UTAH COMPUTER HISTORY PROJECT

DAVID EVANS

Computing research at the University of Utah started in 1965 when former university president James Fletcher recruited Berkeley professor David Evans to return to his home state to establish a computer science division within the electrical engineering department. This division became its own department in the early 1970s. Evans graduated from the University of Utah in 1953 with a Ph.D. in physics. Before returning to Utah, Evans developed computing systems, first at Bendix as project manager of the commercially successful G-15 computer and follow-on G-20 (1955-1962). While at Berkeley from 1962-1965, Evans and G-15 architect Harry Huskey initiated Project Genie, which led to innovations such as the Scientific Data Systems 940 time-sharing operating system.

Upon his return to the University of Utah, Evans wanted to cultivate a culture of creativity. He hired faculty with diverse experiences and backgrounds and encouraged interactive use of computing for a variety of creative pursuits. With a $5 million award from DARPA to develop a center of excellence in computer graphics, Evans drew in faculty beyond traditional academic walls, along with renegade students ready to usher in a new wave of computing at the University of Utah.

EVANS AND SUTHERLAND

After establishing the computer science division at Utah, Evans recruited Ivan Sutherland from Harvard University. Together they founded pioneering computer graphics company Evans and Sutherland in 1968. Their employees included University of Utah students or alumni: Jim Clark (Silicon Graphics), Ed Catmull (Pixar) and John Warnock (Adobe). For the next two decades, Evans and Sutherland helmed the development of computer systems for simulations using computer graphics. The duo would go on to launch simulators for commercial flight training, digital projectors for planetariums and other entertainment applications.

Evans's true passion was computer graphics, and it led to University of Utah's pioneering role and prominence in the computing research community. His unique vision, elevated by the talented group of faculty and students he recruited, led to research that impacted many areas in computing in its early days.

EARLY COMPUTER ARCHITECTURE

Computer science professor Robert S. Barton led early computer architecture research efforts at Utah (1967-1973). With intense passion for proper notation and its role in efficient problem solving, Barton was enamored with reverse Polish notation from Copi and Lukasiewicz. While managing an ALGOL compiler team at Burroughs in 1959, the disconnect between the program structure and the machine architecture inspired Barton to design computer architectures specialized for high-level programming languages. He implemented this vision as chief architect of Burroughs B5000 to B8500 lines. At Utah, Barton continued to envision machines that were efficiently specialized to a programming notation. He observed that 1960s-era architectures exhibited a significant amount of parallelism but the programming languages were stringently sequential. He encouraged his Ph.D. student, Al Davis, to devise a programming language in which parallelism was the default and sequence was only applied where necessary. The programming language embodied the popular dataflow principle: when operands arrive at an operator, the operator "fires" and sends the results to whatever happens next. Although other researchers were also pursuing similar ideas, notably Dennis and Rodriguez at MIT, Barton and his colleagues produced the first operational dataflow system, called the DDM-1 architecture. Barton left Utah in 1973 to create the Interactive Research Center at Burroughs in La Jolla, CA and recruited several Utah colleagues: Davis, Duane Call and Charles Seitz.

Barton's influence in building the right machine for the job undoubtedly influenced the first commercial graphics machine, the LDS-1 by Evans and Sutherland and the Geometry Engine, a precursor to Silicon Graphics, founded by Utah alumnus Jim Clark in 1982. SGI systems supported very high levels of parallel computation for their time and included specialized graphics processing units. The SGI Origin 3800 at NASA, commissioned in 2000, had 1024 processors, making it one of the largest shared-memory supercomputers ever built.

PROGRAMMING LANGUAGES AND PERSONAL COMPUTERS

Alan Kay, a student of Evans, developed object-oriented programming technology, a foundation of current programming systems. At Utah, Kay learned to think of computers as dynamic, interactive personal devices to support creative thought - the founding principle of his work. Kay's Ph.D. thesis (1969) described the design of the FLEX machine, a flexible, extensible programming language developed in collaboration with Ed Cheadle. Kay dreamed of a device called the Dynabook, a portable electronic device the size of a three-ring notebook with a touch-sensitive liquid crystal screen and a keyboard - precursor to the Apple iPad.

Along with other Utah graduates, Kay's early career was spent as a founding computer science researcher at Xerox PARC. At PARC, Kay was involved in the design of Alto, often called the first personal computer. More significantly, Kay invented Smalltalk, the first object-oriented programming language, for which he received the prestigious ACM Turing Award in 2003.After leaving Xerox, Kay held research positions at Atari, Apple,Hewlett-Packard and Disney before starting Viewpoints Research Institute, a nonprofit organization dedicated to supporting educational media for children.

NUMERICAL LIBRARIES

In the area of numerical libraries, University of Utah professor Tony Hearn (Utah faculty from 1969-1980) developed REDUCE, the first algebraic mathematics package released in 1968 and still used worldwide today. REDUCE capabilities include symbolic differentiation and tensor and non-commutative algebraic calculations. It is used in quantum electrodynamics and quantum chromodynamics, electrical network analysis, celestial mechanics, fluid mechanics, general relativity, numerical analysis, plasma physics and a variety of engineering problems such as turbine and ship hull design.

