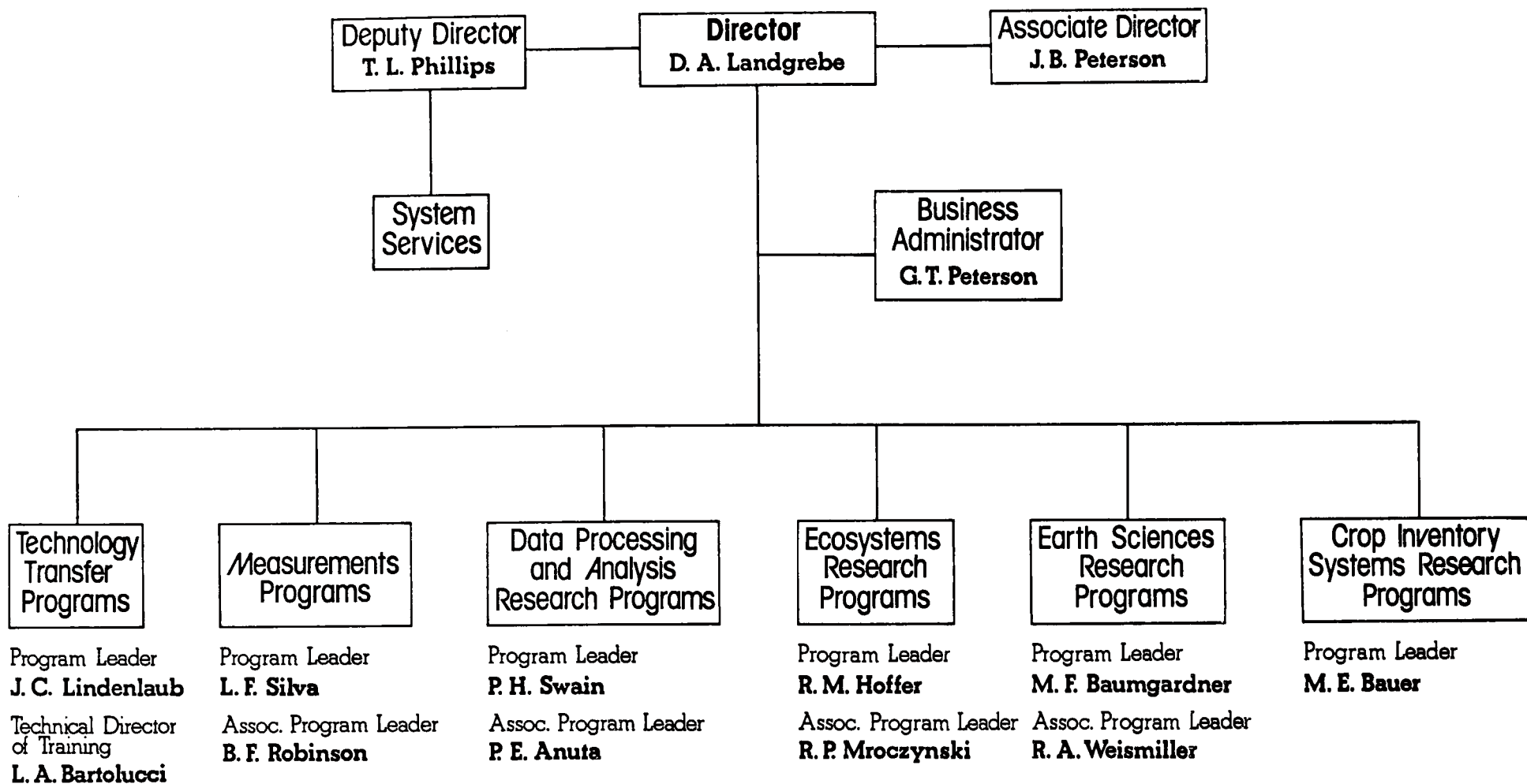


LARS Publication 042778

# Purdue/LARS Organization



Organization of the Laboratory for Applications of Remote Sensing

## The Laboratory for Applications of Remote Sensing

The Laboratory for Applications of Remote Sensing (LARS) is a research laboratory within Purdue University focusing the University's resources on development of improved techniques for analyzing earth resource information. A multidisciplinary staff from various departments within the schools of agriculture, engineering, and science compose the LARS team. Over the Laboratory's eleven year history, the team has been responsible for many of the developments in remote sensing technology.

