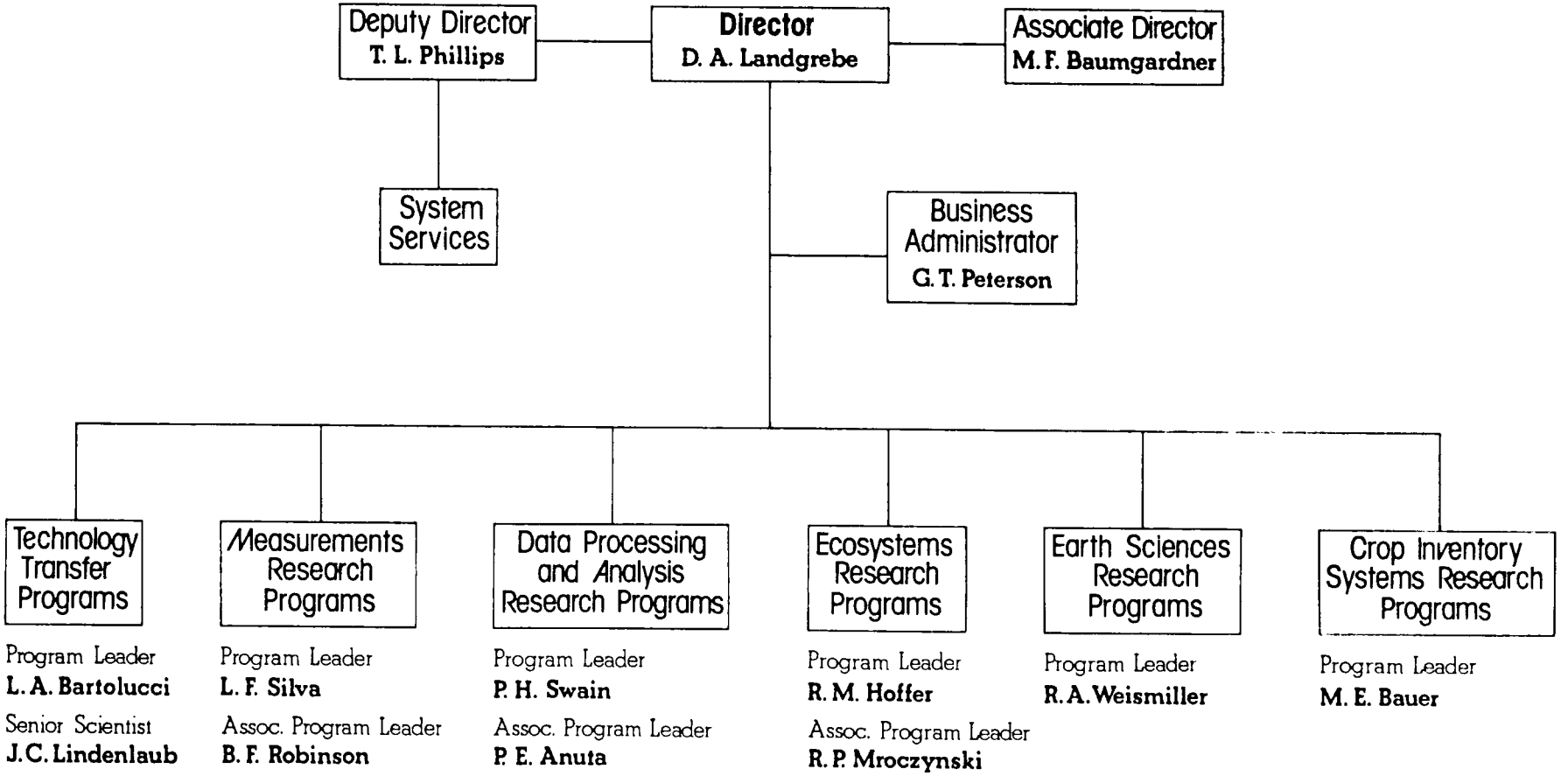
LARS Publication 070780

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 and using earth resources data. An interdisciplinary staff from various departments within the schools of agriculture, engineering, and science compose the LARS team. Over the Laboratory's fourteen year history, this 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: expanding understanding of the earth surface features and their spectral properties; designing suitable instruments and measurement techniques; developing quantitative remote sensing data 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.

To support this research effort the Laboratory operates a computational facility centered around an IBM 3031 computer with 2 megabytes of memory. The system uses the VM370 operating system and extensive amounts of special purpose software to support research and analysis of multispectral image data. The system has 10 tape units, 2000 megabytes of disc memory and associated printers and card reader/punches. Communication equipment with the system provides for 58 addressable ports to terminals elsewhere in the laboratory and around the east, south, and midwest of the U. S.

