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Forest Service

Engineering Staff

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Engineering Field Notes

Engineering Technical Information System

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1993 *Engineering Field Notes* Article Awards

Engineering Field Notes is pleased to have provided for 25 years a means for Forest Service engineers at all levels and in all Regions to share their experiences. We feel that this sharing is vital to doing more with less, and we applaud each of our authors.

In 1993, we shared information in many diverse fields. These include:

Ecosystem Roads Management
Uses of GPS
Energy Conservation
Heat Pump Installations
Information Management Products
Geotextiles
One-Map Initiative
Computer-based Instrumentation Systems

So now, it is that time of year again. Time for you (our readers) to tell us which 1993 articles you feel were most informative, beneficial, and interesting; which articles helped your office save money; which articles helped you develop more effective ways of accomplishing your work .

Once you have chosen 1993's top three articles, please complete the rating sheet on the following page. Rate only three articles. Rate them from 1 (best) to 2 (second best) to 3 (third best). If you feel that an article has helped or will help the Forest Service save money or other resources, please let us know. Remember, with *Engineering Field Notes* it is one person/one vote—so your vote counts!

After you have voted, cut out the rating sheet along the dotted line, fold and staple it closed, and mail it back to us at EFN. (For your vote to count, we must receive your rating sheet by June 1, 1994.)

Contests aside, we would like to thank each and every EFN author, as well as all EFN readers, who made 1993 a great year. Each one of you deserves a pat on the back for helping to foster an environment where information and experiences are viewed as valuable resources and are shared accordingly.

We would also like to take this opportunity to encourage you to start thinking of an *Engineering Field Notes* article for 1994. Why not share your experiences through *Engineering Field Notes* in 1994?

1993 *Engineering Field Notes* Awards

Article	Author	Choice (1, 2, 3)	$ Saved
January/February			
Environmental Roads Initiative Project	Walt Brooks and Jeff Moll	___	___
Federal Energy Efficiency Award Presented to USDA Forest Service	Pamela J. Finney and George Kulick	___	___
Using the Global Positioning System to Locate Genetic Trees for a Geographic Information System	Thomas Howie	___	___
'Watts' Happening in Energy Conservation: Tips for Saving Energy in Facilities	George Kulick	___	___
March/April			
Ground-Coupled Heat Pump Installations in Region 8	Randy L. Warbington	___	___
'Watts' Happening in Energy Conservation: Tips for Saving Energy in Vehicles	Shelly Leclaire	___	___
May/June			
Coordinated Technology Implementation Program (CTIP) Study No. F-5; Nonstandard Stabilization	Douglas E. Scholen	___	___
Dust Abatement Product Comparisons in the Northern Region	Steve Monlux	___	___
Production and Maintenance of a Single-Edition Series of Quadrangle Maps (One-Map Initiative)	Andre J. Cotsman	___	___
Use of Geotextiles on Federal Lands Highway Projects	Craig S. Dewey	___	
'Watts' Happening in Energy Conservation: Tips for Saving Energy in Facilities, Part 2	George Kulick	___	___
July/August			
Construction of a Portable Bridge West Engineering Zone, Three Rivers District, Kootenai National Forest	Tom Grabinski	___	___
Develop Computer-Based Instrumentation Systems for Measuring and Recording Timber Harvesting Machine Functions—Phase 1	Clarence Obiozor, Tyrone Kelley, Timothy P. McDonald, and Bryce J. Stokes	___	___
Ecosystem Roads Management Project	Jeffrey E. Moll	___	___
Evaluation of the American Ranger Clearing Machine	Michael A. Thompson	___	___
Specifications for Differential GPS Coordinate Data Submission to the Geometronics Service Center	Troy Warburton	___	___
The Use of GPS for Cadastral Surveys in the Rocky Mountain Region	Carl Sumpter	___	___
'Watts' Happening in Energy Conservation: Compressed Natural Gas (CNG) Vehicular Fuel	Mike Arias and Tom Hooker	___	___
September/October			
Barrier-Free Accessible Trail Surface Materials Region 1 Materials Engineering Investigations	Stephen Monlux	___	___
Canyon Creek Bluffs Rock Slope Stabilization: Sweet Home, Oregon	John W. Arambarri and Michael T. Long	___	___
Chunkwood Roads	Dick Karksy	___	___
Evaluating GPS in a Dense Tree Canopy	Tony Jasumback	___	___
The Marking of a Man	Timothy A. Kent	___	___
Modification of GSA Metal Wastebaskets for Use as Seed and Litter Traps	Michael O. Cain and Michael G. Shelton	___	___
'Watts' Happening in Energy Conservation: Tips for Saving Energy in Facilities, Part 3	George Kulick	___	___
November/December			
Environmentally Sensitive Roads	Jeffrey E. Moll	___	___
Monitor Hand Pump Accessibility Modification	Clifford R. Stephenson	___	___
Overview of Information Management Products and Services Produced by the Geometronics Service Center and Nationwide Forestry Applications Program	Roberta Carroll, Carl Fonnesbeck, Ann Boeder, Robert Eggli, Larry Jensen, Robert Mahoney, Marcia Thomas, and Barry Napier	___	___
Surfacing Trails with Nonstandard Stabilizers	Doug Scholen	___	___

TEAR ALONG THIS LINE ⟶

COMMENTS: _____

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Name _____
(OPTIONAL)

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TEAR ALONG THIS LINE ⟶

1993 Forest Service Engineers of the Year

Congratulations to our four 1993 winners pictured below. In recognition of their achievements, Sterling Wilcox, Director of Engineering, will present each a special plaque at a ceremony in Washington, DC, April 6, 1994. A brief summary of their individual accomplishments follows.

These outstanding individuals were selected from an excellent list of nominees from the National Forest System and Research. Judging was close in all categories, with a tie for Engineering Manager, hence four awards this year. Representing a sampling of the outstanding individuals we have in Forest Service engineering, other finalists included:

Management	*Technical*	*Technician*
John Quenoy, R2	Dale Hawley, R1	Marjorie Lubinski, RI
David Green, R4	Gary Heezen, R2	Henry Riffel, R2
Richard Sawaya, R6	Gary Miller, R3	Roger Anderson, R3
Richard Graves, R8	Wilden Moffett, R4	Randy Fredericksen, R4
Theodore Wegner, FPL	Robert Olson, R5	Marsh Nelson, R5
	Steven McDonald, R9	Louie Leeds, R8
	Robert Ross, FPL	Richard Ahlfs, R9
	Jim Schaefer, R10	

Robert R. Kaufman

Manager of the Year

Lolo National Forest (Region 1)

As program officer for technical services, Bob has made many contributions in all areas of forest management, as well as provided leadership, motivation, and development to his staff. He has represented the Forest at public meetings pertaining to review of the forest plan, and regularly represents the Forest with county commissioners, State and Federal highway officials, special-use permittees, land exchange proponents, and members of the logging and mining industries. He developed cooperative bridge construction projects with county officials, including two in the Timber Bridge initiative, and developed an MOU with a cooperator on trail management. He is currently developing a cooperative relationship with the Confederated Salish and Kootenai Tribes. Bob initiated coordination among cost-share Forests to promote consistent approaches to cost-share administration.

Personally involved in the application of new ideas, Bob has provided an environment and encouragement for development and experimentation with new concepts. With Bob's encouragement, the Lolo NF used the charette process for facility planning and design. The process was also used to develop the site plan for the Areal Fire Depot. The Lolo NF was a leader in the use of global positioning systems (GPS), and recently purchased laser survey instruments. The staff utilizes a full range of road design software, is presently conducting training for the use of TONTOCAD, and is participating in initial testing of the interactive road design system (IRDS). Earlier, Bob developed and contracted the first "turnkey" road construction project in Region 2, and implemented low-volume road specifications that were the forerunner of Spec 299, Composite Road Construction. Bob continues to encourage full use of A&E contracting, and has led the way to developing "open-ended" A&E contracts that have enhanced flexibility and responsiveness in meeting Forest needs. Bob has also authored several professional papers, including papers on using slope indicator instruments, determining road standards in steep terrain, and managing aggregate sources.

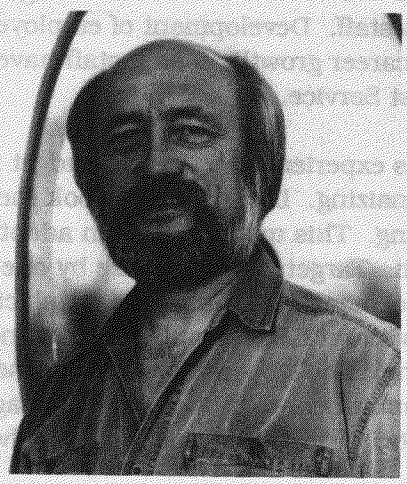
Bob has promoted an atmosphere of customer service and satisfaction. His staff is continually sought out to contribute ideas and develop strategies in all program areas. Under Bob's leadership, the Lolo NF is

considered to have one of the top lands, minerals, and engineering organizations in the Region. Bob's leadership in affirmative action and employee development have been recognized through awards, and demonstrated through creative recruitment and training positions for numerous female and minority professionals and technicians. Himself a registered professional engineer, Bob encourages his employees to seek registration. He has several professional engineers and a professional architect on his staff. Development of employees has been reflected in the successful career growth as past staff have advanced, both in and out of the Forest Service.

