United States
Department of
Agriculture

Forest Service

Engineering Staff

Washington, D.C.

Engineering Field Notes

Volume 18
November-December
1986

Engineering Technical Information System

Engineering Field Notes

Administrative Distribution

- Professional Development
- Management
- Data Retrieval

This publication is an administrative document that was developed for the guidance of employees of the Forest Service—U.S. Department of Agriculture, its contractors, and its cooperating Federal and State Government Agencies. The text in the publication represents the personal opinions of the respective authors. This information has not been approved for distribution to the public, and must not be construed as recommended or approved policy, procedures, or mandatory instructions, except by Forest Service Manual references.

The Forest Service—U.S. Department of Agriculture assumes no responsibility for the interpretation or application of this information by other than its own employees. The use of trade names and identification of firms or corporations is for the convenience of the reader; such use does not constitute an official endorsement or approval by the United States Government of any product or service to the exclusion of others that may be suitable.

Please direct any comments or recommendations about this publication to the following address:

FOREST SERVICE—USDA
Engineering Staff—Washington Office
Attn: D.J. Carroll, Editor
M.J. Baggett, Editorial Assistant
P.O. Box 2417—Washington, D.C. 20013

Telephone: Area Code 703—235-8198

1986 *Field Notes* Article Awards

The year is coming to a close, which means it is time to vote on the best three Field Notes articles of the year.

Did you find any articles particularly useful or interesting? Did any article help you save time or money on a specific task? Did a Field Notes article help you, in any way, to perform better on the job?

If so, please complete the rating sheet on the next page. Select the three articles that you found most useful, interesting, or informative and rate them from 1 (highest) to 3 (lowest). Wherever applicable, please indicate the amount of money you believe was saved or could be saved as a result of the article.

NOTE: DO NOT RATE MORE THAN THREE ARTICLES.

Tear out the page along the perforation and mail it to the Washington Office. YOUR RATING SHEET MUST BE DELIVERED TO THE WASHINGTON OFFICE BY DECEMBER 31, 1986, for your selection to be counted.

If you have a better way to perform a certain task--or if you have some information that you feel should be shared--write an article for Field Notes, and you may win an award!