One of these terminals contained within the Laboratory consists of a PDP 11/34A minicomputer with 128k bytes of main memory. This minicomputer system has 140 megabytes of disk memory, a Varian 4211 electrostatic printer plotter, a Talos 44 x 60 inch table digitizer, a Tektronix 4054 graphics display system, and a Comtal Vision One/20 19 inch color display system with track ball cursor control. These systems are available to researchers on a 24 hour per day basis. Several thousand frames of Landsat and other multispectral data are also available for research use.

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 research specific problems than is usually possible in the normal university organizational structure. The Program Leaders, led by the Directors, plan and coordinate all technical activities at LARS.

Technology Transfer programs have an overall aim of transferring remote sensing technology from the research laboratory to the technology's potential users. Emphasis is placed on conveying an understanding of both the principles and fundamental concepts supporting the technology and the methodologies developed for using it. Educational and training programs have been developed to achieve these aims, and educational materials have been created in their support. Many of these materials are used in other remote sensing educational programs in this country and abroad.

Work carried out by this program area has contributed significantly to the broader understanding of remote sensing technology. Some of the most significant contributions include:

* Development of a one-week short course on Remote Sensing Technology and Applications offered monthly. Since 1972, more than 500 people representing over 200 organizations have attended.

* Development of a one-week short course on Advanced Topics in the Analysis of Remote Sensing data; offered annually in recent years.

* Expansion of short-course offerings through spceial-interest courses given in the locations where course participants can most easily assemble.

* Development of 25 multi-media, self-instructional educational modules on the Fundamentals of Remote Sensing, two of these cooperatively with another organization. Since the modules first became available in 1976, over 2500 individual modules have been sold worldwide.

* Development of a Visiting Scientist Program serving individuals or groups of scientists who visit LARS for extended periods of time to learn and evaluate digital analysis. Since 1973, over 85 visiting scientists from 28 countries have benefited from this program.

* Evolution, maintenance, and educational support of a remote terminal system that allows subscribers direct access to LARS' Earth Resources Data Processing System and data library. More than 1000 individuals have received training and applications experience through this system.

* Development of printed educational materials ranging from single-concept introductory brochures, through simulations, case study exercises, and a textbook published by McGraw-Hill in 1978.

Current program interests include:

* Extending analysis capabilities to additional users at costs and levels commensurate with their needs and resources.

* Research in the processes and effects of technology transfer concentrating on how to best achieve educational goals and on the social, political and economic implications inherent in the technology transfer process.

* Increased refinement and extension of existing educational programs to reach more potential users more effectively.

* Extending the effectiveness of the educational materials through evaluation of their current usefulness and addition to the existing body of materials as needs become evident.

* Expand the international technical assistance and the remote sensing institution building programs in developing countries.

The mission of Measurements Research is to investigate the relationship of the measureable radiation characteristics of crops, soils, and other earth surface features to their biological, physical and chemical properties and to interpret and organize data for remote sensing research.

The major accomplishments of Purdue's measurements research activities have been:

* The development and implementation of a high resolution spectral data acquisition system (.4 - 14 μm) for field research in remote sensing. This system has gathered high quality data for ten years of successful field research (1970 - present).

* The technical direction of the spectral data acquisition activities of the NASA Large Area Crop Inventory Experiment (LACIE). This responsibility included coordinating the acquisition of calibrated spectral data for spectrometers mounted on trucks and helicopters, and for airborne multispectral scanner data. The experiment was conducted from 1974 to 1978 at sites in Kansas, North Dakota and South Dakota which typified the wheat producing areas of the Great Plains of the United States.

* The development of a data access facility which enables researchers to analyze the relationships between the spectral characteristics of thousands of high-resolution spectra and extensive concurrent agronomic data gathered during the LACIE Field Measurements Project. The data analysis software designed for this data bank enables researchers to obtain and analyze data and present results with significant efficiency. This analysis capability and the organized storage of calibrated and registered data with accurate descriptive agronomic characterization is a major milestone in field research for remote sensing.

* The development of a multiband spectral data acquisition system. This system, to be available at moderate cost to the remote sensing community from commercial manufacturers, enables researchers to acquire spectral data under field conditions that are easily comparable to those acquired by others with a similar system.

* The development of soil moisture mensuration principles utilizing both optical and microwave data. Techniques have been developed that correlate reflectance changes in optical bands with soil moisture levels. Additionally an instrumentation principle has been developed that uses an in situ UHF system to measure available soil moisture as a function of depth below the soil surface.

Major areas of interest for measurements research activity include:

* Acquiring spectral and ancillary data in support of programs of remote sensing research.

* Conducting research on sensory related problems and assessing their impact on data quality and multispectral data processing.

* Conducting research on improved methods of data acquisition including data verification, data calibration, data correlation, and development of new and improved instrumentation.

* Conducting research on the application of remote sensing technology to situations outside the earth resources arena, such as biomedical applications.

* Conducting research on the basic characteristics of remotely sensed data and developing analytical procedures for data from new sources.

