

Field Grid Sense (CRIS Project SD00189) : Precision Farming Pioneer : South Dakota State University

Early Precision Farming CRIS Project as listed in : (Agri-topics: Precision Farming , page 9 : USDA, National Agricultural Library Digital Collections: <https://handle.nal.usda.gov/10113/7083479>

SDSU : USDA CRIS Project: 1989-1993

Applying and Recording Agricultural Chemicals Simultaneously via Computer Control Project No. SD00189

To ensure safety plus enhance productivity, applied chemicals for crop production need to be feasibly utilized with as much control as possible. A machinery system (both hardware and software) is being designed to control and adjust the release of pesticides so that the on-the-go applied delivery corresponds to the soil environment. A laptop microcomputer (positioned within the tractor cab) is the main component and provides simplicity, reliability and establishes the capability to record and maintain a chemical-field history. (Project Duration: 10/4/89-9/30/93)

Investigator(s): Froehlich, D. P., Klosterman, T., Alcock, R., Agricultural Engineering South Dakota State University, Brookings, South Dakota 57007

Investigator Positions (1991):

D.P. Froehlich – Mech. Eng. Dept. Head, R. Alcock – Ag. Eng. Dept. Head, T. Klosterman- Ag. Eng. Farm Manager

- **CRIS Project Support:** SD Agricultural Experiment Station (AES) , CASE-Brookings, SD (Tractor Dealership) , Raven Ind. , Hiniker Company C&R Supply (Sprayer Equip.), United States Department of Energy, Governor's Office of Economic Development - CITE Grant from the State of South Dakota
- **Qlane® software** (copyright 1990) and **Field Grid Sense** are trademarks of the Software and System developed & copyrighted by South Dakota State University.



SDSU Ag. Engineering Field : Field Corners marked by Ovals. (Image U.S. Geological Survey: August 1991: Google Earth)



SDSU: Redfield/Dakota Lakes No-Till Drill Precision Placement and Controlled Traffic Beginning Step of Field Grid Sense and FGS Precision Farming Monitor

No-Till Drill Development began in the Spring of 1986 with design/construction in SDSU's Ag. Engineering Shop SDSU: Dr. Dwayne Beck and Dr. D.P. Froehlich

CRIS Project SD00189 Related Information: (SDSU's College of Engineering, College of Agriculture, Ag. Engineering, Dakota Lakes Research Farm)

- * 1987 ASAE Paper NCR 87-204, "All Crop No-Till", D.L. Beck and D.P. Froehlich: No-Till Drill developed (1986-87) for Precision Travel Management of Ag. Machinery in farmed fields.
- * 1988 ASAE Paper NCR 88-1014 , "Granular Applicator For in-Ground Placement of Chemicals", Rapid City SD, ASAE Summer Meetings, J.A. Schumacher and D.P. Froehlich. : "Field Grid Sense system described leading to a Farm-based Precision Farming Fld. Monitor for Real-time Map Display-Collection-Control of Spatial: Activity/ Data/ Notes"
- * 1989 June - CSRS "Review of Programs of SDSU Ag. Engineering" concluded that continued research on Field Grid Sense has good potential for success.
- * 1989 ASAE Paper No. 891606 "Computer Controlled Application in Controlled Traffic Fields" New Orleans ASAE meeting, J.A. Schumacher and D.P. Froehlich
- * Farm and Ranch Guide, Feb 9, 1990, Page B-10. "Lap-Top Computer Controls Fertilizer Rates in Research" article on the 1989 ASAE Paper No. 891606.
- * Farm Journal March 1990, "Change rates on the run" by Larry Reichenberger: Article on SDSU's Field Grid Sense
- * SDSU, South Dakota Horizons 1990 "Field Grid Sense makes both environmental and economic sense: D.P. Froehlich, J.A. Schumacher, D.G. Ollila
- * Invited FGS Presentation at "Software Workshop for Management of Fertilizer Nutrients" cosponsored by USDA/SCS at Tulsa, Oklahoma , March 20-21 1990.
- * Dr. David Waits (Founder of Precision Farming's: SST Software) while still representing NASA (Agriculture) made a scheduled trip to Brookings SD (Summer 1990) to discuss Field Grid Sense and Precision Farming Technology with D.P. Froehlich and J.A. Schumacher.
- * SAE Technical Paper 901590 " Spatially Control and Record Field Operations Via Laptop", J.A. Schumacher and D.P. Froehlich, Milwaukee WI, presented on Sept. 10-13, 1990
- * Successful Farming October, 1990 "Precisely Apply Chemical with an Office Computer" : Article on SDSU's Field Grid Sense
- * Dr. Maurice Horton (Dept. Head - Plant Science) hires J.A. Schumacher (SDSU-Ag Engineer) to work with Soil Science Researchers (Nov. 1990)
- * ASAE Meeting Presentation, Chicago Ill, by D.G. Ollila "Integrating Field Grid Sense System with Direct Injection System" Dec. 1990,

Paper No. 901628: D.G. Ollila, J.A. Schumacher and D.P. Froehlich: (The "Site Specific Technologies" session moderator singled-out special recognition to South Dakota State University for its collective and early Site Specific Technology work at the session wrap-up to which the filled room gave a standing ovation.)

* Successful Farming April 1991, "Computer Chemicals - Lap-top computer is the brains to a simple system that alters chemicals on the go" by Dave Mowitz

* Field Grid Sense presented at American Farm Bureau Federation's annual convention, January 1992. J.A. Schumacher (FGS), K.A. Klemme (Yield Sensor), A. Bly (Precision Conservation)

* "Proceedings of Soil Specific Crop Management: A Workshop on Research and Development Issues: April 14-16, 1992, Minneapolis, Minnesota". Dr. Steven Borgelt (University of Missouri) presentation "Sensor Technology and Control Strategies for Managing Variability" included the work of SDSU's Yield Sensing work in the Proceedings (Klemme et al.,1992).