The Lolo NF has experienced a drastic budget reduction necessitating significant downsizing. Last year Bob took the lead in designing his staff's downsizing. This model has been adopted for the Forest's entire downsizing plan. Targeted to downsize by one-third, Bob has completed his last out-placement. This included outplacing 14 people, and was accomplished without EEO complaint, grievance, union conflict, or even a hostile meeting. Bob's openness, willingness to listen, empowerment of people, and commitment to participative management have all led to achieving results. Throughout, his unit has always achieved all assigned targets.

Active in support of youth, Bob has been a softball and soccer coach, umpire, and referee, and he was president of a youth wrestling club. Bob is also active in his homeowner's association, and has served on the community land use planning committee.

Michael R. Florey
Manager of the Year
San Bernardino National Forest (Region 5)



As Forest Engineer, Mike participates as a full member of the Forest management team, projecting engineering as an integral portion of the entire Forest program rather than as a separate function. Through Mike's guidance, engineering has developed strong partnerships with the Districts accomplishing Forestwide goals, and is recognized by Rangers and staff for their service concept.

Mike continually challenges old standard methods, and seeks to streamline engineering processes for accomplishing work. He tries new things where risks make sense. To reduce preconstruction time and costs for trails, he has encouraged employees to do away with detailed surveys and rely on typical sections, flagged locations, and specifications for contract preparation. On four recent campground projects, he encouraged fitting roads to the ground with careful, non-geometric horizontal alignment and standard sections, and without vertical control. These initiatives reduced costs and better blended projects with the landscape with no loss in quality or increase in contract administration problems.

Forest facilities have developed over time with no clear direction for design intent; styles varied even within single sites. Mike took the lead to develop an architectural theme for the entire Forest, providing a design framework for new facilities as well as those being reconstructed. Mike initiated a minor construction program resulting in improvements to three District offices, seven fire engine garage/workshops and numerous smaller projects. The Forest accomplished modification of all facilities to provide gender-equal restrooms and sleeping accommodations. Mike also has taken the lead in providing accessibility in all new projects and in retrofitting existing facilities as possible. For example, the National Children's Forest project includes 3,400 acres dedicated to outdoor education and recreation for children of all abilities. Mike worked with several of the youth, getting their input on accessible trail locations and actually locating the trail with their assistance.

Mike initiates partnerships, and his expertise is frequently sought by Forest staff; State, county, and local agencies; and private consultants. For example, the Children's Forest project also included paving an

existing road to a historic fire tower. Mike established a partnership with a local contractor to pave the road with Glassphalt, which replaces a portion of the aggregate with recycled glass. Mike also established a partnership with the City of Big Bear Lake, local water district, and Regional Transportation Planning Agency to plan an ISTEA project including a bicycle/pedestrian trail, visitor information station, tram transit stops, comfort stations, and rehabilitation of a historic damkeeper's house. Mike assisted Districts in finding funding for obliterating roads long before Congress authorized the use of road maintenance funds to obliterate roads. Because of his positive working relationship, the District CALTRANS office requested that Mike be a team member for a project developing alternatives for replacement of a bridge over Big Bear Lake Dam.

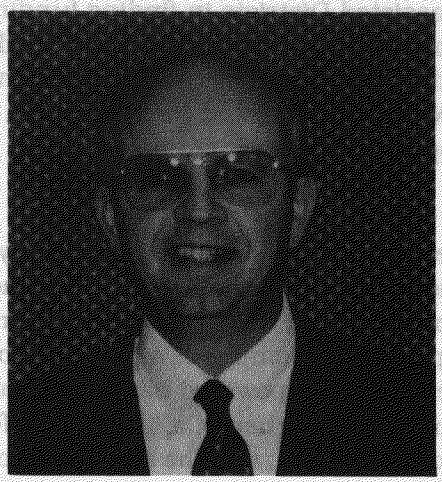
Mike has developed an excellent staff who enjoy and take pride in their work. To remove barriers, promote project ownership, and improve career development, Mike reorganized the Engineering Staff into project teams. In response to an employee's proposal to investigate the use of alternative fuels, Mike empowered her to look into the issue. She has now received a grant from Southern California Gas for $1750/vehicle fueled by compressed natural gas, and the Forest is proceeding to purchase three such vehicles. Mike's work force diversity is typified by his five direct reports—one white male, one Asian male, one Hispanic female, one African-American female, and one white female. As a registered professional engineer, Mike instills in his employees the need to continue professional development. He has established upward mobility and focus placement positions to allow development that otherwise would not have been available. With shrinking budgets, Mike has recognized the need to provide more flexibility in the engineering organization, reducing from 59 to 32 FTE's. Achieving a blend of force account and contract work, Mike continues to re-examine the organization for more efficient ways of accomplishing the work. Throughout, all targets are continually met within budget.

Mike has been a volunteer director for the Van Loon Mutual Water Company, and a member of the Upper Santa Ana Water Resources Association. As president of the Forest employee association, Mike took out a large personal loan to purchase vending machines that are now nearly paid off and will soon provide funding for employee services. Mike assisted with designing and obtaining building permits for a local church structural modification. After the Los Angeles riots, Mike saw an opportunity to employ inner-city youth on two projects, providing them interesting challenges and a real sense of accomplishment.

Larry W. Pearson

Engineering Technician of the Year

Wallowa-Whitman National Forest (Region 6)



Larry's sustained exceptional engineering support for the Forest Service mission, vision, and guiding principles has been recognized through performance ratings and numerous awards and letters from many quarters throughout his career. Larry chaired the national committee that prepared the *Guide for Implementation of Variable Tire Pressure (VTP)* and participated on the National committee that developed C-provision for use of VTP on timber sales. He worked with Districts and timber purchasers to implement VTP technology on four sales, and assisted other Forests with this new technology. Larry coordinated the retrofitting of FS vehicles with CTI equipment and developed a partnership with a purchaser to install equipment on a privately owned logging truck.

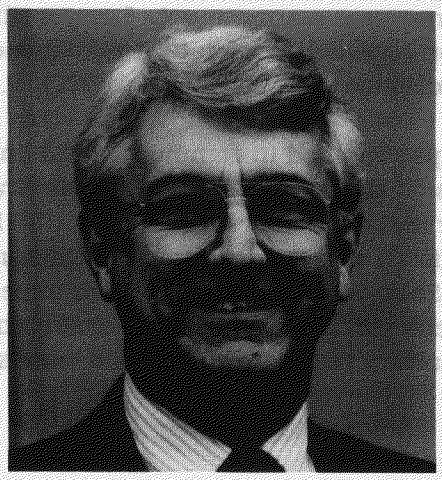
Larry is a member of the Regional Cost Guide Committee, and past chair of the Zone III Cost Guide Committee. Larry participates on the Regional C-Provisions Review Committee developing new timber sale contract provisions. He has participated in updating and rewriting Regional special project specifications for construction and road maintenance for both timber sales and public works. He is a member of the Regional Training Cadre, developing curriculums and moderating a wide variety of certification category courses, and assisted with updating the Public Works Administration exam.

Larry coordinates the Forest construction certification program, arranging and monitoring the exams on the Forest, and reviewing results with the candidates. He also convenes panels for the oral exams, ensuring diversity in panel membership. Larry provides technical assistance to the field in all phases of design and contract preparation, reviewing contract packages and performing interim and final inspections, and resolving claims. In addition to being an Engineering Representative (ER), Larry has also served as the Forest Service Representative (FSR) on timber sales. Larry participated in researching and developing specifications implementing the concept of partnering with contractors on two recent construction contracts totaling approximately $1 million.

Larry coordinates and provides expertise in the use of engineering computer program applications. He converted the Forest's standard drawings to AUTOCAD and manages the Engineering DG system. Larry has served on numerous Forest ID teams for a wide range of projects, always keeping the total Forest program and needs in mind. As the Forest value analysis coordinator, he has been instrumental in leading the analysis of not only construction projects, but also resource programs such as snag policy and fire resource management. Larry authored Engineering Field Notes articles on road obliteration techniques and temporary stream and marshy area crossings.

Larry has long participated in community and church activities. He served 10 years on the Baker City Council, several as vice mayor; he is in his twelfth year and past chair of the Baker City Public Works Advisory Committee; he is an 11-year veteran of the Baker City budget boards and member of the Solid Waste/Recycling Committee; and he is a trustee for the City of Greenhorn. Larry chairs the deacon board and the advisory board for the Calvary Baptist Church, and serves as the moderator for the church.

