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Final Report on the First Three Years of Operation of RIACS (1983-85)

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April 15, 1986

Research Institute for Advanced Computer Science
NASA Ames Research Center

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The Research Institute for Advanced Computer Science (RIACS) is a facility of the Universities Space Research Association (USRA) operated at the NASA Ames Research Center at Moffett Field, California. The operating objectives of RIACS are three:

1. Conduct research in advanced computer science in areas of interest to the aerospace community.
2. Promote cooperative research between the computer science community and the aerospace science community.
3. Seek application of computer science research results to scientific research.

The RIACS contract supports a "core program" of research in support of these goals and authorizes RIACS to undertake a series of separately-funded "task orders" in support of the second and third goals.

RIACS was established in June, 1983. Most of the effort in 1983 was devoted to hiring an initial scientific staff, acquiring and installing a computing facility, and setting up administrative offices. At the end of 1983, RIACS had 5 staff members on board, including 4 scientists and 1 support person. Nine task orders had been initiated. During 1983, the scientific focus of RIACS was agreed on and approved by the RIACS technical monitor. This focus was (and continues to be) to explore matches between advanced computing architectures and the processes of scientific research. We envisage improved computing support for these processes to consist of two new kinds of computer system interposed between the working scientist and the basic hardware: virtual machines for parallel computation and scientist's-aide workstations.

During 1984, the scientific work of RIACS started moving forward. The significant achievements were initiation of an architecture evaluation through a NASA/DARPA sponsored study of the MIT static dataflow machine, specification of a graphical language for expressing distributed computations, and specification of an expert system for aiding in grid generation for two-dimensional flow problems. (See Table 1.) By the end of 1984, the staff had grown to 17 persons, including 6 core-supported scientists, 3 task-supported scientists, 3 support personnel, and 5 visitors and summer students. Ten additional task orders were initiated. There were 32 reports published, of which 20 appeared in books, journals or conferences.

Table 1: Research Accomplishments, 1984

Milestone	Progress
Initiation of concurrent architecture evaluation experiments.	In September, 1984, as part of Task 16, we conducted an evaluation of the MIT static dataflow machine and the VAL language. We have continued the research as part of our core effort and have identified connections between the problem-solving process itself and the architectural levels of a Project-"R" system. We may propose to DARPA to undertake similar studies of new architectures developed in their "rapid prototyping" program and studying general methods of introducing parallelism into abstract algorithm specifications.
Initiation of an expert systems project.	Two projects have been initiated. One, part of our core effort, is Briggs's part in a project called FDEX to automatically generate grids for the 2-D flow solver program at Ames. The other, part of Bishop's Task 14, will develop automatic 3-D grid generation tools on the IRIS workstation.
Prototype visual programming environment for a selected computational model.	Two projects have been initiated. One, part of Bishop's Task 14, will examine graphical methods of specifying computations over grids. Another, part of our core effort, will consider a graphical language for dataflow programming and will use easily available bitmapped workstation technology.
Artificial intelligence research plan.	Joined with H. Lum to publish a plan that encompasses the AI research in both RIACS and the Information Sciences Office. This led to Task 21, which will produce a brochure containing the plan by March 31, 1985.

In 1985, even more significant progress took place. The staff grew to 29 persons, including 5 core-supported scientists, 10 task-supported scientists, 5 support personnel, and 9 visitors and summer students. Nineteen additional task orders had been initiated. By the end of 1985, 31 separate projects were underway in four categories (see Table 2). The significant accomplishments were demonstration of a prototype graphical shell (a visual language for distributed programming), completion of the dataflow architecture study, acquisition of an Intel hypercube and initiation of its evaluation, coupling of an IRIS workstation to the Cray computers in the Numerical Aerodynamic Simulator (NAS) facility, demonstration of the Concurrent C parallel programming language, initiation of the Sparse Distributed Memory (SDM) parallel architecture project, and initiation of a parallel machine testbed. (See Table 3.) There were 91 reports published, of which 69 appeared in books, journals or conferences.

Table 2: Principal RIACS Projects in 1985.

