

NAECON 87

18-22 MAY 1987



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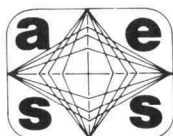


Proceedings of The
**IEEE 1987 National Aerospace
and Electronics
Conference
NAECON 1987**

Held at the Dayton Convention Center
May 18-22, 1987

Sponsored by

**The Institute of Electrical and
Electronics Engineers
Dayton Section
Aerospace and Electronic Systems Society**



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This is VOLUME 4
OF FOUR VOLUMES

VOLUME ONE CONTAINS:

Digital Technology and Applications

VOLUME TWO CONTAINS:

Avionics Subsystems and Weapons Technology

Flight Control

Software Development and Management

VOLUME THREE CONTAINS:

Human Interface

Simulation and Training

Command, Control and Communications

VOLUME FOUR CONTAINS:

Aerospace Engineering Systems

Artificial Intelligence

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President's Message



The NAECON '87 Committee and the Board of Directors are proud to present this official record of the technical papers presented at this, The 39th consecutive NAECON. We feel that, once again, the conference offers an outstanding combination of technical programs and exhibits. This year's theme, "Building Our Future Through Advanced Technology," recognizes the challenge of today's technical community to increase their knowledge and add to the "building blocks" of existing technology.

Many individuals and organizations from both industry and government have worked hard to assemble this conference. We are confident that you will be impressed with the quality of the over 200 technical papers contained in the following pages. In addition to the fifty-eight technical ses-

sions, five tutorials and two special sessions were also presented, with the SDI session being reshown throughout the conference.

As in past years, the principal sponsorship of NAECON is the Dayton Section of the Institute of Electrical and Electronics Engineers (IEEE) and the Aerospace and Electronic Systems Society (AESS) of the IEEE. Technical co-sponsorship continues to be furnished by the American Institute of Aeronautics and Astronautics (AIAA), the Dayton Section of the Institute of Navigation (ION), the Kittyhawk Chapter of the Association of Old Crows (AOC), the Dayton-Wright Chapter of the Armed Forces Communications and Electronics Association (AFCEA), the Dayton Branch of Sigma-Xi Research Society of America, the Engineering Management Society (EMS), the Air Force Association (AFA), the American Defense Preparedness Association (ADPA), the Society of Automotive Engineers (SAE), the Human Factors Society (HFS), and for the first time this year, the Society of Logistics Engineers (SOLE).

A higher-than-ever level of support from industry has made possible an outstanding exhibits presentation. This has always been an integral part of NAECON and contributes greatly to the overall success and enjoyment of the conference. A listing of our exhibitors, co-sponsors and contributors is included in these pages. A special thanks to all exhibitors for their continued support of NAECON and for working with us through the Dayton Convention Center renovation.

It has been my pleasure to serve as the President of NAECON '87. NAECON is a totally volunteer organization and I am honored to have had the opportunity to have worked with so many whose dedication and energy have made this conference so successful. It is this dedication and loyalty which will continue the traditions of excellence that have become associated with NAECON in the future.

MARY TERBAY
PRESIDENT NAECON '87

NAECON— PAST and PRESENT

The National Aerospace Electronics Conference, developed simultaneously with the advent of jet propulsion and missiles following World War II, is now in the 38th year of spawning new developments in technology and avionics. NAECON, still a leader in stimulating advancements in aerospace electronics, has helped to nurture this technology by acquainting military and industrial technical personnel with new ideas as well as new problems.

In 1948, there was a realization by electronic research and development scientists that electronics held the key to the solution of many problems arising at supersonic speeds. These men felt that there was a growing urgency that the attention of the nation be focused on the gap in our military and technological program. They realized the vital need for placing emphasis and recognition on research and development.

Mr. George Rappaport suggested an annual technical conference be held in Dayton, Ohio—the Birthplace of Aviation and the heart of the Air Force's research and development effort—to discuss and disseminate technical progress in this vital area. Mr. Rappaport discussed the conference with other members in the Dayton Section IRE (since changed to IEEE) and on June 3rd and 4th, 1949, the first annual technical conference on Airborne Electronics was launched with Mr. John E. Keto (formerly Chief Scientist of the Aeronautical Systems Division) serving as President.