Purdue/LARS' activities include conducting research, developing technology, and training people in the use of quantitative remote sensing systems. Such systems utilize the tremendous data volumes now available from instruments aboard high flying aircraft and earth-orbiting satellites.

Research interests at LARS center on the development of remote sensing technology and its applications including: expanding understanding of earth surface features and their spectral properties; developing quantitative remote sensing analysis systems; increasing the ability of computers to assist the analyst in remote sensing analysis; and applying newly developed analysis systems to specific earth resource problems.

LARS is in an exceptionally favorable position to serve as a training center as well as a research institution by virtue of: its position as an integral part of a broad-based, top-level university; its organizational structure; its interdisciplinary approach; and its breadth and depth of experience in remote sensing research and applications. Being closely integrated into the university structure, the Laboratory is able to attract outstanding scientists to its program.

### LARS Organization

A key to the interdisciplinary research efforts at LARS is the Laboratory's organizational structure shown on the next page. The six major program areas have specific responsibilities for conducting research within their area while coordinating with and supporting each other. This design provides much greater opportunity for flexibility in programming and forming compatible teams to attack specific problems than is usually possible in the normal university organizational structure. The Program Leaders, led by the Director, Associate Director, and Deputy Director, plan and coordinate all technical activities at LARS.

Technology Transfer is responsible for developing and utilizing educational and training materials which aid the process of transferring newly developed remote sensing technology from the research to the applications arena. In addition, methods and technology which support quick and effective transfer of remote sensing analysis capability (such as remote terminal systems) are supported. Responsibilities of the group include:

- \* Developing Specialized Educational Packages such as the LARSYS Educational Package
- \* Organizing and Conducting Intensive Short Courses
- \* Supporting the Development of Remote Sensing Informational Materials
- \* Coordinating Visiting Scientist Programs at the Laboratory
- \* Developing Specialized Educational Materials on Newly Developed Remote Sensing Techniques
- \* Hosting Visitors to the Laboratory and Arranging Information Exchange Sessions.

Measurements Research Programs develop instrumentation and related facilities for the collection of reliable data for laboratory and field studies as well as airborne and spaceborne investigations. Additional investigations are conducted

to relate observable radiation characteristics of various materials to their physical and chemical properties. Supporting investigations are designed and conducted for scientists in other program areas. Aerial photography data is also acquired to support research investigations and data analysis activities for the laboratory research program. Major research areas include:

- \* Development of Laboratory and in situ Measurement Instrumentation
- \* Advancement of in situ Measurement Techniques
- \* Radiation Modeling
- \* Interpretation of Spectral Flux Measurements
- \* Aerial Photographic Techniques
- \* Biological Applications of Spectral Measurements

Data Processing and Analysis Research Programs conduct research in the development and application of computer processing techniques for remote sensor data. Activities in this program area are divided roughly into two categories: data handling research and data analysis research.

Data handling research projects include:

- \* Data Base Organization and Management
- \* Geometric Rectification
- \* Image Registration
- \* Data Enhancement

Data analysis research projects include

- \* Statistical Design and Analysis
- \* Theoretical Pattern Recognition
- \* Applied Spatial and Multispectral Pattern Recognition

Ecosystems Research Programs involve both research and applications activities directed toward the utilization of remote sensing technology for natural resource inventories. Emphasis is placed upon development of the capability to identify, map, tabulate, and characterize selected land uses, forest resources, and water resources of importance to various user groups. Much of the research is directed at the testing and refinement of various computer-aided analysis techniques. The interpretation of data derived from supplemental sources such as color infrared photography is stressed, in order to better understand the scene characteristics and to define more effective man-machine interactions in analyzing multispectral scanner data.