1986 Field Notes Article Rating Sheet

Article/Author	Choice (1,2,3)
ASNAP: Administrative Site Needs Assessment Process (L. Kanno, R-5)	____
Device to Measure Road Dustiness—1985 Summer Field Evaluations (D. Taylor, WO)	____
Keeping Beavers From Plugging Culvert Inlets (P. H. Fisher, SDEDC)	____
The Mammoth Alternate Exit Road Aerial P-Line Survey (G. Salsig, R-5)	____
Using HP-41C for Preliminary Road Cost Estimation (F. Ou, WO; T. Durston, R-6)	____
Potential for Engineering Cost Savings With Analytical Photogrammetry (W. Valentine, R-1)	____
Decisions...Decisions...Decisions (J. Suhr, R-4)	____
Network Analysis Using Microcomputers for Transportation Planning (J. Sessions, OSU)	____
Study of Quality of Aerial Photography (H. Lachowski, WO)	____
Determining the Critical Thaw-Weakened Period in Asphalt Pavement Structures (J. McBane, R-1; G. Hanek, R-1)	____
Close-Range Photogrammetry (L. D. Whitmill, GSC)	____
Terrain Profiles for Cable Logging in Region 1 With Analytical Photogrammetry (W. Valentine, R-1)	____
Region 3 Crew Quarters Standard (L. Archambault, R-3)	____
Report on the Photogrammetric Survey on the Kaibab National Forest Hearst Mountain Project in Fiscal Years 1983 and 1984 (D. Mouland, R-3; W. Stephens, R-3)	____
Electronic Navigation Systems May Offer Accurate Field Coordinate Location for Resource Management Activities (D. Gasvoda, MEDC)	____
Microcomputer Programs Available on the RTIP Bulletin Board (C. Schwarzhoff, WO)	____
Modeling and Testing Two-Stump Anchor Systems for Skyline Yarders (R. Toupin, R-6)	____
A Computer Simulation Program to Estimate the Speed and Productivity of Tracked Skidders (K. Gleason, R-1)	____
Gradeability and Cost Considerations in Vehicle Operations on Steep Roads (P. Anderson, OSU; J. Sessions, OSU)	____
Modeling Running SKyline Performance Based on Mechanical Capability of the Yarder (S. Wilbanks, R-5; J. Sessions, OSU)	____
Water Well Monumentation (R. Wisehart, R-5)	____
Solar-Powered Water Pumping Systems for Remote Sites (H. Kringler, R-1)	____
Evaluation of Microcomputer Hardware Features for Engineering Applications (F. Ou, WO)	____
Cadastral Surveying—Photogrammetrically (S. Johnson, R-6)	____
Fence Failures at Dog Legs and What To Do About Them (D. McKenzie, SDEDC)	____
Selecting Construction Slash Treatment Methods (J. Weissling, R-2; A. Marty, R-3)	____
The First Nationwide Forest Service Remote-Sensing Workshop: A Significant Step Into the Future (J. Greer, NFAP)	____
RTIP Bulletin Board—What's New? (C. Schwarzhoff, WO)	____
Aggregate Design Considerations (B. Kolzow, R-6; T. Stuart, R-5; S. Coghlan, R-9; C. Davis, R-8; B. Hinshaw, R-1; B. Pertile, R-1, Retired)	____
I Rip 'Em Flexes Its Muscles (W. Cox, R-6)	____
The Technology of Technology Transfer—A Blueprint for Success (C. Connolly, WO)	____
Identifying Haul Speeds Controlled by Grade and Surface Type or Horizontal Alignment and Road Width for Forest Development Roads (M. Evans, R-3)	____
Engineering Expert Systems (F. Ou, WO)	____
Ground Penetrating Radar: A Review for Resource Managers (J. Greer, NFAP)	____
Facilities Maintenance Management (G. Lippert, WO)	____
Lost River Ranger Station—Breaking New Ground (W. Moffett, R-4)	____
Evaluation Report—Computer-Aided Drafting/Design for Use By Forest Service Architects and Structural Engineers (R. Sandusky, R-5; M. Hoelting, R-8; N. Hernandez, R-5; S. Sichau, R-6)	____
Road Program Costs: Continuing Efforts Addressing the Issue (C. Weller, WO; T. Zealley, WO)	____
Evaluation of Loran-C Radio Navigation Systems for National Forest Application (H. Humerickhouse, R-8)	____
Forest Service Map Products Produced form USGS DLG Data (D. Beus, GSC; R. Eggli, GSC)	____
Guide for Selecting Clearing Widths (A. Marty, R-3; J. Weissling, R-2)	____
Project Management Software Review (M. Hanson, R-9; A. Scheible, R-6; J. Zirkle, R-8)	____

TEAR ALONG THIS LINE →

COMMENTS: ____

____

____

____

____

____

NAME ______________________
(OPTIONAL)

(FOLD HERE)

FOREST SERVICE—USDA
ENGINEERING STAFF (1113 RP-E)
P.O. BOX 2417
WASHINGTON, DC 20013

FOREST SERVICE—USDA
ENGINEERING STAFF
ATT. D.J. CARROLL (1113 RP-E)
P.O. BOX 2417
WASHINGTON, DC 20013

(FOLD HERE)

TEAR ALONG THIS LINE →

Cost Reduction in Washington Office Systems Operation & Maintenance

Fong Ou
Engineer, Systems Analysis & Development
Washington Office Engineering Staff

This article reports one example of the Washington Office Engineering Staff's efforts to improve efficiency and reduce cost.

The Engineering Systems Operation and Maintenance (SO&M) staff reduced their systems operation and maintenance cost by 37 percent or $6,115 in the first half of 1986. SO&M supports a number of national systems including the Road Design System, Transportation Information System, Potable Water System, Dams, and Transportation Analysis Group programs. The total operation and maintenance cost at the Fort Collins Computer Center (FCCC) for these systems in a 6-month period was $16,504 for 1985 and $10,389 for 1986. The following factors affect the system operation and maintenance cost.

FILE MANAGEMENT

The 1985 cost profile showed that the file storage cost accounted for 52 percent of the total system operation and maintenance cost. Therefore, our system specialists paid particular attention to the following opportunities, using the biweekly media report of each account from FCCC to track the file management costs.