Core (C) or Task (N)	Project
PROGRAMMING ENVIRONMENTS FOR PARALLEL MACHINES:	
C, 29	Intel Hypercube and Its Programming Tools (*Raugh, Chan, Blachman*)
C	Concurrent C (*Brown*)
C	Instrumentation of Parallel Algorithms (*Adams*)
C	Multiprocessor Comparison (*Brown*)
14, 32	CFD Graphics Workstation (*Bishop, Houston*)
30	Sparse, Distributed Memory (*Kanerva*)
PROGRAMMING ENVIRONMENTS FOR DISTRIBUTED SYSTEMS:	
C	Graphical Shell (*Brown, Denning*)
C	Multimedia Mail and Conferencing (*Leiner*)
15, 22, 33	Performance of FDDI Networks (*Johnson, Sevcik*)
31	Security in Supercomputer Networks (*Bishop*)
C	Access Control and Privacy in Large Distributed Systems (*Leiner, Bishop*)
MATCHING PROBLEM DOMAINS WITH PARALLEL ARCHITECTURES:	
C	Parallel Processing for Image Contour Extraction (*Adams*)
C	Parallel Numerical Algorithms (*Chan, Patrick, Raugh*)
16	MIT Dataflow Machine Study (*Adams, Brown, Denning*)
20	Feasibility of Hypercube Concurrent Processing Systems (*Bruno*)
SPECIAL PROJECTS FOR NASA	
10, 28	Computational Chemisty (*Levin*)
11, 27	NAS Technical Studies (*Levin*)
12	NAS Performance Modeling (*Sevcik*)
15, 33	Local Area Networks for Space Station (*Johnson*)
15A	Space Station Data System Study (*Brown*)
17,34	Cray-2 Algorithm and Performance Studies (*Calahan*)
21	RIACS/ISO Brochure (*Adams, Denning*)
22	Network Modeling Techniques (*Sevcik*)
23, 38	Chemistry Algorithms (*Partridge*)
24	UNIX Concurrent Programming Methodologies (*Brown*)
25	NAS Security Risk Analysis (*Long*)
26	Planning and Learning Research (*Cheeseman*)
35	Orbital Expert Systems (*Boy*)
36	Air Traffic Control (*Scoggins*)
37	NAS Graphics Studies (*Gomez*)
39	Processing Capabilities for NAS (*Kramer*)

Table 3: Research Accomplishments, 1985

Milestone	Progress
Prototype of a visual programming environment for concurrent processing.	This milestone was achieved in August 1985 with the completion of the graphical shell (gsh). Improved versions of the gsh are planned for 1986.
Initiation of project to evaluate concurrent architectures.	This milestone was achieved in several ways. a) A 32-node Intel iPSC hypercube machine was installed in September 1985; Tony Chan, on leave from Yale, and Mike Raugh have initiated a project to evaluate algorithms for CFD (computational fluid dynamics) and CC (computational chemistry). b) An image contour extraction study has been planned as part of performance tool development for 1986. c) John Bruno, a collaborator at UC Santa Barbara and principal investigator of Task 20, worked out efficient mappings of implicit and explicit CFD algorithms to the Intel hypercube and wrote programs testing the methods.
Demonstration of at least one expert system.	We expected to demonstrate a prototype grid-generation expert system, but this project was terminated on the departure of Rick Briggs.
Coupling of symbolic manipulator system to IRIS workstation and possibly demonstrating its use for some aspects of grid generation.	This project was contingent on release of new software by a research group at HP Labs; the software was not released in 1985. The project is deferred until 1986.
....	....
Developed experimental version of Concurrent C and initiated distribution to test sites.	Serendipitous accomplishment.
Initiated project on sparse distributed memory, an example of a new class of massively parallel pattern computers.	Serendipitous accomplishment.
A performance comparison on Sequent and Intel hypercube multiprocessors was completed.	Serendipitous accomplishment.

Table 4 summarizes task orders by the Ames branches and divisions who supported them, and Table 5 summarizes them by the total funding each year. Table 6 shows the staff sizes by year.

Table 4: Task Order Summary by Branch, 1983-85.

Code	Name	No. Tasks	Total $
FL	Aerospace Human Factors Research Division	2	146,138
FSN	Aircraft Guidance and Navigation Branch	1	5,746
RCR	Computational Research Branch	2	39,175
RI	Information Sciences Office	6	483,955
RN	Numerical Aerodynamic Simulation Projects Office	2	134,453
RNE	NAS Systems Engineering Branch	9	537,160
RTC	Computational Chemistry Branch	14	902,464
TOTALS		**36**	**2,249,090**

Table 5: Funding Summary by Year, 1983-85.

Year	CORE Funds ($)	TASKS No.	TASKS Funds ($)	TOTAL ($)
1983	495,000	9	297,847	792,847
1984	471,000	8	372,601	843,601
1985	1,031,000	19	1,578,642	2,609,642
TOTALS	**1,997,000**	**36**	**2,249,090**	**4,246,090**

Table 6: Staff Sizes.

Category	1983	1984	1985
Scientist (core)	2	6	5
Scientist (task)	1	3	10
Support	1	3	5
Visitors (core)	-	2	3
Visitors (task)	1	1	1
Summer Student (core)	-	2	5
TOTALS	**5**	**17**	**29**

The RIACS Annual Reports for 1983, 1984, and 1985 provide full details behind the statements above.