wichita, Kansas. This effort is sponsored by the Ada Joint Program Office (AJPO).

The development of the UK suite, the Ada Evaluation System (AES), was accomplished by the British Standards Institute and Software Sciences Ltd. This effort was sponsored by the United Kingdom Ministry of Defence.

The agreement between the two governments established the AJPO as the office responsible for carrying out the merger. As a result, the ACEC contractor developed an initial approach to merging the two suites after completing a substantial study of the AES. Their observations and analysis were used as a starting point for Merger Workshop discussions.

The Workshop co-chairs were Mr. Raymond Szymanski of Wright Laboratory, Evaluation & Validation Program Manager, and Mr. Dan Roy, of the Software Engineering Institute, Real-time Embedded Systems Testbed (REST) Project Leader.

The accomplishments of the Workshop are an important contribution to defining the merged product. Improvements in portability, usability, and completeness are expected as a result of the recommendations made and issues addressed.

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## **1.0 EXECUTIVE SUMMARY**

### **1.1 Background**

Dr John Solomond, AJPO Director, decided that the Ada community would be best served by a single Ada compiler evaluation suite. This test suite would embody the best capabilities of two government developed test suites, the ACEC of the US DoD, and the AES of the UK MoD.

In June 1991, the governments agreed to a suite merger with the US DoD's AJPO responsible for the activity. The AJPO, in turn, tasked Mr. Raymond Szymanski, the E&V Project manager, with management responsibility for the merged product. Mr. Szymanski is also responsible for the Planned Product Improvement cycle on the existing ACEC.

As specified in the merger agreement, the merged suite will have unlimited distribution to the Ada community both in the US and internationally.

### **1.2 Workshop Initiation**

The success of the ACEC, as measured by over 200 users and the benefits derived from its use, is attributable to several management practices and technical factors employed during its development. These practices and factors include: product peer review during development, user evaluation between releases, selection of technically competent developers and reviewers, and team membership consistency. Additionally, participants from each user sector, government, industry and academia, provided the necessary multiple perspectives to insure all user needs were considered.

Following this successful formula, workshop invitees included the developers of the ACEC & the AES, a variety of users of both suites, compiler vendors, and independent evaluators of the ACEC & AES. This mix ensured that both test suites, as well as many types of future merged-suite users, were well represented.

### **1.3 Workshop Philosophy**

The workshop was organized in a fashion to permit the participants to re-orient themselves to the details of both test suites and hear independent assessments of each. To allow this, the developers of both the ACEC and the AES were invited to present details of their suite's latest version, and plans for future versions. Individuals who have used either one or both suites were invited to present their findings of each suite's strengths and weaknesses. Additionally, the merger project office was invited to

present a proposed approach to merging the two suites. These presentations would then be followed by nearly two days of discussion on the merger subject.

#### 1.4 Workshop Accomplishments

The debates and discussions that ensued during the workshop were vigorous and informing. As a result, the workshop succeeded in providing numerous positive recommendations relevant to merging the ACEC and AES. Some of those recommendations are listed below in a non priority order. Details of these recommendations, related issues and relevant discussion are contained in the main document sections and the appendices.

- Recommended "portability", "usability", and "completeness" as primary requirements for the merged product.
- Recommended the merged product to be an ACEC adaptation of AES technology and functionality.
- Recommended a level of technical review be performed on AES elements prior to inclusion in the merged suite.
- Recommended the E&V Reference System as the future home for all AES non-compiler-related assessors.
- Recommended a priority for the integration of AES compiler-related assessors
- Recommended user interface improvements
- Recommended analysis reporting improvements

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## **2.0 ACEC & AES MERGER WORKSHOP PROCEEDINGS**

This section provides a summary of the workshop presentations, merger issues, discussions and merger recommendations.

### **2.1 Opening Remarks**

The ACEC/AES Merger Workshop opened with a welcome and an introduction to the area by Mr. George Robertson, of Fleet Combat Directional Systems Support Activity (FCDSSA), San Diego. Mr. Robertson detailed the Navy's commitment to the Ada Language and the challenges they faced during the upcoming transition years. In closing, Mr. Robertson described FCDSSA's usage of the ACEC test suite during evaluation of the Navy's Ada Language System / Navy (ALS/N).

Mr. Raymond Szymanski, Merger Workshop co-chair, welcomed everyone on behalf of Dr. John Solomond, AJPO Director and Mr. Dan Roy, fellow co-chairman. He stated the main objective of the workshop was to review and refine an approach to merging the ACEC and the AES. He reminded the participants that they were chosen on the bases of their technical expertise, their ability to work cooperatively as part of the merger team, and for the different professional perspectives they could provide. He reviewed the proposed agenda for the meeting and briefly discussed the various presentations that would be forthcoming.

Mr. Dan Roy commented on the need for the workshop attendees to consider cultural differences in the development of the two suites in addition to considering the views of users, vendors, and governments. He stated that his philosophy for the workshop is that the process of evaluation is more important than the specifics of the technology.

### **2.2 Summary of Presentations**

The workshop was organized in a fashion to permit the participants to re-orient themselves to the details of both test suites and hear independent assessments of each. To allow this, the developers of both the ACEC and the AES were invited to present details of their suite's latest version, and plans for future versions. Individuals who have used either one or both suites were invited to present their findings of each suite's strengths and weaknesses. Additionally, the merger project office was invited to present a proposed approach to merging the two suites. These presentations are summarized below. The presentation vu-foils can be found in the appendices.

Note: Unfortunately, the AES developers were unable to attend the Workshop. However, AES information was presented by other attendees.



### **2.2.1 ACEC Version 3.0 Product - Boeing**

Sam Ashby, Kermit Terrell, and Barbara Decker-Lindsey of the Boeing Defense and Space Group Product Support Division provided a status report on ACEC Version 3.0 development and a comprehensive presentation on ACEC Version 3.0 capabilities.

Mr. Ashby reported that ACEC Version 3.0 testing has been completed on five target systems, including the DEC self-hosted Ada, Telesoft VAX self-hosted Ada, VAX hosted compiler targeted to a 1750A processor (TLD), Meridian DEC Station self-hosted (UNIX), and Verdix self-hosted Silicon Graphics. All problems identified during testing were resolved and delivery was made to the customer on 18 December 1991. Mr. Ashby concluded by stating that the product is currently undergoing final customer review.

Mr. Terrell's presentation detailed the improvements made to the ACEC in Version 3.0 which included test suite reorganization, additional performance tests, new and expanded assessors, a new pre-test capability, and an enhanced user interface.

Ms. Decker-Lindsey's presentation detailed the capabilities of the ACEC Version 3.0 analysis tools and explained where improvements were made in analysis tool capabilities and user interfaces. These improvements include a user menuing system, an editable results data base, a data extraction tool, and a reduction in the number of steps required to perform the analysis.

### **2.2.2 AES Version 2.0 Assessment - Boeing**

Mr. Tom Leavitt presented a review of the AES Version 2.0, based on his experience with running the AES, focusing specifically on the test harness, specific performance tests, assessors, and analysis and reporting capabilities. Mr. Leavitt's activities for this review included reading the documentation, examining the source code for the performance tests, executing the performance test groups, and running other selected AES elements.

### **2.2.3 AES Version 2.0 Assessment - SEI**

Mr. Neal Altman presented a review of the AES Version 2.0, based on his experience with running the AES, focusing on the executable benchmark tests and the test harness as primary concerns, with the checklists and documentation as secondary concerns. He also discussed AES organizational issues and features.

#### **2.2.4      ACEC Version 3.0 Assessment - SEI**

Mr. Patrick Donohoe presented his experience with ACEC Version 3.0. He discussed the suite's documentation and the pre-test setup steps. He also discussed the performance tests that he had run to date.

#### **2.2.5      E&V Reference System Version 3.1 Demonstration - TASC**

Dr. Bard Crawford gave a demonstration of the Evaluation and Validation (E&V) Reference System Version 3.1 which is implemented with a hypertext capability. During this presentation he discussed the purpose of the E&V Reference System and demonstrated the new functionality and usability provided via hypertext.

#### **2.2.6      ACEC & AES Merger Technical Approach - Boeing**

Mr. Kermit Terrell presented a proposed approach to merging the ACEC and AES. As background information he provided a set of high level merged-suite requirements along with a list of technical issues that would need to be addressed prior to the merger. Mr. Terrell also presented details of AES technology and capabilities which should or should not be considered for inclusion in the merged product.

This presentation formed the basis for the issues, recommendations, and discussions that are contained in the following sections. Therefore, these items are not repeated in this section.

### **2.3    Issues and Recommendations**

This section outlines the issues and recommendations that were formulated during the discussion portion of the Workshop. The participants were encouraged to raise issues, provide comments and tender recommendations as if all issues could be researched and all non-conflicting recommendations could be implemented. This approach proved successful in creating a robust list of issues and recommendations, even though the participants knew a priori that the scope of the merger could not support this assumption.

The following issues were raised at the workshop and are briefly discussed in the sections below. Additional discussion on each is provided in the appendices.

- Basic approach for merger
- Development of a merger requirements document

- Utilization of AES performance tests
- Utilization of AES assessors
  - Compiler-related
  - Non-Compiler-related
- Functionality of user interface.
- Ease of test suite setup.
- Functionality of the reporting tools.
- Functionality of the analysis tools

### 2.3.1 Issue - Basic Merger Approach

Should the merged suite be an adaptation by the ACEC of AES functionality or an adaptation by the AES of ACEC functionality ?

**Discussion:** The basic approach to merging the two suites should be based upon high level requirements that consider the following: portability, usability, completeness, ease of adaptation, number of users of each suite, and the types of intended users.

The designs of the ACEC and AES were significantly influenced by the developers' understanding of who the end users were intended to be. The AES, which was designed for use on a single host by a centralized test facility, is not easily ported to new host/target combinations and currently has few users. The ACEC, however, which was designed to be portable to accommodate the independent tester, currently has two hundred users who test compilers on many different host and target combinations.

Both suites require an amount of adaptation by the user. The ACEC was designed for ease of adaptation and support is provided to the user in the documentation for this process. The AES emphasized ease of use over portability. For this reason the adaptation effort is higher.

A review of the AES test harness code reveals that it would be difficult and expensive to port this system to hosts beyond the original. Porting this harness to many hosts would not only be cost prohibitive from a development perspective, but from a maintenance one as well.

Another consideration is the user base of each suite. For the hundreds of ACEC users to employ the AES method of doing business, would require a significant investment in learning a new system. This is neither logical nor efficient as there are considerably more ACEC users than AES users.

**Recommendation:** The merged suite should be an adaptation by the ACEC of AES technology and functionality.

### **2.3.2      Issue - Development of a Merger Requirements Document**

**Should a Merger Requirements Document be produced prior to initiation of the merger ?**

**Discussion:** The proposed approach to the merger is a simple blending of ACEC and AES technology and functionality, without the addition of new technology or functionality. That is, if the technology and functionality does not exist in either of the suites, it will not exist in the merged suite.

The ACEC and AES differ significantly in both technology and functionality as a result of having development requirements that varied significantly. However, a union of these requirements, brought about by a simple merger, may not allow the merged suite to meet today's user requirements. The ACEC, for example, has not implemented each and every item on its pre-planned product improvement list. Items such as compiler reliability, which neither suite has addressed, is a good candidate for implementation in the merged suite. There are many more examples of desired technology and functionality for the merged suite which were recommended by the workshop participants.

**Recommendation:** Although a formal requirements document for the merged suite does not need to be developed, any established requirements should not be just a simple blending of ACEC and AES requirements. The merged suite requirements should allow for technology and functionality which currently does not exist in either suite.

### **2.3.3      Issue - AES Performance Tests**

**Should the AES performance tests be included in the merged suite ?**

**Discussion:** The AES contains many tests which will be useful in the merged product as they address technical nuances not addressed by the ACEC. In areas that the ACEC does address, some AES tests are different enough to provide additional useful information. A review of the AES tests has indicated that they should all be thoroughly reviewed before inclusion in the merged suite.

**Recommendation:** Incorporate AES performance tests into the merged suite after a thorough review and modification as necessary. Where appropriate include in existing ACEC groups and subgroups. If necessary, create new groups and subgroups.

#### **2.3.4     Issue - AES Assessors**

**Should the AES assessors be included in the merged suite ?**

**Discussion:** The assessors which are common between the two suites are in the areas of capacity limits, diagnostic messages, program library manager and symbolic debugger. These are all compiler-related functions. The AES contains assessors for functions which the ACEC does not. These assessors evaluate both compiler-related and non-compiler-related functions.

There is value in providing the merged suite user with additional assessors which evaluate compiler-related functions. Although these tests are not usually automatable they do provide additional information upon which to base a selection decision.

**Recommendation:** Incorporate AES compiler-related assessors into the merged suite after a thorough review to eliminate redundancy with ACEC assessors and perform modification as necessary.

##### **2.3.4.1     Issue - Compiler-related Assessors**

**Which assessors from the AES should be incorporated in the merged suite and in which priority ?**

**Discussion:** The following AES assessors were recommended for inclusion in the merged suite and are listed in priority order as determined by the workshop participants.

- Profiler

- Cross-referencer
- Test coverage analysis
- Test bed generator
- Pretty printing
- Stub generator
- Syntax-based editing
- Assertion checker
- Name expander

**Recommendation:** Include the assessors named above in the merged suite.

#### **2.3.4.2 Issue - Non-Compiler-related Assessors**

**Should the merged suite provide assessors that evaluate non-compiler-related tools ?**

**Discussion:** The AES assessors address both compiler and non-compiler-related tools. The ACEC has restricted itself to compiler-related issues since non-compiler evaluation issues were relegated to the Evaluation & Validation Reference System; like the ACEC, a product of the E&V Project.

The increasing size of the test suite is also a concern. Adding non-compiler-related assessors to the suite is an unwarranted and unnecessary growth when these assessors have a natural home in the E&V Reference System.

**Recommendation:** Incorporate the non-compiler-related assessors from the AES into the E&V Reference System.

#### **2.3.5 Issue - User Interface**

**Should the merged suite provide all current AES test harness functionality ?**

**Discussion:** The AES test harness provides the user functionality that is not provided by the ACEC. These functions include an interactively accessible database, a command file generation capability, an Ada program generation capability and test-harness-level direct execution mode.

Inspection of the AES source code for the desired functions reveals that many features are host dependent and, therefore, may not be readily ported to other hosts. One reason may be that the operating system for a new host may not be able to provide the same support to implement the desired functions as the original AES host did.

**Recommendation:** Investigate methods for providing the desired functions from the AES test harness in a portable fashion. Incorporate these functions if they can be implemented in a portable manner.

#### **2.3.5.1 Issue - Interactively Accessible Database**

Should the merged suite provide an interactive capability to determine the number of tests that have and have not run, and the tests' status ?

**Discussion:** This capability would be extremely useful for the user who traditionally runs custom subsets of the tests.

The AES provides a capability to interactively determine which tests have been run and their status. However, the data it outputs are rather cryptic and sometimes difficult to correctly interpret. The ACEC provides this information on its test reports, after completion of testing. Although the data required is available in the ACEC, no ACEC mechanism exists to access that data interactively during the testing process.

**Recommendation:** Provide the merged suite user with the capability to interactively determine the number of tests that have and have not run, and the tests' status. Provide this capability through existing ACEC data structures if it does not significantly expand the database.

#### **2.3.5.2 Issue - Command File Generation Capability**

Should the merged suite provide a command file generation capability for the purpose of implementing a highly interactive test selection user interface ?

**Discussion:** The AES allows the user to interactively select individual tests for execution via a command file generation capability. The ACEC allows the users to select pre-defined fixed groups of tests by either editing the existing command files or creating new command files, depending on the execution host. However, many users will be interested in running tests which may be combinations of subsets of larger pre-defined groupings. A powerful, highly interactive test selection user interface could provide the functionality required by a user who desires to create custom test groupings.

The solution discussed may require a database capability whose development cost may be far beyond the scope of the merger effort. Additionally, this capability may not be portable which is in direct conflict with the portability requirement.

A compromise solution would be to provide selection capabilities on pre-defined subgroups instead of on individual tests. This approach may alleviate the requirement for the database capability.