APPLICATIONS

From the beginning of computing at the University of Utah, interdisciplinary research endeavors that combined computing with scientific simulation were cornerstones of advancing high-end computing, such as the Center for the Simulation of Accidental Fires and Explosions (CSAFE) created through the Department of Energy's Advanced Simulation and Computing Program. In addition, the application of computing has led to breakthroughs in other fields, as evidenced by Nobel Laureate Mario Capecchi's work in molecular genetics.

EDUCATION

Computer science education at the University of Utah has trained high-performance computing researchers around the world. Elliot Organick joined Utah in 1971 with a mandate to shape an innovative undergraduate curriculum in computer science. He wrote 19 expository books and founded the Association for Computing Machinery's special interest group on computer science education (SIGCSE). Organick's efforts led to the development of the New Math curriculum for school children in response to the Soviet Sputnik satellite launch in the late 1950s. Another Utah faculty member Bill Viavant, described and recommended a model for academic programs in computer science as part of ACM's Curriculum '68 Committee. Organick (1985) and Viavant (1990) received ACM SIGCSE Awards for Outstanding Contributions to Computer Science Education.

This is the first in a series of three displays on the role of Utah students and faculty in computing history. The others describe high-performance networking and storage and high-performance analysis.

UTAH COMPUTER HISTORY PROJECT

A special thanks to the J. Willard Marriott Library Special Collections, Artist Anna Campbell Bliss and the Computer History Museum for contributing materials for this display and associated video.

THE UNIVERSITY OF UTAH

HIGH PERFORMANCE COMPUTING

"... At the University of Utah, we are about to begin an experiment on a larger scale in which we simulate engineering systems by computers and allow the student to experiment with these. We make the conjecture that this kind of a thing will be better for the superior students."

– David Evans, Presented to the 1967 Conference of Associated University Bureaus of Business and Economic Research, October 11, 1967.

"The best way to predict the future is to invent it."

– Alan Kay, Utah PhD 1969, ACM Turing Award 2003.

"Interesting colleagues are essential."

– Ivan Sutherland, from ACM Turing Award website, written by Robert Burton.

"Dave was clever about admitting students who had unusual records. He decided that in every class we're going to admit a few outliers, folks who were clearly interesting, but for whom the academic system didn't exactly fit."

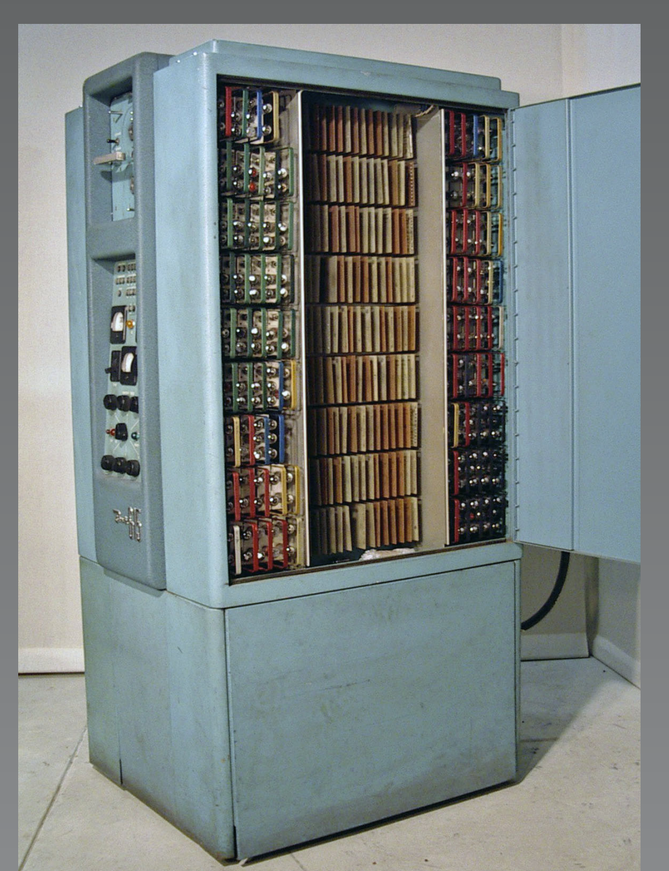
– Ivan Sutherland, from "The University of Utah and the Computer Graphics Revolution," Kent Bowen, Harvard Business School Case Study 9-607-036, April 2007.

"Good ideas don't often scale."

– Bob Barton, from "The Early History of Smalltalk," Alan Kay, HOPL-II, 1993.

"The basic principle of recursive design is to make the parts have the same power as the whole."

– Bob Barton, from "The Early History of Smalltalk," Alan Kay, HOPL-II, 1993.