Research is also focused on the analysis of spectral reflectance and emittance data obtained in the field, in order to better understand the energy-matter interactions taking place and to allow for more effective interpretation and analysis of remote sensor data. Major areas of activity therefore include:

- \* Land Use Mapping
- \* Forest Resource Inventories
- \* Rangeland Inventories
- \* Water Quality Studies
- \* Snow Cover Mapping
- \* Spectral Data Analysis

Earth Sciences Research Programs study the multispectral radiation properties of soils and geologic materials, and define and quantify relationships between multispectral radiation and the chemical-physical properties of earth surface features. The long range objective of this research is to develop techniques which will make possible the use of

computer-assisted analysis of multispectral scanner data to identify, characterize and map important soils and geologic features.

- \* Mineral Resource Investigations
- \* Land Form Studies
- \* Geologic Applications
- \* Agricultural Soils Studies
- \* Engineering Soils Studies
- \* Land Resources Inventories
- \* Land Use Analyses
- \* International Test Sites

Crop Inventory Systems Research Programs conduct research on the development and application of remote sensing technology for obtaining crop production information. Research currently is being performed on crop identification and area estimation by machine processing of LANDSAT data. The potential use of remotely sensed temporal-spectral measurements to assess crop condition and predict crop yield is also being explored. LARS' Crop Inventory Program, Measurements Program and Computer Facility, in cooperation with NASA and USDA, are acquiring and processing fully annotated and calibrated sets of spectral measurements augmented with agronomic and meteorological data. This data base is available for use in quantitatively determining temporal-spectral characteristics of crops, defining future sensor systems, and developing advanced data processing and analysis techniques.

- \* Crop Acreage Estimation
- \* Crop Yield Prediction
- \* Crop Condition Assesment

Following are brief resumes of the senior staff members at LARS.



## DAVID A. LANDGREBE

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Director of LARS and Professor  
of Electrical Engineering

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B.S., M.S., and Ph.D. Electrical Engineering, Purdue University. He has held positions at Bell Telephone Laboratories, Interstate Electronics Corporation and Douglas Aircraft Company. He is engaged in research in data representation and analysis and teaches advanced courses in Electrical Engineering. He has been active in the field of remote sensing since 1965. Dr. Landgrebe served on the 1967-1968 National Academy of Sciences Space Applications Study, and the Academy's Committee on Remote Sensing Programs for the Earth Resources Survey (CORSPERS).

In 1975 he served as Chairman of the NASA Working Group to define the system parameters for Thematic Mapper, a satellite multispectral scanner for the 1980's.

In 1973 he was awarded NASA's Exceptional Scientific Achievement Medal for "his outstanding contributions to the space program." He is a member of Tau Beta Pi, Eta Kappa Nu, Sigma Xi honoraries, the American Association for the Advancement of Science and the American Society for Engineering Education and a fellow of the Institute of Electrical and Electronic Engineers. He is also a member of the Editorial Board and Associate Editor of the journal, Remote Sensing of Environment.

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As Director of LARS, Dr. Landgrebe is responsible for the overall management of the Laboratory and its relations with all academic units. He is the Principal Investigator of several of the Laboratory's grants and contracts. His research activities are with regard to use of spatial information in image data analysis and the relation of sensor system parameters to the information extractive (data analysis) process.