Another approach requires additional functionality in the report generation tools. Although this does not solve the selection problem, it does produce only results for desired tests by allowing the user more flexibility in data output selection.

**Recommendation:** The merged suite should provide the capability to select custom sets of tests for execution, minimally at the ACEC subgroup level. The approach used must be highly portable and as such, shall avoid all non-portable database schemes.

#### **2.3.5.3 Issue - Ada Program Generation Capability**

**Should the merged suite provide an Ada program generation capability to generate test code ?**

**Discussion:** The AES provides an Ada program generation capability to create test code. This capability is useful when testing a single system or when code is required to determine compiler capacity limits. However, the most common usage of the merged suite will be to compare multiple versions of a compiler or to compare different compilers. In this mode, code that is automatically generated may not be at a level of detail capable of distinguishing between systems. Also, there is some question of repeatability, i.e. whether the same code will be generated each time precisely the same for each system under test.



As for code generation for testing compiler capacity limits, the ACEC already contains a successful mechanism for providing this capability.

**Recommendation:** Automatic code generation capabilities are of limited value except for capacity testing. This value does not justify an investment in the the merger effort.

#### **2.3.5.4    Issue - Test-Harness-Level Direct Execution Mode**

**Should the merged suite provide a capability to execute tests without exiting the test harness ?**

**Discussion:** The AES provides an interactive mechanism to select individual tests for execution from the test harness level. The ACEC does not provide this mechanism.

The AES capability is highly dependent upon the VAX operating system utility, STARLET. This utility provides the operating system interface for the user. Although a harness level test selection capability is useful, it does not provide enough utility to justify an attempt to create a portable capability. To begin with, the same capability can be produced in a portable fashion which simply requires the user to temporarily exit the harness to execute the necessary command files. Second, no assumptions can be made about the availability of a STARLET-like utility on any other operating systems. Therefore, if they did not exist they would have to be created by ACEC users for each compilation system, significantly increasing the effort required to adapt the test suite.

**Recommendation:** Do not implement a harness-level direct execution mode in the merged suite.

#### **2.3.6        Issue - Test Suite Setup**

**Should ease of setup be a primary requirement ?**

**Discussion:** As the merged suite will be portable and designed to accommodate the individual user, and not a large government-run test facility, great care must be taken in developing an appropriate set-up process. Consideration must be given to the fact that the user's host and target combinations are numerous as will be their experience level in using compiler evaluation suites. It is therefore essential that the user be provided with considerable written assistance for the purpose of initiating the evaluation process. Although this initiation requires the

accomplishment of a limited number of steps prior to actually executing the test suite, if they are not accomplished then the suite cannot be successfully executed.

An acceptable set-up process should meet the following requirements:

- Consists of quality documentation
  - Enumerates the depth of knowledge required by the tester.
  - Identifies key milestones.
  - Completely and unambiguously defines the setup process and procedures.
- Considers the variability of compilers.
- Provides a logical approach to the problem.

**Recommendation:** Use the ACEC set-up process as a framework for developing the merged suite set-up process and ensure that it meets the requirements listed above.

### **2.3.7      Issue - Report Styles**

**Should the analysis reports favor the management-level reader or the evaluation expert-level reader ?**

**Discussion:** The AES produces one type of report. This report is used to document results for a single system and is aimed at the management-level reader. The ACEC produces two types of reports. One is used to document strengths and weaknesses in a single system, while the other is used to compare results from multiple systems. Both are aimed at the compiler evaluator-level reader.

The advantage of a management level report is that conclusions are drawn for the reader who does not have to do any analysis. The disadvantage is the reader is given little if any opportunity to question the conclusions, examine the results, and draw one's own conclusions. The evaluator-level reports provide significant amounts of data and require the reader to understand the technical issues and the process involved in reaching conclusions.

There is a need for both types of reports, one for management and one for the evaluator. As requests for evaluation results by procuring

agencies become more commonplace, the need for the former type of document will increase accordingly. These agencies are not expected to retain compiler evaluation experts who are capable of interpreting evaluator-level reports. As the number of new compilers continues to increase the need for an evaluator-level report will increase also. The anticipated increase in the number of new compilers is a result of anticipated changes to the Ada language via the Ada9X language revision project.

**Recommendation:** Provide a configurable analysis report capability which selectively provides for the needs of both management personnel and the compiler evaluators.

### **2.3.8      Issue - Assessor Report Capabilities**

**Should the merged suite provide the capability to perform comparative analysis of assessors ?**

**Discussion:** Any quantification of data will provide a management level reader with an analysis report they usually seek to avoid doing personally. On the other hand, where the quantified data is qualitative in nature, the reader will be done a disservice in drawing conclusions from this data.

Since the ACEC provides a comparative analysis capability for the performance tests, many users will expect the merged suite to provide the same type of capabilities for the assessor results. As a minimum, results from each system should be output next to each other in a columnar fashion to permit easy, manual comparison of the results

**Recommendation:** Investigate comparative analysis of assessor results for the merged suite to determine the utility of this capability. If it proves worthwhile, implement this capability in the merged suite.

## APPENDIX A - ATTENDEES

### ACEC/AES Merger Workshop FCDSSA, San Diego 22-24 January 1992

| <u>NAME</u>                         | <u>MAILING /NET ADDRESS</u>   | <u>TELEPHONE</u> |
|-------------------------------------|---|------------------|
| <u>Merger Workshop Co-chairs:</u>   |   |                  |
| SZYMANSKI, Raymond                  | WL/AAAF-3<br>WPAFB, OH 45433-6543<br>szymansk@ajpo.sei.cmu.edu  | (513) 255-3947   |
| ROY, Dan                            | Software Engineering Institute<br>CMU<br>Pittsburgh, PA 15213<br>dmr@sei.cmu.edu                                | (412) 268-6180   |
| <u>Merger Workshop Participants</u> |   |                  |
| ASHBY, Sam                          | Boeing Defense & Space Group<br>P.O. Box 7730, MS K80-13<br>Wichita, KS 67277-7730<br>tleavitt@ajpo.sei.cmu.edu | (316) 526-2691   |
| ALTMAN, Neal                        | SEI<br>CMU<br>Pittsburgh, PA 15213<br>na@sei.cmu.edu  | (412) 268-7613   |
| BOWLES, Ken                         | Telesoft<br>13040 Caminito Mar Villa<br>Del Mar, CA 92014<br>kbowles@ajpo.sei.cmu.edu                           | (619) 755-7288   |
| CRAWFORD, Bard                      | TASC<br>55 Walkers Brook Dr.<br>Reading, MA 01867<br>crawford@ajpo.sei.cmu.edu                                  | (617) 942-2000   |
| DECKER-LINDSEY, Barbara             | Boeing Defense & Space Group<br>P.O. Box 7730, MS K80-13<br>Wichita, KS 67277-7730<br>tleavitt@ajpo.sei.cmu.edu | 316) 523-1500    |
| DONOHUE, Pat                        | SEI<br>CMU<br>Pittsburgh, PA 15213<br>pd@sei.cmu.edu  | (412) 268-7616   |

|                          |   |                |
|--------------------------|---|----------------|
| EILERS, Dan              | Irvine Compiler<br>34 Exec Pk, #270<br>Irvine, CA<br>deilers@ajpo.sei.cmn.edu                                   | (714) 250-1366 |
| EVANS, Bobby             | DoD Ada Validation Facility<br>WPAFB, OH 45433<br>evansbr@adawc.wpafb.af.mil                                    | (513) 255-4472 |
| FERGUSON, Clarence 'Jay' | N.S.A.<br>958 School Lane<br>Gambrills, MD 21054<br>cferguson@dockmaster.ncsc.mil                               | (410) 688-7636 |
| GICCA, Greg              | Telesoft<br>10 Northwood Dr.<br>Merrimack, NH 03054<br>giccag@ajpo.sei.cmu.edu                                  | (617) 270-0676 |
| GRUBE, Trudy             | ORI<br>3578 Kettering Blvd.<br>Dayton, OH 45439   | (513) 299-4141 |
| LANGDON, Major Kim       | CECOM Signals Warfare<br>Vint Hill Farms Station<br>Warrenton, VA 22186<br>langdonk@ajpo.sei.cmu.edu            | (703) 349-6938 |
| LEAVITT, Tom             | Boeing Defense & Space Group<br>P.O. Box 7730, MS K80-13<br>Wichita, KS 67277-7730<br>tleavitt@ajpo.sei.cmu.edu | (316) 523-2023 |
| MCKEE, Gary              | McKee Consulting<br>P.O. Box 3009<br>Littleton, CO 80161<br>gmckee@ajpo.sei.cmu.edu                             | (303) 795-7287 |
| RHOADS, Barbara          | ORI<br>3578 Kettering Blvd.<br>Dayton, OH 45439<br>rhoadsb@ajpo.sei.cmu.edu                                     | (513) 253-2623 |
| TERRELL, Kermit          | Boeing Defense & Space Group<br>P.O. Box 7730, MS K80-13<br>Wichita, KS 67277-7730<br>leavitt@ajpo.sei.cmu.edu  | (316) 523-2022 |
| WOOD, Jon                | Institute for Defense Analysis<br>1801 N. Beauregard<br>Alexandria, VA 22311<br>wood@ida.org                    | (703) 845-6632 |

## APPENDIX B - AGENDA

**ACEC/AES Merger  
FCDSSA, San Diego  
22-24 January 1992**

**Wednesday, 22 January 1992**

|           |   |
|-----------|---|
| 0800-0830 | Visitor and Parking Pass Acquisition<br>at Visitor Control                    |
| 0830-0845 | Orientation/Introduction to FCDSSA<br>Mr. Lloyd Stiles                        |
| 0845-0900 | Co-Chair Comments<br>Dan Roy -- SEI<br>Raymond Szymanski -- Wright Laboratory |
| 0900-1000 | ACEC Version 3.0<br>Boeing  |
| 1015-1130 | ACEC Version 3.0 (CON'T)  |
| 1300-1500 | AES Version 2.0 (CANCELLED: UNABLE TO ATTEND)<br>UK MOD                       |
| 1515-1600 | AES Version 2.0<br>Boeing   |
| 1600-1700 | ACEC / AES Experience at SEI<br>SEI   |

**Thursday, 23 January 1992**

|           |   |
|-----------|---|
| 0800-0900 | E&V Reference System Version 3.1 - Hypertext based Demonstration<br>TASC  |
| 0900-1000 | Proposed Technical Approach to Merging the ACEC and AES<br>Boeing         |
| 1015-1130 | Proposed Technical Approach to Merging the ACEC and AES (CON'T)<br>Boeing |
| 1300-1700 | Discussion of Proposed Technical Approach                                 |

**Friday, 24 January 1992**

**0830-1600**      **Discussion of Proposed Technical Approach (CON'T)**

## **APPENDIX C - PRESENTATIONS**

|    |   |      |
|----|---|------|
| C1 | Co-Chair Comments - R. Szymanski .....                            | C-2  |
| C2 | ACEC Version 3.0 Product - S.Ashby, K. Terrell, B. D-Lindsey..... | C-5  |
| C3 | AES Version 2.0 Assessment - T.Leavitt.....                       | C-45 |
| C4 | AES Version 2.0 Assessment - N. Altman.....                       | C-54 |
| C5 | ACEC Version 3.0 Assessment - P. Donohoe.....                     | C-60 |
| C6 | E&V Reference System Ver. 3.1 Demonstration -. B. Crawford.....   | C-64 |
| C7 | ACEC & AES Merger Technical Approach - K. Terrell.....            | C-77 |

**ACEC/AES  
MERGER WORKSHOP  
CO-CHAIR COMMENTS**

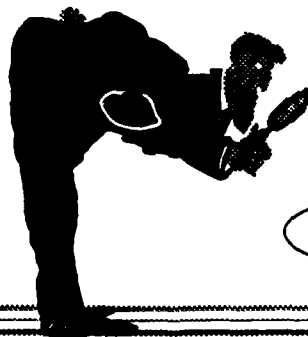
- WORKSHOP OBJECTIVE
- PARTICIPANTS
- WORKSHOP REPORT
- AGENDA



R.SZYMANSKI

**WORKSHOP OBJECTIVE**

- REVIEW AND REFINE APPROACH TO MERGING ACEC AND AES



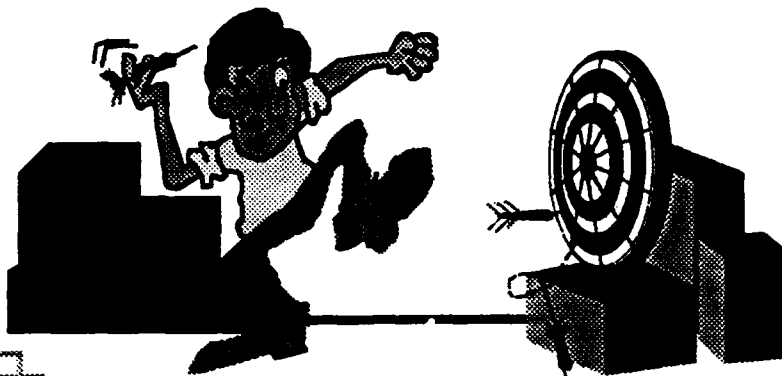
ACEC / AES

R.SZYMANSKI



## **PARTICIPANTS**

- INVITED ON FOLLOWING BASES
  - ABILITY TO CONTRIBUTE
  - INDIVIDUAL PERSPECTIVE
  - CAPABILITY AS A TEAM PLAYER



R.SZYMANSKI

## **WORKSHOP REPORT**

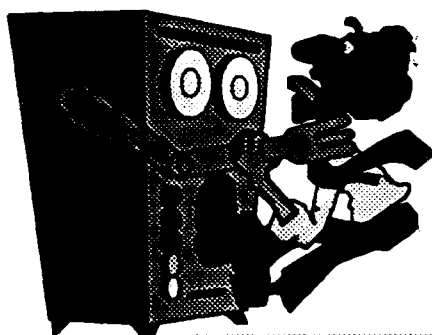
- PRELIMINARY REPORT
  - MAILED 2 WEEKS FOLLOWING WORKSHOP
- FINAL REPORT DRAFT
  - MAILED 4 WEEKS FOLLOWING WORKSHOP
- PROCEEDINGS TO BECOME FORMAL WL TECH REPORT



R.SZYMANSKI

## AGENDA

- CHANGES
- HIDDEN



R.SZYMANSKI

## **Ada Compiler Evaluation Capability (ACEC)**

**Contract Number  
F33615-86-C-1059  
WL/AAAF**

**Boeing Defense and Space Group  
Product Support Division**

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## **Where we are**

**Version 3.0 Testing completed  
Ran on 5 systems  
Identified and resolved 205 problems  
Version 3.0 to the customer 18 Dec 91  
Tapes (3134 files - 24 megabytes)  
Documentation (printed and on-line)  
Under final customer review  
Maintenance**

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## **Release Contents**

**Total Performance Tests (1627)**

**Groups**

**Subgroups**

**Assessors**

**Analysis Tools**

**User Documentation**

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## **Documentation**

**User's Guide (352 pages)**

**How to set-up and run**

**Reader's Guide (189 pages)**

**Why and how to interpret**

**Version Description Doc (398 pages)**

**Descriptions and references**

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## Overview of Release 3.0

### Structure

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## GROUP AND SUBGROUP ORGANIZATION

### Examples from the avionics subgroup of the application group

|              |                                    |
|--------------|------------------------------------|
| ap_avdum.ada | - dummies                          |
| ap_avpkg.ada | - common packages                  |
| ap_av01_.inc | - individual tests                 |
| ap_av02_.inc | .                                  |
| ap_av03_.inc | .                                  |
| ap_avm01.inc | - first main program               |
| ap_av04_.inc | - individual tests                 |
| ap_av05_.inc | .                                  |
| ap_av06_.inc | .                                  |
| ap_avm02.inc | - second main program              |
| ap.com       | - VMS command file for this group  |
| ap.unx       | - UNIX command file for this group |