The FGS Harvester System (Oct,1991- Aug. 1992) produced first generation digital combine databases for yield maps, moisture maps and topography maps. FGS Harvester sensors included (capacitive-grain moisture, ultrasonic depth-grain level, dual inclinometers-topography, temperature, distance) the data being collected/displayed with FGS's In-Cab Monitor System. The initial FGS Mapping System produced (visionary) informative maps for research and structured farm usage. However, an upgrade to (large-scale) robust DGPS mapping was realized in 1992.

* May 1992: NIST/DOE Energy-Related Inventions Program "Field Grid Sense" Project awarded Funding Grant (\$79,803) D.P. Froehlich, J.A. Schumacher

DOE Grant: Purchased June15 1992: DGPS Differential System from (AIT- Iroquois SD). System setup at Eastern South Dakota Soil and Water Research Farm then moved to Dakota Lakes (Pierre SD). DOE grant next purchased a John Deere 4420 Field Combine (April,1993) and a first generation AgLeader™ yield system with RS232 port and interfaced it to Field Grid Sense/GPS software for Site Specific Yield mapping (1993) at Dakota Lakes Research Farm . It was one of the earliest integrated DGPS/Yield Mapping Systems in the United States/World.

Field Grid Sense System (J.A. Schumacher , D.P. Froehlich, 1989) is noted in the publication "A review and integrating analysis of Spatially-Variable Control of crop production", J.K. Schueller, University of Florida: Fertilizer Research 33: 1-34, p. 13,18. Sept. 1992. (Describes the FGS-Precision Monitor System and its adaptable use in multiple spatial applications (i.e. fertilizing, spraying, combining, etc.) and its ability to spatially record operator observations, (pests and weeds etc.) during field operation – ASAE Paper No. 891606 and SAE No. 901590.) The SOILLECTION system, (supported by Earl Ortlip's 1986 patent), of Soil Teq, Waconia, Minnesota was the first computerized (fertilizer industry) spatially variable industrial spreader (digital soil-map defined). South Dakota State University "opened up a new path" with Field Grid Sense, "Pioneering a Farm-based – Precision Farming Monitor" (operator-map defined). FGS a straight forward spatial monitor/control system, easily adaptable to GPS integration, was early-on a National & Local Catalyst for Precision Farming advancement. The Soil Doctor of Crop Technology, an automatic control system, was another early variable fertilizer system but did not provide the ability to map or define location. Dr. Schueller is the foremost authority on Precision Agriculture technology since the beginning of the 1980's and provided an intensive history review of the technology pre-1992.

- * Sept 14-17 1992: SAE Technical Paper 921651: "Results and advantages of a Spatially-Variable Technology for Crop Yield" : K.A. Klemme, J.A. Schumacher and D.P. Froehlich
- * CITE Grant (\$49,226) funded through Office of Governor's Office of Economic Development "Site Specific Farming Technology" a Cooperatively Supported CITE Project for SDSU and Ag Info Tech (AIT) of Iroquois, SD Jan 12, 1993 – T. Aughenbaugh (AIT) , Dr. D.P. Froehlich (SDSU Eng.), Dr. C.G. Carlson, (SDSU Plant Science/ Ext. Water Quality), J.A. Schumacher (SDSU)
- * Dakota G&R magazine Mid-Jan. 1993: "Site specific farming - a spot in the future? By Cindy Snyder : (CITE Grant: AIT and SDSU Site Specific Farming and GPS Project: Iroquois SD)
- * Stress SDSU Management Symposium, May 24&25 1993 : "Site Specific Farming: The Field Grid Sense Project": (Precision Farming Technology and Agronomic Research)
- * SDSU Impulse - College of Engineering, "Create technology to help farmers", Summer 1993, p.9. : (CITE Project: Ag Info Tech (AIT) and SDSU Engineering & Plant Sciences)
- * J.M. Oolman, MS Thesis, "Precision Farming Using GPS, Yield Sensors, And Grid Soil Sampling To Determine Soil Variability in Cultivated and Broadcast Fertilized Fields". J.M. Oolman – SDSU Plant Science Graduate Assistant (CITE Grant 1993-94), Dr. C.G. Carlson-Thesis Advisor: (SDSU Agronomy/Soil Science Research).
- * NCR-180 Site Specific Crop Management (University & Industry), 1st meeting (Dr. Fran Pierce-Organizer, Dr. Maurice Horton (CSRS)-Committee Advisor), Dec 2-4 1993 in Kalamazoo, MI.. SD Report centered on the "Site Specific Farming Technology" CITE Project with its Site Specific On-Farm GPS project generating great interest. SD Presentation
- * SDSU Researchers, Educators, Alumni and Industry Collaborators have had a large worldwide influence on Precision Ag. with many unique contributions since CRIS SD00189.

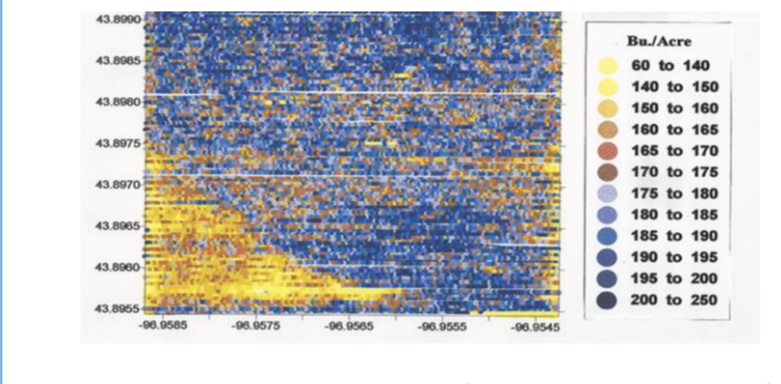
CRIS Project SD00189: Precision Farming Technology

June 14 1991 Field Sprayer Verification (As-Applied Map)