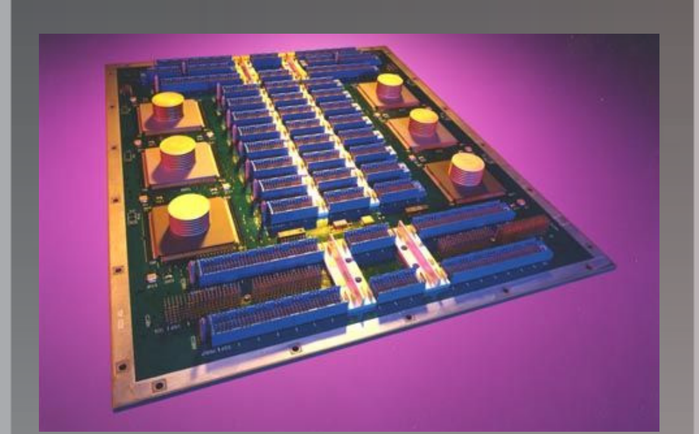
After graduating in 1953 from University of Utah with a Ph.D. in physics, Evans began his industrial career as the project manager of the Bendix G-15, a "small" aviation system that sold for about $50,000 in the late 1950s.

David Evans returned to University of Utah in 1965 to create a new computer science division that a few years later became a standalone department. Among his many professional awards were the 1996 Computerworld Smithsonian Award for Lifetime Achievement, the 1989 ACM/SIGGRAPH Steven Anson Coons Award for Outstanding Creative Contributions and the 1986 IEEE Emanuel R. Piore Award. Evans is shown with Louis Schmittroth, who joined the Utah faculty in 1968 and worked with Evans on early scientific simulation. The Univac pictured here was acquired in 1968, and Schmittroth served as the university's director of the computer center.

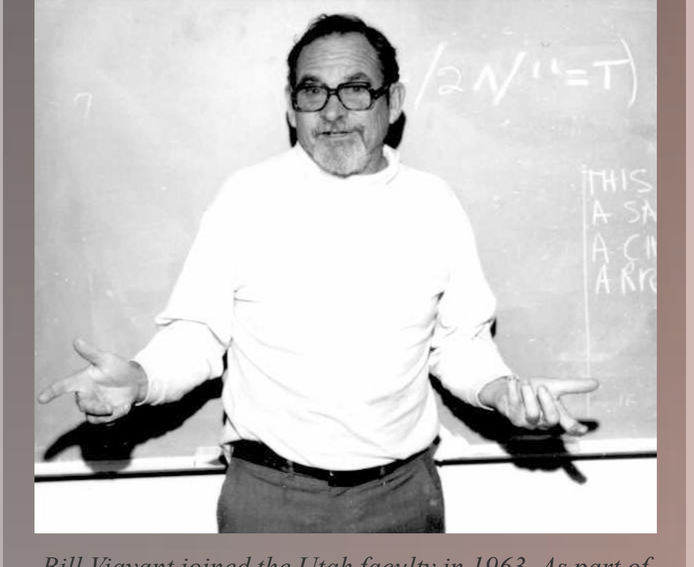
David Evans recruited an eclectic collection of faculty members and graduate students to jumpstart Utah's fledgling computer science program. Ivan Sutherland, pictured here, joined the University of Utah faculty in 1968, and with David Evans, immediately formed the company Evans and Sutherland.

The Evans and Sutherland Line Drawing System was a computer and real-time graphics workstation used for simulation. The first LDS-1 was shipped in August 1969. Sutherland is pictured here with Bob Kahn of ARPA and an LDS-1.

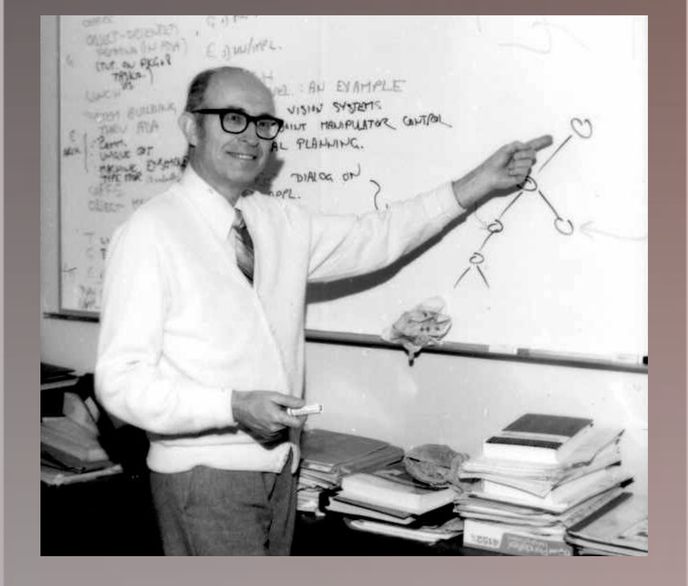
Sutherland was awarded a prestigious ACM Turing Award in 1988 for his work in the early 1960s on the Sketchpad interactive computer-aided design system shown here, a predecessor to the virtual reality systems he designed in Utah. He also received the IEEE John von Neumann Medal in 1998. (photo courtesy of Ivan Sutherland)



