Computer Society President Richard Merwin dies

Richard E. Merwin, a pioneer in the field of digital computers and current president of the Computer Society of the IEEE, died on August 28, of complications following open-heart surgery. He was 58.

Born on October 2, 1922, in East Palestine, Ohio, Merwin was a research professor in computer science at The George Washington University in Washington, D.C. He had been a resident of Georgetown since 1968.

Merwin began his career at the Moore School of Engineering, working on Eniac, shortly after receiving his BSEE degree from the University of Pennsylvania in 1943. Later, he became a research associate at the Los Alamos Scientific Laboratory, where he organized the engineering team for Maniac. At IBM, which he joined in 1951, he was active in the development of the 702 and 705 systems and was engineering manager of the Stretch program. The design of the Stretch computer pushed the technology of the late 1950's to its limits and exerted a major influence on the IBM 7090. He went on to receive an MSEE from Syracuse University in 1960 and a PhD from the University of Pennsylvania in 1965. Subsequently joining the US Army Ballistic Missile Defense Program Office, he served as Deputy Director for Data Processing until 1977, when he became a full-time faculty member at The George Washington University.

Merwin was an active leader in several key areas within the IEEE Computer Society, ACM, and AFIPS. A past member of the society's Board of Governors (1976-77), he also served as editor of the IEEE Transactions on Computers (1975-78), general chairman of Compcon Fall 75, chairman of the Compcon Fall Standing Committee (1975-78), program chairman of NCC 79, and general chairman of Compulog 80. In addition, he held the post of IEEE Division V director (1978-79). Within the ACM he held the post of chairman, Sigmicro (1971-73).

While serving as Computer Society vice-president for publications (1979-80), he played a major role in planning and launching IEEE Computer Graphics and Applications and in establishing the society's cooperative relationship with the National Computer Graphics Association.

An IBM Academic Fellow from 1961-65, Merwin received the ACM Recognition Service Award, 1971-73, and was made an IEEE Fellow in 1975 "for development of ferrite core memories and computer hardware and software programs." In 1978 he received the Annual Sigmicro Award for Outstanding Contributions to Microprogramming—the second such award ever to be granted. (The first one went to Maurice Wilkes.)

His most recent research interests included microprogramming, software management, and distributed data processing.

He is survived by his wife, Sally-Ann (née-Rife); one daughter, Louisa Gay Merwin Hild, 26; and two sons, Ian Alexander, 33, and Richard E. Merwin, Jr., 35. A third son, David Sage Merwin, died in 1979 at the age of 28.

A memorial fund is being established in Dr. Merwin's name by the IEEE Computer Society to support research and education in the field of computer science and engineering. The family asks that, in lieu of flowers, contributions be made to this fund or to the charity of choice. Those who wish to make donations to the Richard E. Merwin Memorial Fund should make checks payable to the IEEE Computer Society, P.O. Box 639, Silver Spring, MD 20901.

A special tribute to President Merwin appears on page 4 of the October issue of Computer.
High-power, low-cost CAD/CAM systems are rapidly becoming a reality. Furthermore, new systems will likely feature distributed processing, built-in diagnostics, and integrated design and manufacturing data bases. These were among the projections presented to members of the Advanced Technical Planning Committee of Computer Aided Manufacturing-International (CAM-I) at its recent meeting in Ithaca, New York. CAM-I is a not-for-profit organization engaged in the research and development of computer-aided manufacturing technology. This look into the future of CAD/CAM was prepared by Robert E. Blauth and presented by ATPC member Richard Simon, both from Computervision.

According to Blauth and Simon, continued evolution of computer hardware will fully support all of the processing and data management requirements of product design, engineering analysis, and manufacturing operations. Furthermore, distributed or hierarchical architecture will enable special-purpose processors to be dedicated to such functions as interactive graphics, arithmetic computations, data-base management, and communications with other computers. These advancements will allow many system functions to be conducted simultaneously, rather than serially as in most of today's single-processor configurations. And built-in diagnostics are already becoming a standard part of minicomputer systems and graphics terminals.