A Field Grid Sense (FGS) sprayer application was conducted to demonstrate the ability to record and maintain a chemical-field history by a farm operator. The FGS application displayed the possibilities of a (Farm-Based) Precision Farming Field-Monitor for Site Specific field tasks (fertilizing, spraying, planting, yield mapping, etc.), as compared to the lone option of computerized Site Specific (Fertilizer-Chemical) Application by Commercial Spreaders in (1990-1991). FGS employed a localized position/ guidance method: (Traffic Lanes/defined path, width, distance, direction, time) in a structured field for this demonstration (pre-GPS usability) . It is a precise repeatable field positioning system that stays in place for all the tasks of the growing and harvest season, (more than a single field operation.) In subsequent years, an affordable and stable Civilian DGPS System (1992) was purchased for monitoring position and guidance in farm sized fields with global based survey accuracy. It should be noted that local positioning components (pass, width, distance, time etc.) are still used in map processing even with DGPS systems - (GPS coordinates anchor grids/points/defined-path to a Global Reference). In this demonstration (field test with water carrier) the sprayer application rate was manually selected by the tractor operator (certified applicator) during field operation. A multi-layered manifold was developed to quickly switch between selected rates. The FGS Monitor-System in real time mapped the applied rate as shown below. FGS's Qlane® software (1990) was used for system control and to collect and map (real-time) spatial field data. GIS/Field code in Qlane's software (J.A. Schumacher, D.P. Froehlich, 1989) was project-created, due to the infeasibility of incorporating (DOS/Based) GIS software (1988-1993) into FGS's Computer Field (Cab) Monitor. Subsequent versions of FGS-(GPS/GIS) computer-software were used in field combines at Dakota Lakes Research Farm (1993) and Producer/cooperator field sites. A FGS/GPS palmtop field scouting system was also developed for use in on-farm research projects. **CRIS Project SD00189 -Pioneer in Precision Farming Technology (1989-1993) – (South Dakota State University Agricultural Experiment Station (AES), SDSU College of Engineering, SDSU College of Agriculture. Special recognition: South Dakota Agricultural Research Farms/non-profit Corporations, Dakota Lakes Research Farm, Farm Cooperators, Agricultural Research Service, Industry Project Support.)**

Precision Technology for Site Specific Farming

1990's Corn-Yield Map: Irrigated Field

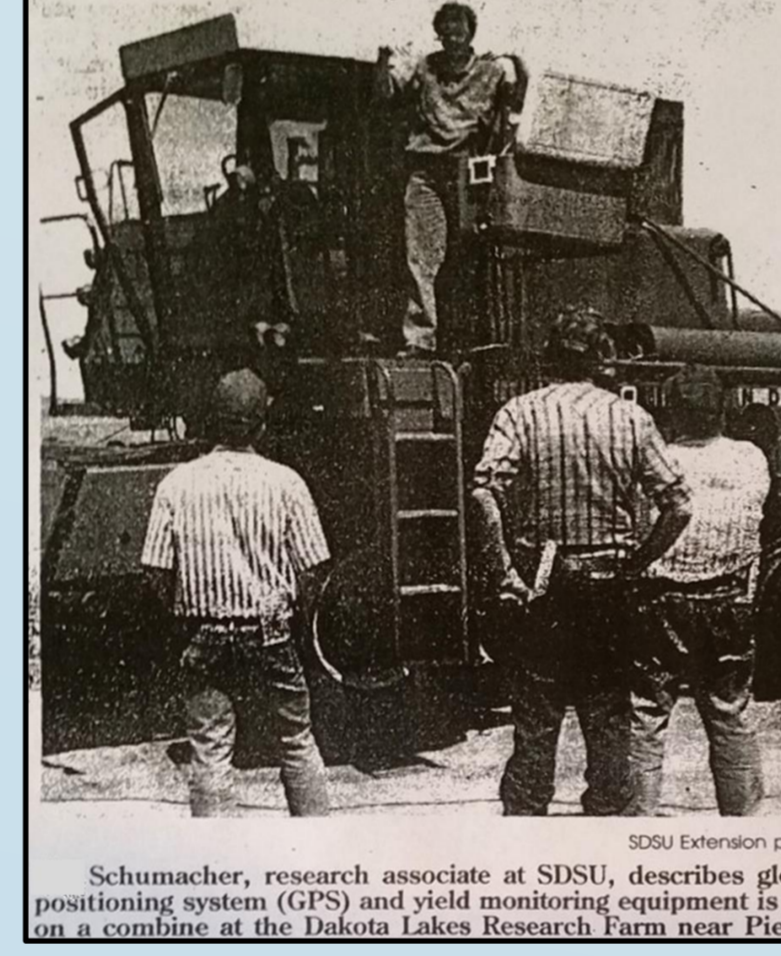


Longitude, Latitude Coordinates (Image Credit: Ron Alverson)