Data Processing and Analysis Research programs focus on research in the development and application of computer processing techniques for remote sensing data. Of interest are preprocessing methods which improve the radiometric and geometric quality of the data; analytical processes which extract information from the raw or preprocessed data; and methods for storage and retrieval of both data and analysis results to facilitate their effective utilization.

Data processing research conducted at LARS has produced significant advancements of the quantitative remote sensing technology. Some of these include:

* Application of pattern recognition and related techniques for the analysis of multispectral data.

* Evolution of the LARSYS software system for effectively interfacing the user with the remote sensing data and computer-implemented analysis tools.

* Development of techniques for precision geometric correction and registration of multisensor and multitemporal data.

* Development of multiclass feature selection techniques for determining most effective subsets of available scene measurements.

* Modeling of sensor system response characteristics and use of these models for resolution enhancement.

* Application of clustering methods for unsupervised classification.

* Development of a system for scene segmentation and maximum likelihood "object" classification.

* Application of sampling techniques in remote sensing to produce precise and unbiased estimates of areal coverage by crop types.

Current research interests of this program area include:

* Scene and sensor modeling for system performance prediction and design.

* Data base design for the digitization, integration, storage and retrieval of multitype remote sensing and ancillary data.

* Image processing techniques for data compression and image enhancement.

* Advanced pattern classification/recognition methods for extraction of spectral, spatial and temporal information from remote sensing data.

* Development of special system configurations and architectures for increasing the effectiveness and efficiency of both interactive and automated image processing techniques.

Ecosystems Research programs involve both research and application activities directed toward the utilization of remote sensing technology for natural resource inventories. Emphasis is placed upon development of capabilities to identify, map, tabulate, and characterize selected land use (non-urban), forest, wild land, and water resource information. Much research is directed at testing and refining various computer-aided analysis techniques. The interpretation of data derived supplemental sources, such as color infrared photography or measurements obtained in the field, is stressed in order to better understand the scene characteristics and to define more effective man-machine interactions for analysis of remotely sensed data.

Major accomplishments of the ecosystems research group include:

* Demonstration of the utility of machine implemented analysis of satellite data for forest and wild land resource inventories.

* Development of the capability to produce traditional line maps (as opposed to pictures or type maps) for representing results of digital classifications.

* Development of a means for a statistical evaluation of classification accuracy in wild lands analyses.

* Augmentation of digital data with slope, aspect and elevation information for machine analysis of forest, snow cover, and wild land resources.

* Development of a three dimensional thermal mixing model for water which may be used in conjunction with remotely sensed data.

* Development of a topographic model incorporating slope, aspect, elevation and satellite data for forestry inventory research.

* Multitemporal classification and change detection techniques applied to satellite data for forestry, wild land, snow cover and water resource analysis problems.

Ecosystems research interests continue to center on the use of remote sensing technology to aid in the identification and management of natural resources:

* Development of new and improved methods for incorporating ancillary information such as slope, aspect, elevation, water shed, etc., into the decision criteria for analyzing forest, wild land, and water resources.

* Identifying and demonstrating the usefulness of remote sensing technology for monitoring certain ecological habitats and their conditions.

* Improving the ability of natural resource managers to use the results of remote sensing technology by developing means to present those results in a traditional, already understood manner and by integrating the technology into already existing information systems.

* Applying the technology to various natural resource problems under varying conditions to demonstrate its usefulness to specific natural resource problems.

* To help resource managers learn and evaluate the benefits of remote sensing technology.

Earth Sciences Research programs include studies of the multispectral characteristics of soils and geologic features and the application of spectral information in surveying earth resources and in monitoring sequential changes in the quantity and quality of these resources. The long range objective is to develop techniques in which digital analysis of multispectral data may be used as a basic tool for soil survey, identification and assessment of soil degradation, land use capability mapping, potential soil productivity mapping, mineral resources investigations, geologic mapping, and land cover mapping.

Accomplishments in the earth sciences research programs include:

* Spectral delineation of soil boundaries from aircraft scanner data.

* Demonstration of relationship between quantitative reflectance measurements and the organic matter content of surface soils.

* Initial field measurement of spectral properties of soils.

* Land use inventory of 34 million hectares in the U.S. portion of Great Lakes Watershed by digital analysis of Landsat data.

* General soils map of White County, Indiana produced by visual analysis of Landsat simulated infrared color composite.

* Established middle infrared as superior to other reflective wavelengths for delineating soil differences.

* Successful geologic mapping at scales of 1:250,000 to 1:100,000 of the Bagdad and Zagros Mountain regions in Iraq and the Desaguadero Area in Bolivia using digital analysis of Landsat Data.

* First use of multisource data, Landsat spectral measurement and geophysical data to enhance anomolies associated with mineralization.

* First use of ancillary data with Landsat data for stratification and delineation of soil differences.