Blauth and Simon predict the evolution of two types of intelligent graphics terminals: sophisticated terminals, capable of performing complex manipulations such as hidden-line removal and generation of shaded images for surfaces and solid objects; and less sophisticated terminals, to serve as stand-alone work stations, remote interactive terminals, or passive, "view only" graphics devices. Improvements in raster (video) display technology and semiconductor memory costs will lead to greater image resolution: 2000 × 2000 pixels by 1985, and perhaps 4000 × 4000 by 1990.

More exotic developments may include large-format, flat-panel displays using plasma or liquid crystal technology, hand-held graphics displays for shop-floor viewing, and perhaps even holographic displays for reviewing and editing final parts in 3-D.

In software, say Blauth and Simon, today's wire frame representations of objects will change to include "solid" geometry. Colored, shaded, 3-D images will be viewed on intelligent graphics terminal CRTs, and animation capabilities will allow dynamic simulation and kinematic analysis of electromechanical assemblies.

Software that meets the needs of design engineers as well as manufacturing engineers will be developed. A further integration may tie the CAD/CAM data base into a corporate management data base. Then a product could be not only designed, analyzed, manufactured, and tested, but checked for product cost, availability of components in inventory, assembly work instructions, and delivery data. Standard, device-independent graphics languages can be used for image generation and manipulation, while higher-level languages support CAD/CAM development and engineering analysis.

New industrial applications will be developed also, the CAM-I committee was told. Kinematic simulation of electromechanical assemblies will facilitate visual checking of clearances and tolerances. Design engineers will use special programs for structural, thermal, and circuit analysis. New programs will allow N/C verification of tool clearances, cutter paths, and fixtures. Parametric, family-of-parts techniques will allow greater use of flexible manufacturing systems. New applications of CAD/CAM technology in manufacturing will include automatic process planning and production planning based on geometric models stored in the CAD/CAM data base. The shared engineering/manufacturing data base, in turn, will minimize redundancy and encourage designing for manufacturability.

**CAM-I committee glimpses CAD/CAM of future**

**CAD/CAM software donated to Arizona State University**

Manufacturing and Consulting Services, Inc., has donated its Anvil-4000L software package to Arizona State University, according to Patrick J. Hanratty, president of MCS.

This new CAD/CAM software will become the primary building block in a comprehensive building and resource expansion plan at the university.

The Anvil-4000L will expand graphics resource capabilities in the colleges of engineering, business, architecture, and liberal arts. The software is being incorporated into the university's present computer system, and a student team has begun curriculum development with the goal of achieving a graphics terminal instructional capability for students in engineering drafting classes by spring 1982.

An executive training program in Anvil-4000L software was completed in June by ASU's Lynn Bellamy, assistant vice-president of computer services, and Barry McNeill, assistant professor of mechanical engineering; both will be instrumental in implementing the program.

Acquisition of a dedicated computer and terminal network is targeted for January 1982. By midyear of 1982, another supermini or central processor will extend the graphics resources throughout the university.

The expansion of the university's computer graphics resources is part of a larger, state-mandated project called Excellence in Engineering for the 80's. Cosponsored by the university, the board of regents, the governor of Arizona, the Arizona state legislature, and local industry, the project is designed to develop technical resources in order to promote Arizona's economic growth. Under the plan, the state will build a Center of Engineering Excellence at Arizona State University to house educational and research facilities in six areas of specialization: solid-state electronics, computers and computer sciences, computer-aided processes, energy systems, thermosciences, and transportation.
IEEE Transactions on Medical Imaging initiated

Four IEEE societies have established a new IEEE Transactions for the scientist and engineer whose research involves the generation, processing, or display of medical images.

Topics of interest will include ultrasonics, x-ray imaging and tomography, digital image processing, microwaves and nuclear magnetic resonance imaging, radiation sensors and detectors, mathematical tools and analysis of image formation, perception, display, and pattern recognition.