Funding a program of the magnitude envisioned became the most serious problem, but a request for a loan from the Cincinnati Section IRE brought immediate response. Only six technical papers were read and

eleven exhibitors displayed their products at the first conference, but the response from the 250 to 300 visitors who attended was most enthusiastic.

In 1960, the name of the conference was changed to the National Aerospace Electronics Conference (NAECON).

From its humble beginning 39 years ago, NAECON has grown in importance as evidenced by its attendance growth and current co-sponsorship by the Dayton Section of IEEE and the Aerospace and Electronic Systems Society (AESS). The Dayton-Cincinnati Section of the American Institute of Aeronautics and Astronautics (AIAA), the Dayton Section of the Institute of Navigation (ION), the Kittyhawk Chapter of the Association of Old Crows (AOC), the Dayton-Wright Chapter of the Armed Forces Communications and Electronics Association (AFCEA), the Dayton Branch of Sigma Xi-Research Society of America, the Engineering Management Society (EMS), the Air Force Association (AFA), the American Defense Preparedness Association (ADPA and the Human Factors Society) are acting as Technical Co-Sponsors.

May 18-22, have been selected for the 1987 Conference. The Theme of this year's Conference is "Building Our Future Through Advanced Technology." The technical program now includes over 50 sessions with over 250 papers covering a broad spectrum of interest, five tutorials, a plenary session, and two special management sessions.

NAECON continues to provide an excellent opportunity for engineers and scientists from industry and government to meet and exchange ideas on the latest development in their areas of interest.

This year the exhibits will again display a wide variety of new electronics and avionics technology.

TUTORIALS

MONDAY — MAY 18

ARTIFICIAL INTELLIGENCE/ EXPERT SYSTEMS CONCEPTS

8:30 AM to 5:30 PM

Instructors:

David C. Dietz, Senior Scientist, Systems Research Laboratories, Inc.,
Dayton, Ohio
Linda F. Brainard, Systems Analyst, Systems Research Laboratories, Inc.,
Dayton, Ohio

Course Synopsis:

This tutorial will present the concepts of Artificial Intelligence with emphasis on basic definitions and techniques. Some of these include search algorithms, pattern matching and data representations. The more popular AI programming languages, LISP and Prolog will be examined. Several application examples will be explained and demonstrated.

The application of Expert Systems is one of the more dramatic examples of AI. The inner workings of an Expert System, the inference engine, will be described. A typical application will be examined and the resulting expert rule set will be built and demonstrated.

Finally, several promising areas within AI, concurrent processing and neural nets, will be discussed.

David Dietz is a Senior Scientist with Systems Research Laboratories in Dayton, Ohio. He received his B.S. in Physics from the University of Dayton in 1970. He has done graduate work in Physics and Systems Engineering. Mr. Dietz is past Chairman of the Dayton Area SIGART (Special Interest Group on Artificial Intelligence). He is also an Adjunct Professor for Artificial Intelligence at the University of Dayton. His professional memberships include the American Association for Artificial Intelligence and the ACM SIGART. His experience in Artificial Intelligence has included LISP language development, pattern recognition, neuron network simulation, and the application of expert systems. He has developed both FORTRAN LISP and ADA LISP. Mr. Dietz is responsible for the Artificial Intelligence Laboratory at SRL.

Linda Brainard is a Systems Analyst with Systems Research Laboratories. Ms. Brainard has a B.S. in Mathematics from California State in 1976. Her current work includes the design and development of advanced systems in LISP for military and commercial applications. She developed DEXPERT™, an expert system building tool, and conducted SRL's LISP/AI classes. She is involved in enhancement and support of SRL's many AI products using LISP, ADA, and FORTRAN. She is a member of the American Association for Artificial Intelligence (AAAI) and ACM SIGART.

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FIBER OPTICS DATA BUSES

8:30 AM to 5:30 PM

Instructors:

Rod Katz, Naval Avionics Center, Indianapolis Indiana
Charles W. Kleekamp, Mitre Corporation, Bedford Massachusetts
John A. Kolling, Sperry Corporation, St. Paul, Minnesota
Charles R. Husbands, Mitre Corporation, Bedford Massachusetts
Roger W. Uhlhorn, Harris Corporation, Melbourne, Florida

Course Synopsis:

The successful application of fiber optics by the telecommunications industry has sparked renewed interest in avionics systems applications. The highly integrated avionics systems proposed for the Air Force Advanced Tactical Fighter (ATF) and the Navy Advanced Tactical Aircraft (ATA) require high speed, multiplexed data buses. Because of its superior wideband/high speed performance and inherent resistance to EMI and EMP threats, fiber optics is becoming the technology of choice to implement advanced military avionics data buses.