## JOHN B. PETERSON



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Associate Director for  
Administration of LARS

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B.S., Oregon State University, M.S. and Ph.D., Soil Science, Iowa State University; National Research Foundation post-doctoral fellowship in geology at the University of California, Berkeley. He received the American Society of Agronomy's Soil Science research award in 1948 and was president of that society in 1958. From 1948 to 1971, Dr. Peterson was Head of the Purdue University Agronomy Department, directing plant and soil science, meteorology and land use. He has served as a consultant on administrative problems in research and education for the FAO, the Rockefeller Foundation, the Ford Foundation and the InterAmerican Development Bank in Latin America, for the Greek Government and for the United States/Saudi Arabian Joint Commission for Economic Cooperation in Saudi Arabia. He is a member

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of the Soil Science Society of America, American Society of Agronomy, Western Society of Soil Science, the Soil Conservation Society of America and Sigma Xi.

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Dr. Peterson assists the Director in the management of LARS, particularly in the supporting services and applications areas. He also conducts research in the use of remote sensing in studying problems of soil mapping and land use.



## TERRY L. PHILLIPS

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Deputy Director of LARS

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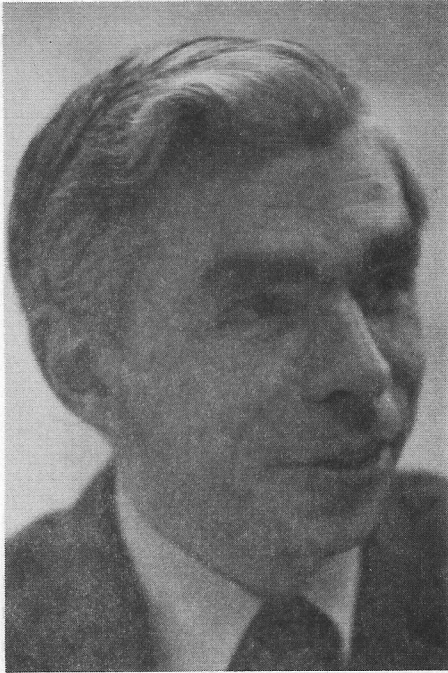
B.S., M.S., Electrical Engineering, Purdue University. He has held positions at Purdue University in the Electrical Engineering Department, National Cash Register Company and the U.S. Navy. He has been a consultant to the Computer Science Corporation, U.S. Geological Survey, Iowa Geological Survey and the Colorado Intergovernmental ADP Council. He is engaged in the development of data handling and processing systems. He has been active in the applications of these systems for Remote Sensing since 1966. In 1976 he was recognized by NASA for the creative development of technology. He is a Senior Member of the Institute of Electrical and Electronics Engineers, and a member of the Association for Computing Machinery, Tau Beta Pi and Eta Kappa Nu societies.

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### EARTH RESOURCES DATA PROCESSING SYSTEM

Mr. Phillips' major contribution at LARS has been toward the development of the Earth Resources Data Processing System which serves Purdue as well as a number of remote terminal sites. Mr. Phillips designed the hardware, software, and data bank concepts for this system. His leadership is responsible for the LARSYS software documentation which has received world-wide recognition from the remote sensing community. As Deputy Director of LARS, Mr. Phillips is responsible for technical and administrative direction for the Laboratory. He is principal investigator of several of the Laboratory's contracts and contributes to many others primarily in the area of system design.





## JOHN C. LINDENLAUB

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Program Leader for Technology Transfer  
at LARS and Professor of Electrical  
Engineering

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Dr. Lindenlaub joined the LARS staff in 1969. Prior to that time, his research interests were in the area of statistical communication theory. Dr. Lindenlaub worked in the data handling and analysis area at LARS until June 1974 when the Technology Transfer program area was formed. He is active professionally having held offices in the Education Research and Methods Division of the American Society of Engineering Education and the Education Group of the Institute of Electrical and Electronics Engineers.

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### TECHNOLOGY TRANSFER

The Technology Transfer program area at LARS has general responsibility for the development of education and training materials and conducting training programs to further remote sensing research and aid in the transfer of the technology from the research arena to the applications arena. Materials development programs include development of the Focus Series, minicourses on the fundamentals of remote sensing, specialized educational packages, such as the LARSYS Educational Package, and case studies. Operational programs include intensive short courses, symposia and the Visiting Scientist program.