The IEEE Transactions on Medical Imaging will begin publishing in early 1982 as a quarterly journal, with 400 pages per year. Highest quality reproduction techniques will be used. The transactions will be a joint publication of the IEEE Engineering in Medicine and Biology Society, the IEEE Nuclear and Plasma Sciences Society, the IEEE Sonics and Ultrasonics Group, and the IEEE Acoustics, Speech and Signal Processing Society.

Details related to submission of manuscripts may be obtained by contacting Dr. Glenn Knoll, Dept. of Nuclear Engineering, 119 Cooley Bldg., University of Michigan, Ann Arbor, MI 48109; (313) 764-4260.

Pictures needed for computer graphics book

Examples of computer graphics work are being sought for a hard-cover publication to be entitled Computer Art. According to the publisher, IPC Science and Technology Press Limited, Computer Art will show a spectrum of computer-generated pictures—from pure-art images to scientific applications and business graphics—and will be the largest collection of computer graphics yet published in a single volume.

IPC wants to hear from anyone producing innovative work on any system—vector/raster, analog/digital, mainframe/mini/micro. Manufacturers, programmers, researchers, artists, and film makers are invited to submit their latest achievements.

Reproduction fees will be paid by the publisher when the final selection of graphics has been made. Contact John Lewell, Editor, Computer Art, 24912 Via San Rafael, Laguna Hills, CA 92653; or 141 Hatherley Court, Hatherley Grove, London W2, UK.
A bibliography of applications of computer graphics to transportation planning and engineering problems

Jerry B. Schneider, University of Washington


Citations by subject

Airport planning and design—41, 71, 72
Automobile design—58
Citizen participation—2, 19, 29, 86, 88
Downtown people-mover (DPM) systems planning and design—40
Highway facilities—6, 14, 16, 42, 43, 83
Highway route planning—5, 6, 18, 30, 31, 32, 56, 57, 89, 90
Highway safety—15, 33, 53, 54
Human figure simulation—20, 64, 93, 94, 95, 96
Planning and design of ride-sharing systems—39, 92
Railroad analysis and planning—49
Simulation of outer space and aircraft operations—73, 91

Simulation of traffic movements—3, 9, 10, 15, 17, 38, 39, 42, 43, 45, 46, 81, 83
Traffic signal optimization—11, 63
Transit facilities and operations analysis and planning—40, 68, 69, 70, 87
Transit system planning and design—1, 12, 13, 16, 21, 24, 25, 26, 27, 28, 40, 44, 50, 52, 55, 61, 62, 65, 66, 67, 75, 76, 77, 78, 84
Transportation data display and editing—4, 7, 8, 23, 30, 32, 34, 36, 37, 51, 57, 59, 60, 79, 85
Transportation education—21
Transportation systems planning—34, 35, 47, 48, 57, 74, 80


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**Geometry engine.** At Stanford, a single chip type provides the basis of a system that performs transformation, clipping, and scaling. Each chip, or geometry engine, is a four-component vector-computing processor controlled by a programmable logic array. A set of 12 chips, each microcoded for a particular set of operations, makes up a geometry system capable of five million floating-point operations per second.

Regularity is of crucial importance in VLSI design because it reduces design time and minimizes errors. In the geometry engine, all one-bit data paths are identical. Thus, in the entire system there are 1536 one-bit data paths, all the same at the circuit level. The PLAs that implement control are themselves regular structures, adapted to different purposes by programming techniques.

**Smart memory.** The pixel-plane system, being developed by Fuchs and Poulton, uses a preprocessor to convert polygon data from the host into input to a set of identical smart memory chips. The system achieves high speed by performing the most time-consuming calculations at each pixel. A z-buffer algorithm determines, for example, whether the pixel is visible in a particular orientation of the scene. The calculations at a particular pixel require a pair of one-bit adders and a one-bit storage element, resulting in only a small increase in silicon area over conventional memory design.

**Special-purpose chips.** Special-purpose hardware has long been used to get more performance than that supplied by conventional computers or bipolar microprocessors. It is just an extension of this approach to convert time-consuming portions of display operations into special-purpose LSI chips. One chip, reported by Whitted, executes visibility tests with the z-buffer algorithm, offloading pixel-by-pixel operations from the host. Another version of the chip is programmed to shade an area smoothly by interpolating intensity values. These circuits are being incorporated in a frame buffer. A simulation indicated that execution times would be reduced as much as 10 to 1 under certain circumstances.