* First county survey (Jasper County, Indiana) of detailed soil differences (1:15,840) using digital analysis of Landsat MSS data.

Current areas of interest include:

* Implementing the use of spectral delineation of soil differences in operational soil surveys.

* Establishing the relationships between spectral map units and soil/plant community differences.

* Determination of the spectral and physical/chemical properties of soil.

* Use of multitemporal Landsat analysis to monitor land degradation (desertification, salinization, water erosion, laterization, accelerated leaching, etc.).

* Use of multidata sources to study geologic mineralization.

* Development of innovative methods of using Landsat multispectral scanner and appropriate ancillary data to create land cover maps.

The overall objective of the Crop Inventory Research at Purdue/LARS is to research, develop and test procedures for obtaining crop production information using remotely sensed spectral measurements, together with meteorological, soils, and ancillary data. The specific objectives are to:

* Determine relation of fundamental crop parameters (maturity stage, leaf area, biomass, moisture status, stress effects, canopy geometry, and grain yield) to reflectance and radiant temperatures of crops.

* Understand and quantify the effect of cultural and environmental factors on the spectral-temporal characteristics of crops.

* Develop methods to assess crop condition and predict crop yield using spectral, meteorological, soils, and ancillary data.

* Develop and test procedures, including sampling, stratification, training, and classification, for using satellite data to estimate the area of crops.

Significant research accomplishments during the past decade at LARS which have contributed to the capability to inventory crop production using remotely sensed data include:

* Apollo IX Experiment: Feasibility of crop identification from space data was demonstrated.

* Corn Blight Watch Experiment: A prototype crop information system based on remote sensing was developed and an integrated test of all system components was performed. A capability to accurately identify crops and several degrees of disease infestation from multispectral measurements was demonstrated.

* Landsat Investigations: Development of methodology, including sampling, stratification, and training procedures, for using Landsat MSS data to make accurate and precise crop area estimates.

* LACIE Field Measurements: A comprehensive set of multidate, multisensor spectral, agronomic, and meteorological data was acquired and processed.

* Crop Spectra Analysis: Relationships of key agronomic variables, including growth stage, leaf area index, biomass, and plant water, to the reflectance of wheat canopies was modeled. Effects of cultural and environmental factors, planting data, fertilization, and available soil moisture on the growth, yield, and reflectance of wheat canopies were quantified.

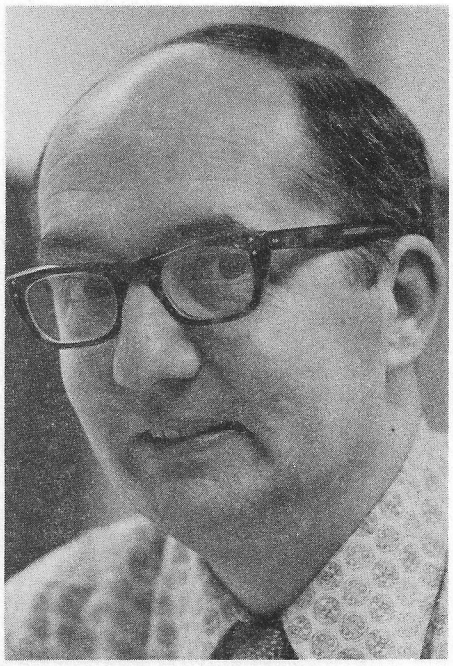
Current areas of research include:

* The crop inventory and measurements program areas, in cooperation with NASA and USDA, are acquiring and processing fully annotated and calibrated multitemporal sets of spectral measurements augmented with agronomic and meteorological data. This data base is being used to quantify and model the temporal-spectral characteristics of crops, define future sensor systems, and develop advanced data processing and analysis techniques.

* Crop development stage, condition and yield prediction models which utilize spectral measurements, together with meteorological and soils data, are being developed.

* Development of stratification and sampling, and classifier training techniques for crop production forecasts based on classifications of satellite data.

David A. Landgrebe



Director of LARS and Professor
of Electrical Engineering

Dr. Landgrebe holds the B.S.E.E., M.S.E.E., and Ph.D. from Purdue University. He has held positions at the Bell Telephone Laboratories, Interstate Electronics Corporation, and the Douglas Aircraft Company. He joined the Purdue faculty in 1962 and began teaching and research activities in the area of signal representation, systems, and data processing. He was named Program Leader for Data Processing Programs at LARS at the time of its organization in 1966. He became its Director in 1969.

Dr. Landgrebe is the author of a number of scientific publications in the field of remote sensing and data representation and analysis. In addition, he has lectured extensively on remote sensing both in the U.S. and abroad. He has participated in a number of National Academy of Sciences and NASA study groups and advisory committees. Among these were the 1967-68 NRC Study on Space Applications (Chairman, Panel D Sensors and Data Systems) and the 1973-75 NRC Committee on Remote Sensing Programs for Earth Resource Surveys (Member, Panel on Information Management). In 1975 he chaired the Landsat D Thematic Mapper Working Group which defined the system parameters for this instrument which is to be flown in 1982. He currently serves on the Committee on Data Measurement and Computation of the Academy's Space Science Board.