Luis A. Bartolucci

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Technical Director for  
Training Programs at LARS

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B.S., M.S., and Ph.D. in Geophysics from Purdue University. Dr. Bartolucci has been involved in Remote Sensing research since 1969. He has played an active role in the development of remote sensing technology for applications in the area of water resources and has also made outstanding contributions in the field of thermal infrared radiation for remote sensing applications. In addition, Dr. Bartolucci has served as consultant to the U.S. Information Agency, the U.S. Agency for International Development, the Interamerican Development Bank and to several Latin American development agencies. He has been Principal Investigator and Project Director of several domestic and international research and training programs involving computer-aided processing and analysis of remotely sensed data for earth resources inventories.

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Dr. Bartolucci is responsible for the LARS educational and training programs. His primary research activities involve the application of remote sensing techniques for water quality assessment and snowcover mapping, spectral signature mixing problems, topographic influence on the spectral response of ground cover types, and the design of integrated information systems for developing countries.



## LEROY F. SILVA

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Program Leader for Measurements  
Research at LARS and Professor of  
Electrical Engineering

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B.S.E.E., Purdue University; M.S.E.E., Massachusetts Institute of Technology; Ph.D., Purdue University. He has been employed by Lincoln Laboratories; Ballistic Research Lab, Aberdeen Proving Ground, Maryland; and C P Electronics, Inc., Columbus, Indiana. He has also been a consultant in electronics and magnetics to several companies. Dr. Silva has been associated with LARS since 1969, and has published in the areas of electronics, magnetics, optics, bioengineering and remote sensing. He is a member of Eta Kappa Nu and Sigma Xi honoraries, and of the Institute of Electrical and Electronic Engineers (Senior Member) and the National Society of Professional Engineers and the American Association for the Advancement of Science. He is a Registered Professional Engineer, State of Indiana.

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### MEASUREMENTS RESEARCH IN REMOTE SENSING

Measurements research is concerned with the physics and optics of natural materials and their effects on the spectral, spatial and temporal variability of remotely sensed data, as well as with the details of remotely sensed data acquisition. LARS has developed sophisticated field and laboratory instrumentation systems for remote sensing research and has helped broaden the fundamental understanding of the spectral properties of natural materials. Dr. Silva has been involved in both the theoretical and laboratory/field aspects of this research.



## BARRETT F. ROBINSON

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Associate Program Leader of  
Measurements Program Area

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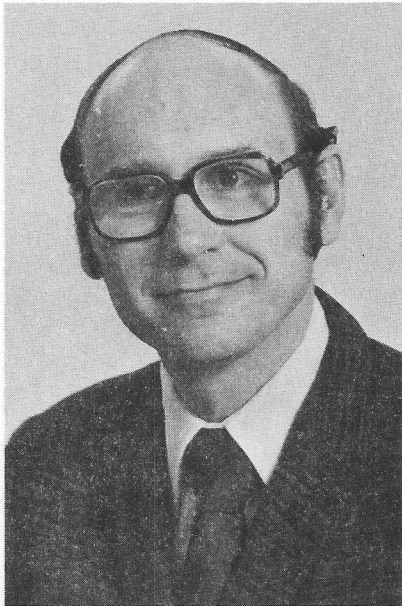
B.S. in Electrical Engineering and M.S. in Mathematics from Purdue University. He is a senior research engineer in the School of Electrical Engineering at Purdue where he serves as coordinator of the undergraduate laboratory program and teaches electronics and systems laboratory courses. His university experience includes an NSF Fellowship and three years as a graduate research assistant in electrical engineering at Purdue. He is a member of the Institute of Electrical and Electronics Engineers and serves as a consultant in electronics and electro-optics.