This tutorial program provides an introductory background in fiber optics technology and the design methodology for fiber optics data transmission systems. Basic data bus/local area network concepts are discussed with an emphasis on the system choices which favor fiber optics. Emerging fiber optics bus standards such as MIL-STD-1773 and the ANSI FDDI bus will be described. Fiber optics implementation of the SAE proposed High Speed Data Bus (HSDB) standard will be discussed and key issues identified. The program will also include advanced technology developments and new avionics bus initiatives such as the development of parallel sensor buses and networks. Proposed enhancements to MIL-STD-1773 including Multiple Speed Data Rate Transmission (MSDRT) and the control of collateral data pipelines will be included.

Rod Katz as Head of the Advanced Communications Technologies Branch, established a significant R&D program in fiber optics at the Naval Avionics Center and was responsible for the definition and administration of 20 contract developments in fiber optics technology, optical sensors and advanced systems concepts. His present position is Staff Consultant for Fiber Optics and Advanced Technologies in the Communication Systems Division - Applied Research Department. He is Task Group Leader for the 8AE AE-9C FO subcommittee with principal responsibility for MIL-STD-1773. Mr. Katz has a B.S.E.E. from the University of Evansville and the Masters Degree in Electronics Engineering from the Rensselaer Polytechnic Institute.

Charles W. Kleekamp is Group Leader for Fiber Optics at Mitre Corp. in Bedford, Mass. He has extensive experience in the application of fiber optics to military systems including programs to replace copper conductors in mobile command and control centers with fiber optics cables. These programs include a 26-pair field deployable voice communications system and remote radar video link systems. Mr. Kleekamp has been very active in developing specifications and standards for military fiber optics components and cables. He has B.S. and M.S. degrees in engineering from the University of Michigan.

John A. Kolling is a Senior Staff Engineer at the Defense Products Groups, Computer Systems Division of Sperry Corporation in St. Paul, Minnesota. He has more than ten years experience in fiber optics technology with responsibility for fiber optics interconnect systems. He has served as project engineer for numerous fiber optics developments including a family of hybrid fiber optics transmitter/receiver modules, MIL-STD-1773 terminals for the AYK-15(A) computer, and a fiber optics signal transfer system for the Ground Launched Cruise Missile (GLCM) control system. Mr. Kolling is a contributor to the SAE AE-9C FO subcommittee and to the ANSI X3T9.5 FDDI Bus STD Committee. He has a B.S.E.E. degree from the University of Minnesota.

Charles R. Husbands has a broad background in the development of communications systems. He has been with Mitre Corporation for thirteen years where he has worked on a variety of communications systems projects most recently concentrating on the application of fiber optics to local area networks. His current position is that of Group Leader for Fiber Optics Systems. Mr. Husbands is a prolific author with many technical papers to his credit. He is a member of the IEEE and Chairman of the SAE AE-9C Fiber Optics Subcommittee. He has a B.S.E.E. degree from the Milwaukee School of Engineering and M.S.E.E. and M.S. in Engineering Mgmt. from Northwestern.

Dr. Roger Uhlhorn is a Principal Engineer and Group Leader for fiber optics design in the Harris Corporation Government Aerospace Systems Division. He coordinates the fiber optic independent research and development activity to provide direction for future fiber optic activity. He has 11 years experience working with fiber optics technology and its application to aerospace systems. Current activities include the development of serial and parallel high speed fiber optic data bus network concepts and components for future avionics systems. Dr. Uhlhorn received the B.S., M.S., and Ph.D. degrees in Electrical Engineering from the University of Illinois at Urbana-Champaign. His paper "Imaging Connector Interconnect System for a Parallel Fiber Optic Data Bus" won the NAECON 1985 Best Paper Award.

