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Current Research Activities at the NASA-sponsored Illinois Computing Laboratory of Aerospace Systems and Software

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The Illinois Computing Laboratory of Aerospace Systems and Software (ICLASS) is a NASA center for excellence in computer science. ICLASS was established in 1985 with two objectives:

- (1) to pursue research in the areas of aerospace computing systems, software and applications of critical importance to NASA; and
- (2) to develop and maintain close contacts between researchers at ICLASS and at various NASA centers to stimulate interaction and cooperation, and facilitate technology transfer.

Current ICLASS research activities are in the areas of parallel architectures and algorithms, reliable and fault-tolerant computing, real-time systems, distributed systems, software engineering, and artificial intelligence.



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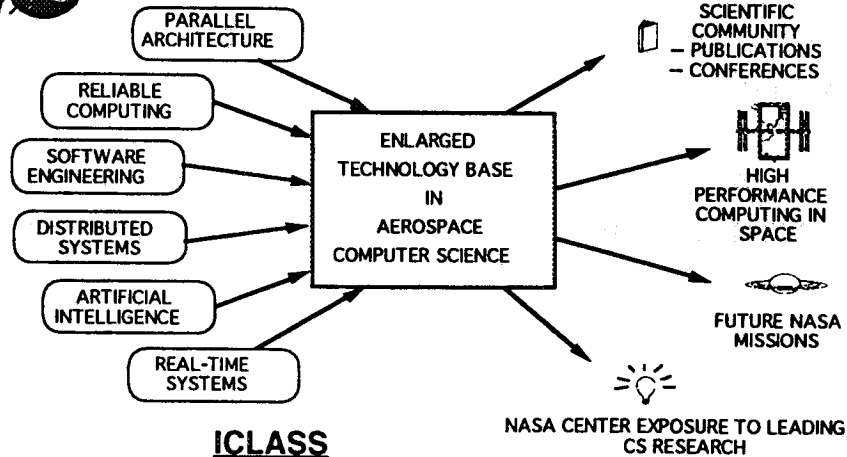
Illinois Computing Laboratory for Aerospace Systems and Software (ICLASS)

- **NASA Center for excellence, established 1985**
- **Objectives**
 - Pursue research in aerospace computing systems, software and applications important to NASA
 - Develop close contacts and stimulate interactions between faculty and students at ICLASS and researchers at NASA
- **Performance period Dec. 31, 1993- Dec. 30, 1994**
- **Annual review, May 24-25, 1993**
 - Attended by 13 NASA people (2 centers & JPL), 1 US Navy, and 4 from industry
 - Panel presentation by NASA et al.
 - Presentations by ICLASS researchers
 - Poster sessions presented by students during breaks
- **Over 70 recent publications**

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- Focus attention of CS researchers on NASA related problems
- Involve graduate students and research faculty
- Enhance NASA Computer Science understanding
- LaRC coordinates and maintains close technical communication

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ICLASS RESEARCH ACTIVITIES - 1994

Development of Parallel Programs for Distributed Memory Multicomputers

Multiprocessor Architectures

Advanced Compilation and Architecture Technology

Resource Management for Parallel and Distributed Systems

Parallel System Performance Analysis

Efficient Execution of Fine-Grained Concurrent Programs

High Performance Memory Systems for Advanced Multiprocessors

Recovery in Dependable Parallel Architectures

A Design Environment for Fault Tolerant Systems

Dependability Validation of High Performance Systems

Verification of VHDL Digital Systems

Functional Programming and Scientific Computing

Formalization of Code Re-Use Through Abstract Algorithms

Three Dimensional Vision Systems

Engineering Integrated CAD/CAM Systems for Reduced Cost Manufacturing

Reliable, Distributed, Database Management Systems

Real-time Multiprocessor Operating Systems

A Prototype Environment for Real-Time Systems

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Parallel Architecture and Algorithms

● Development of Parallel Programs for Distributed Memory Multicomputers

→ Design of efficient parallel algorithms to run on a variety of parallel architectures

→ Develop algorithms on top of abstract parallel programming framework (Chare Kernel)

● Multiprocessor Architectures

→ Develop, model and analyze high performance multiprocessor architectures that are fault tolerant and highly mission adaptive

→ Refine, test and port methodology for modeling and analyzing the performance of parallel processors under real workloads

● Advanced Compilation and Architecture Technology

→ Focus on the architecture and compiler techniques required to close the gap between peak performance and sustained performance of high performance multiprocessor systems

● Resource Management for Parallel & Distributed Systems

→ Develop more efficient algorithms for combinatorial searches on sequential and parallel computers

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Parallel Architecture and Algorithms

- **Parallel System Performance Analysis**
 - Software tool set, Pablo, that supports source code performance instrumentation and graphical performance analysis
 - Focus of ICLASS student input-output performance optimization
- **Efficient Execution of Fine-Grained Concurrent Programs**
 - Focus on how to implement fine-grained, object-oriented concurrent programs to execute efficiently on a variety of parallel architectures, from small-scale, shared-memory multiprocessors to fine-grained, massively concurrent multicomputers
- **High-Performance Memory Systems for Advanced Multiprocessors**
 - Research aims at improving speed of large-scale multiprocessors
 - Focus of ICLASS student - memory hierarchy performance of the operating system

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Reliable and Fault Tolerant Computing

- **Recovery in Dependable Parallel Architectures**
 - Develop new concepts in reliable memory management for dependable operation of parallel architectures
- **A Design Environment for Fault Tolerant Systems**
 - Investigate the development of a highly instrumented simulation-based CAD environment
 - Environment allows a designer to interactively evaluate the reliability and performance characteristics of proposed designs during the design process
- **Verification of VHDL Digital Systems**
 - Development of System-level verification tools capable of handling large systems
 - Emphasis on early detection of design errors
- **Dependability Validation of High Performance Systems**
 - Improve memory management performance in object-oriented, dynamically allocated, garbage collected virtual memory systems
 - Evaluate reliability by fault simulation

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Software Engineering and Artificial Intelligence

- **Functional Programming and Scientific Computing**
 - Address the problems of expressiveness and efficiency in functional programming languages, emphasizing their use for scientific computation
- **Formalization of Code Re-Use Through Abstract Algorithms**
 - Study form and use of new abstraction method, using data structure independent algorithm skeletons
- **Three Dimensional Vision Systems**
 - Computer vision systems capable of three-dimensional interpretation of "flat" video images
- **Engineering Integrated CAD/CAM Systems for Reduced Cost Manufacturing**
 - Develop tools which improve interface between design and manufacturing
 - Move more manufacturability information into the design phase

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Distributed Systems and Real-Time Systems

- **Reliable, Distributed, Database Management Systems**
 - Design a reliable, distributed database management system
- **Multiprocessor Operating Systems**
 - Design and implement of customizable operating systems for real-time and high-performance multiprocessor applications
- **A Prototyping Environment for Real-Time Systems**
 - Build the Prototyping Environment for Real-Time Systems (PERTS)
 - PERTS an environment for
 - Evaluation of new design approaches
 - Experimentation with alternative system building blocks
 - Analysis and performance profiling of prototype real-time systems

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