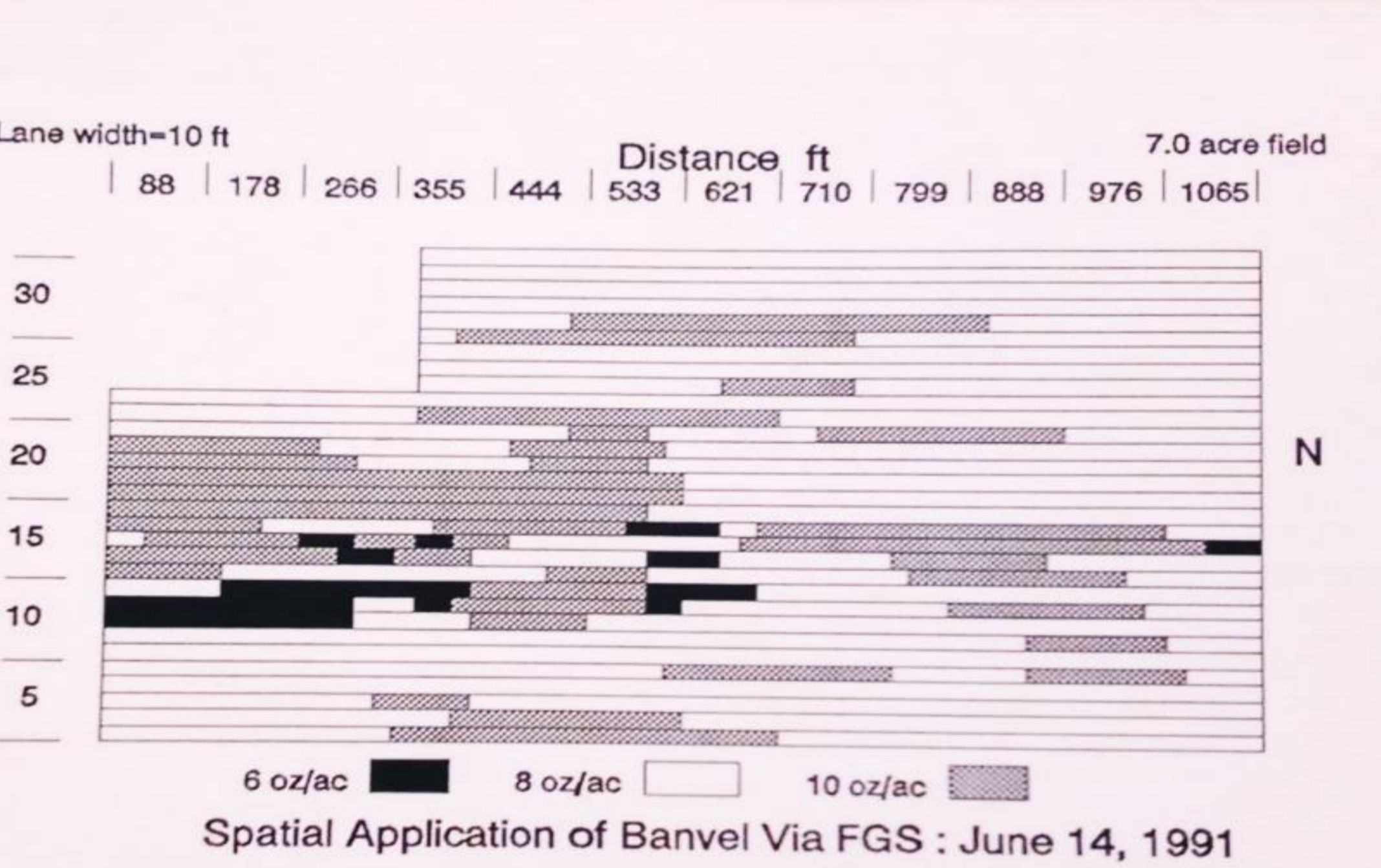
DGPS Yield-map reflective of the first maps developed with the integrated (SDSU) FGS/Ag Leader yield mapping system: (1993- Dakota Lakes Research Farm, AIT-CITE project and 1994- Alverson Family Farms (SDSU cooperator: (J.M. Oolman Thesis project)).

(Note: The Alverson's have been employing Precision Farming techniques since 1983 with "Ridge-Plant" Farming: (1983: Controlled Traffic, Swath Control, Ridge-Guided Auto Steer, Residue Management, 1988 - Precision Seeding (spacing & variable down pressure) - Variable Rate Fertilizer (non-mapped) and strip trials (N,P,K), 1993-1994 - Yield monitor and DGPS mapping (starting with the SDSU project). Historical data collection and real-time spatial field management has been of high value to their operation in developing long-term Soil Health, Soil Productivity, Carbon Sequestration & Water Resource Management since 1983.

Dakota Lakes DGPS/Yield Combine (1993)



Schumacher, research associate at SDSU, describes global positioning system (GPS) and yield monitoring equipment in use on a combine at the Dakota Lakes Research Farm near Pierre.

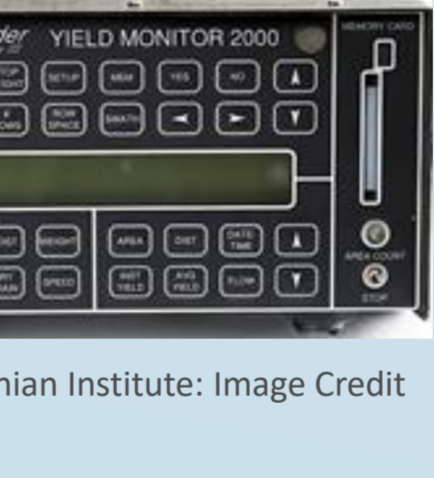


Spatial Application of Banvel Via FGS : June 14, 1991

SDSU Ag. Eng. Field (Campus)

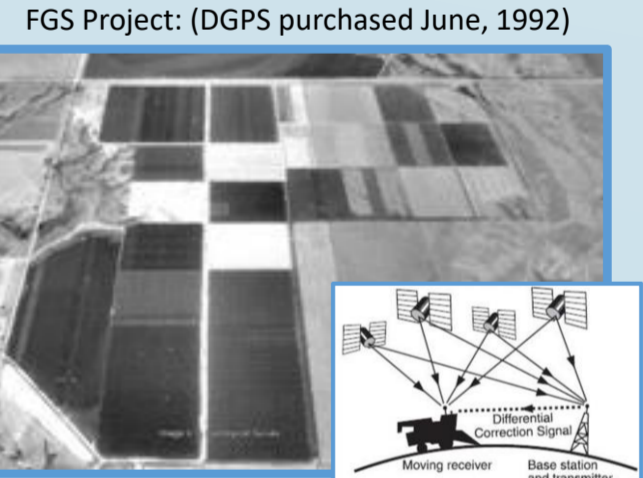
1065 ft. by 310 ft. (31 Lanes * 10 ft.) Field Northwest of the SDSU Football Stadium

