Earth Science Systems
ESSential Underground Information

Research and Development Services

Earth Science Systems, LLC (ESS) is a small business specializing has geophysical research and development. We have assembled a team seasoned scientists and engineers to tackle the complete R&D cycle from conceptual ideas to product manufacturing. Our broad experience in instrument design, physical modeling, data analysis, and field logistics provides innovative and insightful solutions. We work for large and small clients in both the government and private sectors. ESS's core disciplines are described below, followed by brief bios for our key employees. Consult our web site for information regarding specific products.

Geophysics

ESS has developed new methods through our thorough understanding of existing technologies, emerging technologies, and the needs of science and industry. We specialize in ground penetrating radar, electromagnetic induction, galvanic resistivity, induced polarization, nuclear, and seismic methods. ESS's scientists are experts in both surface and borehole methods.

Electronics

Our engineers have decades of experience in instrumentation design. The electronics industry is evolving at a rapid pace, paving the way for instruments that are more capable, accurate, and easier to use. ESS's instruments pack more capabilities into smaller and less-expensive packages than other instruments on the market.

Software

Numerical modeling is essential for instrument design, survey design, and data interpretation. Our team has developed data modeling, inversion, and processing programs for most geophysical methods. We routinely survey and use the latest research codes from academic institutions and government laboratories. ESS's developers have decades of experience in the creation and support of commercial software packages.

Hardware

Our mechanical engineers are adept at working with the constraints imposed by geophysical instrumentation. They develop and test equipment for deploying geophysical instruments and reducing logistical constraints. ESS's custom robotics support activities in difficult environments.

Contact info

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Charles P. Oden, PhD, PE
President and CTO

Charles Oden has nearly two decades of experience in the design, creation, and evaluation of geophysical instrumentation and the corresponding data analysis software. Dr. Oden has developed instruments that make nuclear, galvanic, seismic/acoustic, EM induction, and ground penetrating radar measurements. He has written numerous programs for data processing, physical modeling, and visualization; ranging from user-friendly commercial applications to in-house engineering and modeling routines. He draws on his cross-disciplinary knowledge base in geology, electrical engineering, geophysics, and scientific computer programming to facilitate innovative solutions to real world problems. As an adjunct professor, he contributes to teaching and research in the geophysics, computer science, and engineering departments at Colorado School of Mines.

B.S. Geology, U. Nebraska, 1989
B.S. E.E., U. Nebraska, 1991
Ph.D. Geophysics, Colo. School of Mines, 2006

Current Projects

- Create software to model, process, and invert EM induction data to detect, characterize, and classify unexploded ordnance.
- Create software to model, process, and characterize bridge decks using ground penetrating radar (GPR).
- Develop a GPR array system with enhanced penetration capabilities to aid utility detection efforts. This addresses the most fundamental difficulty with GPR.
- Develop a GPR array system to continually assess the health of roads and bridges. Multi-sensor systems will be mounted on fleet vehicles that continuously travel the roadways. The GPR units will collect high-resolution data from vehicles traveling at highway speeds.
- Develop miniaturized wireless sensors units for in-situ geophysical monitoring. Sensor units measure spontaneous potential, DC resistivity, induced polarization, seismic vibrations, and more.
- Develop multi-physics finite element modeling routines for high frequency electromagnetics, EM induction, and galvanic resistivity. These routines will support 3D modeling of arbitrary geometries and be the basis for 3D inversion algorithms.

Past Projects

- Designed or helped design approximately twenty different well-logging probes and several families of data acquisition systems.
- Develop a temperature compensated down-hole natural gamma probe.
- Developed a variable-frequency sonic logging tool.
- Conducted Monte Carlo modeling to investigate the feasibility of a down-hole prompt neutron activation probe for in-situ mining assays.
- Established a method for measuring arsenic concentration using delayed neutron activation and conventional logging probes.
- Developed a high dynamic range GPR for use in lossy soils.
- Developed a migration algorithm to compensate for degraded image resolution caused by lossy soils.
- Cross-hole EM induction modeling.
- Experimented with blind source separation for passive surface seismic surveys.
- Created a user-friendly commercial well log analysis package for galvanic, nuclear, acoustic measurements; and for groundwater modeling.
- Created an open source GPR data processing package.

Dr. Oden has published in peer reviewed journals and conference proceedings. Consult the ESS website for a list of publications.

Dan P. Jones, PGp
Chief Operations Officer

Dan Jones has over 15 years experience in geophysics industry, and has managed several service companies. His expertise includes the applied use and knowledge of geophysical techniques and current state-of-the-art instrumentation applied to the shallow subsurface. These techniques include seismic, magnetics, electromagnetics, electrical, and ground penetrating radar as applied from both the surface and boreholes. In addition, his work as a project manager, and eventual role as branch manager of a local geophysical office, has provided him with a wealth of knowledge regarding geophysical survey

design, budgeting, operations management, and technical reporting.

B.S. Geophysics, Colo. School of Mines, 1994
M.S. Geophysics, Colo. School of Mines, 1997

Current Projects

- Managing a multi-year multi-million dollar equipment development project.
- Researching aided inertial navigation for locating geophysical sensors and instrumentation.