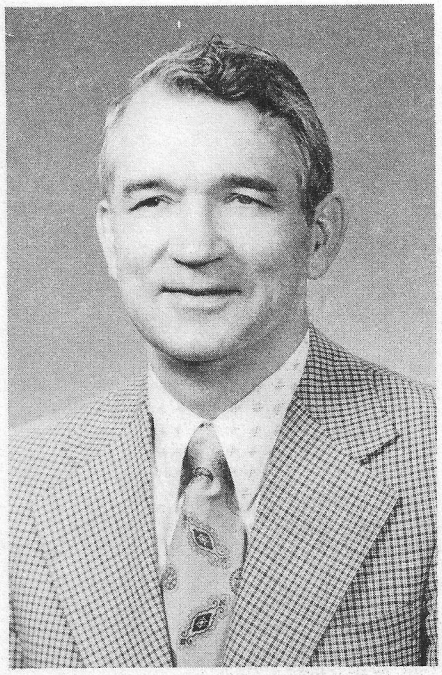
He serves as a member of the Editorial Board and as Associate Editor of the journal Remote Sensing of Environment and as a member of the Administrative Committee of the IEEE Geoscience and Remote Sensing Society; he is treasurer of the Central Indiana Section of the IEEE.

He is a Fellow of the Institute of Electrical and Electronics Engineers, a member of the American Society of Photogrammetry, the American Association for the Advancement of Science, and the American Society for Engineering Education. He also is a member of the Tau Beta Pi Association, Eta Kappa Nu, and the Society of Sigma Xi honoraries.

He holds the NASA Exceptional Scientific Achievement Medal for his work in the field of machine analysis methods for remotely sensed earth resources data.

As Director of LARS, Dr. Landgrebe has overall responsibility for the Laboratory. His research interests are with regard to the design of spectral, spatial, temporal, and ancillary features for representing information in data and in information extraction algorithms for optimal data analysis techniques.

Marion F. Baumgardner

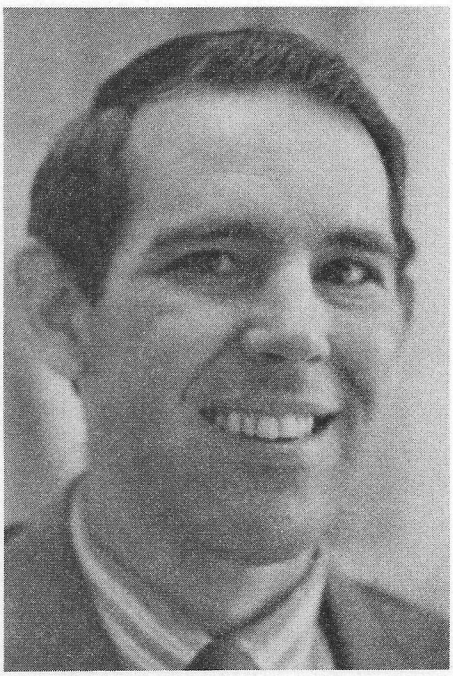


Associate Director of
Administration of LARS

B.S., Texas Tech University; M.S. and Ph.D., Purdue University; Honorary D.Sc., DePauw University. The author of numerous scientific papers, Professor Baumgardner serves frequently as 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, the Soil Science Society of America, and the Indiana Academy of Sciences. Having traveled and lectured in more than 50 countries, Dr. 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 1980s and 1990s. He served on the National Academy of Sciences' Committee on Remote Sensing for International Development, is currently chairman of the Agricultural Research Institute's National Study Panel on Remote Sensing, serves on the executive committee of the Working Group on Remote Sensing and Soil Survey of the International Soil Science Society, and is vice-chairman of the Working Group in Ecological Botany for the International Union of Biological Sciences.

Dr. Baumgardner assists the Director in the management of LARS, particularly in 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