Gary L. Murphy
Technical Engineer of the Year
Engineering Staff (Region 8)



Over the years, Gary's performance has consistently exceeded the average, especially in those elements related to directing and introducing technical programs. Through enthusiastic communication and demonstration, he has gained the acceptance of skeptics, implemented new techniques, and brought practical solutions to resource management situations in support of Forest Service goals and objectives.

Under Gary's leadership as the group leader for transportation development, the Region is implementing new timber bridge technology. A portable bridge utilizing new stressed deck technology has been developed for temporary stream crossings. Such technology will substantially reduce streamside damage while promoting cost-effective multiple-use of the structures. An 86-foot-long span timber bridge was designed and constructed utilizing an integrated glue lam, stressed T girder and deck system, the first of its kind in the Forest Service. Increasing the timber bridge span technology will increase use of this renewable, esthetically attractive material, while decreasing the environmental impact of intermediate span supports.

As central tire inflation (CTI) coordinator, Gary formed and chaired a Regional steering committee to guide Regional implementation. He actively sought industry cooperation and participation in installing and testing CTI equipment, and worked with Forests to introduce CTI as part of timber sales.

Gary places high value on development and maintenance of professional and technical skills. He devised some unique teaching techniques to improve student involvement, offer hands-on practical exercises, and introduce a little fun into learning. Gary assumed total leadership for designing, managing, and conducting the Region's first Technology Transfer and Training University. This University brought over 300 technicians, engineers, and professionals of other disciplines together in one place for a week of intensive classroom experiences. Nearly 60 subjects were covered in one week, reducing training costs about 40 percent and being recognized as one of the most successful technology transfer conferences ever conducted in the Region.

He is a registered Professional Engineer and past president of the local NSPE chapter. He organized an R-8 task group to explore the need for professional registration for certain jobs, and to recommend a Regional policy. Gary developed course material and was the principle engineering instructor for the Sale Area Layout and Harvesting Institute. Gary also has lead responsibility for the Regional construction certification program, ensuring the continued quality of the Regional construction program. Annually, Gary conducts or instructs five to seven internal workshops. Gary ensures minority and female participation in teams, and equitable representation in training sessions and workshops.

Not only has Gary sought opportunities to implement technical developments, he continually communicates and shares the technologies and accomplishments with others both internally and externally. This has included co-authoring technical papers on CTI technology, portable bridge technology, and techniques for teaching technical subjects. The papers were published in Agency publications and professional proceedings, and presented at training sessions, workshops, industry meetings, and professional conferences.

Gary has long contributed much of his own time to community activities. Over 20 years he has coached numerous Little League and high school age baseball and basketball teams. Presently coaching Little League baseball, Gary served as president of the Stone Mountain Youth Basketball League with nearly 400 youths. He is proud of his career 75 percent win record, and coaching a team in the 1983 Georgia State Basketball Championship. He served as president of an elementary school PTA. Gary also has served in two churches as President of the Men of the Church.

Licensing Requirements for Federal Engineers

John L. Zirkle, P.E.
George Washington National Forest

Current Situation

Based on a 1992 survey conducted by the National Society of Professional Engineers (NSPE), 42 States exempt Federal Government employees from complying with State licensing laws. However, the Federal Government does not have immunity from State laws for projects covered under many of the environmental statutes—Clean Water Act, Safe Water Drinking Act, Resource Conservation and Recovery Act, Clean Air Act, Compensation and Liability Act, etc. Many States are requiring drawings and specifications for projects covered by these acts to be "sealed" by a professional engineer (PE) licensed in their State. For this reason many Federal agencies are reviewing their policies regarding licensing requirements for engineers and architects. The Southern Region of the Forest Service recently responded to these new "sealing" requirements by implementing a policy that requires Forest engineers in eight Southeastern States to be licensed professional engineers.

Why Should Engineers be Licensed?

State licensing laws should apply to ALL individuals engaged in the practice of engineering. The "practice of engineering" means:

> ". . . performing or doing, or offering or attempting to do or perform any professional service or creative work such as consultation, investigation, evaluation, planning, design, or inspection of construction for the purpose of assuring compliance with drawings and specifications, in connection with any public or private utilities, structures, buildings, machines, equipment, processes, work or projects, wherein the **public welfare or safeguarding of life, health or property** is concerned or involved, when such professional service requires engineering education, training and experience, in the **application of special knowledge** of the mathematical, physical, or engineering sciences to such service or creative work."

This is West Virginia's definition, which like most States closely follows the Model Law recommended by the National Council for Examiners of Engineering and Surveying (NCEES).

Licensing laws and boards of registration to enforce them exist because the practice of engineering involves public welfare and the safeguarding of life, health or property. It simply does not make sense to exempt individuals engaged in the practice of engineering from licensing laws because they happen to be Government employees—local, State, or Federal. The public should be afforded the same degree of protection regardless of who employs the engineer.

Requiring all Government engineers to comply with licensing laws does not mean every Government engineer would have to be licensed. Not all engineers engaged in private practice are licensed either. All States have an exemption in their licensing laws for those ". . . engaging in the practice of professional engineering as an employee under a licensed professional engineer, provided that such practice shall not include responsible charge of design or supervision." This is how the Commonwealth of Virginia's law reads. Similar wording is used by the other States.

An article in the December 1992/January 1993 issue of *Government Engineer* offers the following arguments supporting the elimination of Government exemptions from State licensing laws:

- Provides additional assurances that Government engineers, whom the public depends upon as the primary guardians of public welfare, are qualified to protect the public interest.

- Increases the public's confidence in the Government by providing assurances that Government engineers are held to the same standards of education, experience and qualifications that are expected of engineers in private practice.

- Enhances mutual confidence and respect between Government engineers and those in private practice who engage in public work projects; and

- Improves the quality of Government performance in safeguarding the public's interest because licensed engineers tend to feel more (personally) responsible for their work, and therefore make decisions more prudently.

Also, licensed professional engineers practice within a code of ethics that provides some degree of protection over political influences that might not be in the best interests of public welfare and safety. The Challenger space shuttle disaster is often offered as an example that may have been avoided had a licensed professional engineer been in "responsible charge" of the final decision to launch.

It would be imprudent to assume that just because someone has graduated with a degree in engineering that they are competent to practice engineering in responsible charge of the completed work. Would you

want to undergo surgery by an unsupervised physician who simply graduated from medical school? Or would you like to be represented by an attorney who didn't have to pass the bar exam? Before anyone should be permitted to practice a profession that requires the application of special knowledge to protect public health and welfare, the State must make a reasonable effort to determine competency.

Engineering Competence

The engineering profession, like medicine and law, requires several steps beyond graduating from college to satisfy the *minimum* competency requirements to practice. These steps vary slightly from State to State but all basically follow these:

(1) Graduation from an approved engineering curriculum—usually a 4-year ABET (Accreditation Board for Engineering and Technology) accredited curriculum.

(2) Pass an 8-hour written exam on the Fundamentals of Engineering.

(3) Attain a minimum of 4 years of hands-on engineering experience under the supervision of a licensed professional. Experience is to be professional in nature and progressive in complexity.

(4) Pass a second 8-hour exam designed to measure in a limited degree the ability to apply the fundamentals of engineering to solve practical problems.

(5) Recommended for licensure by not less than three licensed professional engineers who have personal knowledge of applicant's engineering experience and ethical character.

Just because individuals can successfully go through this process does not mean they are competent to solve any engineering problem encountered. This process merely identifies a group of professional engineers who can, with few exceptions, successfully solve engineering problems that they feel competent to attempt. As John Constance writes in his book *How to Become a Professional Engineer - The Road to Registration*, ". . . the individual engineer is the best judge of his or her own total competency. Therefore, most registration laws have at least implicitly placed the burden of proof of competence on the registrant as an ethical requirement." Registration boards will ". . . revoke a license on evidence of breach of ethical conduct in this and other respects." In other words, licensed professional engineers are only licensed to practice in those areas that they feel competent in, based on their education, experience, and training.

Proposed Licensing Policy for Federal Engineers

The Federal Government should require those employees engaged in the practice of engineering, as previously defined, to comply with the licensing laws of the States in which they practice. Only licensed professional engineers should occupy positions where the engineer is in responsible charge of design or supervises other engineers engaged in the practice of engineering. Such a policy would bring new meaning and emphasis to the title "Professional Engineer."

The title "Professional Engineer" should be reserved for the licensed professional engineer only. This would be in keeping with most State licensing laws. Title protection enables the public to quickly and easily distinguish the licensed professional engineer from the unlicensed engineer. Title protection also helps in reinforcing the "practice of engineering" as one of the learned professions in the minds of the public.