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## EXECUTION-TIME TEST GROUPS

| Group Name               | Abbrev | Number of subgroups |
|--------------------------|--------|---------------------|
| Application              | ap_    | 15                  |
| Arithmetic               | ar_    | 14                  |
| Classical                | cl_    | 13                  |
| Data Storage             | do_    | 5                   |
| Data Structures          | dr_    | 19                  |
| Delays and Timing        | dt_    | 3                   |
| Exception Handling       | xh_    | 8                   |
| Generics                 | gn_    | 2                   |
| Input/Output (MIS)       | io_    | 12                  |
| Miscellaneous            | ms_    | 6                   |
| Optimizations            | op_    | 30                  |
| Program Organization     | po_    | 4                   |
| Statements               | st_    | 10                  |
| Storage Reclamation      | sr_    | 2                   |
| Subprograms              | su_    | 8                   |
| Systematic Compile Speed | sy_    | 11                  |
| Tasking                  | tk_    | 7                   |

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## ASSESSOR GROUPS

| Group Name           | Abbrev | Subgroup Name     | Abbrev |
|----------------------|--------|-------------------|--------|
| Capacity Assessor    | yc_    | compile_time      | ct     |
|                      |        | run_time          | rt     |
| Debugger Assessor    | yb_    |                   |        |
| Diagnostics Assessor | yd_    | compiler_errors   | ce     |
|                      |        | compiler_warnings | cw     |
|                      |        | link_time         | lt     |
|                      |        | run_time          | rt     |
| Library Assessor     | yl_    |                   |        |

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## SUPPORT GROUPS

| Group Name            | Abbrev | Subgroup Name          | Abbrev |
|-----------------------|--------|------------------------|--------|
| Analysis              | za_    | Comparative Analysis   | ca     |
|                       |        | Condense               | cn     |
|                       |        | Menus                  | mn     |
|                       |        | Single System Analysis | sa     |
| Command Files         | zc_    |                        |        |
| Documentation         | zd_    |                        |        |
| Global & Timing Files | zg_    |                        |        |
| Math Packages         | zm_    |                        |        |
| Pretest               | zp_    |                        |        |

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## COMMAND FILES

Organized by group & subgroup  
 Standardized command spelling  
 Glossary of commands  
 Ada programs for difficult-to-adapt steps  
*Compilation time stamps, calculations*  
 Capacity test calculations

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## Overview of Release 3.0

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## Performance Tests

|                                       |                   |
|---------------------------------------|-------------------|
| <b>Execution Time</b>                 | <b>1627 tests</b> |
| <b>Code Size</b>                      | <b>1627 tests</b> |
| <b>Compile Speed</b>                  | <b>588 tests</b>  |
| <b>Link Speed</b>                     | <b>571 tests</b>  |
| <b>Compile and Link Speed</b>         | <b>588 tests</b>  |
| <b>Systematic Compile Speed Group</b> | <b>92 tests</b>   |

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## SYSTEMATIC COMPILE SPEED

| <u>Test Area (subgroups)</u> | <u>Number</u> |
|------------------------------|---------------|
| compilation_unit_size        | 45            |
| compile_time_arithmetic      | 2             |
| generics                     | 12            |
| optimization                 | 6             |
| pragma_inline                | 3             |
| program_library_size         | 2             |
| smart_recompilation          | 6             |
| source_presentation          | 4             |
| subunits                     | 6             |
| symbol_table_size            | 2             |
| with_clauses                 | 4             |

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## NEW PERFORMANCE TESTS

| <u>Test Area</u>   | <u>Number</u> |
|--|---------------|
| Array of records vs record of arrays vs parallel arrays                                | 3             |
| Zero vs non-zero based arrays  | 4             |
| Coding style: CASE vs IF   | 4             |
| Coding style: exception raising vs explicit IF   | 4             |
| Reclamation test using function returning an<br>unconstrained type in several contexts | 1             |
| Algebraic simplification "handedness" bias   | 3             |
| Allocate statically sized storage in blocks  | 4             |
| UNCHECKED_CONVERSION between arrays and records  | 4             |
| Passing integer parameters   | 12            |
| "+" and "-" functions for TIME and DURATION  | 4             |
| Reordering expressions   | 8             |
| High-precision temporaries   | 6             |

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## NEW PERFORMANCE TESTS CONTINUED

| <u>Test Area</u>  | <u>Number</u> |
|---|---------------|
| SELECT with variable number of ACCEPT alternatives            | 4             |
| Algorithm used in selective wait                              | 2             |
| Order of evaluation of guards in a selective wait             | 1             |
| Variability of exception processing time with number of tasks | 2             |
| Reclamation test for task created via allocation              | 1             |
| Variability of task creation with a pre-existing active tasks | 2             |
| Task-switch time  | 3             |
| Scheduling of task or master on creation                      | 1             |
| Task scheduling after interrupt                               | 1             |
| A rule-based expert system                                    | 1             |
| Caching/paging  | 36            |
| Pipelining  | 8             |
| Shared variable   | 2             |

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## RUN-TIME MEMORY SIZE

Determine size of run-time objects  
 Write as performance tests with ancillary data  
 Use 'SIZE where possible, otherwise 'ADDRESS  
 Variability with respect to common optimizations  
 Structures to measure  
     Task control blocks  
     Activation records  
     Variant records  
     Objects of an unconstrained type

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## ASSESSORS

**Diagnostic Assessor**

**Debugger Assessor**

**Library Assessor**

**Capacity Assessor -- New**

**For each assessor**

**Readme file**

**Report template**

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## **DIAGNOSTIC ASSESSOR**

### **Tests:**

**Compiler error messages - 34 tests**

**Compiler warning messages - 30 tests**

**Link-time error messages - 7 tests**

**Run-time error messages - 10 tests**

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## **DIAGNOSTIC ASSESSOR**

### **Template questions:**

**Is the diagnostic message printed?**

**Is the message in the general area of difficulty?**

**Is the message in the correct specific location?**

**Does the text of the message clearly define the difficulty?**

**Is relevant non-local information listed where appropriate?**

**Is error recovery appropriate?**

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## **DEBUGGER ASSESSOR**

**29 debugging scenarios**

**User performs debugging operations**

**New:**

**Labels**

**Line numbered files**

**Tests:**

**Functional capabilities**

**Performance**

**Capacity**

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## **LIBRARY ASSESSOR**

**22 scenarios**

**New:**

**Times, sizes collected in Systematic Compile**

**Speed group**

**Tests:**

**Functional capabilities**

**Performance**

**Capacity**

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## **CAPACITY ASSESSOR**

**Compile-time tests - 32**

**Run-time tests - 9**

**Testing guided by:**

**default or user-selected ranges of values**

**default or user-selected time limit**

**Branch-and-bound plus binary search technique**

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## **COMPILE-TIME TESTS**

**Source code generated at time of test by supplied  
source generators**

**Tests static limits definable at compile time:**

**Quantity – names, tasks, elements, etc.**

**Size -- literal pool, declarative region**

**Depth of nesting – IF, generics, subunits, etc.**

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## **RUN-TIME TESTS**

**May result in system crash on weaker systems**

**Tests dynamic features defined at run time:**

**Quantity – tasks, objects, elements, etc.**

**Size – arrays, collection, data segment**

**Depth of nesting -- subprogram calling**

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## **Overview of Release 3.0**

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## PRETEST

### Purpose

Aid user in getting started

Organize adaptation effort

Provide useful system information

Prepare to execute test suite, analyze data

### Contents

Readme file – zp\_rdme1.txt

Test programs, command files

Report template

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## PRETEST CONTINUED

1. Access Ada Compilation System
2. Test label ADDRESS
- 3-4. System Clock/Calendar Tests
5. Compile Baseline Files *{Mandatory}*
6. Test Inner Timing Loop Iteration Count
- 7-9. Test Math Package Adaptation
10. Test Preprocessor zg\_incid
11. Test Performance Command Files *{Mandatory}*
12. Compile Analysis Tools
13. Test Condense
14. Test Comparative Analysis

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## COLLECTION OF RESULTS

Test results written to standard output

Compilation log (host)

Execution log (target)

Save logs to text files

Input to analysis phase

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## EXECUTION LOG

```

\ACEC begin mainprogram\*****AR_FL_M01
                                outer loop count
                                inner loop count
                                microseconds |
problem name                    bits   min  mean  |  sigma
\acac_problem_name\ ar_fl_fit_oper_01
    xx:= 1.0;
\acac_measurements\            96    43.7  45.1  15  3   3.5%#
\acac_problem_name\ ar_fl_fit_oper_02
    xx:= yy;
\acac_measurements\            128   111.3 114.2  14  4   2.9%
>>> ancillary data

\ACEC end  mainprogram\*****AR_FL_M01
  
```

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## COMPILE AND LINK TIMES

Ada programs bracket commands, issue time stamps  
 Elapsed, CPU versions  
 Calculations performed in CONDENSE  
     Subtract overhead  
     Error checking

```

\acac begin\ AP_AVM01
\acac begin e\ 2380.000 21 DEC 1991
\acac end e\ 2400.000 21 DEC 1991
\acac end\ AP_AVM01
  
```

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## Overview of Release 3.0

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## Analysis Tools

Menu

Condense

Comparative Analysis

Single System Analysis

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## **ANALYSIS MENU**

**Portable interface to**  
**Condense**  
**Comparative Analysis**  
**Single System Analysis**  
**Link with 0-3 tools, depending on space**  
**Dummies provided**  
**Analysis tools executable**  
**From menu**  
**Batch, using request files created by menu**

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## **CONDENSE**

**Call from Menu, SSA, CA, or batch**  
**Convert log files to database files**  
**Run-time error diagnosis**  
**Compute compilation times**  
**Cross check execution, compilation results**  
**Incremental mode adds to database**  
**Optional reports**  
**No Data Report**  
**Exceptional Data Report**  
**Multiple Data Report**

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## **DATABASES**

**Execution time/Code size**

**Compilation time/Link time**

**Text files**

**Readable, modifiable by user**

**By group, subgroup**

**Duplicate results adjacent**

**One result selected for analysis**

**Input to Comparative, Single System Analysis**

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## **Comparative Analysis**

**Groups**

**Summary of all groups**

**Application profile mode**

**System factors & confidence intervals**

**Outliers**

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## Main Menu

### ----- Main Menu -----

- a. -CONDENSE
- b. -COMPARATIVE\_ANALYSIS
- c. -SINGLE SYSTEM\_ANALYSIS

HElp    QUIT    NExt

Select 1 tool (separate selections with comma):

=> "b,ne" <cr>

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## System Menu

### ----- System Menu -----

- a. -system\_1
- b. -system\_2
- c. -system\_3
- d. -All Systems

HElp    QUIT    MAIn  
NExt    PRevious

Select 2 or more systems to be compared (separate selections with comma):

=> "d,ne" <cr>

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## Metrics Menu

---

Metrics Menu

---

|                                |         |
|--------------------------------|---------|
| a. -EXECUTION_TIME             | := .tim |
| b. -CODE_SIZE                  | := .siz |
| c. -COMPILE_TIME               | := .cmp |
| d. -LINK_TIME                  | := .lnk |
| e. -COMBINED COMPILE_LINK_TIME | := .cml |
| f. -All Metrics                |         |

---

HElp      QUIT      MAIN  
 NExt      PRevious      DEfault names

Select 1 or more metrics (separate selections with comma):  
 => "a,c,ne" <cr>

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## Groups Menu

---

Groups Menu

---

|                              |             |
|------------------------------|-------------|
| a. -APPLICATION              | := applic00 |
| b. -ARITHMETIC               | := arithm00 |
| c. -CLASSICAL                | := class00  |
| d. -DATA_STORAGE             | := storag00 |
| e. -DATA_STRUCTURES          | := struct00 |
| f. -DELAYS_AND_TIMING        | := delays00 |
| g. -EXCEPTION_HANDLING       | := except00 |
| h. -GENERIC                  | := gener00  |
| i. -INPUT_OUTPUT             | := input_00 |
| j. -MISCELLANEOUS            | := miscel00 |
| k. -OPTIMIZATIONS            | := optimi00 |
| l. -PROGRAM_ORGANIZATION     | := progra00 |
| m. -STATEMENTS               | := statem00 |
| n. -STORAGE_RECLAMATION      | := reclam00 |
| o. -SUBPROGRAMS              | := subpro00 |
| p. -SYSTEMATIC_COMPILE_SPEED | := system00 |
| q. -TASKING                  | := taskin00 |
| r. -All Groups               |             |

---

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## CA Report Options

CA Report Options

- a. -SUMMARY\_REPORT
- b. -FULL\_REPORT and SUMMARY\_REPORT
- c. -SUMMARY\_OF\_ALL\_GROUPS\_REPORT                := summr00
- d. -All Above
- e. -SPECIAL\_REPORT                                := specia00
- f. -Write all reports in current request to one file   := compar00.rpt
- g. -Change length of output line to                := 80

HElp     QUit     MAIn  
NExt     PRevious   DEfault names

Select 1 or more reports (separate selections with comma):

=> "b,f,ne" <cr>

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## Run or Save Request

Current Selection Is  
PROGRAM : COMPARATIVE\_ANALYSIS  
SYSTEMS : system\_1  
          system\_2  
          system\_3  
METRICS : EXECUTION TIME, COMPILATION TIME  
GROUPS : DATA\_STORAGE, STATEMENTS, TASKING  
OPTIONS : SUMMARY\_REPORT, FULL\_REPORT,  
          One output file.  
          Output line length: 80

- a. -Run immediately
- b. -Store request in new Request file
- c. -Append request to existing Request file

HElp     QUit     MAIn     PRevious     DO request  
Select 1 option, and enter "DO" to apply (separate selections with comma):  
=> "a,do" <cr>

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## Single System Analysis

Language Feature Overhead  
Optimizations  
Coding Style Variations  
Ancillary Data  
Failure Analysis  
Compile Speed Analysis  
Code Size Analysis

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## Overview of Release 3.0

Structure  
Performance Tests  
Assessors  
Pretest  
Gathering Data  
Analysis Tools  
Documentation

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## **USER'S GUIDE**

**Pretest directions**

**Readme files**

**Trouble shooting guide**

**Glossary of commands**

**Steps for adding tests**

**Non-generic version of MATH**

**Running on a simulator**

**Groups and subsets of tests**

**Changing compilation options**

**Modifying tests to use system-dependent features**

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## **READER'S GUIDE**

**Organization of the test suite**

**Citations to other works**

**Report reviews**

**Interpretation the analysis reports**

**Interpreting tests with system-dependent modifications**

**Interpretation of compilation time results**

**Implementation trade-offs**

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## **VERSION DESCRIPTION DOCUMENT**

**Test problem descriptions**  
**Test problem to source file map**  
**Tape description**  
**ACEC keyword indexes**  
**Quarantined test problems**  
**Mapping of old to new names**  
**System dependent test problems**  
**Optimization techniques**  
**Assessor information**