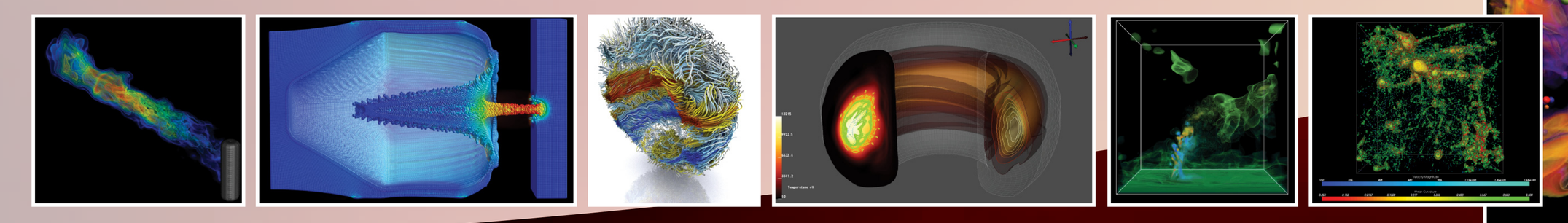
The ES-1 was the Evans and Sutherland company's only foray into building supercomputers. Initiated in 1985, the goal of the ES-1 was to develop a high-end server that could replace the Cray frontends that were used with Evans and Sutherland graphics systems. The first machines were shipped in 1989, but the project was halted in 1990 as supercomputing began to shift towards the use of lower-cost commodity systems. (photo courtesy of Computer History Museum).

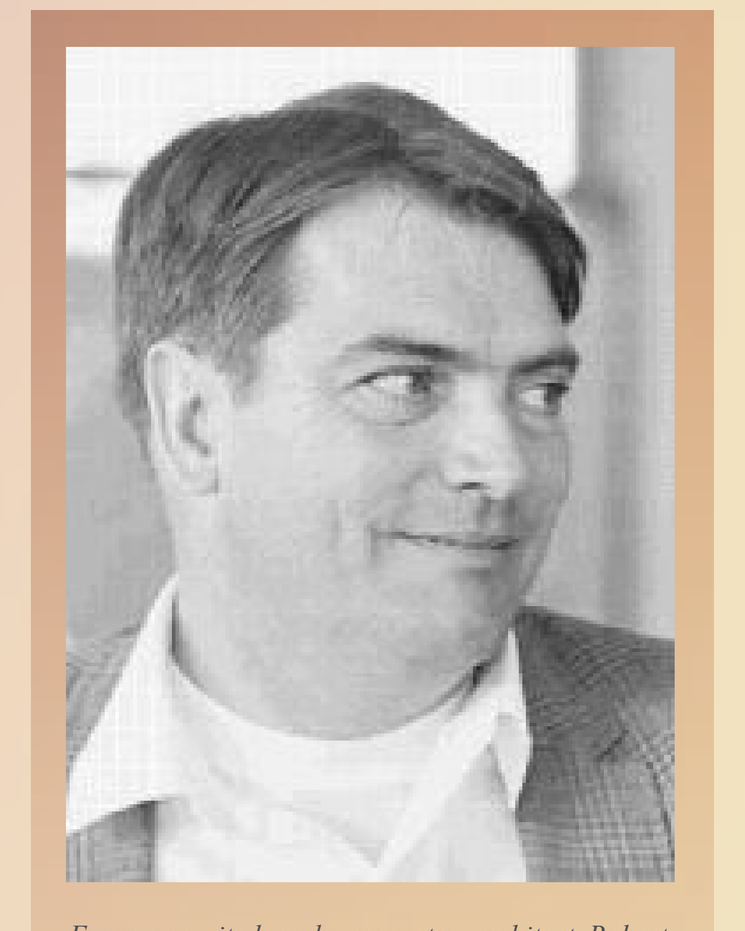


Bill Viavant joined the Utah faculty in 1963. As part of ACM's Curriculum '68 Committee, he participated in early computer science academic curriculum development.



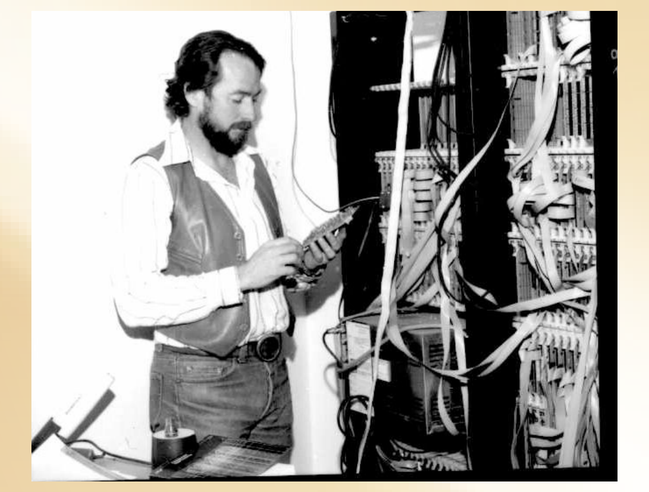
Elliott Organick served on the Utah faculty from 1971-1985, and was a prolific writer of educational monographs and an early proponent of computer science education. He founded SIGCSE and ACM's Computing Surveys. The endowed Organick Lecture series at University of Utah brings in computer science luminaries to inspire the next generation of students.