During this period of downsizing and restructuring let's take a close look at engineering organizations throughout Government to determine how many professional engineering positions are really needed. Most of us have suspected for years that some positions filled with engineers are misclassified based on the actual duties being performed. Many of these positions do not require or warrant the expense of engineers at special, accelerated salary rates. If a position does not involve the "practice of engineering" at the professional level then it should not be filled with an engineer for the following reasons:

- It is not cost effective. For grade levels GS-5 thru GS-9, engineers and architects are paid 26.4 percent more than technicians of similar grade. GS-11 engineers/architects earn 11.7 percent more than GS-11 technicians. GS-12 engineers/architects earn 3 percent more than their GS-12 counterparts.

- It is a disservice to the engineer who is expecting to function and develop at a professional level. This often causes some of Government's most promising engineers to seek employment elsewhere, leaving behind a disproportionate share of mediocre performers.

- It sends the wrong message to technicians and others who observe an individual performing at a subprofessional level but is receiving the accelerated pay reserved for engineers. This causes a morale problem for some technicians who feel underpaid and misclassified.

- It contributes to some engineers having low self-esteem since they are not functioning at the professional level. These engineers tend not to think or act like professionals. The problem is amplified when these individuals become supervisors of other engineers.

- It lowers the value and prestige of the engineering profession in the eyes of our co-workers and the public.

Hopefully downsizing and restructuring will provide us with an opportunity to improve our engineer-to-technician ratio and to strengthen the image of our profession throughout the Federal service.

The proponents for keeping the exemption for Federal engineers often argue that it would be too costly and impractical to comply with State licensing laws since Federal agencies operate in so many different States. They want to wait until there is a national licensing law. Well, don't hold your breath. There is little chance of getting the State licensing boards to surrender their autonomy. There is certainly no burning desire for Congress to pass legislation in an area that has been handled by the States since the first licensing law was passed in 1907. Most engineers would welcome a national licensing law but it's not going to happen overnight. As a profession we need to move in that direction—one step at a time. Recently the Southern Region of the Forest Service took a step in the right direction.

U.S. Forest Service, Southern Region's Licensing Policy

On November 4, 1993, the Southern Region of the Forest Service, which covers 14 Southeastern States and Puerto Rico/Virgin Islands, implemented a written policy to provide for the mandatory licensing and professional registration of specific engineering positions in their organization. As stated previously, this was in response to State laws requiring the "sealing" of engineering documents for certain types of projects covered by Federal environmental statutes. A great deal of study and employee input went into the formulation of the policy. Although not everyone agrees with all of the specifics, the vast majority of the Region's engineers and architects fully support its implementation.

A summary of the main elements of the policy are listed below. Nearly all of this material is taken verbatim from the original text written by Jerome B. Knaebel, the recently retired Regional Director of Engineering.

(1) Requires eight Forest engineers and five Regional Office staff engineers to be licensed and registered as professional engineers in their appropriate State of residence.

(2) Includes the requirement for registration as a provision of the position description for each position listed in item 1 above.

(3) Clearly outlines the professional registration requirements of the job description in all vacancy announcements for the positions listed in item 1 above. Include in the vacancy announcement a statement that the successful candidate, if not already registered in the appropriate State, will be required to obtain such registration within 1 year of the effective date. Failure to

obtain the required registration within the stated time frame will be cause for involuntary reassignment.

(4) Reimburse employees from appropriated funds for all reasonable and necessary expenses associated with licensing and registration as follows:

a. The cost of training or refresher courses and associated materials—reimbursement will be made upon the employee successfully completing the courses AND following taking, but not necessarily passing, the appropriate engineer-in-training (EIT), professional engineer (PE), or professional architectural exam. This is limited to one-time cost reimbursements for courses taken in preparation for both the EIT, PE, and architectural exams.

b. The cost of all EIT, PE, or architectural application and exam fees UPON SUCCESSFULLY PASSING THE EXAM.

c. The use of official time is authorized for employees to take the EIT and PE exams and to apply to the current State of residence for registration under reciprocal agreements. Where such application is being made in compliance with a mandatory provision of a job description, Government facilities and materials may also be used.

d. The cost incurred by any employee already registered in a State for applying for licensing and registration in another State to which the employee has been transferred.

e. The cost of all annual fees for renewal of registration IN THE CURRENT STATE OF RESIDENCE.

This policy should apply to all employees seeking professional licensing and registration. Registration is not something that can be accomplished in a single quantum step upon reaching a target career position. It must be accomplished through a series of steps over a period of many years. Therefore, employees must initiate pursuit of this objective very early in their careers, usually soon after leaving college.

(5) In accordance with existing policy, periodically review position descriptions to ensure they reflect the appropriate degree of technical difficulty and complexity of the duties included. Ensure that position descriptions reflect appropriate shifts in professional work brought on by program changes.

(6) Use existing awards and recognition procedures to recognize employees for professional enhancement and involvement in professional societies, as well as for job performance.

(7) Make mentor training available to supervisors of professional employees to ensure that subordinates have competent advisors to assist in career planning.

(8) Use details to other units to provide employees with a diversity of work experiences.

(9) Devote increased attention to preparing individual career development plans to ensure they include all areas essential to being a fully successful professional engineer.

This policy will ensure that the Southern Region of the Forest Service complies with State laws as authorized by Federal statute, while at the same time providing positive support for the professional enhancement of its employees. It places professional responsibility squarely on those in responsible charge of our engineering design and construction work, yet relieves those same employees from the financial burden created and helps to ensure their protection in the event of tort litigation.

It is anticipated that additional States will impose their rights of primacy in the future. Therefore, it will be necessary to adjust this policy periodically to include those States that elect to do so.

Closing Arguments

No Federal agency would even consider accepting an unsealed set of engineering drawings from an A&E firm. Why shouldn't Government engineers be held accountable for their work by affixing their seal in accordance with the applicable State laws? They certainly have no problem accepting the extra money for supposedly being professional engineers and architects.

What message are Federal agencies sending their engineers by not requiring them to seal their work? Could it be that your work is not worth sealing or that you are not a professional after all? Federal agencies need to stop being afraid and begin finding ways to comply with State licensing laws. They need to start treating their engineers and architects like the professionals they are. The Federal Government needs to stop hiding behind the shield of sovereign immunity and work with the States as an equal partner in enforcing licensing laws for ALL engineers and architects. This issue is not going to go away. We can anticipate continued pressure from the States and from the public for Federal engineers to comply with the licensing laws designed to safeguard public welfare, life, health, and property.

The Federal Government desperately needs more leaders like Jerome B. Knaebel who tackled the licensing and professional development issue for his organization head on. Hopefully his leadership, vision, and commitment to professional engineering in Government will be emulated by others. No, the policy he wrote isn't national in scope. No, it does not abolish the Federal exemption, but it is a first step in the right direction.

Interagency Agreement between the USGS and FS for the Production and Maintenance of a Single-Edition Primary Series Quadrangle Map

André J. Coisman, Geometronics Group Leader
Rocky Mountain Region

Introduction

Engineering Field Notes, Volume 26, May-June, 1993, contained an article entitled "Production and Maintenance of a Single Edition Series of Quadrangle Maps (One-Map Initiative)." It provided a brief historical perspective and description of the initiative's beginning as well as current and future status.

Interagency Agreement

The purpose of this followup article is to inform you that on August 16, 1993, U.S. Geological Survey Director Dallas Peck and Forest Service Chief F. Dale Robertson approved an Interagency Agreement (IA) related to this initiative. The content of the IA in its entirety is as follows:

INTERAGENCY AGREEMENT
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
AND
U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
FOR THE
PRODUCTION AND MAINTENANCE OF A SINGLE-EDITION
PRIMARY SERIES QUADRANGLE MAP

I. PURPOSE

This Interagency Agreement (IA) sets forth the terms and conditions under which the U.S. Department of the Interior, U.S. Geological Survey (USGS), National Mapping Division (NMD), and the U.S. Department of Agriculture, Forest Service (FS) National Forest System (NFS) will coordinate the production and maintenance of a single-edition primary series map for quadrangles containing FS areas of interest. This IA is enacted under the 1992 Memorandum of Understanding (MOU) established

between the USGS and the FS for the production, exchange, and dissemination of cartographic products and services.

II. BACKGROUND

The FS is responsible for the land management of more than 191 million acres of NFS land, including 156 national forests, 19 national grasslands, and 84 experimental forests and ranges. To accomplish its mission, the FS requires cyclically updated base cartographic, remotely-sensed, and geographic or resource spatial data to meet its unique land management requirements.

The USGS, as the Nation's principal civilian mapping agency, is responsible for the production, collection, archiving, and dissemination of base cartographic and remotely sensed data in both conventional map and digital form for the United States, its territories, and possessions. To accomplish this mission, the USGS produces and maintains several series of accurate, general-purpose base maps, and develops and maintains a digital spatial feature data base to meet broad, multipurpose needs.