Field Spatial Application: D.G. Ollila, J.A. Schumacher, K. Klemme



Smithsonian Institute: Image Credit

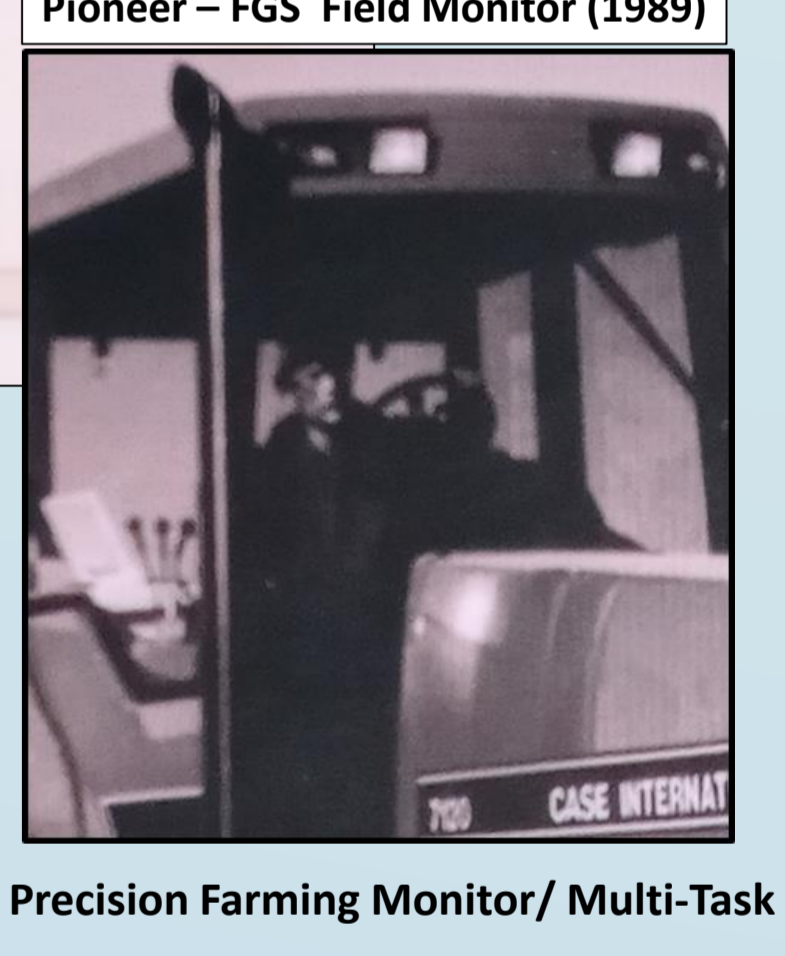
Ag Leader Yield Monitor (1993) SDSU's FGS System merged separate yield-monitor and DGPS data streams in order to create Yield-Maps, (visualized with "Surfer" mapping software by Golden Software, Inc.), for Dakota Lakes Research Farm (Summer/Fall 1993).



Dakota Lakes: DGPS Ready (1993) FGS Project: (DGPS purchased June, 1992)



Diverse Field Applications: DGPS Accuracy (1990's)



Pioneer – FGS Field Monitor (1989)

CRIS Project SD00189 Related Excerpts From: " Bonnie Emmert, Jane Potter Gates, and Joe Makuch. Precision Farming. Agritopics Series, no. AT 95-01. National Agricultural Library, 1994."

"Precision Farming Agri-Topics: AT 95-01 Compiled by: Bonnie Emmert, Water Quality Information Center Jane Gates, Alternative Farming Systems Information Center, Joe Makuch, Water Quality Information Center

Special thanks to: Kenneth Sudduth, Agricultural Research Service, for his helpful comments in reviewing this publication.

December 1994 National Agricultural Library Cataloging Record:

Emmert, Bonnie Precision farming. (Agri-topics ; 95-01) 1. Precision farming--Bibliography. I. Gates, Jane Potter. II. Makuch, Joe. III. Title. az5073.A37 no.95-01"

"Precision Farming What's Here The articles listed in this publication are from newspapers, the scientific literature, and the farm press, and are intended, collectively, to give an overview of precision farming. The listing of research projects comes from the United States Department of Agriculture's Current Research Information System (CRIS) database and serves to acquaint the reader with publicly funded research efforts involving precision farming. The inclusion or omission of a citation should not be construed as endorsement or disapproval. "

"PRECISION FARMING RESEARCH

This section lists examples of precision farming research projects entered on the Current Research Information System (CRIS) database. CRIS is the U. S. Department of Agriculture's electronic documentation and reporting system for publicly funded agricultural and forestry research.

*** Applying and Recording Agricultural Chemicals Simultaneously via Computer Control Project No. SD00189

To ensure safety plus enhance productivity, applied chemicals for crop production need to be feasibly utilized with as much control as possible. A machinery system (both hardware and software) is being designed to control and adjust the release of pesticides so that the on-the-go applied delivery corresponds to the soil environment. A laptop microcomputer (positioned within the tractor cab) is the main component and provides simplicity, reliability and establishes the capability to record and maintain a chemical-field history.

Investigator(s): Froehlich, D. P., Klosterman, T. & Alcock, R. Agricultural Engineering South Dakota State University Brookings, South Dakota 57007 Project Duration: 10/4/89-9/30/93"

The FGS Computer Field Monitor was first conceived (1987) to showcase the possibilities of a (Farm-based) Precision Farming Monitor versus Commercial Variable Fertilizer Application (Soil Teq Inc.)