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### A FAST SCAN WIDE RANGE FIELD SPECTRORADIOMETER

Mr. Robinson participated in the design and directed the implementation of a field spectroradiometer system featuring the ability to produce and process calibrated digital data obtained from subjects insitu in agricultural fields, thus achieving the long time goal of LARS researchers. His other activities include the development of instruments for radiometric field calibration and directing the acquisition of radiometric ground truth data for LARS projects and experiments. He served as aircraft coordinator for the Skylab Wabash River Basin Test Site during 1974. He has had a key role in the LACIE Field Measurements Project in defining and directing the spectral data acquisition by Purdue and NASA/JSC.

## PHILIP H. SWAIN



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Program Leader for Data Processing and  
Analysis Research at LARS; Assistant  
Professor of Electrical Engineering

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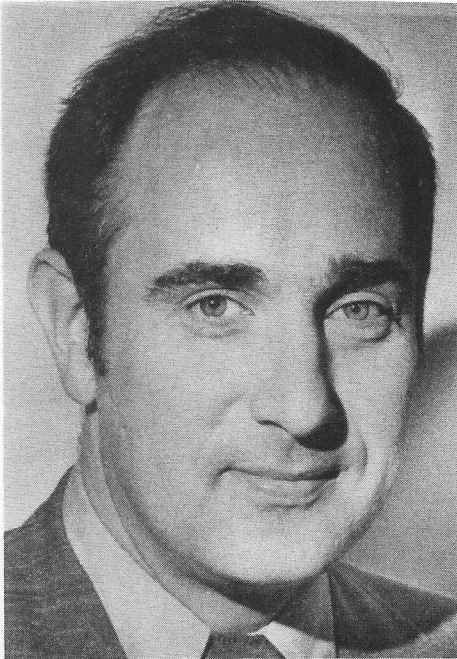
Philip H. Swain (B.S.E.E., Lehigh University, 1963; M.S.E.E., Purdue University, 1964; Ph.D., Purdue University, 1970) is Assistant Professor of Electrical Engineering at Purdue University and Program Leader for Data Processing and Analysis Research at Purdue's Laboratory for Applications of Remote Sensing (LARS). He has been employed by Philco-Ford Corporation and Burroughs Corporation and served as a data processing consultant to Allison Division of General Motors, Bendix Corporation, Midwest Applied Sciences, the National Aeronautics and Space Administration (NASA), and the Universities Space Research Association.

Dr. Swain has been associated with LARS since 1966. His research interests are in the areas of pattern recognition theory and applications as well as the application of advanced computer processing techniques to multispectral remote sensing data. He is a member of Phi Beta Kappa, Tau Beta Pi, Sigma Xi and Eta Kappa Nu honoraries, the Institute for Electrical and Electronics Engineers, and the Pattern Recognition Society.

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### PATTERN RECOGNITION AS A BASIS FOR REMOTE SENSING DATA ANALYSIS

Pattern recognition is well suited for processing large quantities of data with minimal human involvement, which makes it an ideal approach to the analysis of multispectral remote sensing data. Since its inception, LARS has developed its computer-based data analysis system, LARSYS, with pattern recognition techniques as the central focus. Over the years, Dr. Swain has made significant contributions to both the theory and practical application of pattern recognition and has played a major role in the evolution of LARSYS.



## PAUL E. ANUTA

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Associate Program Leader for  
Data Handling Research

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B.S., Electrical Engineering, Purdue University; M.S.E.E., University of Connecticut; M.S., Computer Science, Purdue University. As an employee of the IBM Federal Systems Division he investigated hybrid computer applications and conducted guidance and control systems analysis and software design activities for missile and spacecraft computers. Mr. Anuta joined the LARS staff in 1967, and has designed data handling systems for a multispectral aircraft scanner system, interferometer spectrometer and other sensors. He is a member of the Institute of Electrical and Electronic Engineers, American Society of Photogrammetry, and of Tau Beta Pi and Eta Kappa Nu honoraries.

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### DATA PREPROCESSING

Mr. Anuta is responsible for research and evaluation of remote sensor data preprocessing techniques. Current key data handling research areas are image registration, geometric correction and resolution enhancement of satellite multispectral imagery. The goal of data handling research is to improve the form of the remote sensor data so as to enhance its utility for analysis and information extraction.