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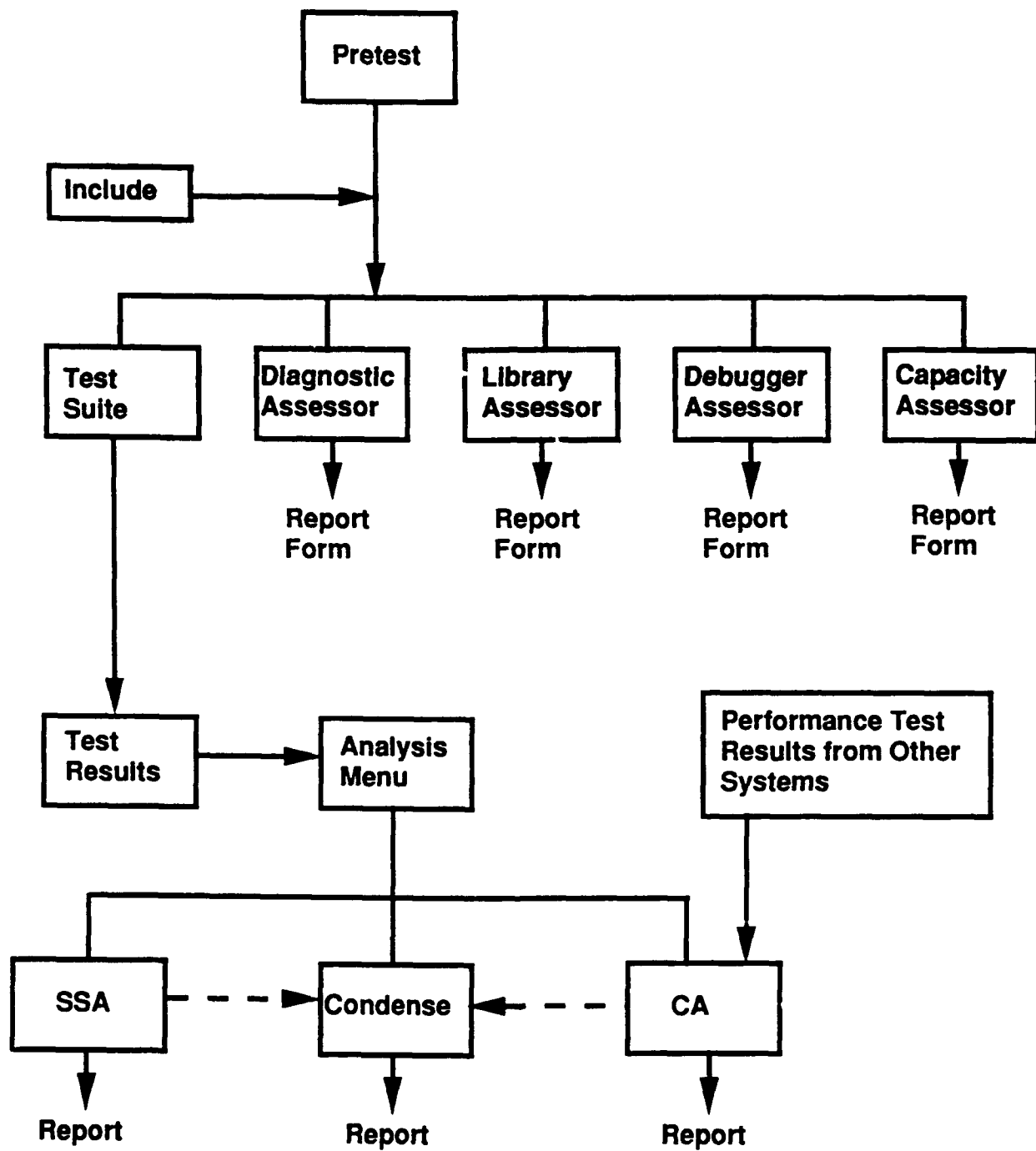
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**THE END**

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## Overview of the ACEC Version 3

Code Size Report

Code Size Report : (physical lines)

----- average bytes per lines : 10.69  
-- based on total line count of 20160  
-----  
----- HIGHEST -- Test : io\_tx\_io\_09  
-- bytes per line : 757.00 -- line count : 1  
-- bytes per semicolon: 757.00 -- semicolon count: 1  
-----  
----- LOWEST -- Test : sr\_ex\_explicit\_04  
-- bytes per line : 0.06 -- line count : 84  
-- bytes per semicolon: 0.17 -- semicolon count: 29  
-----

Code Size Report : (semicolons)

----- average bytes per semicolons : 16.23  
-- based on total semicolon count of 13281  
-----  
----- HIGHEST -- Test : io\_tx\_io\_09  
-- bytes per line : 757.00 -- line count : 1  
-- bytes per semicolon: 757.00 -- semicolon count: 1  
-----  
----- LOWEST -- Test : po\_pa\_d\_library\_05  
-- bytes per line : 0.10 -- line count : 48  
-- bytes per semicolon: 0.14 -- semicolon count: 35  
-----

Code Size Report : (Examples)

-----  
-- Test : cl\_dh\_dhrys\_01  
-- bytes per line : 10.32 -- line count : 47  
-- bytes per semicolon: 19.40 -- semicolon count: 25  
-----  
-- Test : cl\_dh\_dhrys\_02  
-- bytes per line : 7.00 -- line count : 47  
-- bytes per semicolon: 13.16 -- semicolon count: 25  
-----  
-- Test : cl\_dh\_dhrys\_03  
-- bytes per line : 7.00 -- line count : 47  
-- bytes per semicolon: 13.16 -- semicolon count: 25  
-----  
-- Test : cl\_wh\_whet\_01  
-- bytes per line : 29.13 -- line count : 134  
-- bytes per semicolon: 44.36 -- semicolon count: 88  
-----

## Compile Speed Report

### Compilation Speed : (physical lines)

-----  
----- average lines per minute : 111.12  
-- based on total line count of 211908.0  
-----  
----- HIGHEST -- File : ap\_kfm01  
-- lines per minute : 1570.75 -- line count : 4762  
-- semicolons per minute: 811.76 -- semicolon count: 2461  
-----  
----- LOWEST -- File : sy\_cum21  
-- lines per minute : 0.90 -- line count : 209  
-- semicolons per minute: 0.69 -- semicolon count: 162  
-----

### Compilation Speed : (semicolons)

-----  
----- average semicolons per minute : 66.66  
-- based on total semicolon count of 127120.0  
-----  
----- HIGHEST -- File : po\_msm09  
-- lines per minute : 379.35 -- line count : 4348  
-- semicolons per minute: 1055.26 -- semicolon count: 12095  
-----  
----- LOWEST -- File : sy\_cum21  
-- lines per minute : 0.90 -- line count : 209  
-- semicolons per minute: 0.69 -- semicolon count: 162  
-----

### Compilation Speed : (Examples)

-----  
-- File : cl\_dhm01  
-- lines per minute : 578.57 -- line count : 756  
-- semicolons per minute: 280.87 -- semicolon count: 367  
-----  
-- File : cl\_dhm02  
-- lines per minute : 615.72 -- line count : 744  
-- semicolons per minute: 306.21 -- semicolon count: 370  
-----  
-- File : cl\_dhm03  
-- lines per minute : 619.89 -- line count : 748  
-- semicolons per minute: 309.12 -- semicolon count: 373  
-----  
-- File : cl\_ghm01  
-- lines per minute : 306.48 -- line count : 331  
-- semicolons per minute: 173.15 -- semicolon count: 187  
-----

# Failure Analysis Report - Execution Results

## Failure Analysis : by Group and by Type of Failure

| Groups        | Data Summary Categories |      |      |      |      |      |      |      |      |      |      | Total |
|---------------|-------------------------|------|------|------|------|------|------|------|------|------|------|-------|
|               | Valid                   | CmpT | RunT | noDa | Depn | Pkng | Unrl | Xcst | Dely | Vrfy | Othr |       |
| application   | 73                      | 13   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 86    |
| arithmetic    | 108                     | 0    | 0    | 0    | 0    | 0    | 4    | 0    | 0    | 0    | 0    | 112   |
| classical     | 83                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 83    |
| data_storag   | 91                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 91    |
| data_struct   | 224                     | 0    | 0    | 0    | 0    | 0    | 1    | 0    | 0    | 0    | 0    | 225   |
| delays and    | 26                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 8    | 7    | 0    | 41    |
| exception_h   | 58                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 58    |
| generics      | 24                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 24    |
| input output  | 105                     | 0    | 0    | 0    | 0    | 0    | 3    | 0    | 0    | 0    | 0    | 108   |
| miscellaneous | 17                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 17    |
| optimizatio   | 304                     | 0    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 305   |
| program_org   | 74                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 74    |
| statements    | 80                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 80    |
| storage_rec   | 47                      | 0    | 0    | 0    | 0    | 0    | 0    | 13   | 0    | 0    | 0    | 60    |
| subprograms   | 79                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 79    |
| systematic_   | 75                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 75    |
| tasking       | 98                      | 1    | 0    | 0    | 1    | 0    | 1    | 0    | 8    | 0    | 0    | 109   |
| Totals        | 1566                    | 14   | 1    | 0    | 1    | 0    | 9    | 13   | 16   | 7    | 0    | 1627  |

# Failure Analysis Report - Compilation Results

## Failure Analysis : by Group and by Type of Failure

| Groups        | Data Summary Categories |      |      |      |      |      |      |      |      |      |      | Total |
|---------------|-------------------------|------|------|------|------|------|------|------|------|------|------|-------|
|               | Valid                   | CmpT | RunT | noDa | Depn | Pkng | Unrl | Xcst | Dely | Vrfy | Othr |       |
| application   | 35                      | 0    | 0    | 2    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 37    |
| arithmetic    | 22                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 22    |
| classical     | 38                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 38    |
| data_storag   | 14                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 14    |
| data_struct   | 50                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 50    |
| delays and    | 10                      | 0    | 0    | 2    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 12    |
| exception_h   | 17                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 17    |
| generics      | 5                       | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 5     |
| input output  | 22                      | 0    | 0    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 23    |
| miscellaneous | 7                       | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 7     |
| optimizatio   | 64                      | 0    | 0    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 65    |
| program_org   | 20                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 20    |
| statements    | 17                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 17    |
| storage_rec   | 51                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 51    |
| subprograms   | 16                      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 16    |
| systematic_   | 91                      | 0    | 0    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 92    |
| tasking       | 100                     | 0    | 0    | 2    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 102   |
| Totals        | 579                     | 0    | 0    | 9    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 588   |

v\_91

Main Report

7 Jan 1992 14:08:06 226

Ancillary Data

Ancillary Data - List

```
>>> ap_kf_kalman
>>> approximate time per filter call:      4088.5 number of iterations:      800
>>> cl_ac_acker_01
>>> time per call is      12.0
>>> cl_ac_acker_02
>>> time per call is      17.9
>>> cl_dp_task_02
>>> Time per rendezvous =      582.1
>>> cl_dp_task_03
>>> time per rendezvous =      606.6
>>> cl_dp_task_04
>>> time per rendezvous =      581.1
>>> cl_dp_task_05
>>> time per rendezvous =      449.1
>>> cl_dh_dhrys_01
>>> Dhrystones per second, checking:      2553.99
>>> cl_dh_dhrys_02
>>> Dhrystones per second, checking suppressed:      3975.81
>>> cl_dh_dhrys_03
>>> Dhrystones per second, optimize(space),nochecking:      3960.90
>>> dr_ao_array_oper_32
>>> 2-D arrays allocated in row-major order.
>>> dr_ss_tcb_01
>>> Task Control Block size is 256 bits, 32 8-bit bytes
>>> DR_SS_ACTIV_REC_01
>>> activation record size is 416 bits, 52 8-bit bytes
>>> DR_SS_ACTIV_REC_02
>>> activation record size is 352 bits, 44 8-bit bytes
```

v\_91

Main Report

7 Jan 1992 14:08:06 212



## Optimizations

### Dead Code Elimination

| Description   | Optimized? |
|---|------------|
| Time : op_de_dead_05 ( 6.6 ) vs<br>ar_io_integer_oper_01 ( 0.4 )    | no         |
| Size : op_de_dead_05 ( 144.0 ) vs<br>ar_io_integer_oper_01 ( 32.0 ) |            |

```

op_de_dead_05
  FOR i IN int'(1)..int'(5)
    LOOP   ii := i ;
    END LOOP ;
    ii := 0 ;
-- dead assignments within loop, killed by assignment
-- after exit.

ar_io_integer_oper_01  kk := 1 ;

```

### Dead Code Elimination

| Description   | Optimized? |
|---|------------|
| Time : op_de_dead_06 ( 1.0 ) vs<br>st_nu_null_01 ( 0.0 )  | yes        |
| Size : op_de_dead_06 ( 48.0 ) vs<br>st_nu_null_01 ( 0.0 ) |            |

```

op_de_dead_06
  DECLARE
    xyz : real ;
  BEGIN
    xyz := yy * zz ;
  END ;
-- dead assignments within a block. Variable assigned to
-- local which is not referenced before block is exited.

st_nu_null_01  NULL ;

```

## Optimizations

### Dead Code Elimination

| Description   | Optimized? |
|---|------------|
| Time : op_de_dead_02 ( 1.0 ) vs<br>ar_io_integer_oper_04 ( 0.3 )  | maybe      |
| Size : op_de_dead_02 ( 80.0 ) vs<br>ar_io_integer_oper_04 ( 40.0 )  |            |
| <pre> op_de_dead_02 ii := ll ; ii := mm ; -- first assignment is dead -- Optimization test for dead assignment elimination on integers. ar_io_integer_oper_04 kk := ll ; </pre> |            |

### Dead Code Elimination

| Description  | Optimized? |
|--|------------|
| Time : op_de_dead_03 ( 1.9 ) vs<br>ar_flflt_oper_02 ( 1.0 )  | maybe      |
| Size : op_de_dead_03 ( 96.0 ) vs<br>ar_flflt_oper_02 ( 48.0 )  |            |
| <pre> op_de_dead_03 xx := yy ; xx := zz ; -- first assignment is dead -- dead assignment elimination; floating point variable ar_flflt_oper_02 xx := yy ; </pre> |            |

### Dead Code Elimination

| Description  | Optimized? |
|--|------------|
| Time : op_de_dead_04 ( 0.0 ) vs<br>st_nu_null_01 ( 0.0 )                                       | yes        |
| Size : op_de_dead_04 ( 0.0 ) vs<br>st_nu_null_01 ( 0.0 )                                       |            |
| <pre> op_de_dead_04 xx := xx ; -- Assign float variable to itself. st_nu_null_01 NULL ; </pre> |            |

# Language Feature Overhead

## Subprogram Calls: With 0..3 Parameters

| Test Name         | Execution Time | Bar Chart | Similar Groups |
|-------------------|----------------|-----------|----------------|
| su_se_external_01 | 6.7            | *****     |                |
| su_se_external_02 | 8.8            | *****     |                |
| su_se_external_03 | 14.9           | *****     |                |
| su_se_external_04 | 23.3           | *****     |                |

## Code Size

|                   |       |       |
|-------------------|-------|-------|
| su_se_external_01 | 48.0  | ***   |
| su_se_external_02 | 200.0 | ***** |
| su_se_external_03 | 328.0 | ***** |
| su_se_external_04 | 456.0 | ***** |

## Individual Test Descriptions

```

su_se_external_01  proc0 ;
-- simple procedure with no parameters; call to library scope
-- procedure : body is null.

su_se_external_02  proc1 ( xx ) ;
-- simple procedure with one IN OUT floating point parameter,
-- declared in external library unit : body is null.

su_se_external_03  proc2 ( xx , yy ) ;
-- simple procedure with two IN OUT floating point parameters,
-- declared in external library unit : body is null.

su_se_external_04  proc3 ( xx , yy , zz ) ;
-- simple procedure with three IN OUT floating point parameters,
-- declared in external library unit : body is null.