**Research, new products point to increasing interest in solid modeling**

After nearly a decade in research laboratories, solid modeling was all over Siggraph '81—in a tutorial, conference paper, vendors' forum, news release, interview, and on the exhibit floor. In most existing CAD systems, the information contained in the computer is the same as the drawing on the display. In a solid modeling system, on the other hand, the information in the computer is a model, or simulation, of the solid part. As a valid model it can sustain, correctly and accurately, actual design operations. In this approach, the view on the display is merely a projection of the solid model stored in the computer.

In a tutorial organized by Herbert Voelcker and Aristides Requicha of the Production Automation Project at the University of Rochester, the various developers described Rochester's PADL (Parts and Assembly Description Language), General Motors' GMSolid, and Manufacturing Data Systems' Design.

In a paper, E. C. Kingsley, N. A. Schofield, and K. Case reported on Sammie (System for Aiding Man-Machine Interaction Evaluation), developed at the University of Nottingham and marketed by Compeda Limited.

In the vendor forum, Craig Rasmussen of Evans and Sutherland discussed Romulus, originally developed by Shape Data Ltd. from work done at Cambridge University.

In a news release, MARC Software International introduced the ITS-10 CAD system, developed by CAD-System AG, Basel, Switzerland. It includes solid-modeling capabilities.

In an interview, Patrick J. Hanratty of Manufacturing and Consulting Services pointed to the page in his latest**

**Next year's Siggraph set for Boston, July 26-30**


The Siggraph '82 technical program will consist of a blend of paper and panel discussions with major emphasis on human-machine communication and applications demonstrating state-of-the-art techniques. Both hardware and software topics will be featured. Tutorial courses will precede the conference. Product exhibitors are expected to outnumber the 135 who participated in Siggraph '81.

For further information, contact Elaine L. Sonderegger, Siggraph '82 General Chairman, PO Box 353, Derby, CT 06418; (203) 735-9980.


Automated cartography seminar held in Calgary

In view of the many computer systems for cartography and geographic information processing being implemented in Canada, the Canadian Cartographic Association, through its Automation Interest Group, held a special seminar in Calgary, Alberta, last June 22 and 23.

Participating speakers included academics David Douglas, David Mark, Jim Little, Ray Boyle, Chris Gold, Mike Goodchild, Duane Marble, and Barry Wellar. Representing government and industry were Joel Yan, Les Cooke, Roger Tomlinson, John Davis, Richard Groot, Donna Peuquet, and Rainer Padduck. The invited speakers had all been involved in research, development, and applications in the field for many years.

The seminar was divided into four parts. The first presentations were in the geological and petroleum fields. Using case history examples, the second session dealt with advantages and problems of system implementation. The third session presented various technological solutions to problems, pointing out that many difficulties in this rapidly changing field arise from limitations of the interchange process.

The final session was a discussion of substantive technical issues, such as the availability of useful algorithms, relationship data bases versus spaghetti files, and alternative formats in which to store and exchange data.

In addition to the speakers, the conference attracted 56 participants, most of whom were from the oil and mineral exploration industries. The conference was organized by David Douglas, Ray Boyle, and Michael Coulson.

A guide to recent computer-animated films and videotapes

L.R. Speer, University of Washington

In 1979 I co-authored a list of approximately 200 computer-animated films and videotapes available from individuals or film distribution firms.1 These works are generally 10 minutes or less in length and cover a wide variety of topics. Some were made by researchers, some by academicians, and some by professional or commercial artists. What all the films and tapes have in common though is that a computer was used in some way to make their images.

Production of short, computer-animated films and tapes has continued steadily since then, and the listing given here is an update of the 1979 guide. The information for this listing came from the film presentations at Siggraph '80 and '81,2 and from private correspondence with film-makers. It is not necessarily a complete summary of all the recent activity in the field but is an indication of the work being done currently. (The addresses of the sources cited follow the film and tape list.)