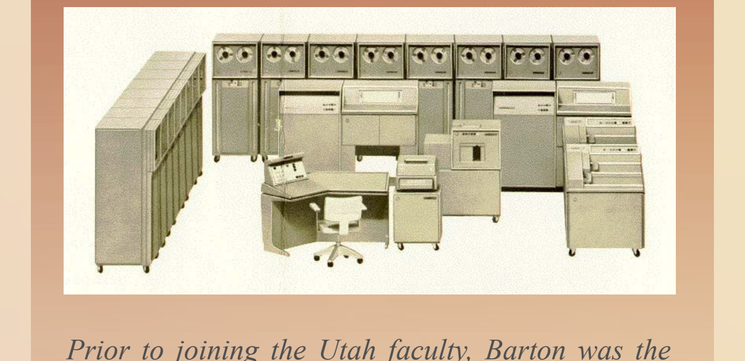
Evans recruited early computer architect Robert Barton to join the faculty in 1967. For his work on language-directed architectural systems, Barton was honored as the first recipient of the IEEE-ACM Eckert-Mauchly Award in 1979, a charter recipient of the IEEE Computer Pioneer Award, and the 1977 recipient of the IEEE Computer Society W. Wallace McDowell Award. (photo courtesy of Alan Kay)

The DDM-1 was built by Barton and colleagues starting in 1972 in collaboration with Burroughs. DDM-1, which stands for Data-Driven Machine, was the first operational dataflow architecture. Barton returned to Burroughs during this period to found its Interactive Research Center and architected several other Burroughs product lines.

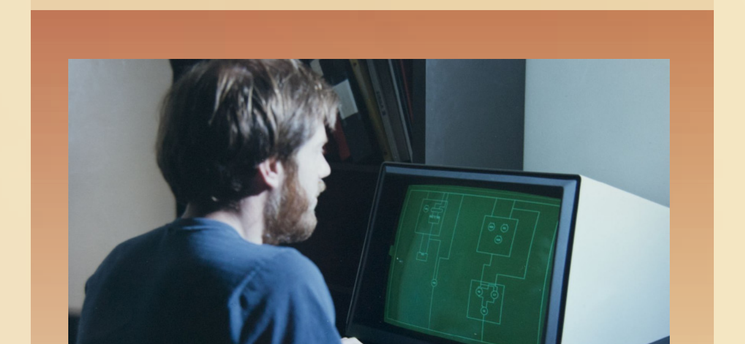


Barton student Al Davis received his Ph.D. from Utah in 1972. He worked with Barton to develop the DDM-1, and returned to Utah in 1977 as a member of the faculty. He is shown here with the DDM-2, the next collaboration with Barton and Burroughs.

As a student of Sutherland, Jim Clark explored the design of virtual reality systems, as shown here in 1972.



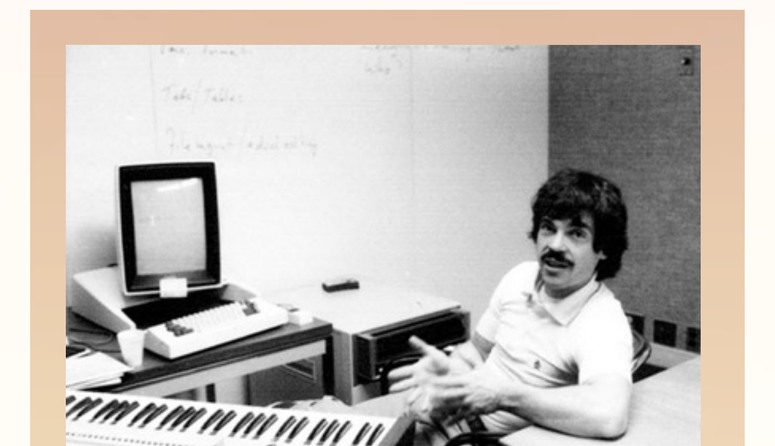
Prior to joining the Utah faculty, Barton was the chief architect of the Burroughs B5000 line, which was first shipped in 1961. The B5000 was the first stack-machine architecture, and the instruction set was optimized to support the ALGOL programming language. (photo courtesy of Burroughs)



Karl Boekelheide is shown programming the DDM-1 using a graphical dataflow programming language called Data-Driven Nets.