```

---

Language Feature Overhead

---

| Performance<br>Range                   | Significant<br>Difference? | Missing<br>Tests | Total<br>Tests | Page |
|--|----------------------------|------------------|----------------|------|
| Subprogram Calls: With 0..3 Parameters |                            |                  |                | 54   |
| 6.7 .. 23.3                            | yes                        | 0                | 4              |      |

---



---

Optimizations

---

| Yes                   | Maybe | No | Missing | No Stat | Total | Page |
|-----------------------|-------|----|---------|---------|-------|------|
| Dead Code Elimination |       |    |         |         |       | 89   |
| 11                    | 3     | 3  | 0       | 0       | 17    |      |

---

# Summary over all groups : product data - product model

|  |    |      |      |      |      |              |
|--|----|------|------|------|------|--------------|
| ----- Pairwise Comparisons: total n = 17 |    |      |      |      |      |              |
| Systems                                  | n: | v_91 | t_91 | s_91 | m_91 | d_91   Mean  |
|  |    | 17   | 16   | 17   | 17   | 16   Vari-   |
| Sys Factor:                              |    | 0.37 | 1.60 | 0.30 | 0.30 | 2.37   ation |
| -----                                    |    |      |      |      |      |              |
| v_91                                     | n: |      | 16   | 17   | 17   | 16           |
| Sys Factor:                              |    |      | 0.37 | 0.37 | 0.37 | 0.37   0.0%  |
| -----                                    |    |      |      |      |      |              |
| t_91                                     | n: | 16   |      | 16   | 16   | 16           |
| Sys Factor:                              |    | 1.60 |      | 1.60 | 1.60 | 1.60   0.0%  |
| -----                                    |    |      |      |      |      |              |
| s_91                                     | n: | 17   | 16   |      | 17   | 16           |
| Sys Factor:                              |    | 0.30 | 0.30 |      | 0.30 | 0.30   0.2%  |
| -----                                    |    |      |      |      |      |              |
| m_91                                     | n: | 17   | 16   | 17   |      | 16           |
| Sys Factor:                              |    | 0.30 | 0.30 | 0.30 |      | 0.30   0.0%  |
| -----                                    |    |      |      |      |      |              |
| d_91                                     | n: | 16   | 16   | 16   | 16   |              |
| Sys Factor:                              |    | 2.37 | 2.37 | 2.37 | 2.37 |              |
| -----                                    |    |      |      |      |      |              |
|  |    |      |      |      |      | 0.0%         |

|   |  |      |      |      |      |                 |
|---|--|------|------|------|------|-----------------|
| ----- Number of Test Problems in the Analysis |  |      |      |      |      |                 |
| No. Problems                                  |  | v_91 | t_91 | s_91 | m_91 | d_91   Possible |
| application                                   |  | 35   | 30   | 33   | 29   | 27   37         |
| arithmetic                                    |  | 22   | 22   | 22   | 21   | 21   22         |
| classical                                     |  | 38   | 35   | 38   | 36   | 33   38         |
| data_storage                                  |  | 13   | 11   | 6    | 10   | 10   14         |
| data_structures                               |  | 50   | 50   | 50   | 49   | 46   50         |
| delays_and_timing                             |  | 10   | 10   | 9    | 11   | 10   12         |
| exception_handling                            |  | 17   | 17   | 17   | 16   | 17   17         |
| generics                                      |  | 5    | 0    | 5    | 4    | 0   5           |
| input_output                                  |  | 21   | 18   | 22   | 18   | 4   23          |
| miscellaneous                                 |  | 7    | 6    | 7    | 6    | 6   7           |
| optimizations                                 |  | 64   | 65   | 65   | 63   | 64   65         |
| program_organization                          |  | 20   | 20   | 16   | 18   | 17   20         |
| statements                                    |  | 17   | 17   | 17   | 17   | 16   17         |
| storage_reclamation                           |  | 51   | 48   | 41   | 7    | 41   51         |
| subprograms                                   |  | 16   | 16   | 16   | 16   | 16   16         |
| systematic_compile_speed                      |  | 89   | 88   | 80   | 79   | 24   92         |
| tasking                                       |  | 90   | 89   | 89   | 87   | 86   102        |
| -----   |  |      |      |      |      |                 |
| Total   |  | 565  | 542  | 533  | 487  | 438   588       |
| -----   |  |      |      |      |      |                 |

Summary over all groups : product data - product model

| Raw Data:      | v_91 | t_91 | s_91 | m_91 | d_91 | Wgts |
|----------------|------|------|------|------|------|------|
| application    | 0.35 | 1.32 | 0.29 | 0.33 | 2.60 | 1.0  |
| arithmetic     | 0.43 | 1.91 | 0.24 | 0.31 | 2.08 | 1.0  |
| classical      | 0.39 | 1.63 | 0.30 | 0.29 | 2.47 | 1.0  |
| data_storage   | 0.35 | 1.70 | 0.37 | 0.22 | 1.79 | 1.0  |
| data_structure | 0.35 | 1.71 | 0.29 | 0.29 | 2.35 | 1.0  |
| delays and tim | 0.30 | 1.50 | 0.30 | 0.31 | 2.69 | 1.0  |
| exception_hand | 0.35 | 1.48 | 0.27 | 0.29 | 2.53 | 1.0  |
| generics       | 1.26 |      | 0.81 | 0.84 |      | 1.0  |
| input output   | 0.50 | 2.71 | 0.32 | 0.37 | 2.26 | 1.0  |
| miscellaneous  | 0.28 | 1.38 | 0.27 | 0.29 | 2.74 | 1.0  |
| optimizations  | 0.37 | 1.69 | 0.33 | 0.29 | 2.30 | 1.0  |
| program_organ  | 0.31 | 1.40 | 0.29 | 0.29 | 2.53 | 1.0  |
| statements     | 0.41 | 1.90 | 0.28 | 0.29 | 2.13 | 1.0  |
| storage_reclam | 0.31 | 1.14 | 0.29 | 0.22 | 2.33 | 1.0  |
| subprograms    | 0.40 | 1.75 | 0.32 | 0.32 | 2.15 | 1.0  |
| systematic_com | 0.62 | 1.55 | 0.62 | 0.45 | 2.23 | 1.0  |
| tasking        | 0.27 | 1.35 | 0.30 | 0.32 | 2.73 | 1.0  |

---- Outlier Statistics: residual \* system factor \* row mean = actual

|               | Bounds | Expect | Got | v_91 | t_91 | s_91 | m_91 | d_91 |
|---------------|--------|--------|-----|------|------|------|------|------|
| -- Very Low : | 0.76   | 2      | 1   | 1    | 0    | 0    | 0    | 0    |
| - Low :       | 0.80   | 2      | 3   | 2    | 0    | 0    | 0    | 1    |
| + High :      | 1.27   | 2      | 0   | 0    | 0    | 0    | 0    | 0    |
| ++ Very High: | 1.33   | 2      | 8   | 2    | 1    | 3    | 2    | 0    |
| Totals :      |        | 8      | 12  | 5    | 1    | 3    | 2    | 1    |

| Residuals | v_91   | t_91   | s_91   | m_91   | d_91  | Means |
|-----------|--------|--------|--------|--------|-------|-------|
| applicati | 0.98   | 0.84   | 0.99   | 1.14   | 1.12  | 0.98  |
| arithmeti | 1.19   | 1.20   | 0.82   | 1.03   | 0.89  | 0.99  |
| classical | 1.05   | 1.00   | 1.00   | 0.95   | 1.03  | 1.02  |
| data_stor | 1.08   | 1.20   | 1.40++ | 0.83   | 0.86  | 0.88  |
| data_stru | 0.97   | 1.07   | 0.98   | 0.97   | 0.99  | 1.00  |
| delays an | 0.80~  | 0.92   | 0.98   | 1.02   | 1.12  | 1.02  |
| exception | 0.96   | 0.94   | 0.94   | 0.98   | 1.09  | 0.98  |
| generics  | 3.55++ |        | 2.81++ | 2.91++ |       | 0.97  |
| input out | 1.12   | 1.38++ | 0.87   | 1.00   | 0.77~ | 1.23  |
| miscellan | 0.77~  | 0.87   | 0.93   | 0.98   | 1.17  | 0.99  |
| optimizat | 1.00   | 1.06   | 1.11   | 1.00   | 0.98  | 0.99  |
| program_o | 0.89   | 0.91   | 1.02   | 1.02   | 1.10  | 0.97  |
| statement | 1.11   | 1.18   | 0.94   | 0.99   | 0.90  | 1.00  |
| storage_r | 0.98   | 0.83   | 1.13   | 0.88   | 1.15  | 0.86  |
| subprogra | 1.12   | 1.10   | 1.09   | 1.10   | 0.92  | 0.99  |
| systemati | 1.54++ | 0.89   | 1.90++ | 1.37++ | 0.86  | 1.09  |
| tasking   | 0.74-- | 0.85   | 1.02   | 1.09   | 1.16  | 1.00  |
| Sys Fact  | 0.37   | 1.60   | 0.30   | 0.30   | 2.37  |       |

# Summary over all groups : product data - product model

```

-----
---- System Names and Descriptions
-----
v_91
-- Host: VAXstation 3100          Target: VAXstation 3100
t_91
-- Host: VAXstation 3100          Target: VAXstation 3100
s_91
-- Host: MIPS R2000A/R3000        Target: MIPS R2000A/R3000
m_91
-- Host: DECstation 3100 MIPS RISC Target: DECstation 3100 MIPS RISC
d_91
-- Host: VAX 6220                 Target: 1750A
-----

```

```

-----
---- System Factors and Confidence Intervals (including graph)
-----
Systems      Low  Mean  High  Ratio | 0.3                                     2.6
-----
v_91         0.32 0.37 0.42  1.00 | + |
t_91         1.42 1.60 1.80  4.37 | |
s_91         0.27 0.30 0.32  0.81 | + |
m_91         0.28 0.30 0.31  0.81 | + |
d_91         2.14 2.37 2.62  6.47 | |
-----

```

```

-----
---- Significant Diff = * | ---- Data Summary: Total n = 588
-----
v_9 t_9 s_9 m_9 d_9 | Gps  Valid NoData Comp RunTim Exclu Other
-----
v_91      *  *  *  *  * | 17   565    9    0    0    14    0
t_91      *  *  *  *  * | 16   542   43    0    0    3    0
s_91      *  *  -  -  * | 17   533   55    0    0    0    0
m_91      *  *  -  -  * | 17   487  101    0    0    0    0
d_91      *  *  *  *  * | 16   438  148    0    0    2    0
-----

```

```

-----
---- Group Weights
-----
application      1.0 | arithmetic      1.0 | classical      1.0
data_storage     1.0 | data_structures 1.0 | delays_and_timing 1.0
exception_handlin 1.0 | generics        1.0 | input_output    1.0
miscellaneous     1.0 | optimizations   1.0 | program_organizat 1.0
statements        1.0 | storage_reclamati 1.0 | subprograms     1.0
systematic_compil 1.0 | tasking         1.0 |
-----

```

Compile and Link --- 20 Dec 1991 12:14:35 --- Page 1

Summary over all groups : product data - product model

| ----- Pairwise Comparisons: total n = 17 |      |      |      |      |      |       |
|--|------|------|------|------|------|-------|
| Systems                                  | v_91 | t_91 | s_91 | m_91 | d_91 | Mean  |
| n:                                       | 17   | 17   | 15   | 17   | 17   | Vari- |
| Sys Factor:                              | 1.08 | 1.24 | 0.31 | 0.58 | 1.59 | ation |
| v_91                                     | n:   | 17   | 15   | 17   | 17   |       |
| Sys Factor:                              |      | 1.08 | 1.09 | 1.08 | 1.08 | 0.2%  |
| t_91                                     | n:   | 17   | 15   | 17   | 17   |       |
| Sys Factor:                              |      | 1.24 | 1.24 | 1.24 | 1.24 | 0.0%  |
| s_91                                     | n:   | 15   | 15   | 15   | 15   |       |
| Sys Factor:                              |      | 0.31 | 0.31 | 0.31 | 0.31 | 0.0%  |
| m_91                                     | n:   | 17   | 17   | 15   | 17   |       |
| Sys Factor:                              |      | 0.58 | 0.58 | 0.61 | 0.58 | 1.1%  |
| d_91                                     | n:   | 17   | 17   | 17   |      |       |
| Sys Factor:                              |      | 1.59 | 1.59 | 1.65 | 1.59 | 1.0%  |

| ----- Number of Test Problems in the Analysis |      |      |      |      |      |          |
|---|------|------|------|------|------|----------|
| No. Problems                                  | v_91 | t_91 | s_91 | m_91 | d_91 | Possible |
| application                                   | 68   | 76   | 52   | 61   | 40   | 86       |
| arithmetic                                    | 108  | 111  | 39   | 107  | 108  | 112      |
| classical                                     | 83   | 80   | 82   | 79   | 54   | 83       |
| data_storage                                  | 91   | 79   | 27   | 75   | 70   | 91       |
| data_structures                               | 224  | 208  | 135  | 215  | 204  | 225      |
| delays and timing                             | 26   | 16   | 16   | 25   | 26   | 41       |
| exception_handling                            | 58   | 52   | 39   | 48   | 39   | 58       |
| generics                                      | 19   | 19   | 7    | 19   | 15   | 24       |
| input output                                  | 104  | 94   | 55   | 93   | 19   | 108      |
| miscellaneous                                 | 16   | 16   | 0    | 16   | 16   | 17       |
| optimizations                                 | 304  | 304  | 168  | 288  | 299  | 305      |
| program_organization                          | 74   | 74   | 54   | 72   | 5    | 74       |
| statements                                    | 80   | 80   | 57   | 80   | 77   | 80       |
| storage_reclamation                           | 47   | 53   | 46   | 50   | 29   | 60       |
| subprograms                                   | 79   | 74   | 36   | 79   | 79   | 79       |
| systematic_compile_speed                      | 73   | 71   | 0    | 59   | 20   | 75       |
| tasking                                       | 87   | 89   | 81   | 78   | 75   | 109      |
| Total   | 1541 | 1496 | 894  | 1444 | 1175 | 1627     |

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Summary over all groups : product data - product model

| Raw Data:      | v_91 | t_91 | s_91 | m_91 | d_91 | Wgts |
|----------------|------|------|------|------|------|------|
| application    | 1.11 | 1.35 | 0.31 | 0.44 | 1.64 | 1.0  |
| arithmetic     | 0.76 | 1.06 | 0.25 | 0.59 | 1.42 | 1.0  |
| classical      | 0.85 | 1.11 | 0.40 | 0.79 | 1.91 | 1.0  |
| data_storage   | 0.75 | 0.84 | 0.27 | 1.00 | 1.04 | 1.0  |
| data_structure | 0.88 | 0.95 | 0.25 | 0.65 | 1.57 | 1.0  |
| delays and tim | 0.64 | 1.11 | 0.50 | 0.54 | 1.29 | 1.0  |
| exception_hand | 1.26 | 0.82 | 0.33 | 0.37 | 1.18 | 1.0  |
| generics       | 0.90 | 0.99 | 0.11 | 0.24 | 1.86 | 1.0  |
| input output   | 1.05 | 1.47 | 0.20 | 0.35 | 0.12 | 1.0  |
| miscellaneous  | 1.05 | 1.30 |      | 0.43 | 1.02 | 1.0  |
| optimizations  | 0.93 | 1.44 | 0.21 | 0.51 | 1.23 | 1.0  |
| program organi | 1.11 | 1.20 | 0.28 | 0.86 | 1.78 | 1.0  |
| statements     | 1.04 | 1.35 | 0.19 | 0.49 | 1.56 | 1.0  |
| storage_reclam | 1.05 | 1.20 | 0.43 | 0.71 | 1.49 | 1.0  |
| subprograms    | 0.99 | 0.98 | 0.16 | 0.46 | 1.63 | 1.0  |
| systematic_com | 1.21 | 1.11 |      | 0.46 | 1.28 | 1.0  |
| tasking        | 1.54 | 0.94 | 0.51 | 0.46 | 1.28 | 1.0  |

---- Outlier Statistics: residual \* system factor \* row mean = actual

|               | Bounds | Expect | Got | v_91 | t_91 | s_91 | m_91 | d_91 |
|---------------|--------|--------|-----|------|------|------|------|------|
| -- Very Low : | 0.62   | 2      | 4   | 0    | 0    | 2    | 1    | 1    |
| - Low :       | 0.67   | 2      | 1   | 0    | 0    | 1    | 0    | 0    |
| + High :      | 1.53   | 2      | 0   | 0    | 0    | 0    | 0    | 0    |
| ++ Very High: | 1.65   | 2      | 4   | 0    | 1    | 2    | 1    | 0    |
| Totals :      |        | 8      | 9   | 0    | 1    | 5    | 2    | 1    |

| Residuals | v_91 | t_91   | s_91   | m_91   | d_91   | Means |
|-----------|------|--------|--------|--------|--------|-------|
| applicati | 1.06 | 1.12   | 1.02   | 0.77   | 1.07   | 0.97  |
| arithmeti | 0.86 | 1.05   | 0.98   | 1.25   | 1.10   | 0.82  |
| classical | 0.78 | 0.88   | 1.25   | 1.35   | 1.19   | 1.01  |
| data_stor | 0.89 | 0.87   | 1.11   | 2.21++ | 0.84   | 0.78  |
| data_stru | 0.95 | 0.89   | 0.93   | 1.30   | 1.15   | 0.86  |
| delays an | 0.73 | 1.10   | 1.94++ | 1.14   | 0.99   | 0.81  |
| exception | 1.46 | 0.84   | 1.34   | 0.81   | 0.94   | 0.79  |
| generics  | 1.01 | 0.98   | 0.41-- | 0.51-- | 1.43   | 0.82  |
| input out | 1.52 | 1.86++ | 0.99   | 0.95   | 0.12-- | 0.64  |
| miscellan | 1.02 | 1.11   |        | 0.79   | 0.68   | 0.95  |
| optimizat | 0.99 | 1.35   | 0.78   | 1.01   | 0.90   | 0.86  |
| program o | 0.98 | 0.93   | 0.86   | 1.41   | 1.07   | 1.05  |
| statement | 1.04 | 1.18   | 0.66-  | 0.91   | 1.06   | 0.93  |
| storage r | 0.99 | 0.99   | 1.41   | 1.25   | 0.96   | 0.97  |
| subprogra | 1.08 | 0.94   | 0.59-- | 0.94   | 1.21   | 0.84  |
| systemati | 1.10 | 0.88   |        | 0.78   | 0.79   | 1.02  |
| tasking   | 1.50 | 0.81   | 1.72++ | 0.83   | 0.85   | 0.95  |
| Sys Fact  | 1.08 | 1.24   | 0.31   | 0.58   | 1.59   |       |