Deputy Director of LARS

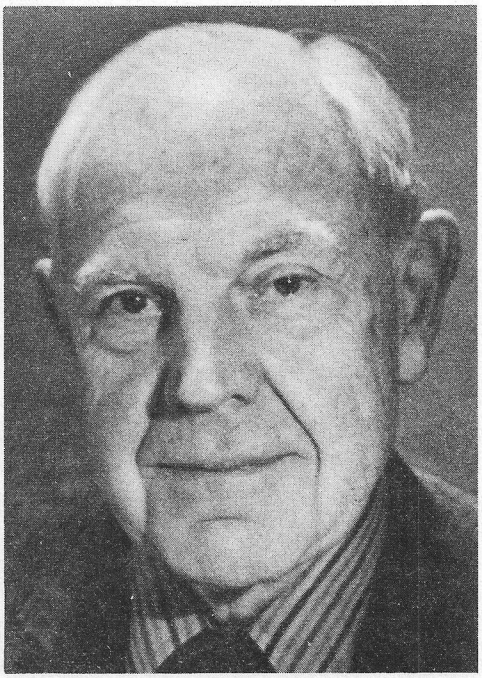
B.S., M.S., Electrical Engineering, Purdue University. He has held positions at Purdue University in the Electrical Engineering Department, National Cash Register Company, and the U.S. Navy. He has been a consultant to the Computer Science Corporation, U.S. Geological Survey, Iowa Geological Survey, the Colorado Intergovernmental ADP Council, U.S. AID, and other groups interested in remote sensing systems. 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, Data Processing Management Association, Tau Beta Pi, and Eta Kappa Nu societies.

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 worldwide 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 B. Peterson

Senior Scientist

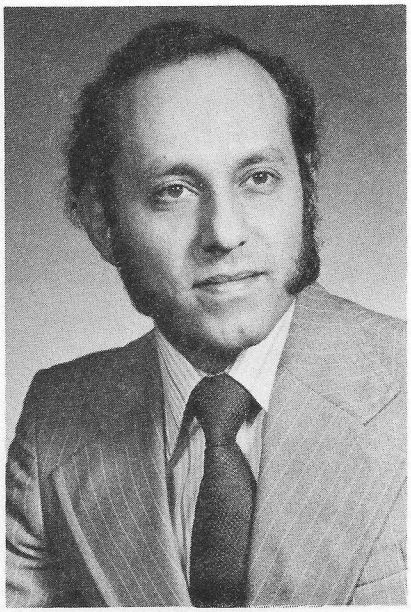


B.S., Oregon State University, M.S. and Ph.D., Soil Science, Iowa State University; National Research Foundation post-doctoral fellowship in geology at the University of California, Berkeley. He received the American Society of Agronomy's Soil Science research award in 1948 and Service Award in 1978 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. His major research interest is the estimation of the moisture tensions of soils from their spectral data. He is a member 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.

Dr. Peterson advises the Director and staff in the applications areas regarding research programs. He also conducts research in the use of remote sensing in studying problems of soil mapping and land use.

Luis A. Bartolucci

Program Leader for Technology Transfer
and Technical Director of Training



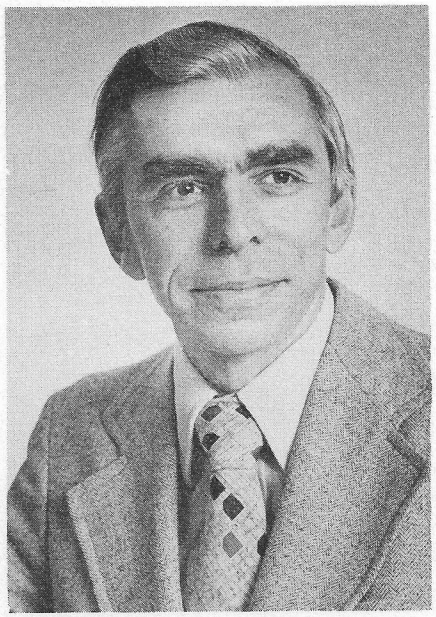
B.S., M.S., and Ph.D. in Geophysics from Purdue University. Dr. Bartolucci has been involved in Remote Sensing Research since 1969. He has played an active role in the development of remote sensing technology for applications in the area of water resources and has also made outstanding contributions 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 Inter-american 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.

TECHNOLOGY TRANSFER

The Technology Transfer program area at LARS has general responsibility for the development of education and training materials and for 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, instructional video tapes, specialized educational materials such as the LARSYS Educational Package, and case studies. Operational programs include intensive short courses, symposia and the Visiting Scientist program.

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

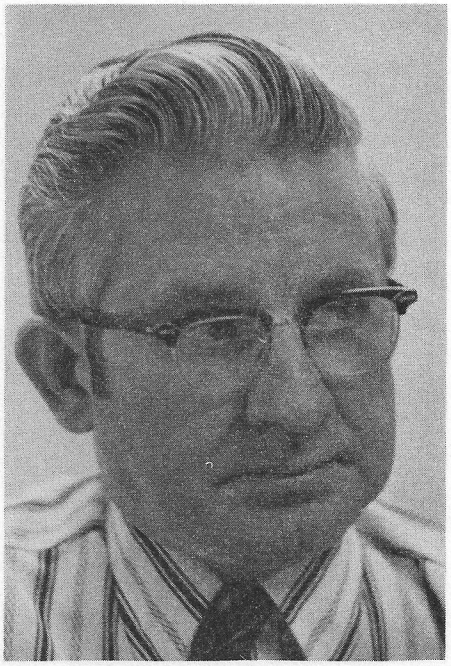
John C. Lindenlaub



Senior Scientist for Technology Transfer at LARS
and Professor of Electrical Engineering

Dr. Lindenlaub began his association with LARS in 1969. He worked in the data handling and analysis area until June 1974 when he became Program Leader of the newly formed Technology Transfer program area. In July 1977 he became Director of the Center for Instructional Development in Engineering. In this capacity he is responsible for programs and activities designed to encourage and increase instructional development activities within the Schools of Engineering. He is active in and has held national offices in the American Society of Engineering Education and the Institute of Electrical and Electronics Engineers.