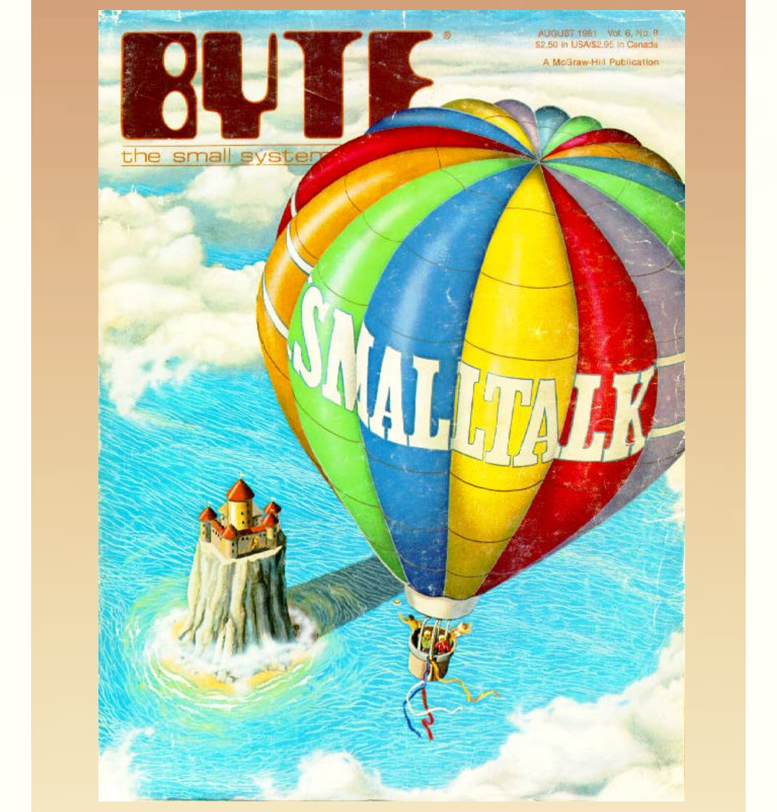
Tony Hearn was on the Utah faculty from 1969-1980, and was chair from 1973 until he left to join RAND Corporation as its Head of the Information Sciences Department. He developed the first algebraic mathematics package REDUCE. (photo courtesy of Tony Hearn)

Jim Clark graduated from University of Utah in 1974. He went on to found Silicon Graphics in 1982, which initially developed high-end graphics terminals like the IRIS 1000 introduced in 1984. The SGI Origin 3800 pictured here was delivered in 2001 (courtesy of Stanford University).