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# Summary over all groups : product data - product model

## ----- System Names and Descriptions

```

v_91
-- Host: VAXstation 3100          Target: VAXstation 3100
t_91
-- Host: VAXstation 3100          Target: VAXstation 3100
s_91
-- Host: MIPS R2000A/R3000        Target: MIPS R2000A/R3000
m_91
-- Host: DECstation 3100 MIPS RISC Target: DECstation 3100 MIPS RISC
d_91
-- Host: VAX 6220                 Target: 1750A

```

## ----- System Factors and Confidence Intervals (including graph)

| Systems | Low  | Mean | High | Ratio | 0.2 | 1.8 |
|---------|------|------|------|-------|-----|-----|
| v_91    | 0.94 | 1.08 | 1.25 | 1.00  |     |     |
| t_91    | 1.09 | 1.24 | 1.40 | 1.14  |     |     |
| s_91    | 0.23 | 0.31 | 0.43 | 0.29  |     |     |
| m_91    | 0.46 | 0.58 | 0.74 | 0.54  |     |     |
| d_91    | 1.39 | 1.59 | 1.82 | 1.47  |     |     |

## ----- Significant Diff = \* | ----- Data Summary: Total n = 1627

|      | v_9 | t_9 | s_9 | m_9 | d_9 | Gps | Valid | NoData | Comp | RunTim | Exclu | Other |
|------|-----|-----|-----|-----|-----|-----|-------|--------|------|--------|-------|-------|
| v_91 | -   | *   | *   | *   | *   | 17  | 1541  | 0      | 14   | 1      | 25    | 46    |
| t_91 | -   | *   | *   | *   | -   | 17  | 1496  | 29     | 31   | 12     | 1     | 58    |
| s_91 | *   | *   | *   | *   | *   | 15  | 894   | 30     | 82   | 15     | 2     | 604   |
| m_91 | *   | *   | *   | *   | *   | 17  | 1444  | 81     | 42   | 21     | 0     | 39    |
| d_91 | *   | -   | *   | *   | *   | 17  | 1175  | 319    | 71   | 22     | 1     | 39    |

## ----- Group Weights

|                   |     |                   |     |                   |     |
|-------------------|-----|-------------------|-----|-------------------|-----|
| application       | 1.0 | arithmetic        | 1.0 | classical         | 1.0 |
| data_storage      | 1.0 | data_structures   | 1.0 | delays_and_timing | 1.0 |
| exception_handlin | 1.0 | generics          | 1.0 | input_output      | 1.0 |
| miscellaneous     | 1.0 | optimizations     | 1.0 | program_organizat | 1.0 |
| statements        | 1.0 | storage_reclamati | 1.0 | subprograms       | 1.0 |
| systematic_compil | 1.0 | tasking           | 1.0 |                   |     |

Execution Times --- 20 Dec 1991 12:14:16 --- Page 1

## **AES Review Outline**

**Background**  
**Test Harness**  
**Specific Test Problems**  
**Assessors**  
**Analysis / Reporting**

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## **AES 2.0 REVIEW BACKGROUND**

**Read documentation and code for performance tests**  
**Executed the performance test groups**  
**Reviewed documentation and ran other selected groups**  
**AES design philosophy assumes testing service**  
**Expected to develop core of people experienced with porting**  
**Relatively small number of performance tests**  
**No automated system comparison tool**  
**Emphasizes textual reporting**  
**Qualitative findings (optimization performed or not)**  
**AES provides broad coverage of capabilities of "whole APSE"**

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## TEST HARNESS

- Does not delete unneeded program library units**
- Harness error messages not helpful**
- New database needed to evaluate tools**
- Manual mode doesn't clearly explain "work/not work"**
- Doesn't document where reports are placed**
- RESULTS.DBS was easily corrupted**

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## TEST HARNESS PORTING EFFORT

- AES forces users to learn operating system interfaces for**
  - Control of split screen**
  - Spawning processes**
  - Invoking job control statements from Ada program**
- Requires information about AES internal structures**
- Requires adaptation of preprocessor**
- Desires compiler supporting all Ada with OS interfaces**

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## OVERVIEW OF FLAWED PERFORMANCE TESTS

14 of 19 tests in Group I (General Runtime Efficiency) are flawed  
9 of 20 tests in Group O (Optimization) are flawed

Flawed tests can be corrected but all require review

Representative examples are presented

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## CRITERIA FOR PERFORMANCE TESTS

With respect to the timing loop, each test problem should:

- Not be loop invariant
- Use live variables
- Contain expressions that are not strength reducible
- Not be unduly foldable
- Follow same path on each repetition
- Use initialized variables

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## AES EXAMPLE 1: TI01D

Test problem contains 40 statements of the form  
Intended to test efficiency of record comparison

**SAME** := A1 = A2 ; -- where A\* is a record  
**SAME** := A2 = A3 ;

...

**NOT\_SAME** := (A1 /= A2) and (A3 /= A4);

**NOT\_SAME** := (A5 /= A6) and (A7 /= A8);

...

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## FLAWS IN EXAMPLE 1

38 of 40 assignments are dead

ALL expressions are loop invariant

Even if record comparisons could raise exceptions, LRM would  
explicitly permit reordering (11.6)

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## AES EXAMPLE 2: T002

Examples RL11 & RL12 are intended to detect whether common subexpressions involving two-dimensional array addressing for integers are recognized as common

RL11  $\Rightarrow$  RAA (K, L) := RBB (K, L) + RV;  
RAA2 (K, L) := RBB2 (K, L) + RV;

RL12  $\Rightarrow$  RAA (K, L) := RAA (K, L) + RV;  
RAA2 (K, L) := RAA2 (K, L) + RV;

AES assumes RL12 will be smaller than RL11 iff common subexpressions are recognized

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## FLAWS IN EXAMPLE 2

Array TYPES are identical so the ALL subscripting expressions are common

All subscripting expressions are loop invariant

Use of ADD\_TO\_MEMORY Instruction can confound interpretation

No "credit" for recognizing that expression could be evaluated once

Conclusions drawn from test results can be wrong

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## AES EXAMPLE 3: TI11

The third part of this problem calculates the FOR loop overhead

Version 1  $\Rightarrow$  If not TRUE1 then – done twice as often as version\_2

$K := K + I2$ ;  $A(K) := K$ ; – I2 is timing loop index

end if;

Version 2  $\Rightarrow$  If not TRUE1 then

$K := K + I2$ ;  $A(K) := K$ ;

end if;

if not TRUE2 then

$L := L + I2$ ;  $A(L) := L$ ;

end if;

Reports "overhead" as  $(\text{time\_for\_v1} - \text{time\_for\_v2}) / \text{iterations\_of\_v1}$

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## FLAWS IN EXAMPLE 3

TRUE1 & TRUE2 are loop invariant

Instruction prefetching will favor second example

The idea that a system has a constant FOR LOOP overhead is flawed

An optimizer may unroll some loops, reducing loop overhead

Complexity of body may permit/prevent keeping FOR index in register

Size determines whether code can use long/short format instructions

Memory effects: cache and/or prefetching and/or "loop mode"

Target processor may have idiomatic instructions

After loop invariant motion, body might be null

Strength reduction on FOR loop index used only as subscript

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## AES EXAMPLE 4: TR23

Test problem to detect whether compiler does loop motion:

```
for I in ONE_TO_TEN loop
  SUM (I) := S + A (I);
  A (INDEX) := S;    - INDEX is out-of-range
end loop;
```

Tests whether value of SUM(1) has been modified

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## FLAWS IN EXAMPLE 4

"A(INDEX) := S;" only invariant if flow analysis determines INDEX  
is never one

Confounds loop invariant motion with data flow analysis

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## AES TIMING LOOP

**Does not subtract off null loop time (documentation says it does)**  
**Does not distinguish between inconsistent measurements and test failures**  
**Uses fixed number of outer loop cycles**  
**Bases inner loop count on clock tick**  
**Does not use confidence levels**  
**Uses nested FOR loops**

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## ASSESSORS

**Includes assessors for non-Ada specific capabilities**  
**Requirements analyzer**      **Version Configuration Control**  
**Editors (general purpose)**      **Command Language Interpreter**

**Includes assessors for various Ada-specific capabilities**  
**Compiler/Linker diagnostics**      **Compiler/Linker capacity limits**  
**Compiler performance**      **Runtime performance**  
**Name expander**      **Pretty printer**  
**Source generator**      **Timing analysis tools**  
**Test coverage tool**      **Stub generator**  
**Assertion checker**      **Cross reference analyzer**  
**Syntax oriented editor**      **Testbed generator**

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## **ANALYSIS / REPORTING**

**AES does not provide comparative analysis tool**  
**AES reports states conclusions without supporting data**  
**TOO2 reports whether optimization performed or not**  
**AES presents a lot of descriptive text along with results**

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## **SUMMARY**

**Test Harness**  
**Inappropriate to non-test service based usage**  
**Test Problems**  
**Many contain flaws which should be corrected**  
**Assessors**  
**AES provides broad coverage of APSE capabilities**  
**Analysis**  
**Lack of automated system comparisons is significant**

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Carnegie Mellon University  
Software Engineering Institute

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# Comments on the Ada Evaluation System

January 22, 1992 (Version 1.0a)

Software Engineering Institute  
Carnegie Mellon University  
Pittsburgh PA 15213

Sponsored by the U.S. Department of Defense



Carnegie Mellon University  
Software Engineering Institute

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## Background

The SEI has had access to the AES for about four years, and has used it in several ways:

- As software subjected to critical review
- As an element in a benchmark tutorial
- As an evaluation tool in performance analysis

The AES elements considered in this talk:

- Executable benchmark tests (primary)
- Test harness (primary)
- Check lists (secondary)
- Documentation (secondary)



## Organizational Issues

### Consistent use of Test Categories

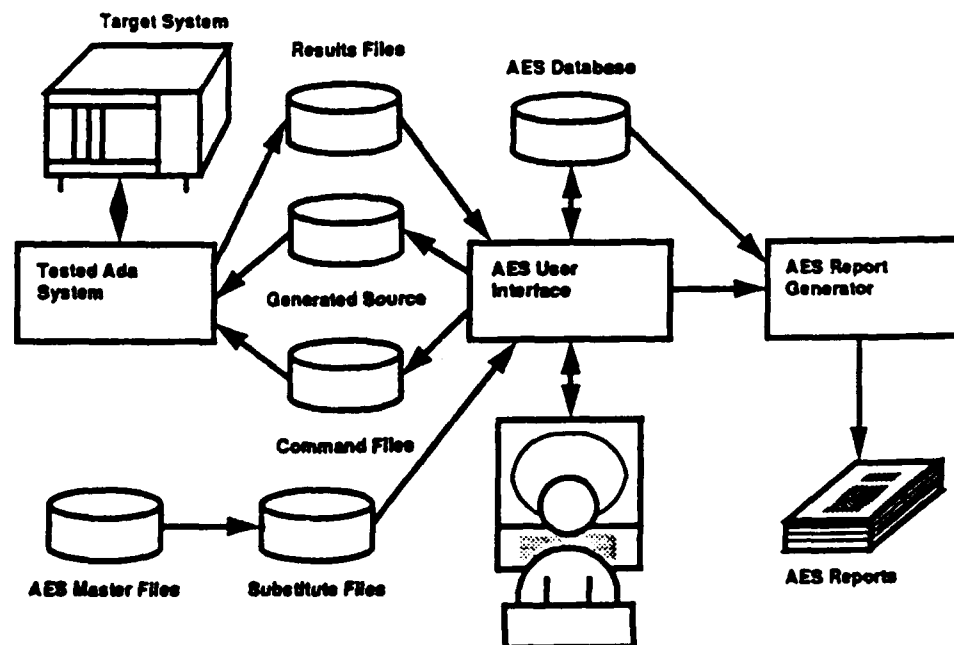
- Tests are organized into groups
  1. Object under test (compiler, loader, etc.)
  2. Concept under tests (optimizations, etc.)
- Categories are used for
  - Documentation
  - File Naming
  - Testing
  - Reports

### Convenient Access to Data (Database)

- Data stored as text
- Database used for results and control variables
- Only one value per database item (e.g. one compiler per database, one test run only)



## File Organization





## User Interface -1

### Strengths

- **Interactive**
- **Integrates all important components**
  - **Set up**
  - **Database**
  - **Testing**
  - **Report generation**
- **Automatic or manual mode using same model**
- **Script driven, flexible**

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## User Interface -2

### Weaknesses

- **Modal (set up mode, test mode, report mode)**
- **Undocumented commands**
- **Partial memory of previous state**
- **Portability complicated by screen interface**
- **Weak help and tutorial**
- **Database access is limited to raw data**
- **No provision for subsetting or exchanging data**



## Scripts

### Scripts provide

- Conditional testing based on test results
- For user modifications
- Convenient substitution points for system dependencies

### Script problems

- Hard to identify truly universal operations (e.g. Verdex does listing with a separate utility, not through compiler)
- Sometimes no handle provided (e.g. Verdex uses ".a" for all source files)
- Operations may be divided or combined (e.g. optimization: pragma, command line switch or both)

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## Focused Testing

### Some of my favorite tests/methods:

- Limit testing (using binary chop)
- Memory allocation strategies (three models)
- Variation in implementation (e.g. case implementation strategies)



## Test Issues

### Identified test needs

- Measuring individual features
- Compare different systems
- Compare different versions
- Time statements
- Coding for performance

### AES vs. ACEC

- Measuring individual features: AES better
- Compare different systems: AES worse
- Compare different versions: AES equal
- Time statements: AES much worse
- Coding for performance: AES better



## Timing

### Features

- Ignores certain biases
- Selects timing based on clock resolution
- Portable, only needs standard clock
- Tests for consistency of results
- Time value is average of all tests, not minimum

### Issues

- No provision for automated substitution
- Not suited for fast timers
- Can only generate average values
- Timing can start before I/O concludes





## Bias Control

AES controls for certain kinds of bias:

- **Memory location effects:** averaged values by multi-statement segments
- **Timing overhead:** tested code segments kept large, timing overhead is assumed to be small
- **Timing variation:** multiple runs, tests which show significant variation are marked as failing

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## Missing but Desirable

- **Open systems:** features and documentation to support customization and extension
- **Presentation:** flexible report and graphic output
  - As part of standard presentations
  - To allow interactive testing
- **Data manipulation:** need to select and exchange data
  - For spreadsheets
  - Raw data for statistical packages
  - In table format for text processing

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Carnegie Mellon University  
Software Engineering Institute

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# Comments on the Preliminary Release of ACEC 3.0

**22 January 1991**

**Software Engineering Institute  
Carnegie Mellon University  
Pittsburgh PA 15213**

**Sponsored by the U.S. Department of Defense**



Carnegie Mellon University  
Software Engineering Institute

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## Background

**SEI has been involved with ACEC for the past few years**

**Release 2.0 has been used in the past year**

- **As software subjected to critical review**
- **As an element in a benchmark tutorial**
- **As an evaluation tool in performance analysis**

**Preliminary release 3.0 was received in mid-December, 1991, so an extensive evaluation of it has not been performed**



## SEI Work to Date with Release 3.0

**All documents read and all pre-test steps run**

**Limited number of performance tests run**

**Problems encountered running SSA and Menu**

**CA and assessor tools not run**

### **SEI Configuration**

- **Compiler: Verdix VADS VMS - MC68030 6.0.5(f)**
- **Host: DEC MicroVAX 3200 running VMS 5.3**
- **Target: 25 MHz Motorola MC68030**
- **Compiler for host-specific analysis tools was DEC VAX Ada 2.1**

3



## Overall Comments

**The User's Guide and the organization of the software are much improved over the previous release**

- **Logical step-by-step guide to pre-tests**
- **Pre-tests incorporate actual execution of tests and analysis tools**
- **Command file naming conventions and division of tests into performance groups makes life easier**

**The Reader's Guide still needs work to achieve the clarity and usefulness of the User's Guide, particularly the sections dealing with the Comparative Analysis tool**

**The pre-test and test suite command files do not adequately address the needs of host-target systems**



## Comments on the Reader's Guide

**The Reader's Guide doesn't yet clearly answer the question: How does the ACEC compare compiler C1 on machine M1 with compiler C2 on machine M2?**

**There should be a clear statement of the level of knowledge required of a user for correct interpretation of all analysis tool outputs.**

**The sections on the Comparative Analysis tool's output and background need to be re-organized and made more understandable.**

**The chapter on timing techniques is good but needs some re-organization to make it more user-friendly**

5



## Some Problems Encountered

**TCAL1 and TCAL2 tests (pre-test step 4) didn't work**

**Double-precision math library test of Power function failed with an Argument\_Error exception**

**SSA tool couldn't open database file created by the Condense tool; Menu program subsequently crashed**

**Menu program crashed immediately when "PS:" was specified in a VMS pathname in the System Names file**

6



## Concluding Remarks

**Provide users with some estimate of how long it takes to set up and run the ACEC and analyze the results**

**Emphasize the need for users to treat running ACEC as part of a larger overall evaluation PLAN**

**Think about graphical output and/or output suitable for analysis by spreadsheets**

**Think in terms of benchmark generation rather than benchmark instantiation**

**Hypertext Version of the  
E&V Reference System:  
A Sampler**

23 January 1992

[Sample material from the  
User's Guide and system screens]

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## 1. INTRODUCTION

The Ada Programming Support Environment (APSE) Evaluation and Validation (E&V) Reference System is a pair of documents developed, and periodically updated, by the APSE E&V Project, sponsored by the Ada Joint Program Office and led by the US Air Force Avionics Directorate of the Wright Laboratory. The documents are entitled the "E&V Reference Manual" and the "E&V Guidebook."