## ROGER M. HOFFER

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Program Leader of the Ecosystems Research Programs, LARS, and Professor of Forestry, Department of Forestry and Natural Resources, Purdue University

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B.S. in Forestry from Michigan State University, M.S. and Ph.D. in Watershed Management from Colorado State University. Dr. Hoffer has been involved full-time in remote sensing research and teaching since 1964, and was a co-founder of LARS in 1966. He has served as a principal investigator on Landsat, SKYLAB, and several other remote sensing projects. At present, he teaches three different courses on Remote Sensing of Natural Resources.

Over 80 scientific publications and papers on remote sensing have been authored or co-authored by Professor Hoffer, including invitational papers at international meetings in Austria, Brazil, Canada, Columbia, Japan, Norway, and the U.S. He has also spent several weeks as a remote sensing specialist in Brazil, Thailand, Afganistan, and Bolivia, in addition to talks and lectures on remote sensing in many other countries throughout South America, Southeast Asia, and Europe. He is a member of the Society of American Foresters, American Society of Photogrammetry (where he has served as the Associate Editor of "Photogrammetric Engineering and Remote Sensing" and as Director of the Remote Sensing and Interpretation Division), Sigma XI, XI Sigma Pi, and several other professional and honorary societies. He is a member of the National Eagle Scout Association, is listed in American Men and Women in Science, and is a certified Photogrammetrist.

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### SPECTRAL ANALYSIS AND MAPPING NATURAL RESOURCES

The focal point of Dr. Hoffer's research activities involves the interpretation and analysis of multispectral scanner data and color infrared photography, with particular emphasis on study of the spectral characteristics of various earth surface features. He has been instrumental in the development and use of computer-aided analysis techniques using multispectral scanner data, particularly for forestry, water resources, and land use applications. He believes that proper understanding and interpretation of the spectral characteristics of the various earth surface features is essential for effective analysis of remotely sensing data (in other words, "think spectral!").



## RICHARD P. MROCZYNSKI

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Associate Program Leader for  
Ecosystem Research Program

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B.S.F. in Forest Production and M.S., Forestry, University of Illinois. He joined LARS in 1969 and has been involved with photo-interpretation and LANDSAT Analysis. He is a member of the Society of American Foresters, active in that organization's Working Group on Photogrammetry and Remote Sensing. In addition, he has served in various capacities with the American Society of Photogrammetry, and is a member of the American Forestry Association and American Management Association.

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### REMOTE SENSING AND NATURAL RESOURCES

Mr. Mroczynski is currently involved with projects dealing with the application of computer-assisted analysis techniques to resource inventory. His special interest is in identifying techniques to improve the flow of forest inventory information.



## MARION F. BAUMGARDNER

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Professor of Agronomy and Program Leader  
Earth Sciences Research Programs  
Laboratory for Applications of Remote Sensing

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B.S., Texas Tech University; M.S., Ph.D., Purdue University. After two years (1964-66) in Argentina with the Ford Foundation, Prof. Baumgardner joined the Laboratory for Applications of Remote Sensing. The author of numerous scientific papers, he serves frequently as a consultant to several international development agencies with assignments in Africa, Asia, Latin America, and Europe. He is a Danforth Associate and a Fellow of the American Society of Agronomy and Indiana Academy of Sciences. Having traveled and lectured in more than 50 countries, Professor Baumgardner is active in a dozen national and international scientific societies. As a participant in the 1974 Summer Study of the National Academy of Engineering's Space Applications Board, he helped to define applications of space technology for the 1980's and 1990's. During his 1974-75 sabbatical year in Europe he was a visiting scientist and guest lecturer in many countries. He served on the National Academy of Sciences' Committee on Remote Sensing for International Development, is currently Chairman of the Agricultural Research Institute's Study Panel on Remote Sensing, and serves on the executive committee of the Working Group on Remote Sensing and Soil Survey of the International Soil Science Society, the Working Group on Remote Sensing in Ecological Botany of the International Union of Biological Sciences and the Committee on Desertification of the American Association for the Advancement of Science.