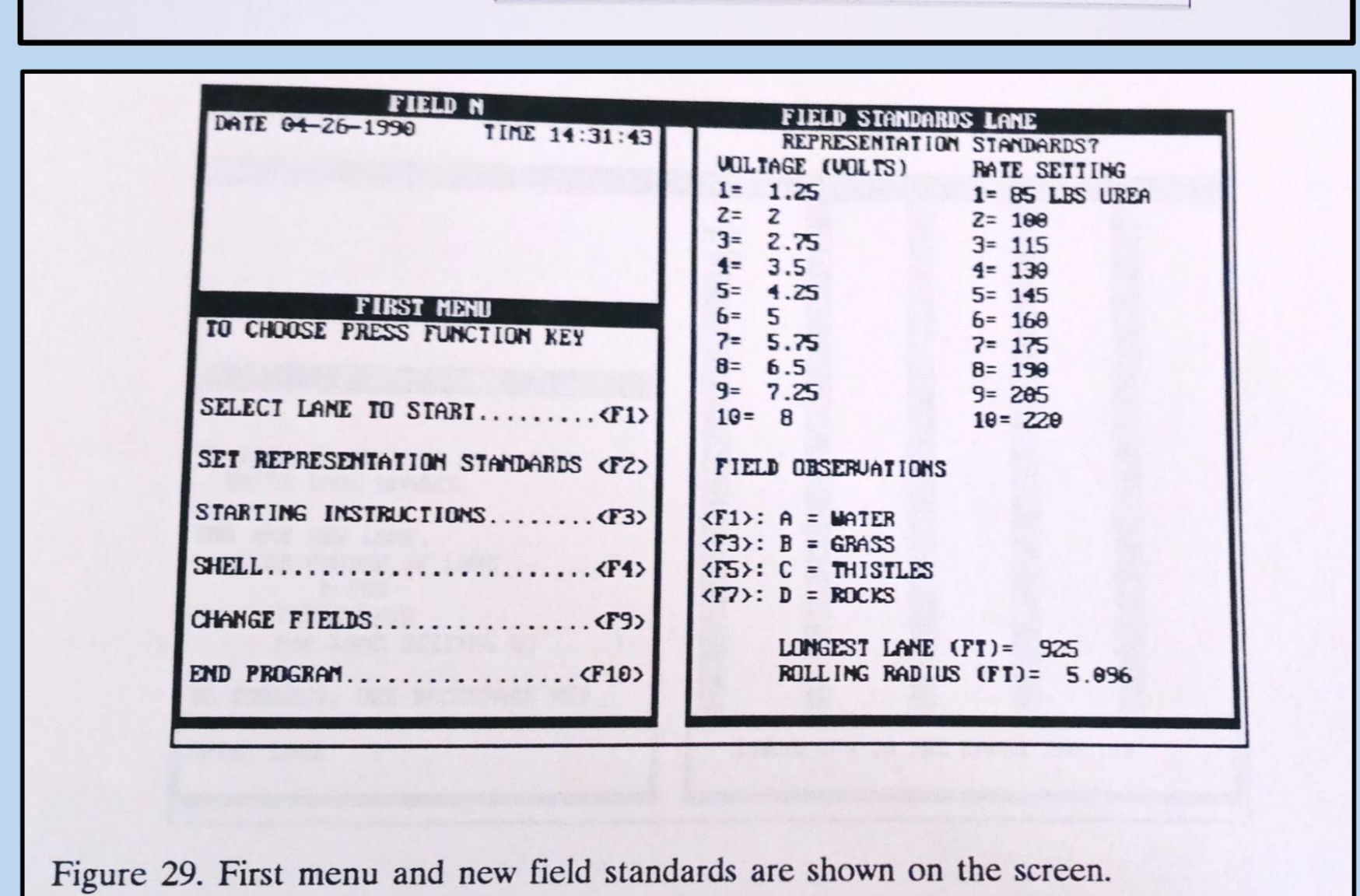
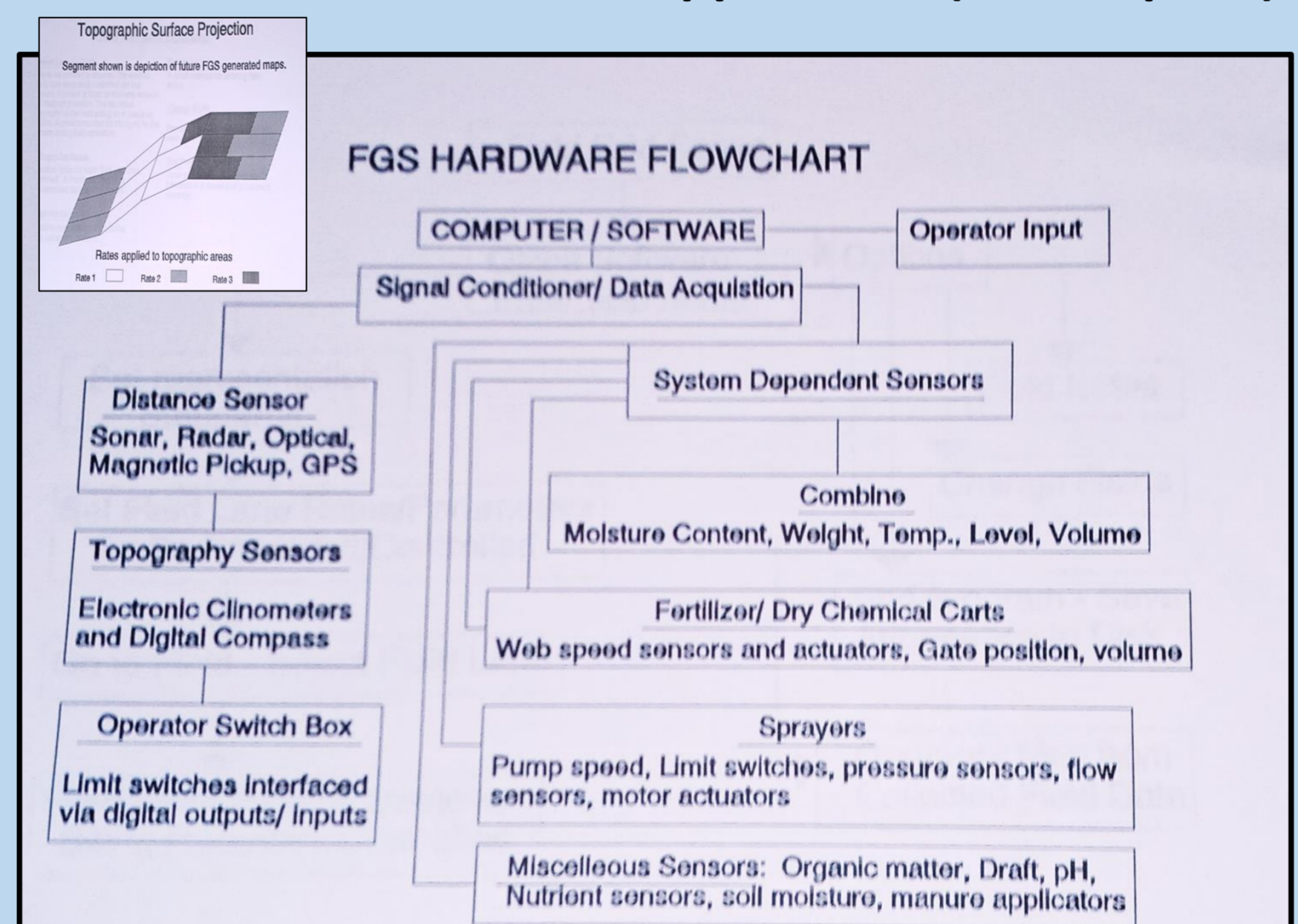