The **E&V Reference Manual** provides a framework for understanding APSEs and their assessment, and establishes common terminology. One chapter discusses an APSE as a whole and its assessment. Other chapters are indexes to APSE component characterization and assessment, organized by life cycle activities, APSE tool category, APSE function, and attribute to be assessed. An entry in an index consists of a description, cross references to other entries in the Reference Manual, and cross references to the "E&V Guidebook." The manual is intended to help a variety of users obtain answers to their questions. As a stand-alone document it is intended to help a user find useful information about index elements and relationships among them. In conjunction with the Guidebook, it is intended to help users find criteria and metrics for assessment of APSEs and their components.

The **E&V Guidebook** provides descriptions of specific instances of assessment technology. These include evaluation (assessment of performance and quality) and validation (assessment of conformance to a standard) techniques. For each category of item to be assessed (e.g. compilation system, test system, whole APSE, etc.), there are brief descriptions of applicable tools and aids -- such as test suites, questionnaires, checklists, and structured experiments -- and references to primary documents containing detailed descriptions. The Guidebook also contains synopses of documents of general historical importance to the entire field of Ada environments and their assessment.

Hard copy versions (1.1, 2.0, 3.0) of both documents have been published beginning in 1987. These are available through the Defense Technical Information Center (DTIC). The Version 3.0 DTIC numbers are:

AD A236 697 -- E&V Reference Manual  
AD A235 494 -- E&V Guidebook

The text of the hypertext version (3.1) is based on the most recent hard copy version (3.0), published in February 1991 -- with a few minor additions and corrections. The hypertext version runs on Macintosh® computers as a set of Hypercard® stacks. It requires Hypercard Version 2.0 or later. It is shipped as a set of three 3.5 inch double-density, double-sided disks, plus this document.

Disk A contains 8 stacks -- two special stacks and part of the E&V Reference Manual.  
Disk B contains 3 stacks -- Chapters 6 and 7, and Appendices of the E&V Reference Manual.  
Disk C contains 18 stacks -- the entire E&V Guidebook.

**E&V-Maps** and **E&V-Help** are the two special stacks mentioned above. The other 27 stacks correspond directly to textual material previously published in the most recent hard copy version (3.0) -- except for the many "hyperlinks" and navigation devices incorporated along with the text in the hypertext version (3.1).

## 2. INSTALLATION AND START-UP

You must have a Macintosh with Hypercard Version 2.0 or later already installed. The E&V Reference System stacks require approximately 1.9 megabytes of memory on your hard disk.

It is very easy to install the system for anyone familiar with the Macintosh desktop system for creating, copying, and dragging folders and files. Perform the following steps to install the system:

1. Create a new folder with a name such as "E&V RefSys"
2. Copy the contents of disk A (8 files) into your new folder.
3. Copy the contents of disk B (3 files) into your new folder.
4. Copy the contents of disk C (18 files) into your new folder.
5. Arrange the 29 icons representing the 29 files in a neatly organized manner such as that shown in Fig. 2-1.

To start the system running, you can double-click on any of the 29 icons. Normally, you will want to start from a high-level view. The way to do this is to double-click on the E&V-Maps icon. This takes you to the first card in the stack; it is called Top-Level E&V Map. If you are already familiar with the system based on past experience, you may want to go directly to one of the chapters by double-clicking on the icon corresponding to that chapter. You can easily get to the help screens from every card in any of the other 28 stacks, by clicking on the ? button. You can also start in the E&V-Help stack by double-clicking on the icon with that name. In fact, a good way to begin, if this is your first look at the system, is to go directly to the E&V-Help stack and browse through the first section called Welcome and Introduction. The help screens are also printed out in Section 3 of this User's Guide.

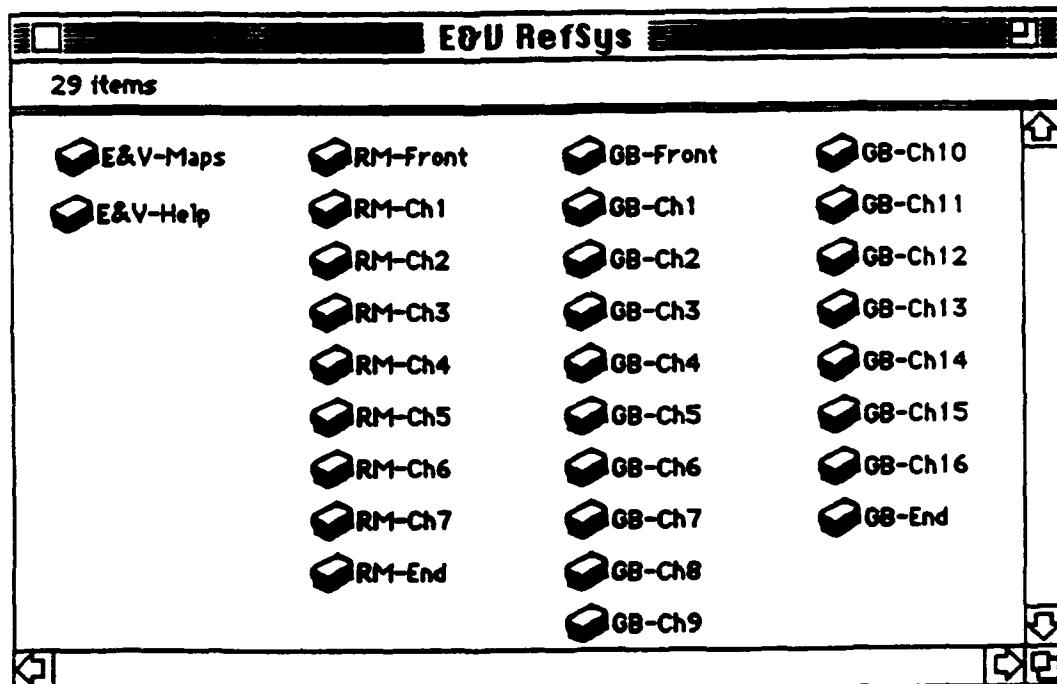


Figure 2-1 Suggested Arrangement of Stack Icons





E&V Help      You should be in User Level 1 : Browsing -- see last card of Home stack  
Use arrow buttons at bottom to go forward or backward.

**Main Menu**

- 1 Welcome and Introduction
- 2 Navigating with "E&V Maps"
- 3 Other Navigation Aids
- 4 Using the Formal Chapters  
(RM 4-7, GB 4-16)
- 5 Early Chapters and Appendices
- 6 Marking, Printing, and User Feedback

**Close**      Welcome and Introduction  
(Click a topic to see it)

\*\*\*\*\*

- 1a Welcome Text
- 1b Welcome Diagram
- 1c Using E&V Help
- 1d Quitting the E&V Help Stack
- 1e Why was the Hypercard Version created?
- 1f How many stacks are there?
- 1g How are they linked together?
- 1h Version 3.1 Upgrades
- 1i Important Things to Remember

**Main Menu**      **Quit E&V Help**

E&V Help      You should be in User Level 1 : Browsing -- see last card of Home stack  
Use arrow buttons at bottom to go forward or backward.

**Main Menu**

- 1 Welcome and Introduction
- 2 Navigating with "E&V Maps"
- 3 Other Navigation Aids
- 4 Using the Formal Chapters  
(RM 4-7, GB 4-16)
- 5 Early Chapters and Appendices
- 6 Marking, Printing, and User Feedback

**Close**      Navigating with "E&V Maps"  
(Click a topic to see it)

\*\*\*\*\*

- 2a The "E&V Maps" Stack
- 2b The Stack Map -- Pictorial Overview
- 2c Navigating from the Maps
- 2d Getting to the Maps
- 2e Using the Maps to see Attribute and Function Definitions

**Main Menu**      **Quit E&V Help**

E&V Help

Welcome and Introduction

## 1a Welcome Text

(Note: be sure to click the "balloon" and then click the "close box")

Welcome to the Hypercard version of the **E&V Reference System -- Version 3.1.**

The system helps users make assessments of tools, tool sets, and environments (APSEs). It contains two electronic "hyperdocuments:"

**"E&V Reference Manual"**

**"E&V Guidebook."**

Assessments fall into two categories:

**Evaluation (E)** is assessment of performance and quality.

**Validation (V)** is assessment of conformance to a standard.

Main Menu



Quit E&V Help

E&V Help

Welcome and Introduction

## 1a Welcome Text - continued

Hard copy versions (1.1, 2.0, and 3.0) have been published beginning in 1987. These are available through the Defense Technical Information Center (DTIC). The Version 3.0 DTIC Numbers are:

E&V Reference Manual -- AD A236 697

E&V Guidebook -- AD A236 494

This electronic version (3.1) is based on the most recent hard copy version (3.0), published in February 1991. Most of the text is the same -- the exceptions to this rule are indicated in "Version 3.1 Upgrades" ( see E&V Help Item 1h). The early chapters of both documents contain background material on the need for E&V and the history of the E&V Project.

Main Menu



Quit E&V Help

E&amp;V Help

Welcome and Introduction

**1a Welcome Text - continued**

The next card is a pictorial representation of the two documents and their relationship to one another.

Other graphical representations of the system may be found in the stack called **E&V Maps** -- a very important stack, which you should be sure to read about a little later in this **E&V Help** stack.

**E&V Help** and **E&V Maps** are of course not included in the hard copy version of the system.

Main Menu



Quit E&amp;V Help

E&amp;V Help

Welcome and Introduction

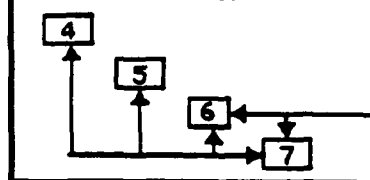
**1b Welcome Diagram**

Welcome to the Hypercard version of the "E&V Reference System."

The system consists of two documents, which contain many inter-document and intra-document links (pointers), as indicated pictorially below.

**E&V Reference Manual (RM)**

Indexes (Chap. 4-7) with pointers to other indexes and to the Guidebook.

**E&V Guidebook (GB)**

Descriptions (Chap 5-16) of individual assessors (evaluators and validators) of various categories of tools and APSEs.

Pointers

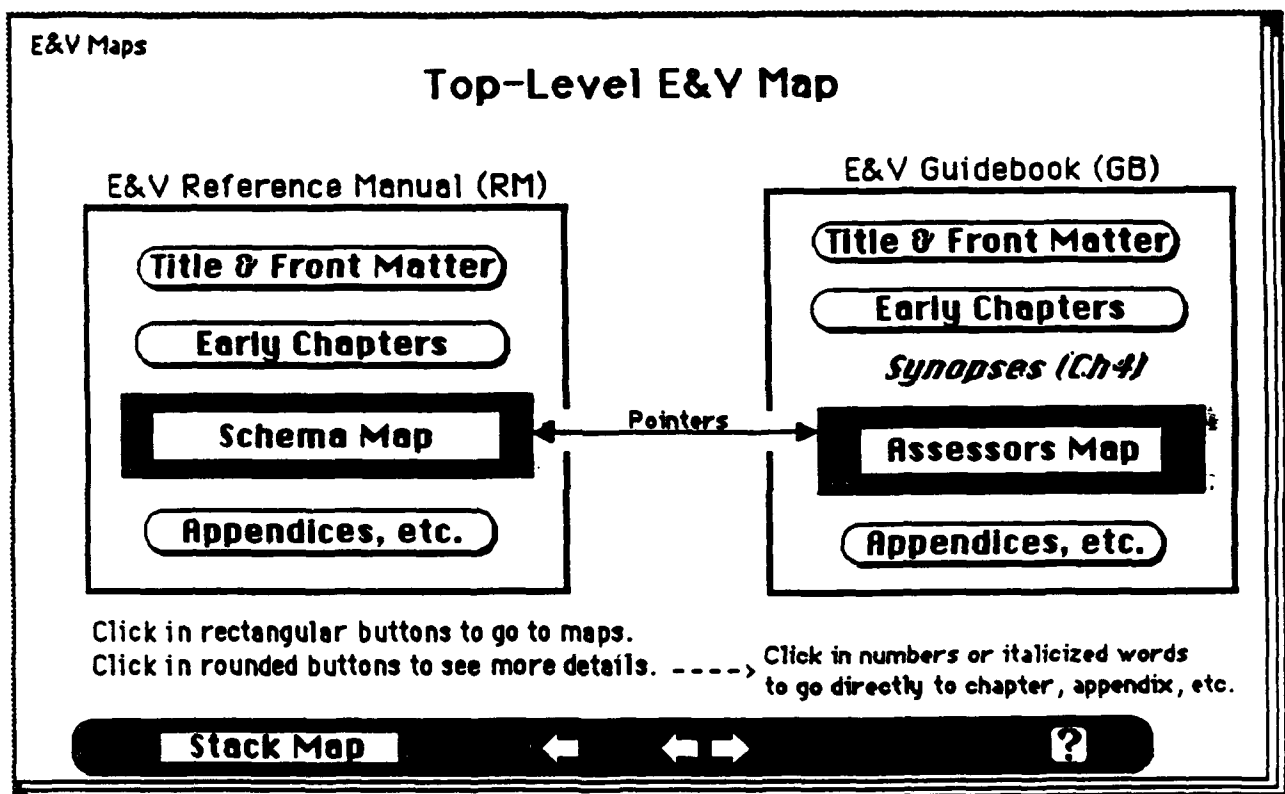
Main Menu



Quit E&amp;V Help

#### 4. E&V MAPS: PRINT-OUT

This section provides a print-out of the eight cards of a special stack called E&V-Maps. The on-screen versions of most of these cards provide a great deal of hidden information -- available in pop-up fields. You will not, of course, have access to the hidden information in this printed form. But, you can see how the top-level access is organized, and you can read about the mechanisms involved by reviewing Part 2 of the E&V-Help stack given previously.