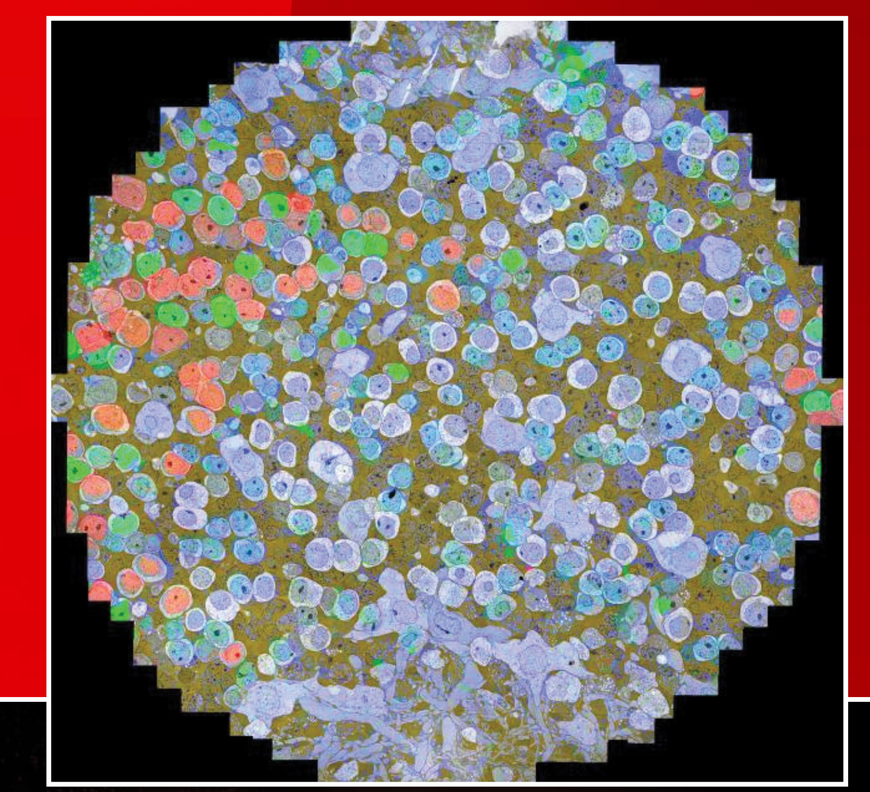


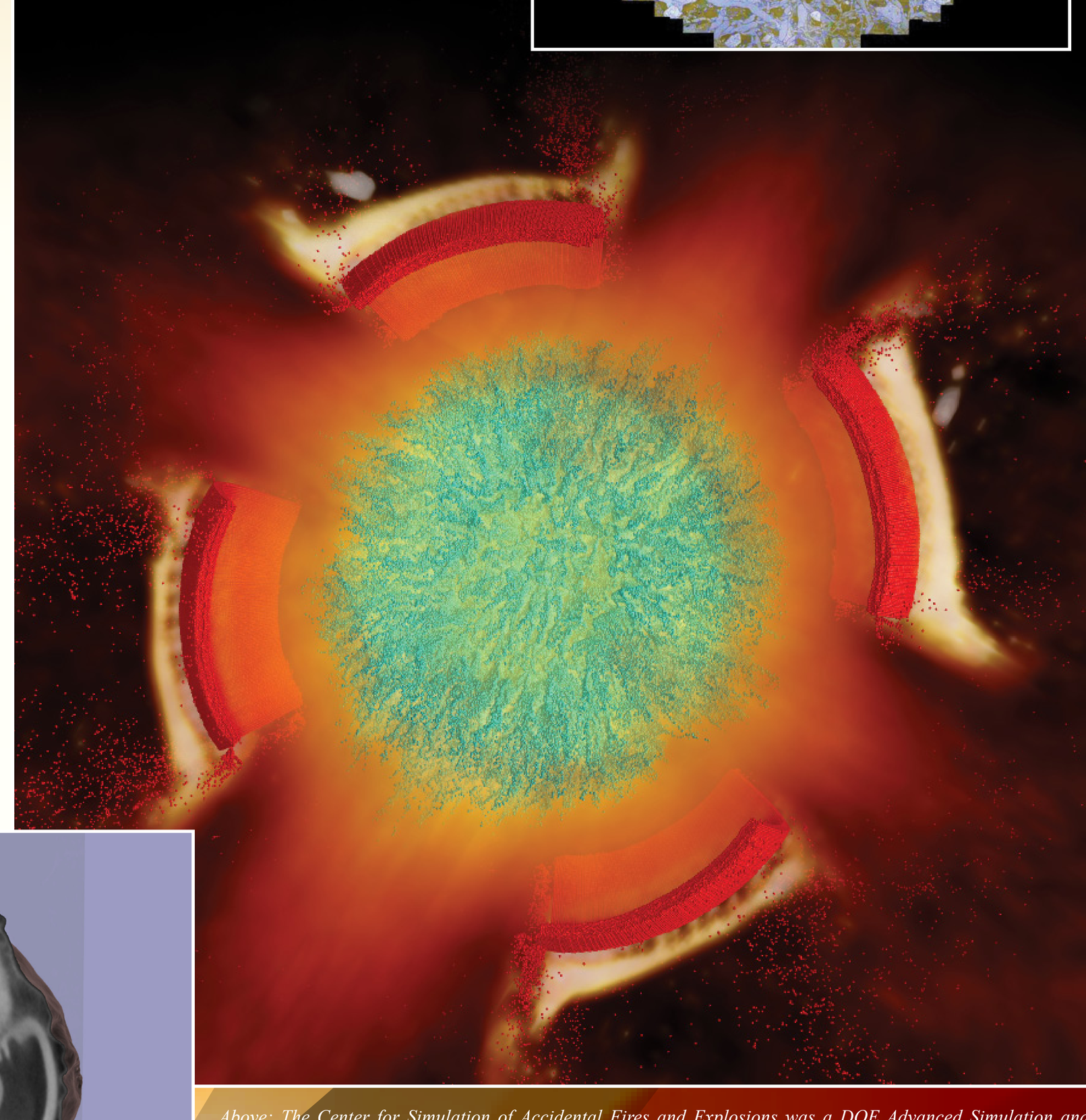
Alan Kay received his Ph.D. from Utah in 1969. He received the ACM Turing Award in 2003, the Kyoto Prize in 2004 and the Charles Stark Draper Prize in 2004.

The FLEX machine, designed by Kay (along with Cheadle) for his 1969 Utah dissertation. (photo courtesy of Apple Computer Corporation)