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OPTICAL COMPUTING 8:30 AM to 5:00 PM

Instructor:

Dr. Darrel G. Hopper, Assistant Professor of Electrical and Computer Engineering, Air Force Institute of Technology, WPAFB, Ohio

Course Synopsis:

The advent of a significant installed base of fiber optic cable in telecommunications and data buses is fueling a drive for optical computing. The performance of switching and logic operations on the signal in the photonic form will eliminate inefficient energy conversions to and from the electrical form. This combination of optical communications and computing is known as Integrated Photonics in AFSC Forecast II terminology. Like fiber optics, optical computing components are inherently highly resistant to EMP/EMI effects. Eventually optical processors will be added to main frame supercomputers to increase speed in problems amenable to solution with a parallel architecture and algorithm.

This tutorial program provides an introduction to optical computing. First, optical computing is defined and put into perspective relative to electronic computing. Then the technology is reviewed. Materials and devices are discussed with an emphasis on their construction, characteristics, and current capabilities and the evolution which may be expected during the next 10 years. Algorithms and architectures are presented for a number of problems with laboratory optical digital computing concepts. Software development requirements are contrasted to the similar process of programming currently available parallel electronic computers. A proposed design for a complete optical computer by the Frame Logic Optical Computing (FLOC) approach will be used to tie optical computing concepts together.

Dr. Darrel G. Hopper is an Assistant Professor in the Air Force Institute of Technology, Department of Electrical and Computer Engineering, at Wright-Patterson AFB, Ohio. Dr. Hopper has analyzed optical information processing for the DoD for five years. He has over fifty publications to his credit and is currently designing and breadboarding a digital optical computer by his FLOC technique.

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KALMAN FILTERING WITH APPLICATIONS TO MULTISENSOR INTEGRATION 8:30 AM to 5:00 PM

Instructors:

Joseph A. D'Appolito, Division Staff Analyst,
The Analytic Sciences Corporation
David A. Whitney, Member of the Technical Staff,
The Analytic Sciences Corporation

Course Synopsis:

Optimal estimation theory, and in particular, Kalman filtering, forms the basis for all modern multisensor system integration algorithms. This course provides an overview of Kalman filtering and its application to multisensor system integration. The course emphasizes the practical application of Kalman filtering rather than abstract theory. A brief review of random processes and the state-space characterization of linear dynamic systems which are essential to understanding Kalman filtering are first discussed. Then a simple, algebraic derivation of the Kalman filter, together with physical interpretation and pertinent examples, are presented. Finally, the issue of practical suboptimal Kalman filter design is discussed and illustrated with several examples from diverse programs including the AN/ARN-101, USAF INU and GPs.

Dr. Joseph A. D'Appolito has over twenty years experience in the application of modern estimation and control theory to the analysis, design and evaluation of integrated multisensor navigation systems. He developed original computer-based techniques for performance evaluation of Kalman filter integrated multisensor navigation systems in the mid-60's. He has participated in or directed the analysis, design, and evaluation for the Air Force, including the Standard INU, AN/ARN-101, DILS, GEANS, MICRON, 621B/Inertial, Beacon/Inertial and GPS/Inertial systems. In addition to inertial navigation, Dr. D'Appolito has worked extensively in the areas of stochastic systems identification and modeling for a broad range of navigation, guidance, communications and signal processing problems at TASC. Dr. D'Appolito received the B.E.E. degree from Rensselaer Polytechnic Institute, the M.S.E.E. and E.E. degrees from Massachusetts Institute of Technology, and the Ph.D. in Electrical Engineering from the University of Massachusetts.

David A. Whitney has been employed as a statistician at TASC since 1980, where he has worked on a variety of system test and evaluation activities. He has responsibility for the technical direction of several test data processing and system modeling activities involving both inertial components and sonar systems. He has also been involved in the development of new algorithms for estimating parameters and validating the structure for large-dimensional models implemented in Kalman filters for test data processing. He is the author of several publications relating to parameter identification and Kalman filtering. Mr. Whitney holds an A.B. degree from Princeton University, M.S. degrees in Applied Mathematics and Statistics from the University of Illinois, and is currently working toward the Ph.D. degree at the Massachusetts Institute of Technology. He is a member of Sigma XI, SIAM, and ASA.