E&V Maps

## Functions Map

Guide to Chapter 7. Functions of the E&V Reference Manual

### 7.1 Transformation

- 7.1.1 Editing
- 7.1.2 Formatting
- 7.1.3 On-Line Assistance
- 7.1.4 Sort/Merge
- 7.1.5 Graphics Generation
- 7.1.6 Translation
- 7.1.7 Synthesis

### 7.2 Management

- 7.2.1 Information Management
- 7.2.2 Project Management
- 7.2.3 Computer System Mgmt

### 7.3 Analysis

- 7.3.1 Static Analysis
- 7.3.2 Dynamic Analysis
- 7.3.3 Formal Verification
- 7.3.4 Problem Report Analysis
- 7.3.5 Change Request Analysis

Click number to go to section.

Click function name to see description.

Click round button to see lower-level details.

Top-Level E&V Map



E&V Maps

## Assessors Map

Guide to Chapters 5-16 of the E&V Guidebook

- 5. General Purpose Assessors
- 6. Compilation System Assessors
- 7. Target Code Generation Aids and Analysis Toolset Assessors
- 8. Test System Assessors
- 9. Tool Support Component Assessors
- 10. Requirements/Design Support Assessors

- 11. Configuration Management Support Assessors
- 12. Distributed System Dev't and RTS Assessors
- 13. Distributed APSE Assessors
- 14. Whole APSE Assessors
- 15. Information Management Support Assessors
- 16. Other Assessors

Click number to go to section.

Click round button to see lower-level details.

Top-Level E&V Map



## 7. Functions

### Chapter Overview:

[Print Marked Descriptions](#)

Introductory Paragraphs (next card)

**Fig 7-1** Function Relationships

**7.1** Transformation 

**7.2** Management 

**7.3** Analysis 

[Top-Level E&U Map](#)


[6](#)
[End](#)


### 7.1.6.13 Linking/Loading



#### Description:

Linking/Loading: The creation of a load/executable module on the host machine from one or more independently translated object modules or load modules by resolving cross-references among the object modules, and possibly relocating elements.  
[©Kean 1985]

Cross References:  Life Cycle Activities

Tools 

#### Guidebook References:


|   |         |   |
|---|---------|---|
| [Completeness                                       | 6.4.9,  |  |
| @GB: Cross-Development System Support Questionnaire | 14.3;   |   |
| Power   | 6.4.22, |   |
| @GB: Linking/Loading Checklist                      | 7.2;    |   |
| Processing Effectiveness                            | 6.4.23, |   |
| @GB: AIM Benchmark Suites                           | 9.5;    |  |

[Top-Level E&U Map](#)


## 7.1.6.7 Compilation



## Description:

Compilation: Translating a computer program expressed in a procedural or problem-oriented language into object code. [Kean 1985]

Cross References:  Life Cycle Activities

Tools 

## Guidebook References:

|   |         |   |
|---|---------|---|
| *EGB: Ada Compiler Specification and Selection Questionnaires | 6.18;   |  |
| Processing Effectiveness                                      | 6.4.23, |   |
| (*EGB: IDA Benchmarks   | 6.2,    |   |
| *EGB: Ada Compiler Evaluation Capability (ACEC)               | 6.3,    |   |
| *EGB: PIWG Benchmark Tests                                    | 6.4,    |   |
| *EGB: University of Michigan Benchmark Tests                  | 6.5,    |   |
| *EGB: UK Ada Evaluation System (AES)                          | 6.7,    |   |
| *EGB: ARTEWG Catalogue of Ada Runtime Implem. Dependencies    | 6.10,   |   |
| EGB: Compiler Assessment Questionnaire                        | 6.12.   |  |

**Top-Level E&V Map**   



## 6.3 Ada Compiler Evaluation Capability (ACEC)

|                |                           |                       |               |
|----------------|---------------------------|-----------------------|---------------|
| <b>Purpose</b> | <b>Primary References</b> | <b>Vendors/Agents</b> | <b>Method</b> |
|----------------|---------------------------|-----------------------|---------------|

## 6.3 Ada COMPILER EVALUATION CAPABILITY (ACEC)

**Purpose:** The Ada Compiler Evaluation Capability (ACEC) Version 2.0 was developed by Boeing Military Airplanes for the Ada Joint Program Office (AJPO) under the direction of the Air Force Wright Research and Development Center (WRDC). Its primary purpose is to provide the capability to determine the performance and usability characteristics of Ada compilation systems. The ACEC consists of the ACEC Software Product and three supporting documents: the ACEC User's Guide, the ACEC Reader's Guide, and the ACEC Version Description Document.

**ACEC Software Product** - The ACEC Software Product consists of performance tests, assessor tools, and support software. The software product makes it possible to:

- Compare the performance of several implementations

**Top-Level E&V Map**   





## 6. Compilation System Assessors

### Chapter Overview

[Print Marked Assessors](#)

Introductory Paragraphs (next card)

|                      |                                     |                      |                                  |
|----------------------|-------------------------------------|----------------------|----------------------------------|
| <a href="#">6.1</a>  | Ada Compiler Validation Cap. (ACYC) | <a href="#">6.11</a> | ARTEWG Runtime Env'mt Tax ...    |
| <a href="#">6.2</a>  | IDA Benchmarks                      | <a href="#">6.12</a> | Compiler Assessment Quest're     |
| <a href="#">6.3</a>  | Ada Compiler Evaluation Cap. (ACEC) | <a href="#">6.13</a> | Weiderman: Compiler Eval Lists   |
| <a href="#">6.4</a>  | PIWG Benchmark Tests                | <a href="#">6.14</a> | Runtime Support Sys Quest're     |
| <a href="#">6.5</a>  | U. of Michigan Benchmark Tests      | <a href="#">6.15</a> | Hartstone Synthetic Benchmark    |
| <a href="#">6.6</a>  | Mitre Benchmark Generator Tool      | <a href="#">6.16</a> | Ada Comp Perf Test Suite (ACPS)  |
| <a href="#">6.7</a>  | UK Ada Evaluation System (AES)      | <a href="#">6.17</a> | Prod Quality Ada Comp (PQAC)     |
| <a href="#">6.8</a>  | Compilation Checklist               | <a href="#">6.18</a> | Ada Compiler Spec & Sel Quest're |
| <a href="#">6.9</a>  | Program Library Mgmt Checklist      |                      |                                  |
| <a href="#">6.10</a> | ARTEWG Catalogue of Runtime ...     |                      |                                  |

[Top-Level EOU Map](#)

### 6.7 UK Ada Evaluation System (AES)

| Purpose | Primary References | Vendors/Agents | Method |
|---------|--------------------|----------------|--------|
|---------|--------------------|----------------|--------|

|     |                                |  |  |
|-----|--------------------------------|--|--|
| 6.7 | UK Ada EVALUATION SYSTEM (AES) |  |  |
|-----|--------------------------------|--|--|

**Purpose:** Evaluation of Ada compilers and associated linkers/loaders, program library systems, debuggers, and run-time libraries. A test suite and a methodology (AES) were developed by Software Sciences Ltd., under sponsorship of the UK Ministry of Defense (MoD). The British Standards Institute (BSI) has been sponsored by the MoD to provide an Ada Evaluation Service, using the AES. Interested parties, such as compiler vendors or potential compiler purchasers, may pay BSI to conduct an evaluation or to supply a copy of an existing evaluation report.

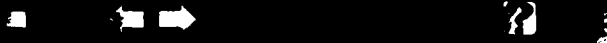
|                  |                               |         |
|------------------|-------------------------------|---------|
| ERM: Compilation | 7.1.6.7, (ERM: Accuracy       | 6.4.1,  |
|                  | ERM: Anomaly Management       | 6.4.2,  |
|                  | ERM: Capacity                 | 6.4.6,  |
|                  | ERM: Cost                     | 6.4.11, |
|                  | ERM: Operability              | 6.4.21, |
|                  | ERM: Processing Effectiveness | 6.4.23, |

[Top-Level EOU Map](#)

E&amp;V Guidebook, Version 3.1

Chapter 8. Test Systems Assessors

**Table 8.1-1 Testing Capabilities Checklist**

| Table 8.1-1 Testing Capabilities Checklist   |       |       |
|--|-------|-------|
| FEATURE  | FOUND | NOTES |
| Static Analyzers<br>Code Auditors<br>Consistency Checkers<br>Interface Analyzers<br>Completeness Checkers  |       |       |
| Tool Building Services<br>Common "Front-End" Facilities for<br>Languages of Interest (Parsing,<br>Source & Internal Form Manipula-<br>tion, Execution Facilities)<br>Tool Composition Aids |       |       |
| <b>Top-Level E&amp;V Map</b>   |       |       |

E&amp;V Guidebook, Version 3.1

Chapter 13. Distributed APSE Assessors

**Figure 13.1-1 Distributed APSE Questionnaire**

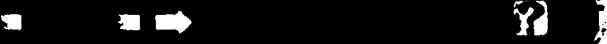
**Architecture**

Type of Distribution  
What is distributed on the APSE: processing resources, data, or both?

Heterogenous/Homogenous  
Does the APSE support a heterogenous hardware configuration or is it restricted to implementation on a homogenous hardware configuration?  
Is there special hardware required for its implementation on a heterogenous configuration?  
Are there special software communication protocols that are required for implementation on a heterogenous configuration?

Node Transparency  
Is the same toolset available on all nodes in the APSE?  
If so, how is the commonality defined (e.g., common user interface, common functionality, and support by a common vendor)?

If not:  
Is the user-interface and functionality the same across all nodes?

**Top-Level E&V Map**


## **ACEC - AES Merger**

**Objectives**  
**Interface**  
**Performance Tests**  
**Analysis**  
**Assessors**

Work Shop

BOEING

1/16/92 1

## **Objectives**

**Portability**  
**Ease of adaptation**  
**Ease of use**  
**Minimize cost/benefit ratio for users**  
**Upward compatability (200 ACEC users)**

**Take the best of the AES and add it to  
the ACEC**

**Resource Constraints**

Work Shop

BOEING

1/16/92 2

## **Interface Issues: The Test Harness**

**Database**

**Preprocessor**

**Command file generation**

**Ada program generation**

**Direct execution mode**

Work Shop

BOEING

1/16/92 3

## **Database**

**Keeps track of progress**

**Insure that checkout tests have been run**

**Using information from checkout tests**

Work Shop

BOEING

1/16/92 4

## **Command File Generation**

**Ease the adaptation process**

**Do not have to remember file names**

**Tailoring**

**Database information**

**User requests**

**Work Shop**

**BOEING**

**1/16/92 5**

## **Ada Program Generation**

**Conserve disk space**

**Parameterization**

**System Adaptation**

**Work Shop**

**BOEING**

**1/16/92 6**

## **Direct Execution Mode**

**Adaptation difficulty**  
**Some tests are NOT automatable**  
**Debugger**  
**Diagnostics**  
**Interactive versus batch**  
**Number of tests**  
**Running time**

Work Shop

BOEING

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## **Adaptation**

**Command language**  
**Tool specific commands**  
**Ada/Operating system interface**  
**Screen control**

Work Shop

BOEING

1/16/92 8

## The ACEC under the Test Harness

|                          |                             |
|--------------------------|-----------------------------|
| <b>Pretest</b>           | <b>Interactive / Manual</b> |
| <b>Entering results</b>  | <b>Automatic / Manual</b>   |
| <b>Performance tests</b> |                             |
| <b>Groups</b>            | <b>Batch</b>                |
| <b>Individual tests</b>  | <b>Interactive / Direct</b> |
| <b>Entering results</b>  | <b>Automatic</b>            |
| <b>Analysis</b>          | <b>Interactive / Batch</b>  |

Work Shop

BOEING

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## The ACEC under the Test Harness

### Assessors

|                         |                                     |
|-------------------------|-------------------------------------|
| <b>Debugger</b>         | <b>Interactive / Manual</b>         |
| <b>Entering results</b> | <b>Manual</b>                       |
| <b>Diagnostics</b>      | <b>Interactive / Manual</b>         |
| <b>Entering results</b> | <b>Manual</b>                       |
| <b>Library</b>          | <b>Interactive / Manual / Batch</b> |
| <b>Entering results</b> | <b>Manual / Automatic</b>           |
| <b>Capacity</b>         | <b>Batch</b>                        |
| <b>Entering results</b> | <b>Automatic</b>                    |

Work Shop

BOEING

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## AES Performance Tests

Review and Integrate into ACEC groups

Use ACEC timing loop

Provide for automatic gathering of results

Integrate in Comparative and Single  
System Analysis tools

Work Shop

BOEING

1/16/92 11

## Performance Tests: AES / ACEC Map

| AES group |                                   | ACEC group |
|-----------|-----------------------------------|------------|
| A         | compiler performance tests        | SY         |
| I         | general run-time efficiency tests | various    |
| J         | NPL Performance Test Suite        | various    |
| K         | tasking tests for MASCOT systems  | TK         |
| L         | general tasking tests             | TK         |
| M         | storage management tests          | SR         |
| N         | input/output tests                | IO         |
| O         | optimization tests                | OP         |
| R         | implementation dependency tests   | various    |
| V         | benchmark tests                   | CL         |

Work Shop

BOEING

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## **Analysis**

**Menu**

**Input data**

**Single System Analysis - AES reports**

**Comparative Analysis**

Work Shop

BOEING

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## **AES Assessors**

**Similar Assessors**

**Candidates for inclusion**

**Non-candidates**

Work Shop

BOEING

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## Assessors: AES / ACEC Map

| AES group |                                  | ACEC group |
|-----------|----------------------------------|------------|
| B . . F   | compiler information tests       | YD         |
| G         | compiler capacity tests          | YC         |
| Q         | run-time limit tests             | YC         |
| S         | erroneous execution tests        | YD         |
| T         | incorrect order dependency tests | YD         |
| U         | linker/loader tests              | YL,SY      |
| D*        | debugger tests                   | YB         |
| LS        | PLS scenario support tests       | YL         |
| S*        | source generator tests           | YL         |

Work Shop

BOEING

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## Debugger Assessor: AES versus ACEC

|                     | AES  | ACEC |
|---------------------|------|------|
| Number of questions | 272  | 118  |
| Test programs       | 11 + | 36   |
| Scenarios           | 5    | 29   |
| Detail of scenarios | less | more |

Work Shop

BOEING

1/16/92 16

## **Debugger Assessor: AES**

### **Harness**

**Generates command files, capacity tests**

**Prompts for some results**

**Generates report for capacity**

### **Questionnaires**

**Fewer programs, reused**

**Menu to call subprograms from TDF01**

Work Shop

BOEING

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## **Debugger Assessor: ACEC**

**Report template for recording:**

**Test results, execution time**

**Comments on usability**

**Commands used**

**More detailed scenarios**

**More comparable between systems**

**Program(s) for each scenario**

**Tasking, non-tasking separate**

Work Shop

BOEING

1/18/92 18

## Debugger Assessor: AES Areas with Little Overlap

|                   | <u>AES</u> | <u>ACEC</u> |
|-------------------|------------|-------------|
| Documentation     | 25         | 0           |
| Source display    | 15         | 2           |
| Error handling    | 13         | 0           |
| Macros            | 9          | 2           |
| Tracing           | 17         | 1           |
| Private types     | 7          | 0           |
| Heap              | 6          | 0           |
| Debugging file IO | 3          | 0           |
| Performance       | 16         | 4           |
| Capacity          | 13         | 1           |
| Overall summary   | 10         | 0           |

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## Duplicate Assessors

Merge selected tests

Review AES approach

Review for easier portability

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## **Assessors: AES only**

**C\*** command language interpreter  
**E\*** editor tests  
**N\*** name expander tests  
**P\*** pretty printer tests  
**R\*** requirements analyses tests  
**T\*** test support toolset tests  
test bed generator  
stub generator  
test coverage analysis  
timing analysis (profiler)  
assertion checker  
**V\*** version and configuration control tests  
**X\*** cross-reference tests

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## **Assessors: Candidates for inclusion**

Profiler  
Test coverage analysis  
Cross reference  
Pretty printing  
Syntax based editing  
Test bed generator  
Name expander  
Stub generator  
Assertion checker

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## **Assessors: Non-candidates**

**Command language interpreter**

**Editor tests (general)**

**Requirements analyses tests**

**Version and configuration control tests**

**Move to Reference System**

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## **Summary**

**Interface**

**Database**

**Command file generator**

**AES Performance Tests**

**Review and merge**

**Analysis**

**AES Assessors**

**Review and merge**

**Make others available**

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