It is beyond the scope of this brief introduction to go into detail about the methods used in the production of these works. However, for those interested in experimenting, references 3 through 7 contain useful information, especially for those persons wanting to make film or still photographs of color CRT images.

References


2. Siggraph is the annual conference of the Special Interest Group on Graphics of the Association for Computing Machinery. Information can be obtained from ACM, 1133 Ave. of the Americas, New York, NY 10036.


Computer-animated films and videotapes

The Butterfly Catastrophe, N. Max, 1980, 4.5 minutes, color, silent, 16 mm, videotape, rental, sale. To introduce catastrophe theory, the butterfly surface is represented in four dimensions with time as the extra dimension. Source: IFB

Cell Division in the Cartilage Plate During Bone Growth, N. Kember, D. Clark, 1977, 8 minutes, b/w, sound, 16 mm. Four animated sequences simulate cell division and maturation in the cartilage columns of the growth plate. Source: Clark

Computer-Aided Design at General Motors, GM Design Staff, 1977, 20 minutes, color, sound, 16 mm. Illustrates the use of computer graphics in a large computer-aided design system. Source: GM

Computer Animation Clips, Colin Cantwell et al., 1980, 1 minute, color, sound, 16 mm. Three television commercials made by animating successive drawings produced on a tabletop x-y plotter. Source: Marks

Computer Simulator for Acoustic Phased Arrays, A. Duerinckx, 4 minutes, b/w, 16 mm. Animation of the acoustic pressure waves in the near-field generated by a linear phased array excited with short pulses. Source: Duerinckx

Cosmos Sample Reel, J. Blinn and P. Cole, 1980, 17 minutes, color, silent, 16 mm. A collection of the computer-animated sequences from Carl Sagan’s Cosmos television series. Source: Blinn
Three kinds of cartographic animation are explored here: spatio-temporal data display, surface exploration, and an examination of spatial process. Source: Moellering

Downtown People Mover Simulation, E. Joline, 1979, 16 mm. Source: Joline

Emulation of Real-Time Texture Generation, J. Yan et al., 1980, 6 minutes, color, silent, 16 mm. Texture generation adds realism to scenes used in aircraft training simulators, providing better motion and attitude information to the pilot/traimee. Source: Yan

Euclidean Illusions, S. Vanderbeek and R. Weinberg, 1980, 6 minutes, color, sound, 16 mm. An abstract art film produced with the electronic scene generator at NASA-Houston. Source: Vanderbeek

Frank's Latest, Frank Crow, 1980, 20 seconds, color, sound, 16 mm. A short clip using dithered color on a shallow (10-bit) frame buffer. Source: Crow

Halley Fly-By/Tempel II Rendezvous, L. Lee et al., 1978, 12 minutes, color, silent, 16 mm. A simulation of a proposed mission to encounter Halley's Comet and the comet Tempel II. Source: JPL

Interaction of D+ and HD, K. Birkenshaw and D. Clark, 1975, 13 minutes, b/w, sound, 16 mm. Computer-generated sequences of interaction between deuterium ions and hydrogen deuteride. Source: Clark

Interactive Molecular Graphics, T. Ferrin and R. Langridge, 1980, 10 minutes, color, silent, 16 mm. Depicts the use of a sophisticated computer graphics system to interactively design and analyze molecular models. Source: Ferrin

Ion-Dipole Charge Transfer Trajectories, F. Wolf and D. Clark, 1974, 10 minutes, b/w, sound, 16 mm. Animation of the potentials in real and configuration space of Ar and CO charge transfer interactions. Source: Clark

Limit Curves and Curves of Infinite Length, N. Max, 1979, 14 minutes, color, silent, 16 mm, videocassette, rental, sale. Seven short computer-animated sequences show the construction of limit curves from a sequence of approximation curves. Source: IFB

Limit Surfaces and Space-Filling Curves, N. Max, 1979, 10.5 minutes, color, silent, 16 mm, videocassette, rental, sale. Presents four examples of infinite constructions in two and three dimensions. Source: IFB