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INTRODUCTION TO REAL-TIME FLIGHT SIMULATION AND TRAINERS 9:30 AM to 4:30 PM

Instructors/Subjects:

Richard Heintzman - Overview, History, Visual Systems
Arthur T. Gill - Coordinator, Visual Displays/Image Input Devices
Frank M. Cardullo - Air Vehicle Modeling, Aerodynamics
Dr. Kenneth B. Donovan - Radar and Visual Digital Image Generation
H. Reed Puckett - Avionics Processors, Electronic Combat
Mark T. Adducchio - Maintenance Trainers

Course Synopsis:

This tutorial will acquaint engineers and managers with many of the design considerations, performance capabilities, limitations, and pitfalls associated with real-time, man-in-the-loop simulation. Both training simulators and R&D simulators which support aircraft development and research will be addressed. Emphasis will be placed on discussion of parameters which are key drivers of performance, complexity and cost.

The tutorial outline: OVERVIEW - History, Elements of a Simulator, Simulator Architectures; AIR VEHICLE - Basic Modeling Principles, Flight, Aerodynamics; VISUAL SYSTEMS - Overview, Displays, Image Generation; AVIONICS - Overview, IR/EO Sensors, Radar, Data Bases, Avionics Processors, Electronic Combat; and MAINTENANCE TRAINERS - Definitions, Types, Trends.

Frank M. Cardullo is an associate professor in the Watson School of Engineering, Applied Science and Technology at the State University of New York at Binghamton. He is a consultant to numerous major aerospace companies and has held engineering positions with industry, working in visual simulation, motion and force cueing, and vehicle dynamics modeling.

Richard J. Heintzman is the Technical Expert for the Aircrew Training Systems Division, Deputy for Engineering, Aeronautical Systems Division. He has coordinated R&D supporting flight simulators and use of simulators in the aircraft industry. He was instrumental in the development of numerous visual systems both in-house at ASD and under contract.

H. Reed Puckett is a Member of the Technical Staff, Electronic Combat Operations, AAI Corporation. He has been an integral part of the electronic combat simulation history at AAI and has been a leading figure in the application of new technology to the simulation field.

Arthur T. Gill is an Electronics Engineer in the Visual and Avionics Simulation Branch, Deputy for Engineering, Aeronautical Systems Division. He has previous experience in coordinating R&D activities for development of visual simulation display technology and at ASD, has been actively involved in the development of several visual systems under contract.

Dr. Kenneth B. Donovan is Manager of the Advanced Simulation Technologies Engineering Unit, Simulation and Control Systems Department, General Electric Co. - Daytona Beach. He is responsible for R&D of simulation techniques for existing and emerging computer image generation (CIG) products including spatial modeling tools, real time image generation algorithms, photographic texture techniques, simulator display techniques and applications of CIG technology.

Mark T. Adducchio is a Project Engineer in the Maintenance Training Systems Branch, Deputy for Engineering, Aeronautical Systems Division. At ASD, he has provided technical support for the GLCM Missile Procedures Trainer and maintenance trainers for the F-15, F-16 and the B-52 OAS.

PLENARY SESSION

TUESDAY, 19 MAY 1987

9:00 AM - 12 Noon

CONVENTION CENTER THEATRE

Moderator:

Lieutenant General William E. Thurman,
Commander, Aeronautical Systems
Division, WPAFB



LT. GEN. W. E. THURMAN

Speakers:

General Lawrence A. Skantze,
Commander AFSC, Andrews AFB

General Earl T. O'Loughlin,
Commander AFLC, Wright-Patterson AFB

Mr. Joseph T. Gallagher, Vice President &
General Manager, Aircraft Division,
Northrop Corporation

Mr. Edwin A. Goldberg, Vice President & General Manager, TRW Electronic
Systems Group, TRW Inc.



GEN. L. A. SKANTZE

General LAWRENCE A. SKANTZE is Commander, Air Force Systems Command, Andrews Air Force Base, Md. He directs the research, development, test and acquisition of aerospace systems for Air Force operational and support commands. He assumed this command in August, 1984.

The general is a command pilot and wears the senior missile badge. His military decorations and awards include the Distinguished Service Medal with one oak leaf cluster, Legion of Merit with one oak leaf cluster, Meritorious Service Medal with one oak leaf cluster and Army Commendation Medal.

General Skantze is no stranger to NAECON nor Wright Patterson Air Force Base. He was Deputy for AGM-69A SRAM at ASD in 1971. In 1979 he took command of the Aeronautical Systems Division until August 1982.