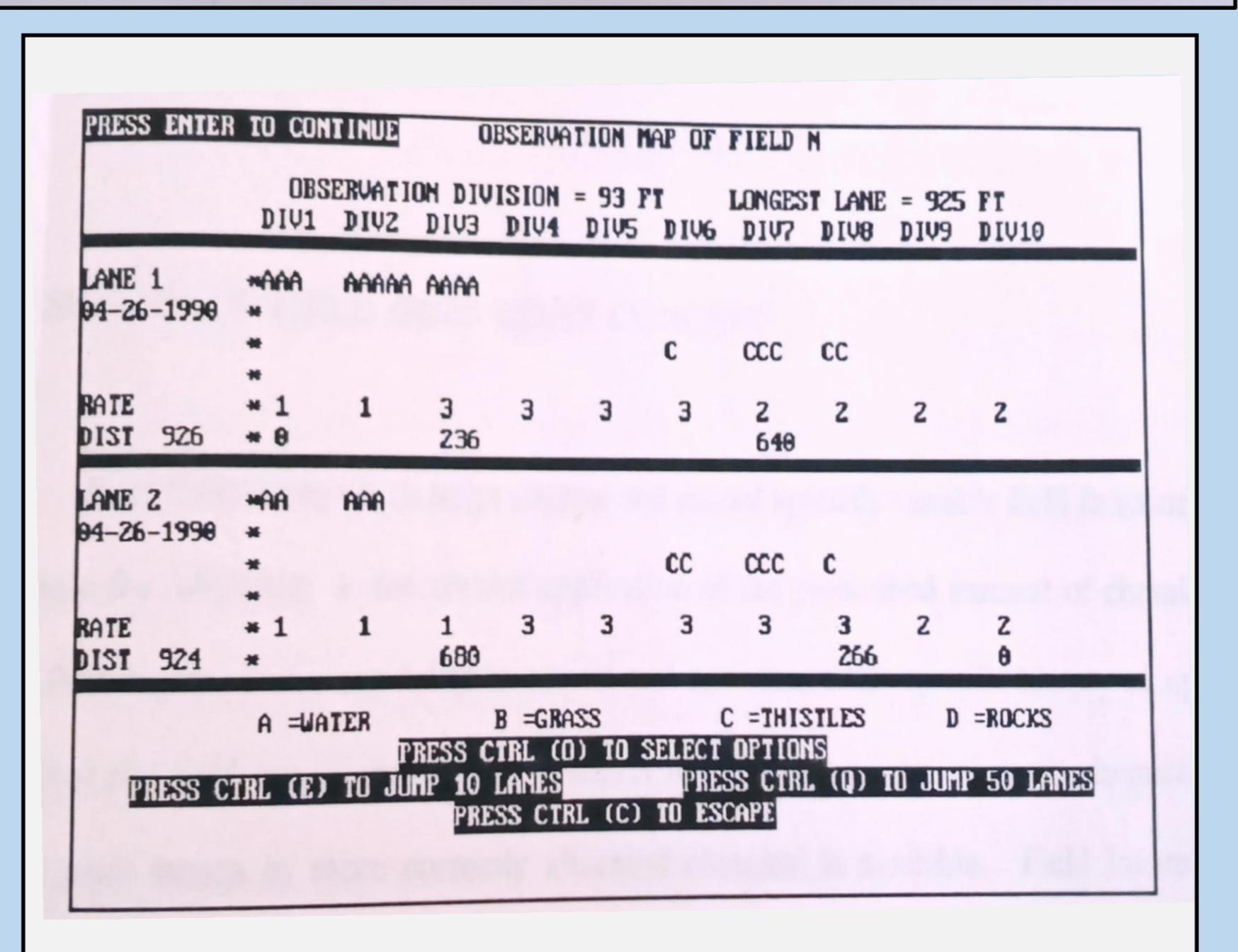
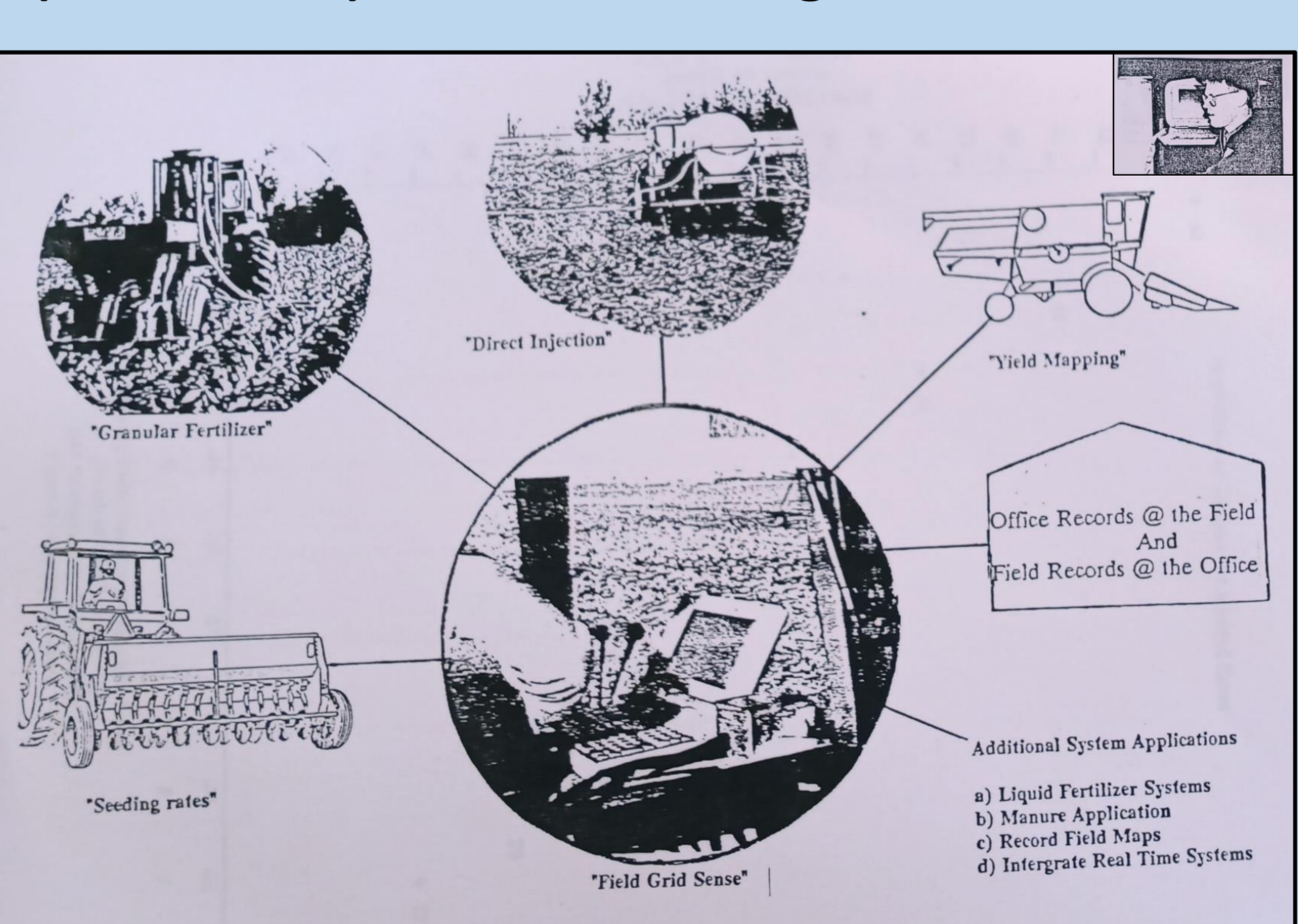