Dr. Lindenlaub was instrumental in conceiving and developing education and training materials for the LARS remote terminal network, the minicourse series in the Fundamentals of Remote Sensing, the LARS monthly short course, and the Visiting Scientist program. His current educational research interests include the utilization and management of nontraditional instructional formats.



LeRoy F. Silva

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

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.

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 meterials. Dr. Silva has been involved in both the theoretical and laboratory/field aspects of this research.

Barrett F. Robinson

Associate Program Leader of
Measurements Program Area

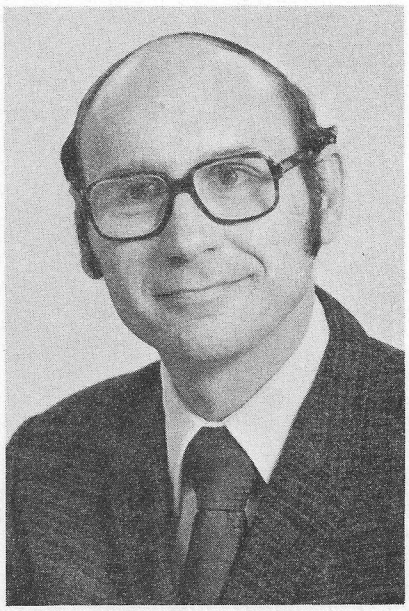
B.S. in Electrical Engineering and M.S. in Mathematics from Purdue University. He is a senior research engineer in the School of Electrical Engineering at Purdue where he serves as coordinator of the undergraduate laboratory program and teaches electronics and systems laboratory courses. His university 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.

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

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

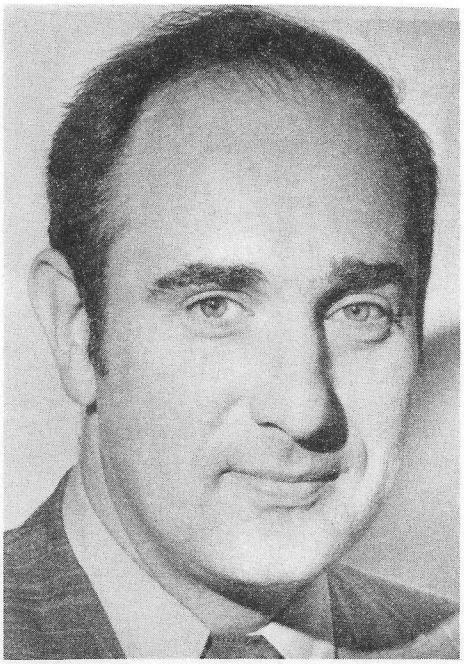


Philip H. Swain (B.S.E.E., Lehigh University, 1963; M.S.E.E., Purdue University, 1964; Ph.D., Purdue University, 1970) is Associate Professor and Program Leader for Data Processing and Analysis Research at Purdue's Laboratory for Applications of Remote Sensing (LARS). He has been employed at Philco-Ford 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 has a strong interest in the development of teaching methods for complex technologies such as remote sensing and is co-author and co-editor of the textbook Remote Sensing: The Quantitative Approach, McGraw-Hill, 1978. Dr. Swain is a member of Phi Beta Kappa, Tau Beta Pi, Sigma Xi, and Eta Kappa Nu honoraries, the Institute for Electrical and Electronics Engineers, the Pattern Recognition Society, and the American Society of Photogrammetry.

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

Associate Program Leader for
Data Handling Research

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.

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

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

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 teaches three different courses on Remote Sensing of Natural Resources and has served as a principal investigator on Landsat, Skylab, and several other major remote sensing projects.

Professor Hoffer is author or co-author of more than 120 scientific publications and papers on remote sensing. He has presented invited papers at international meetings throughout the world and spent several weeks as a remote sensing specialist in Brazil, Thailand, Afghanistan, and Bolivia. He has been a consultant to several national and international agencies and has served on numerous technical panels at the request of NASA.