The FS and the USGS have a long history of cooperation in the production of maps and associated digital data products. Previous agreements between the two agencies have resulted in improved service to the public through significant reduction in duplication of effort and the sharing of maps and digital data products meeting common standards.

III. SCOPE

Under this IA, the FS and the USGS will collaborate on the production and maintenance of a single-edition full color primary series map for 7.5-minute (15-minute in Alaska) quadrangles containing FS areas of interest. These maps are referred to by the FS as the Primary Base Series (PBS). The FS will assume primary responsibility for maintenance of single-edition maps for most areas of FS interest. The USGS will assume primary responsibility for maintenance of selected single-edition maps containing FS areas of interest. Assignment of primary responsibility for individual maps will be noted in an amendment to this agreement. The USGS will be responsible for the printing and distribution of quadrangle maps produced under this IA.

As needed, the FS and USGS will cooperate on such supporting activities as exchange of program planning information, acquisition of aerial photography, collection and exchange of digital cartographic data, exchange of stable base source materials, exchange of correction/edit guides and related revision materials, and technical assistance and technology transfer.

IV. AUTHORITIES AND POLICIES

This IA between the FS and USGS is joined under authority of the Economy Act of 1932, as amended (31 U.S.C. 1535-1536) and Office of Management and Budget Circular A-16 as revised in 1990.

V. DEFINITIONS

Primary series maps subject to this IA will be produced and maintained by both Agencies in accordance with the provisions contained in jointly prepared USGS/FS single-edition quadrangle procedures, standards, and specifications documents.

Quadrangle maintenance is defined as all activity associated with the planning and execution of revision or updating of quadrangle content. Such tasks include, but are not limited to, coordinated program planning, project technical planning, quadrangle revision/update, product generation, and quality assurance.

VI. RESPONSIBILITIES

Forest Service (FS)

FS will:

- Define the current FS area of interest and identify associated quadrangles.
- Monitor changes in status of NFS land and, in coordination with the USGS, modify the quadrangle inventory as needed.
- Develop the annual FS PBS program of work in coordination with USGS.
- Coordinate requirements for product content, accuracy, format, and symbolization specifications with the USGS to maintain joint product standards.
- Maintain working copies of quadrangle maps and related materials, e.g., quadrangle reports, assigned to the FS in accordance with joint procedures, standards, and specifications.
- Identify FS-assigned quadrangles needing replacement mapping and/or standard update, and coordinate revision with the USGS.
- Produce quadrangle-based separation film materials for each assigned quadrangle.
- Provide USGS with separation film materials for printing.

- Provide USGS with FS PBS correction guides, available digital data, and other supporting revision materials for USGS-assigned quadrangles as needed.

- Maintain a level of effort with PBS revision which supports the FS PBS program and ensures timely and efficient completion of work as mutually agreed.

- Provide the USGS with technical assistance and opportunities for technology transfer as needed.

U.S. Geological Survey (USGS)

USGS will:

- Provide FS with quadrangle reports, correction files, and other materials as needed for quadrangles assigned to the FS.

- Coordinate USGS primary quadrangle revision program for USGS-assigned single-edition quadrangle areas. Include coordination of related A-16 requirements with the FS.

- Coordinate requirements for product content, accuracy, format, and symbolization specifications with the FS to maintain joint product standards.

- Provide FS with available digital data and other supporting revision materials for FS-assigned quadrangles as needed.

- Maintain all correction files for quadrangles identified under this IA.

- Maintain quadrangle maps and related materials, e.g., quadrangle reports, assigned to the USGS as part of this IA in accordance with joint procedures, standards, and specifications. Maintain permanent map reproduction materials for all quadrangles covered under this agreement.

- Evaluate replacement mapping and standard update needs identified by the FS and accomplish as resources permit.

- Produce quadrangle-based separation film materials for each assigned quadrangle.

- Print and distribute all quadrangle map products produced under this IA.

- Price all maps produced under this agreement the same as other USGS maps of the same series.

- Store all separation and derivative materials produced under this IA and fill orders for film products.

- Maintain a level of effort with PBS revision which supports the FS PBS program and ensures timely and efficient completion of work as mutually agreed.

- Accomplish reprint/minor revision tasks as needed for quadrangles identified under this IA. Provide FS with duplicate reprint materials.

- Provide the FS with technical assistance and opportunities for technology transfer as needed.

Forest Service and U.S. Geological Survey

The FS and the USGS will evaluate all primary series quadrangles identified as containing FS areas of interest and determine primary Agency responsibility for their maintenance.

The FS and USGS will meet at least twice annually to:

- Review and coordinate the FS PBS Program of Work and the USGS primary series quadrangle revision and reprint programs.

- Review status of work-in-progress.

- Identify and address programmatic and technical issues that surface through execution of this IA. As needed, issues will be passed to joint working groups for further discussion. Recommendations will be provided to the Management Oversight Group.

VII. IMPLEMENTATION PLAN

A joint USGS/FS Management Oversight Group will be maintained to provide overall coordination of the single-edition primary series map program. Membership shall consist of an equal number of senior managers from USGS-NMD and FS-NFS-Engineering-Geometronics Service Center. A joint Standards Working Group will be maintained to document and maintain joint edition standards, and define and resolve product content, accuracy, format, symbolization, and similar specifications issues. Joint Programmatic and Printing and Distribution Working Groups will be established as needed to address specific program, process, and other operational coordination issues. To provide continuity, the joint Technical Working Group, established prior to the implementation of this IA, will remain as constituted or as amended and will continue to serve at the discretion of the Management Oversight Group.

VIII. TECHNICAL REQUIREMENTS

It is the intent of both the FS and USGS that primary series maps produced under this IA shall meet graphic and content standards contained in the jointly prepared single-edition quadrangle map procedures, standards, and specifications documents.

IX. FINANCIAL ARRANGEMENTS

The revision of most quadrangles in or near NFS land will be accomplished using methods comparable to Limited Update procedures (USGS Supplemental Technical Instruction 93-2-C) and will not require a transfer of funds between USGS and FS. When quadrangles are identified as needing to be revised using standard update or replacement mapping procedures, and cannot be accomplished within existing capacity, a separate cooperative agreement involving work-share and/or cost-share arrangements will be negotiated.

X. PERIOD OF AGREEMENT

This IA will remain in effect until terminated by either Agency and may be modified at any time upon joint approval.

XI. POINTS OF CONTACT

U.S. Geological Survey: Chief, National Mapping Division

Forest Service: Deputy Chief, National Forest System

XII. APPROVALS

Director, U.S. Geological Survey U.S. Department of the Interior	Chief, Forest Service U.S. Department of Agriculture

Conclusions

Subsequent to the signing of this IA, WO Engineering distributed sample copies of the color prototype Single Edition Quadrangle, Mt. Defiance, OR and WA, to Regional Offices who in turn made distribution to Forest Supervisors and District Rangers.

A joint final review of the USGS/FS revised cartographic map standards and templates for this series is scheduled for mid-January 1994 at the Geometronics Service Center (GSC) in Salt Lake City, Utah. Upon finalization, the phased transition from production of Primary Base Series products that we now have to the revised standards will begin. This IA establishes the FS as a national mapping authority with responsibility for maintenance of approximately 20 percent of the quadrangles in the United States.

This partnership initiative will provide value added information to public map users while significantly reducing duplication of efforts that will result in overall dollar savings. This effort is a model example of an activity contributing to the Administration's goal of "Reinventing Government."

Road Closure and Obliteration Project

Jeff E. Moll, P.E.
Project Leader, Roads Program
San Dimas Technology and Development Center

The following "flier" was sent by DG to Forest Service field units in late February 1994, summarizing expectations at the time for the Road Closure and Obliteration Project. Response from the field was overwhelming. Forests and Districts in Regions 1, 3, 4, 5, 6, 8, and 10 offered information, experience, and comments. Many excellent suggestions were made for expanding project scope and inclusion of critical topics. These are summarized following the original document.

The San Dimas Technology and Development Center (SDTDC) is undertaking a 2-year road closure and obliteration project. Employees from all disciplines are encouraged to participate. Road closure and obliteration is becoming important as an integral part of watershed and hydrologic restoration, and is also an important component of ecosystem management.

Project goals include taking a proactive stance in anticipation of field needs for information on closure devices, types of obliteration, methodologies, success rates, appropriate machinery, production rates, and cost estimating. Information will also be made available on new technologies, construction materials and equipment, innovations, and the results of research. Much beneficial work has been done; our primary goal is assemblage of a broad knowledge base.

Closure devices include gates, posts, fences, or may be crafted from native materials such as boulders, soil, logs, slash piles, and vegetative plantings. Information will be displayed in matrix form on purpose, type, application, and cost.

Types of obliteration range from simple abandonment to mechanical unbuilding and return to contour. Information on optimizing type on a given road segment will be provided, also in matrix format if appropriate.