GENERAL EARL T. O'LOUGHLIN

General EARL T. O'LOUGHLIN is Commander of Air Force Logistics Command, headquartered at Wright-Patterson AFB, Ohio. His command mission is to provide worldwide technical logistics support to all Air Force active and reserve force activities, 60 allied nations and designated U.S. government agencies.

General O'Loughlin is a command pilot with more than 6,000 flying hours and extensive experience in strategic bombing, reconnaissance, refueling, and maintenance systems. His career has run the gamut, from flying B-29s on combat missions over North Korea in 1953 to serving on the Air Staff at the Pentagon in Washington, D.C. When he commanded the 380th Bombard-

ment Wing in upstate New York during the mid-seventies, his wing won the Fairchild Trophy as best bombardment wing during the Strategic Air Command's annual bombing and navigation competition. In addition, he served two tours of duty in Southeast Asia.

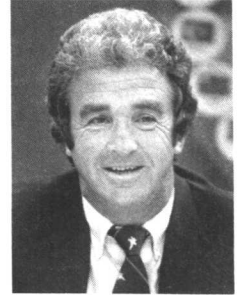
His previous assignments have included vice commander of Air Force Logistics Command, commander San Antonio and Oklahoma Air Logistics Centers, and deputy chief of staff for maintenance and deputy chief of staff for contracting and manufacturing at Air Force Logistics Command headquarters.

Mr. JOSEPH T. GALLAGHER is Vice President and General Manager of the Aircraft Division of Northrop Corporation, a Los Angeles-based diversified aerospace firm which operates primarily in the fields of aircraft, electronics, and technical and management support services. Prior to his present assignment, Mr. Gallagher has held several positions at Northrop, including Vice President of Engineering.

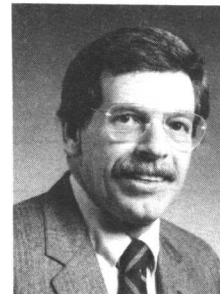
The Aircraft Division is Northrop's largest operating organization. Fighter aircraft and large commercial aircraft structures are designed and produced, and research and development in a wide range of aeronautical technologies are performed at the division's Hawthorne and El Segundo, California facilities.

Mr. Gallagher has an HNC degree from Belfast College of Technology in Aeronautical Engineering, a MSC degree from Cranfield Institute of Aeronautical Sciences, and a Juris Doctor in Law from Southwestern University School of Law. He has continued his education in avionics and mathematics at UCLA, and in management at Harvard Business School.

Mr. Gallagher is a Fellow of the Royal Aeronautical Society, and a Fellow and Chairman of the Design Integration Technical Committee for AIAA. He is a member of the Aerospace Council of the SAE, a member of the Institute of Electrical and Electronic Engineers, Inc., a member of NASA Advisory Council, and the USA member on the NATO AGARD Flight Mechanics Panel.



JOSEPH T. GALLAGHER



EDWIN A. GOLDBERG

Mr. EDWIN A. GOLDBERG is the Vice President and General Manager of the Electronic Systems Group of TRW's Electronics & Defense Sector. This \$800M per year operating group of TRW is responsible for advanced electronic research as well as development, analysis, and design of avionic, ground, and spacecraft electronic systems. Products include special purpose communication systems, digital signal processing equipment, telemetry subsystems, anti-jam communication processors, satellite communications payloads, electronic warfare systems, and microelectronic components.

Mr. Goldberg has 31 years of experience in electronic systems development. He joined TRW in 1956, went to the Aerospace Corporation at its inception in 1960 and returned to TRW in 1965.

He has held numerous line and project management positions related to missile, spacecraft, aircraft, and ground-based systems development. Functionally, he has been responsible for applications of guidance and control, position determination and tracking, ground station operations, strategic and tactical communications, command and control, ballistic missile defense, trainers and simulators, high energy lasers, avionics, and data base management systems.

Mr. Goldberg received a B.S. degree from Yale University in 1954 and an M.S. degree from Massachusetts Institute of Technology in 1956, both in electrical engineering. He has been a member of the teaching staff at the Massachusetts Institute of Technology, the University of California at Los Angeles, and the University of California. He and his wife, Gayle, live in Los Alamitos.

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