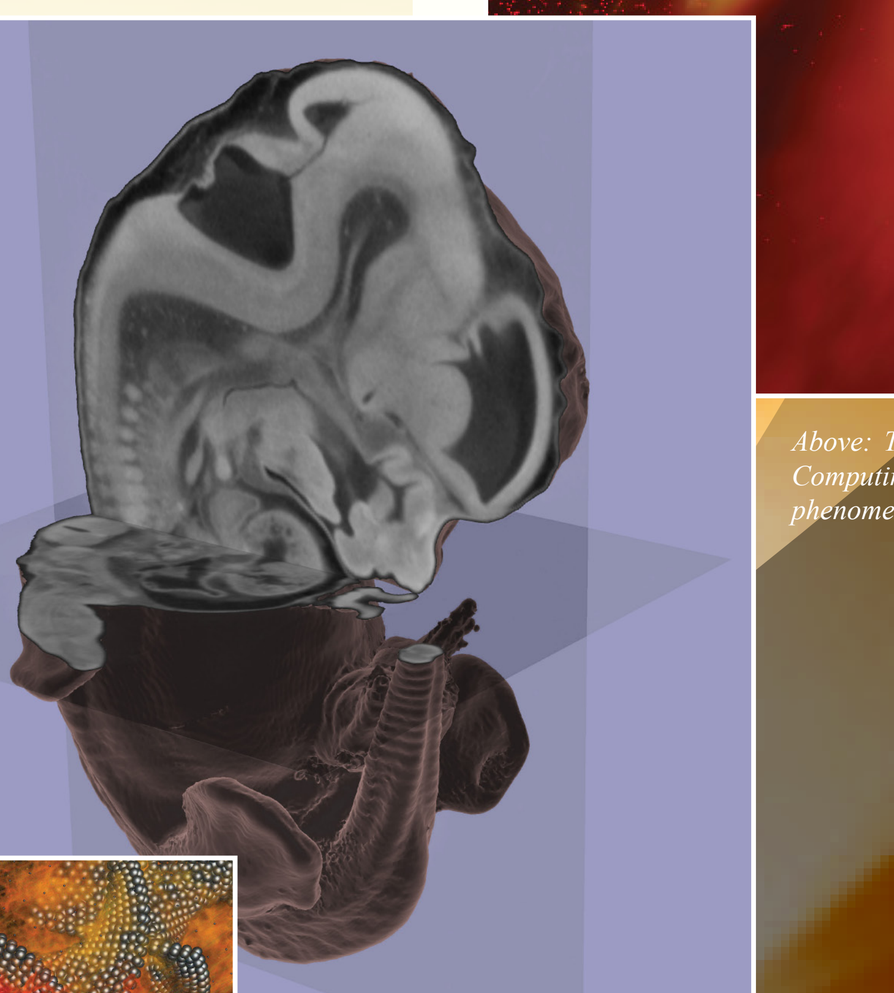


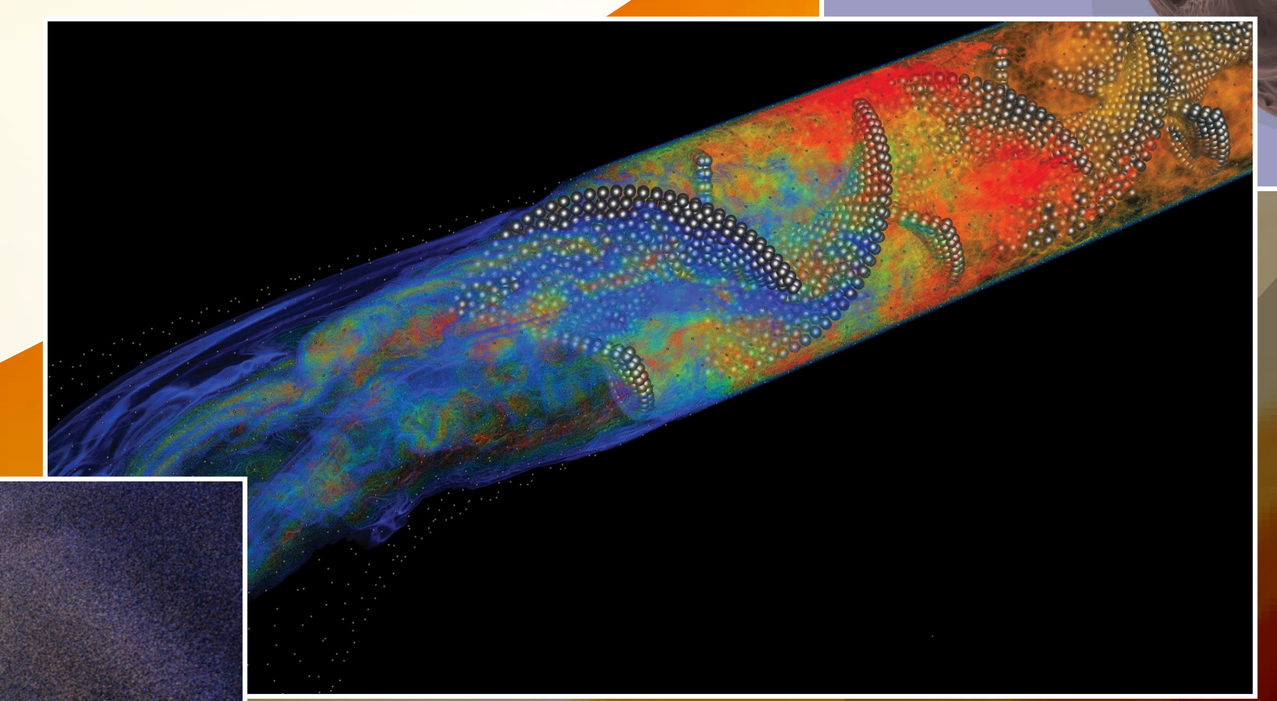
While at Xerox PARC, Kay invented Smalltalk, the first complete realization of the integration of programming languages, interactive graphic displays and pointing devices. Smalltalk gave rise to object-oriented programming languages. (courtesy of smalltalk.org)





Above: The Center for Simulation of Accidental Fires and Explosions was a DOE Advanced Simulation and Computing program from 1997-2010. C-SAFE produced cutting-edge research in simulating complex physical phenomena including reacting flows, material properties, multi-material interactions, and atomic level chemistry.





Above: Mario Capecchi, a Distinguished Professor in Utah's Department of Human Genetics, was a co-recipient of the 2007 Nobel Prize for Physiology and Medicine, along with Sir Martin Evans and Oliver Smithies, "for their discoveries of principles for introducing specific gene modifications in mice by the use of embryonic stem cells." This technology allows scientists to create mice with mutations in any desired gene. This visualization of a mouse's brain permits the analysis of early mouse development.