Nascap-Scatha, J. Cassidy, 1980, 6.5 minutes, b/w, sound, 16 mm. Nascap is a computer program that simulates spacecraft electrical charging. The film uses that program to show the forces built up on a scientific satellite called Scatha. Source: Cassidy

New Developments in Day/Night Computer-Generated Imagery, Evans and Sutherland Corp., 1977, 7 minutes, color, sound, 16 mm. Shows a variety of simulations of the pilot's point of view in land, sea, and air environments. Source: Evans and Sutherland

Newtonian II, L. Schwartz, 1978, 5.5 minutes, color, sound, 16 mm, rental, sale. Patterns of abstract geometric shapes set to music. Source: Schwartz

Pioneer II—Saturn Encounter, J. Blinn et al., 1979, 2 minutes, color, silent, 16 mm. A simulation of the Pioneer 11 encounter with Saturn in September, 1979. Source: Holzman
Russian Ant, Dimitri Okhotsinsky, 1976, 10 minutes, b/w, 16 mm. Animation of a hypothetical "hexaped" vehicle moving over irregular terrain. Source: Csuri

Sierpinski's Curve Fills Space, N. Max, 1980, 4.5 minutes, color, sound, 16 mm, video cassette, rental, sale. The proof that Sierpinski's limit curve passes through every point in a square is illustrated. Source: IFB

Space Shuttle Flight Simulation, R. Weinberg and J. Smith, 1978, 7 minutes, color, silent, 16 mm. A simulation of the deployment arm aboard the space shuttle maneuvering a payload in space. Source: Smith

Spatial Ramifications of the Cube, M. Gottlieb, 1975, 5.5 minutes, color, sound, 16 mm, rental, sale. Shows the process by which hypercubes are formed, beginning with a zero-dimensional cube, or point, and building up through a line and a square to the hypercube. Source: Gottlieb

Sphere Eversions, N. Max, 1980, 7.5 minutes, color, silent, 16 mm, video cassette, rental, sale. Excerpted from Max's earlier film, Turning the Sphere Inside Out, are three computer-animated sequences using different rendering techniques to show the sphere as it evolves. Source: IFB

The Structure and Function of Hemoglobin, D. Clark et al., 1980, 25 minutes, color (stereo-anaglyph method), 16 mm. Uses computer-drawn stereo pairs of images to explain the mechanism by which hemoglobin binds and releases oxygen. Source: Clark

Tomato Bushy Stunt Virus, A. Olson and N. Max, 1980, 4 minutes, color, silent, 16 mm. Shows the structure and arrangement of the protein molecules in the coat of the title virus. The pictures were generated using the ATOMELL package on a CDC 7600, and filmed on a Dicomed recorder. Source: Max

Traffic Crashes in Washtenaw County, H. Moellerling, 1972, 7 minutes, color, silent, 16 mm. Traffic crash data from Washtenaw County, Michigan, for the years 1968-70 are displayed in this film. The animation algorithm is written so that as a crash increases in severity, the symbol representing it is drawn larger and is shown for a longer period. Source: Moellerling

USS Transit Station Documentation, E. Joline, 1977, 16 mm. Source: Joline

UTC/NI Urban Traffic Network Simulation, E. Joline, 1976, 16 mm. Source: Joline

Vol Libre, L. Carpenter and R. Speer, 1980, 4 minutes, color, sound, 16 mm. The technique of fractal surface generation and manipulation is shown. Here a fractal landscape is created and then traversed as if the viewer were hanging-gliding. Source: Carpenter

Voyager I Encounters Jupiter, J. Blinn and C. Kohlhase, 1979, 3 minutes, color, silent, 16 mm. A simulation of the Voyager 1 encounter with Jupiter in March, 1979. Source: Kohlhase

Voyager II Encounters Jupiter, J. Blinn and C. Kohlhase, 1979, 6 minutes, color, silent, 16 mm. A simulation of the Voyager II encounter with Jupiter in July, 1979. Included in the simulation are various planetary phenomena discovered during the Voyager I encounter. Source: Kohlhase