Potentials for research include plot rainfall simulation for the effects of ripping and straw covering on hydraulic conductivity; hydrologic restoration; re-establishment of subsurface flow; and erosion potential; paired watershed studies for hydrograph modification; and reduction of increased drainage networking due to roads.

This project is heavily dependent on submissions from the field. Many Forest Service units have extensive experience; this project allows sharing and showcasing. We need information on your projects, yet we are designing for outreach with minimal impact on your time. We ask for whatever information exists; SDTDC can develop CAD drawings, specifications, procedures, and photography. Participate in this project by contributing to efforts at environmental enhancement and make a difference!

Jeff Moll is the project leader for the Road Closure and Obliteration Project. He may be contacted at (909) 599-1267 or J.Moll:WO7A. FAX (909) 592-2309.

SDTDC's address is:

444 E. Bonita Ave.
San Dimas, CA 91773

Suggestions from the field for expanding project scope include:

- Inclusion of terminology, definitions, and/or a glossary of terms.
- Guidelines for the NFMA, NEPA, and Interdisciplinary Team processes.
- Guidelines for consideration of the inventory status of bridges and major culverts existing behind closures and not slated for removal.
- Inventory process guidelines.
- Planning, location, design, and construction of roads to facilitate the closure and obliteration process and re-contouring.
- Development of survey procedures, design software, and construction (or de-construction) staking for re-contouring road prisms, using the latest technologies.
- Preparation of standard specifications and a format for special project specifications.
- Compilation of a library of AUTOCAD drawings.
- Information on contracting.
- Conversion of roads to trails.
- Use of volunteer and manual labor.
- Incorporation of wildlife drinkers.

- Information on restoration of natural drainage patterns.
- Information on the stability of closed and obliterated roads.
- Preparation of monitoring and tracking procedures for closed and obliterated roads.

Errata to "Specifications for Differential GPS Coordinate Data Submission to the Geometronics Service Center"

In the July-August 1993 issue of *Engineering Field Notes*, the standard formats given in the "Specifications for Differential GPS Coordinate Data Submission to the Geometronics Service Center" contained two errors. One example was omitted and one was improperly titled. The following are the correct formats.

Standard Formats

Example of Point Feature Format

METADATA STATEMENT

PNT, 083092, R04A, 1, 08, 10, 6, 6, 3D, 1, 1, 20, 180, NAD27, SPC27, 1101

COORDINATE POINT DATA

BOI, 6S, 44E, 24, 427, 745720.10, 441661.60

Example of Line or Polygon Feature Format

METADATA STATEMENT

LNE, 083092, R04A, 1, 08, 10, 6, 6, 3D, 1, 1, 20, 180, NAD27, SPC27, 1101

COORDINATE DATA

BOI, 6S, 44E, 24, 101
745720.10, 441661.60
745718.66, 441653.30
745715.21, 441644.17

Example of Special Circumstance Feature Format

METADATA STATEMENT

SPC, 083092, R04A, 1, 08, 10, 6, 6, 3D, 1, 1, 20, 180, NAD27, SPC27, 1101

COORDINATE POINT DATA

BOI, 6S, 44E, 24, 556, **393C4**, 745720.10, 441661.60
(Identifying Mineral claim, 393, corner 4)

Example of a Non-Standard Feature Format

METADATA STATEMENT

NON, 083092, R04A, 1, 08, 10, 6, 6, 3D, 1, 1, 20, 180, NAD27, SPC27, 1101
Description statement would have to be included.

COORDINATE POINT DATA

Format would be unique to the user.

With a common framework of guidelines, the use and reliability of GPS data will become an integral part of map revision and new mapping. The added information contained in the Metadata Statement will aid the user in determining the appropriate application and reliability of the coordinate data. The framework will encourage standardization of GPS data so its usefulness can be maximized and questionable data can be identified.

The Lasersoft Revolution

Jeff E. Moll, P.E.
San Dimas Technology and Development Center

Introduction

LASERSOFT and the Laser Technology, Inc. (LTI) Criterion 400 survey laser instrument constitute a virtual revolution in pre-design activities for many projects requiring field survey in the Forest Service. The instrument makes and downloads survey measurements in a couple of seconds; LASERSOFT is MS-DOS compatible software that provides a user-friendly platform for survey management and data conversion into formats required by several widely used PC-based road and site design software systems. This article provides information specific to LASERSOFT V1.0 usage, in addition to brief overviews of laser instrument capabilities and existing and planned survey routines. "Reflector assemblies" and rods used during a laser survey are described, as are control and test surveys conducted to date. Step-by-step instructions for a simple survey are available from the San Dimas Technology and Development Center (SDTDC), including "quick key" help menus and options made possible by the LASERSOFT system.

LASERSOFT is an evolution of ROADSOFT, created by LTI software engineers primarily for low-volume road surveying and data conversion for import into LUMBERJACK and FLRDS road design systems. Incorporation of a conversion for ASCII 3-D coordinate files followed, as did conversions for RDSPC and ROADCALC, capable of performing higher-standard and geometric design. The 3-D information may be tailored for import not only to road design systems, but terrain modeling, site design, and CAD type software, making possible a host of survey applications useful in most resource areas of the Forest Service. Indeed, the name was changed so specialists in all disciplines would realize the system is not restricted to road-related or engineering surveys. LASERSOFT operates on several MS-DOS compatible data recorders and the PC.

LASERSOFT is much more sophisticated than previous laser survey management systems discussed by this author, although one—MC-TRAVERSE, which runs on the Corvallis Microtechnology, Inc. MC-V data recorder—has been refined by the Malheur National Forest and is being used by Forests in Region 6.

The LTI Criterion 400 Survey Laser Instrument

The instrument uses an infrared semi-conductor laser diode for slope distance (SD) measurement. A vertical tilt-sensing encoder provides vertical inclination (VI), while a fluxgate electronic compass measures magnetic azimuth (AZ), completing the data required to establish a point's 3-D location in space.

Manufacturer specifications give the instrument a slope distance measurement range of 1.5 to 9,150 meters (5 to 30,000 feet) when sighted on a retrodirective prism, and from 1.5 to 450 meters (5 to 1500 feet) when sighted on a "non-cooperative" target, such as a tree or the ground. A common 7.5-centimeter (3-inch) diameter plastic automotive reflector—with hundreds of tiny prisms—carried by a rodperson, is used in conjunction with a filter on the instrument to ensure measurement only to the desired point. With filter and reflector, the instrument will measure through heavy vegetation, reducing the amount of clearing required compared to existing survey methods.

Accuracy specified by LTI for slope distance measurements is plus-or-minus 0.1 meter (0.3 foot); for vertical inclination, plus-or-minus 0.2 degree (0.35 percent slope); and for azimuth, plus-or-minus 0.5 degree. Results of controlled tests performed by SDTDC show average error to be within these values.

Eye safety for the instrument meets FDA Class 1, (CFR 21), which means no measurable eye damage results after three hours of constant exposure to the laser beam. The laser beam contains only 5 percent of the energy of the average TV remote control. See Figure 1 for the survey laser field hardware configuration.

Surveying Routines

LASERSOFT duplicates standard traverse and cross-sectioning and makes possible an economical, efficient "repeating radial." Standard methodology is potentially replaced, as the repeating radial makes full use of laser system utility in providing quick data collection to any point of interest. Gone are the instrument constraints that defined development of the standard method.

A traverse is simply a string of points—called points-of-intersection, or PI's—connected by survey measurements that establish their 3-D locations. Cross-sections are also strings of points, referred to as side shots, and associated with a particular PI. Thus, the traverse may be considered a baseline, while side shots are made from the baseline to points of interest. The cross-section is generally made along the angle bisect in the traverse, allowing the assumption of horizontal angle; the surveyor needs to make only distance and vertical control measurements to determine the 3-D location of a side shot. PI #1 in Figure 2 shows a standard cross-section, the horizontal angle in this case perpendicular to the traverse link between PI #1 and PI #2.