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### A GLOBAL INFORMATION SYSTEM FOR MAPPING AND MONITORING EARTH RESOURCES

Professor Baumgardner's primary research interest lies in the relationships between the spectral characteristics and the physical/chemical properties of soils. In the practical applications of these relationships he is investigating the use of computer-implemented analysis of multispectral data to discover more rapid and better methods for assessing soil productivity and land use capabilities and for preparing soil surveys and land use inventories. He is greatly interested in and encouraged by the potential applications of a global information system in the developing nations for providing heretofore unavailable inventories of land, vegetation, water, and mineral resources. Since 1974 Prof. Baumgardner has been particularly active in using digital analysis of Landsat multispectral scanner data to map and monitor natural resources in arid and semiarid lands.



## RICHARD A. WEISMILLER

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Associated Program Leader for  
Earth Sciences Research Program

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B.S., Agronomy, with Highest Distinction, Purdue University; M.S., Soil Mineralogy, Purdue University; Ph.D., Soil Chemistry-Clay Mineralogy, Michigan State University. He joined LARS in 1973 after four years as a Captain in the USAF, serving as a research scientist, Civil Engineering Research Division, Air Force Weapons Laboratory, Kirtland AFB, New Mexico. During August 1974-July 1975 Dr. Weismiller served as Acting Program Leader for Earth Sciences Research. He is a member of Phi Eta Sigma, Alpha Zeta, and Sigma Xi honoraries, the Soil Science Society of America, the American Society of Agronomy, the Clay Minerals Society, and the Soil Conservation Society of America. He is also listed in American Men and Women in Science. His publications are in the areas of remote sensing as related to soils and land use and infrared spectroscopy studies of clay minerals.

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### APPLICATIONS OF REMOTE SENSING TO SOILS AND LAND USE STUDIES

Among Dr. Weismiller's primary research interests are the relation of the spectral reflectance of soils to their physical and chemical properties and the application of remote sensing technology to soils mapping, land use inventories and change detection as related to land use. He is currently the principal investigator of a grant to cooperate with governmental agencies within the State of Indiana in the application of remote sensing technology to the solution of problems in resource management. Also Dr. Weismiller managed the Great Lakes Project which entailed computer-aided analysis of Landsat-1 multispectral data to prepare a current land use inventory of the 34,500,000 hectares within the U.S. portion of the Great Lakes watershed.



## MARVIN E. BAUER

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Program Leader of Crop Inventory  
Systems Research

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With B.S.A. and M.S. degrees from Purdue University in Agricultural Economics and Agronomy and a Ph.D. from the University of Illinois in Crop Physiology, Dr. Bauer joined the LARS staff in 1970. He is a member of the American Society of Agronomy, Crop Science Society of America, and American Society of Photogrammetry and is the author of 15 publications on the application of remote sensing technology to crop inventory.

He has had key roles in the design, implementation, and analysis of results of several major remote sensing projects including the 1971 Corn Blight Watch Experiment and Crop Identification Technology Assessment for Remote Sensing project. He has been the principal investigator of a recently completed LANDSAT investigation for crop identification and area surveys. Currently, he is the technical leader of the field measurements research being conducted in support of the Large Area Crop Inventory Experiment being conducted by NASA, USDA, and NOAA.

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### CROP PRODUCTION INVENTORIES

At LARS, research projects are being conducted on the application of remote sensing to crop production surveys. These efforts include development and testing of computer-aided techniques for training, classification, and sampling LANDSAT multispectral scanner data for crop area estimation. Using measurements from high resolution spectrometers, the relationship of crop, soil, and meteorological variables to the spectral reflectance-emittance of crops is being studied.