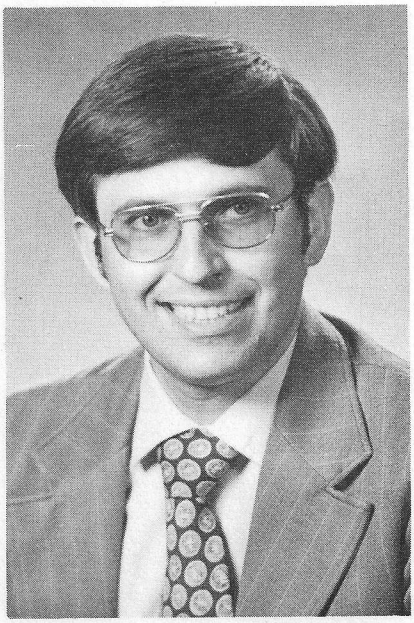
Dr. Hoffer is a member of the Society of American Foresters, American Society of Photogrammetry (where he has served as the Associate Editor of Photogrammetric Engineering and Remote Sensing and as Director of the Remote Sensing and Interpretation Division), Sigma Xi, Xi Sigma Pi, and several other professional and honorary societies. He received the 1978 Alan Gordon Memorial Award in recognition of his pioneering work in the field of remote sensing, is a Certified Photogrammetrist, and is listed in American Men and Women in Science.

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 refinement and evaluation 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 sensed data (in other words, "Think spectral!").

Richard P. Mroczynski

Associate Program Leader for
Ecosystem Research Program



B.S.F. in Forest Production and M.S. in Forestry, University of Illinois. He joined LARS in 1969 and has been involved with photo-interpretation and Landsat Analysis.

He has been principal investigator and manager of a number of projects which involved the inventory of natural resources. Significant among these have been projects with: NASA and the St. Regis Paper Company involving the development of a Forest Resource Information System; Ducks Unlimited (Canada) for a Waterfowl Habitat Inventory over 200,000 square miles in Canada; and a Derelict Land Survey for the Indiana Division of Reclamation.

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 the American Management Association.

REMOTE SENSING AND NATURAL RESOURCES

Mr. Mroczynski is currently involved with projects dealing with the application of photointerpretation and computer-assisted analysis techniques to resource inventory. His special interest is investigating how aerospace remote sensing techniques can be applied to improve the flow of information to decision makers.

Richard A. Weismiller

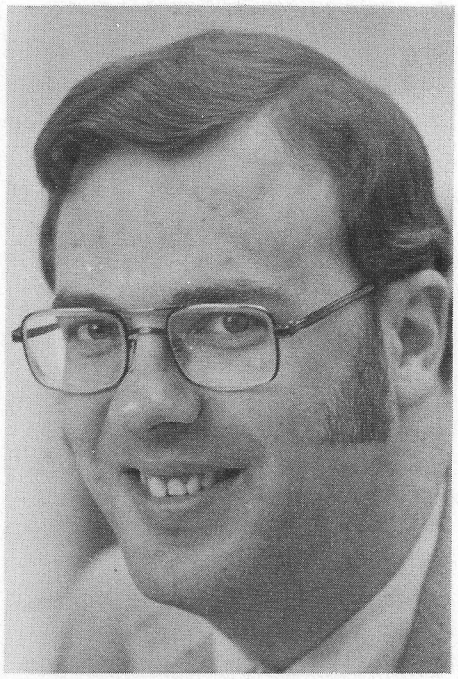
Program Leader for
Earth Sciences Research Program

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 in the USAF, serving as a research scientist, Civil Engineering Research Division, Air Force Weapons Laboratory, Kirtland AFB, New Mexico. During May 1974-July 1980 Dr. Weismiller served as Associate Program Leader for Earth Sciences Research at LARS. 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.

APPLICATIONS OF REMOTE SENSING TO SOILS AND LAND USE STUDIED

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 and inventorying and monitoring soil erosion, land use inventories and change detection as related to land use. He has served as 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.

Marvin E. Bauer



Research Agronomist and Program Leader
of Crop Inventory Systems Research

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, IEEE Geoscience and Remote Sensing Society, American Society of Photogrammetry, and several honorary societies. He is the author of more than 30 publications on the spectral characteristics of crops and the application of remote sensing technology to crop identification, area estimation, and yield prediction. He recently became Editor-in-Chief of the journal Remote Sensing of Environment.

Dr. Bauer 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 the Large Area Crop Inventory Experiment. He has been the principal investigator of a recent Landsat investigation for crop identification and area estimation. Currently he is the technical leader of field research being conducted to quantify and model the radiation characteristics of agricultural crops and soils in relation to their agronomic properties.

CROP PRODUCTION INVENTORIES

At LARS, research projects are being conducted on the application of remote sensing to crop production surveys. One area of emphasis is the development and testing of computer-aided techniques for training, classification, and sampling Landsat multispectral scanner data for crop area estimation. A second area of emphasis is the development of an approach to crop yield prediction which utilizes remotely sensed multispectral measurements, as well as meteorological and soil productivity data. The investigations in both areas are supported by studies of the relationships of crop, soil, and meteorological variables to the spectral reflectance-emittance of crops by using calibrated, multitemporal measurements from controlled experiments and commercial fields.