Past Projects

- Lead geophysical contractor in a multi-disciplined United States Department of Agriculture (USDA) research project using multi-frequency electromagnetics and ground penetrating radar to map shallow clay lenses on a 20+ acre USDA test farm. Continuity and depths of the clay layers were analyzed for water retention consideration in comparison with localized crop yield on both small and large area scales.
- Performed a comprehensive range of surface geophysical surveys for environmental, geohydrologic, geotechnical, and engineering applications. These applications have included subsurface characterizations for landfills, quarries, disposal areas, site redevelopment, road/bridge/building infrastructure, utility engineering, environmental cleanup, and other miscellaneous projects. The preparation and completion of the surveys encompassed all phases of geophysical investigation from initial planning, survey design, field data acquisition, data reduction and interpretation, to the presentation of findings.
- Performed geophysical surveys on many major military facilities for numerous prime contractors. Typical surveys include utility locating for the safe placement of boreholes, test pits, and trenching for environmental remediation systems as well as investigations for miscellaneous buried objects.
- Used geophysical methods to detect unexploded ordinance using magnetic and electromagnetic methods at various federal facilities.
- Through direct application of geophysics toward subsurface characterization and object detection, developed hands-on experience and vast knowledge of the extreme variability of subsurface soils conditions and their specific effects on the various geophysical techniques to locate subsurface targets. Designed custom surveys to utilize multiple techniques to overcome deficiencies of certain geophysical methodologies in the presence of site-specific subsurface conditions.
- Completed numerous borehole logging and imaging surveys for environmental, groundwater, and geotechnical engineering applications. These surveys were conducted for investigations dealing with Superfund and National Priority Listed Sites, military base closures, groundwater restoration studies, landfill siting and expansions, slope stability evaluations, and capital engineering projects such as dams, power plants, and water storage facilities.
- Completed modeling software to fit and parameterize spectral resistivity data with an empirically derived frequency dispersion equation (modified Cole-Cole). Included a graphical interface for direct interaction and parameter control by the user.
- Completed the 40 hour health and safety training as well as annual refresher classes under OSHA 29 CFR1910.2201, Title 8, CCR5192. Have also completed confined space entry training OSHA 29 CFR 1910.146 for application to subterranean pipeline and utility vault inspection and related geophysical surveying.

Richard Albano, PhD
Scientific Programmer

Richard Albano's experience and interests include numerical simulation in the physical sciences, numerical analysis, and software engineering. My professional software engineering experience has included developing large commercial software products. Through his background in physics and mathematics, he has contributed a variety of original solutions to these products. Before concentrating on software engineering, he was a practicing researcher specializing in plasma physics and electrodynamics.

B.S. Physics, Idaho State U., 1976
M.S. Space Physics, U. Alaska, 1980
Ph.D. Physics, UCLA, 1989

Current Projects

- Develop software tools and algorithms for guidance and positioning using an Inertial Measurement Unit (IMU). Implement an Extended Kalman Filter to merge IMU and other data guidance data such from encoders and other devices.
- Developed software for processing high resolution video frames in real time for vehicle positioning.
- Developed a multithreaded navigation framework to process these numerous navigation algorithms in real time using a multi-core computer. A pair of NVIDIA graphics cards are used for general purpose computing of the imaging algorithms.

Past Projects

- Provides medical simulations for medical device manufacturers. Developed and implemented a physics-based model of catheter behavior that provided a high degree of realism. This included realistic catheter response while confined to a network of vessels and arteries. The model could handle multiple coaxial catheters with varying degrees of stiffness. Also, catheters could have a variety of tip shapes which could be rotated and deformed naturally in accordance with vessel and device boundaries.
- As a staff scientist, Richard worked on imaging through turbulence along the earth's surface, detection of cavities in dielectric material, measuring dielectric properties of solids and liquids, processing hazardous waste with microwaves, electromagnetic coupling to electronic structures, electronic detonator susceptibility, real time response testing of nuclear reactor data monitoring system and explosively driven MHD power generation.
- Worked on a Plasma Separation Process for separating isotopes of Uranium for commercial power production. The plasma was heated with high power microwaves supplied via over-moded circular waveguide. A serious problem concerned an Alumina window in the system that would crack due to uneven heating by the incident field. Developed and ran algorithms to predict the electromagnetic pattern incident on the window. Also developed algorithms to model a variety of mode converters that could be used to convert undesirable waveguide modes to patterns with more evenly distributed power.

Stan Smith
Project Manager

Stan Smith specializes in ground penetrating radar (GPR) and has decades of experience as a field geophysicist. He has conducted numerous GPR training courses, and has been instrumental in researching advanced applications of GPR.

Projects

- Worked with Dr. Olhoeft of the Colorado School of Mines to develop and test new techniques for non-destructive evaluation of railroad grades and sub-grades using GPR. The methods they developed were able to detect fouled ballast, clay extrusions, and perched moisture. All of these conditions are serious problems that require maintenance for safe railroad operation. Helped to establish this method as a routine monitoring procedure.
- Worked with Dr. Olhoeft and other researchers to develop automated pavement thickness measurement routines using GPR data. Detected subgrade moisture and other detects. Helped establish this method as a routine procedure in road construction and maintenance plans.
- Conducted GPR surveys to evaluate the structural health of bridge decks.
- Conducted standard near-surface geophysical surveys for unexploded ordnance detection, utility location, tunnel detection, landfill delineation.
- Conducted geophysical surveys to locate voids for various transportation departments.

In addition to these key personnel, ESS maintains a staff of electrical, mechanical, geophysical engineers, and programmers.