Figure 29. First menu and new field standards are shown on the screen.

Qlane®1990 FGS software

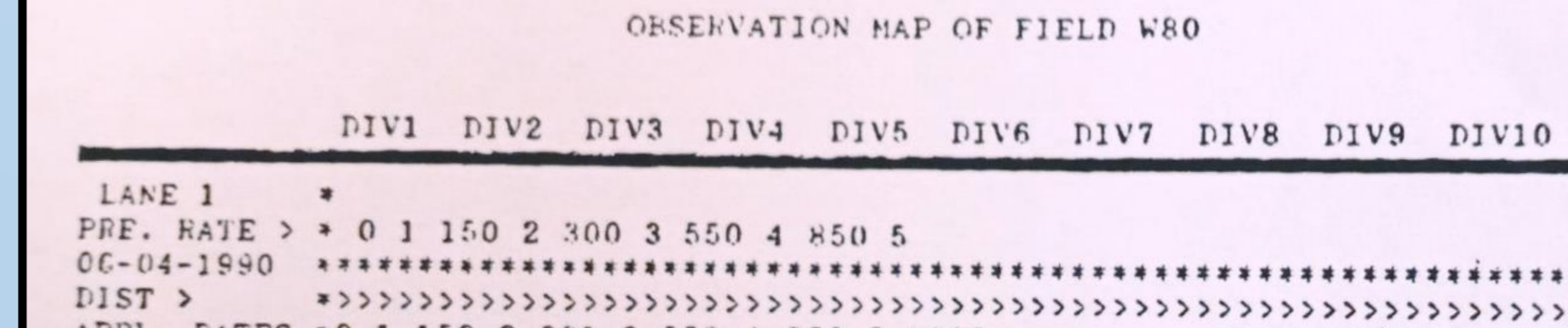
Stress SDSU Management Symposium, May 24 & 25 1993 "Site Specific Farming: The Field Grid Sense Project"

J.A Schumacher, C.G. Carlson, D.P. Froehlich, K. Klemme, D.E. Clay and R. Gelderman

Abstract: "Global Positioning System (GPS) satellite technology is an emerging tool that has important applications in cropland agriculture. GPS technology is used to precisely determine location coordinates (latitude and longitude). Using an onboard computer, GPS can be used to identify location of a moving tractor, sprayer, or combine in real time. As a consequence, applications of fertilizer, pesticide, and seed can be varied and recorded according to geographic location in real time. The Field Grid Sense Project is working on the development of site specific equipment that can be used with GPS technology and Geographic Information Systems (GIS). Two major emphasis within this project have been on the development of combine yield sensors and site specific sprayer technology. Soil science researchers from South Dakota State University will be developing algorithms that can be used in South Dakota site specific farming systems. These systems have the potential to manage problem soils in a field to reduce occurrence of stress from nutrients and weed pressure while minimizing contamination of the environment. The agronomic project as proposed is interdisciplinary and involves the private sector, engineering discipline and the plant sciences."



Field Records @ the Office K.A. Klemme



Qlane®1990: Real-time Mapping in the Cab

SDSU's CRIS Project SD00189 : Pioneering Catalysis in Precision Farming

J.A. Schumacher - Research Engineer (retired) Dr. D.P. Froehlich - Professor Emeritus