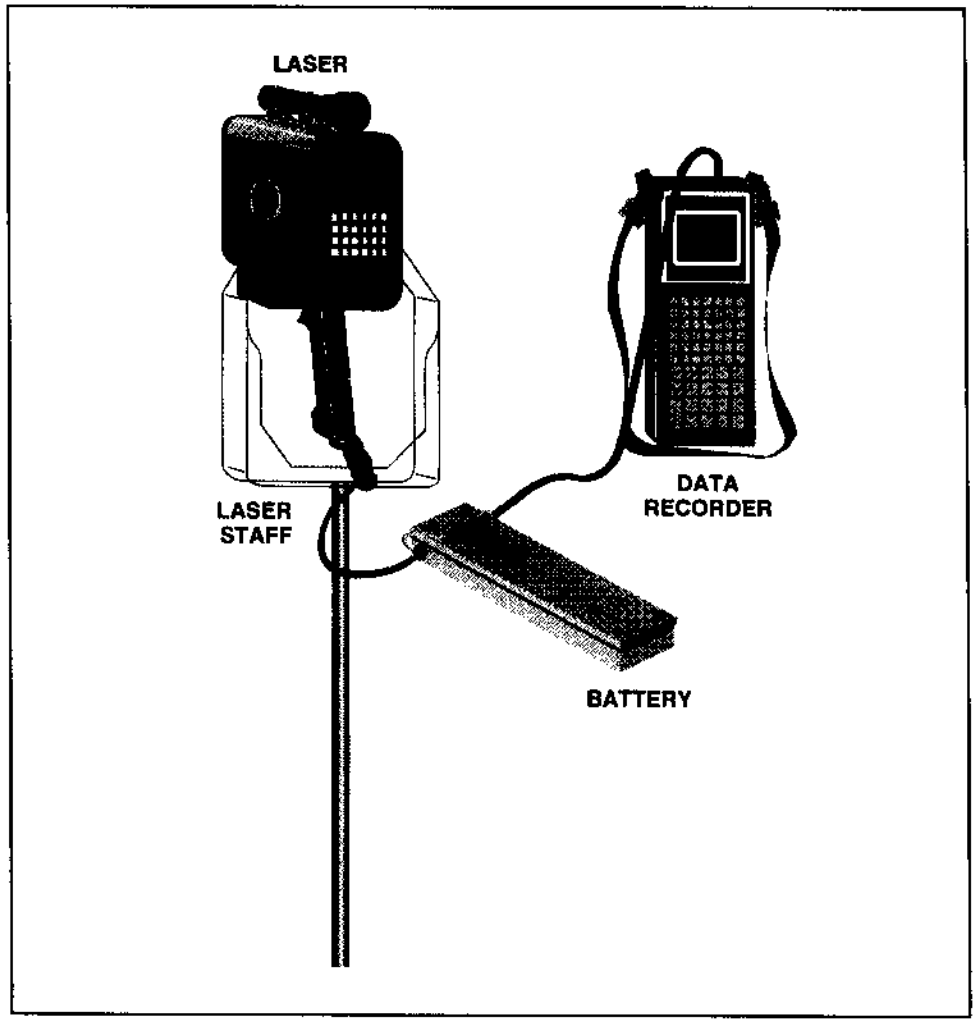


Figure 1.—Survey Laser Field Hardware Configuration.

Radial side shots require collection of 3-D information, as they may be made in any direction. PI #2 shows simple radial side shots, while radial side shots associated with PI #3 illustrate use of turning points. The instrument must be set up on the turning point for measurement to subsequent side shots, generally due to a lack of sight distance to the side shot from the PI.

Multiple radial shots may be made from a turning point side shot as well as from a PI, and multiple side shot lines may be built at a PI (see PI #4). Thus, the term "repeating radial" actually refers to three types of repeatability: these multiples, and their repeating nature at any PI. The repeating radial takes full advantage of laser functionality in that a commanding position—one with a good view—may be occupied by the instrument person to maximize the number of side shots possible at the PI or turning point; these positions need not lie within the project corridor. Road

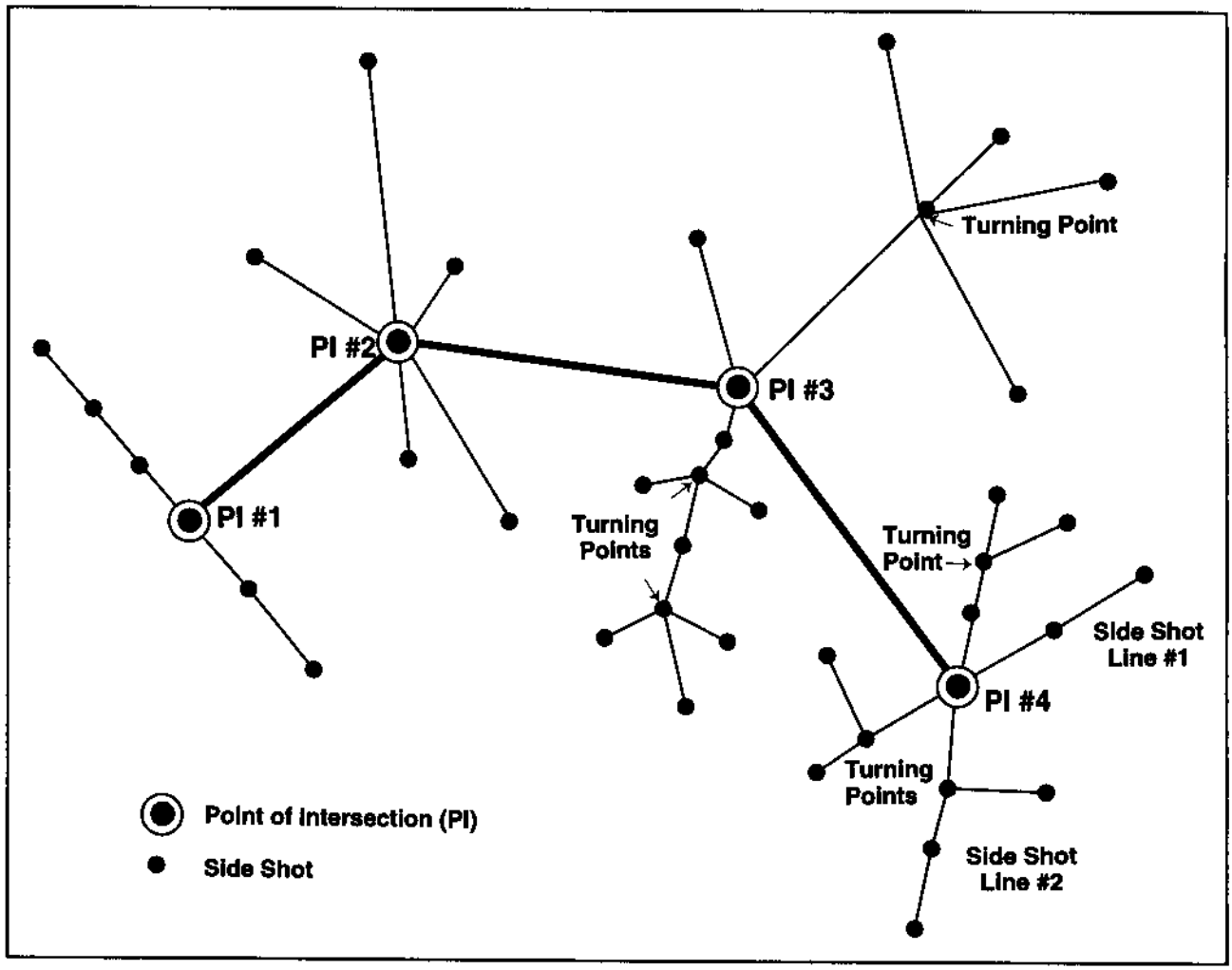


Figure 2.—Plan View of Traverse and Side Shots.

or site design software accepting stacks of 3-D coordinates are used in conjunction with the repeating radial survey.

LASERSOFT operators have requested that algorithms be developed for an automated construction staking routine; the prototype planned will accept road design results from the LUMBERJACK road design system and provide measurements (to be made with the laser) for the iterative staking process. Additionally, an automated "GRID," systematically built of foresight and backsight traverse links, and with side shot capabilities, is under consideration for site surveys and mapping projects requiring higher precision.

The Instrument Rod and Reflector Assembly

Some remarks concerning the instrument rod and "reflector assembly" are helpful in clarifying options available during surveying. The instrument rod used by SDTDC is a modified telescoping EDM prism staff,

adjustable for height of instrument (HI) between approximately one and two meters (three to six feet), and fitted with a bull's-eye bubble for maintaining plumb.