Waves on a String and Fourier Analysis, A. Appleton and D. Clark, 1975, 23 minutes, b/w, sound, 16 mm. The mathematical properties of transverse waves are illustrated by computer-drawn images of a stretched string on which various disturbances propagate. Source: Clark

Zooms on Self-Similar Figures, N. Max, 1979, 8 minutes, color, sound, 16 mm, video cassette, rental, sale. Contains the zoom scenes from five other films in Max's series of topology films. Source: IFB

Sources of computer films and tapes

Blinn
James Blinn
Lucasfilm Ltd.
PO Box 186
San Anselmo, CA 94960

Carpenter
Loren Carpenter
Lucasfilm Ltd.
PO Box 186
San Anselmo, CA 94960

Cassidy
Jack Cassidy
Systems Science and Software
3398 Carmel Mountain Rd.
La Jolla, CA 92121

Clark
David Clark
Audio-Visual Center
Univ. of London
11 Bedford Square
London WC1B 3RA UK

Crow
Frank Crow
Computer Science Dept.
Ohio State University
Columbus, OH 43210

Csuri
C. Csuri
Dept. of Art
Ohio State University
Columbus, OH 43210

Duerinckx
Andre Duerinckx
Thomas J. Watson Research Center
IBM Corporation
Yorktown Heights, NY 10598

Evans and Sutherland
Evans and Sutherland Corp.
580 Arapeen Dr.
Salt Lake City, UT 84108
(801) 582-5847

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OR: Beaverton 503/644-5900
WA: Bellevue 206/452-5160

Thorsen Company
HI: Honolulu 808/524-8633

Trans Alaska Data Systems
AK: Anchorage 907/276-5616

Mountain
PAR Associates
CO, WY: Denver, CO 303/371-1410
UT, ID, MT: Centerville, UT 801/292-8145

Southwest
Computer Peripheral Sales
AZ, NV (Clarke Co.): Phoenix, AZ 602/942-4025

BFA Corporation
NM: Albuquerque 505/292-1212
TX (El Paso): 915/542-1762

USDASA Engineering
TX: Dallas 214/661-9633; Austin 512/454-3579; Houston 713/681-0200
AR, OK: Broken Arrow, OK 918/252-9646

Midwest
Dytec North, Inc.
MN, ND, SD: St. Paul, MN 612/645-5816

Resource Data Systems
IL (No.), IN, WI: (Scott Co.): Northbrook, IL 312/564-5440

Digital Systems Sales, Inc.
MO, IA (So.): KS, NE, IA (Excl. Scott Co.):
Grandview, MO 816/765-3337; St. Louis, MO 314/946-0186; Wichita, KS 316/685-9725; Omaha, NE 402/346-1039

Lowry & Associates, Inc.
MI, KY, OH, PA, WV: Brighton, MI 313/227-7067; Grand Rapids, MI 616/363-9699; Cleveland, OH 216/398-9200; Dayton, OH 513/435-7694; Pittsburgh, PA 412/922-5110

Southeast
WA: Brown Instruments, Inc.
GA, LA, NC, SC, TN, AL, FL: Atlanta, GA 404/455-1035; Mandeville, LA 504/628-8701; Durham, NC 919/685-1580; Columbia, SC 803/798-8070; Oak Ridge, TN 615/482-5761; Huntsville, AL 205/883-8660; Orlando, FL 305/425-6505; Ft. Lauderdale, FL 305/776-4800; Melbourne, FL 305/723-0766; Ft. Walton Beach, FL 904/243-3189

Interton Corp.
VA, DC, MD: Springfield, VA 703/569-1502

Northeast
MA, ME, NH, VT, RI: Winchester, MA 617/779-5770; Springfield, MA 413/737-6824; Godfrey, CT 203/624-7800

NACO Electronics Corp.
NY (Excluding Metro NY/LI): North Syracuse, NY 315/699-2651; Cicero, NY 315/672-3751; Fairport, NY 716/223-4490; Utica, NY 315/735-1831

Technical Marketing Associates, Inc.
NJ (No.), NY (Metro/LI): Hackensack, NJ 201/664-9222

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