Additionally, SDTDC has manufactured two prototype reflector assemblies, named in honor of the reflector that makes laser surveying applications possible, and at $0.79, the cheapest of the hardware componentry (Figure 3). One assembly has a Lietz orange-and-white paper target and a reflector attached to a plate. The other incorporates a flashlight into the target, useful for sighting-on in heavy brush. The reflector assemblies are adjustable to any height on the reflector rod, allowing

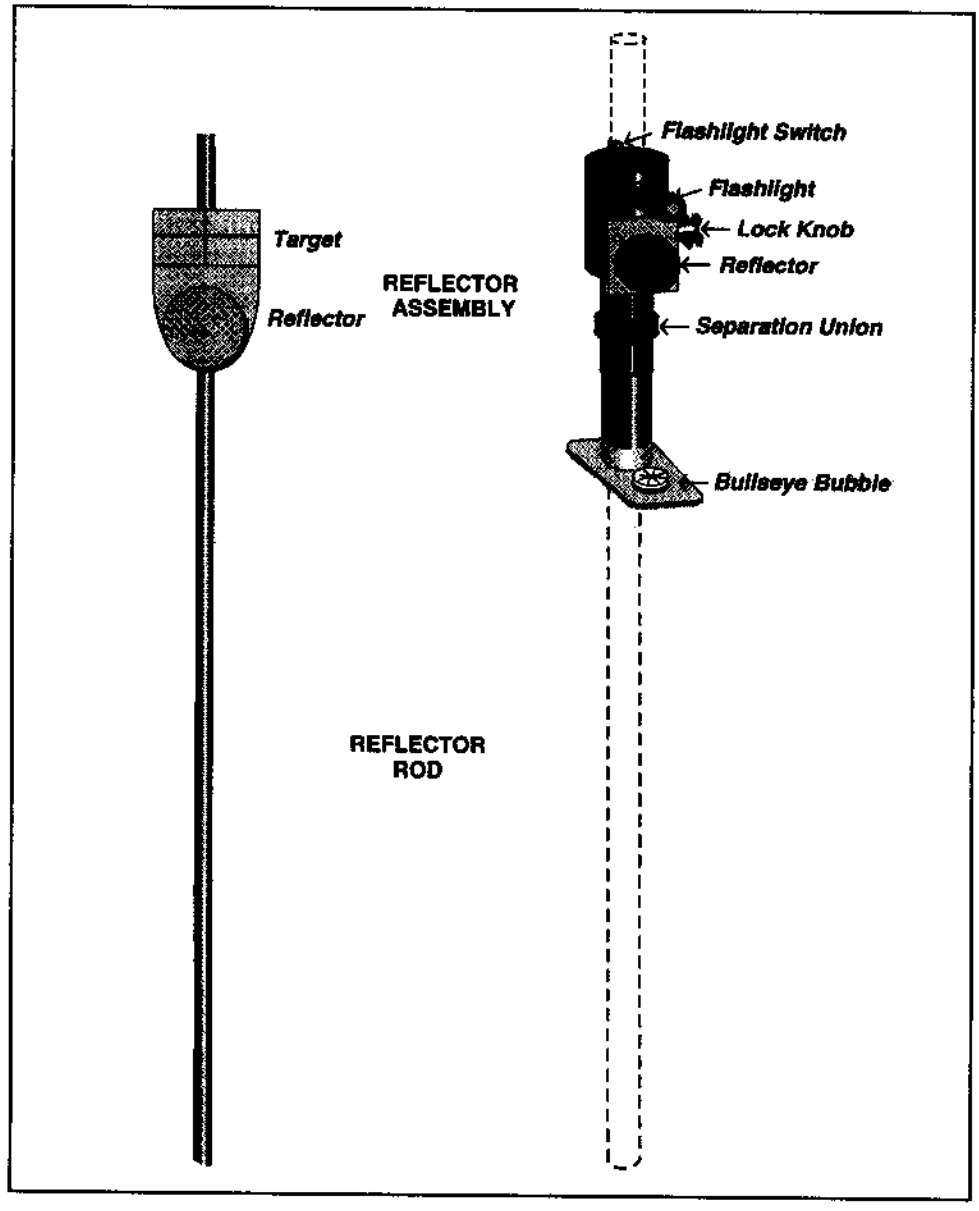


Figure 3.—Reflector Assemblies and Rod.

management of height of reflector (HR) and "boot heights." The assembly with the flashlight also has a bull's-eye bubble that separates from the reflector/target portion for maintaining plumb even as the reflector is booted up the rod. Booting up or down is sometimes required to provide line-of-sight for the instrument person. Individual boot heights may be input into the Traverse Pt. and Side Shot Pt. Screens of LASERSOFT; like HI and HR, they are automatically reduced by the software.

The vertical distance between target and reflector centers is 8.9 centimeters (3.5 inches). This matches the distance between scope and receiving diode—at instrument center between yoke knobs and thus, also HI—in the laser instrument. HI should be set for comfort by the instrument person; HR (the center of the reflector) usually is set the same as HI. The laser scope is sighted on the target (flashlight); the instrument makes measurements between instrument center and reflector center.

A reflector assembly designed by LTI presents two targets, one situated as described above and the other centered 3 inches below the center of the reflector. The lower target is sighted-on by a transit that supplies higher precision horizontal and vertical angles. The transit is coupled with a laser diode for slope distance measurement. Refinement of this prototype instrument and the reflector assemblies is ongoing.

The horizontal distance (in inches) between the center of the reflector rod and the reflector surface is referred to as prism offset, and should be measured and input—along with HI and HR—into the Inst/Targ Height screen of LASERSOFT. These values remain in effect for all measurements until different values are keyed in; only one set of values may be input for a particular traverse point and the associated side shots.

Control and Test Surveys

Several control and test surveys have been conducted to date. These include control surveys for investigation into instrument accuracy and precision, and various test surveys for troubleshooting survey management software, investigating instrument utility, and predicting economic benefits.

As noted above, control surveys indicate average sensor error is within LTI system specifications. Instrument precision is described in terms of the 95 percent error as follows: E95 for slope distance is 1.8 centimeters (0.06 foot); for vertical inclination, 0.05 degree (0.08 percent slope); and azimuth, 0.11 degree.

Test surveys thus far conducted include:

(1) Duplication of a standard traverse and cross-section low-volume road survey performed by a five-person crew using a 100-foot cloth tape, 75-foot retractable logger's tapes, and hand clinometers and compasses. A two-person laser crew performed the same work on the ground in 80 percent of the time. Neither

survey required clearing. Manually keypunching standard data into the LUMBERJACK road design system required 83 minutes, while electronic laser data transfer and related activities with LASERSOFT requires between 5 and 15 minutes.

(2) A four-person laser crew performing low-volume road surveys in brushy, mountainous terrain on the Gunnison National Forest of Region 2 produced at the rate of one station, 30.5 meters (100 feet) every 2 minutes. The average distance between PI's was 15 meters (50 feet). Thus, one PI stake was pounded per minute on the average. Approximately 3 percent of shots required clearing. Data conversion and import into LUMBERJACK took less than 10 minutes per road. Average road length was 1200 meters (4000 feet).

(3) The North Zone of the Black Hills National Forest, also in Region 2, hosted a test survey consisting of a 12 PI traverse with cross-sections averaging six side shots each. The survey was performed by the standard method and duplicated first with an EDM for control, and then with the laser instrument. Many deviations from control by the standard are apparent when comparing traverse, profile, and cross-section plots. Inspection reveals causes including low resolution of standard instruments, and human error in reading standard instruments and in recording and keypunching standard data. Comparisons of laser-derived versus EDM plots shows almost perfect overlay: only a couple of cross-section plots are off by as much as the width of a plotted line. Heavy oak brush was manually pushed out of the way to provide sight distance on approximately 36 shots during the standard and EDM surveys. Similar clearing was required on only four shots during the laser survey.

(4) Road obliteration surveys on the Six Rivers National Forest in Region 5 performed by a four-person laser crew in which 4.5 meter (15 foot) deep by meter (100 foot) embankments over 76 centimeter (30 inch) CMP were to be removed. Repeating radials were employed requiring an average of 45 minutes per site. An average of 60 shots—only a few of which needed clearing—were made at each site. The data were electronically imported into Design Cad software for contour map development. Templates can be fabricated in field design to model recontouring, and earthwork quantities and construction staking notes can be generated after survey completion on a laptop computer at the site. Thus, all field work supporting preconstruction activities may be completed in a single trip.

(5) A "GRID" prototype has been tested for higher precision survey requirements, with the points in the grid established by foresight/backsight traverse links. This routine allows data

averaging, and thus increased accuracy; the duplication also feeds error tracking and correction algorithms. Results for a 20 point grid indicate raw closure ranges of 1:500 to 1:5000 horizontally and between 1:50 and 1:500 vertically, depending on site conditions. This particular grid was performed with the laser on a staff; tighter closures are possible when tripod-mounting the instrument.

(6) Numerous other surveys have been conducted by SDTDC to test LASERSOFT algorithm outputs for the following options:

- foresight/backsight averaging;
- reduction of turning points on side shots;
- reduction of boot height and HI and HR inputs; and
- reduction of side shot data to coordinates for extra side shot lines at a PI.

Step-by-step instructions for a simple survey, including quick key help menus and options made possible by LASERSOFT, are available by contacting J.Moll:WO7A or (909) 599-1267. SDTDC plans to issue a Tech Tip detailing the instructions in the spring of 1994.

Additional information on the LTI Criterion 400 survey laser and LASERSOFT program may be obtained from LTI at (303) 649-1000.

Engineering Field Notes

Administrative Distribution

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THE ENGINEERING FIELD NOTES is published periodically as a means of exchanging engineering-related ideas and information on activities, problems encountered and solutions developed, or other data that may be of value to Engineers Service-wide.

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