(1) Keeping single active files in mass storage. The storage cost on disk for a file with large programs or data bases such as the Transportation Information System was as high as $63.34 for 2 weeks, or $1,646 per year. Our strategy was to archive the backup files or use tapes. A similar strategy also was applied to working files that would not be used for some time.

(2) Deleting unnecessary files. Although the storage cost on tape was only $0.75 per file for 2 weeks, the annual cost for tape storage could amount to $19.50 for 1 file and $195 for 10 files.

SYSTEMS OPERATION

The operation cost for a large system could exceed $30 per run. The following actions can be taken to reduce this cost:

(1) Understand the problem before trying to find a solution. This avoids unnecessary computer runs.

(2) Use batch mode. A demand run can cost 4 times more than a batch run.

An EXAMPLE

Figure 1 shows the monthly cost of one of the Washington Office FCCC accounts from October 1984 to May 1986. The account was used to support TOPAS. It reveals that the average monthly cost was more than $1,000 from October 1984 to December 1985 and less than $500 after January 1986. The difference is a result of using batch runs for operation and maintenance.

CONCLUSIONS

Our case illustrates that simply using common sense can achieve cost reduction. A little extra effort can lower costs, and pennies saved can accumulate to become big dollars. Our experience of a $6,115 cost avoidance supports this scenario.

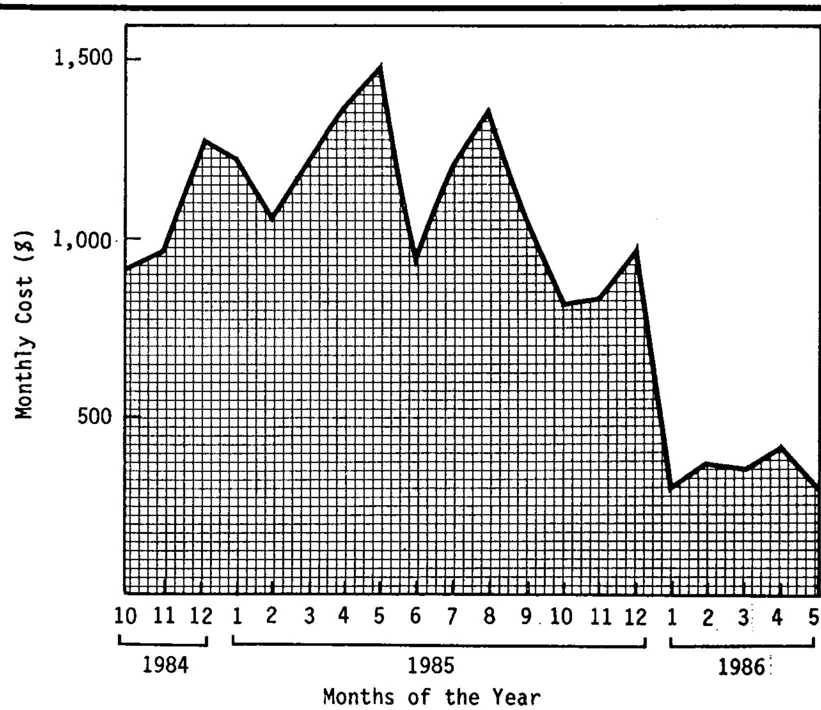


Figure 1.--Monthly system operation and maintenance cost of one Washington Office Engineering systems account.

Forest Service Map Products Produced From USGS DLG Data

Daniel L. Beus
Computer Programmer
Geometronics Service Center
Washington Office Engineering

Robert J. Eggli
Cartographer
Geometronics Service Center
Washington Office Engineering

INTRODUCTION

The Geometronics Service Center (GSC) in Salt Lake City, Utah, produces and updates the Forest Service's Primary and Secondary Base Series (PBS and SBS) maps. With the introduction of computer technology, GSC has developed the ability to create map products from digital data and store that data for subsequent uses. The United States Geological Survey (USGS) has map data available in digital form from various scale sources. These data have been collected in a manner that, with the use of conversion software developed at GSC, produces map products of a quality comparable to the same product created by traditional methods.

WHAT IS DLG DATA?

The two basic types of digital cartographic data collected by the USGS are digital elevation model data (DEM) and digital line graph (DLG) or topologically structured data. DLG data support automation of the cartographic processes and automated spatial data analysis. The data contained in DLG data files are represented as points, lines, and areas. The line data category is the major data type used to create a planimetric map product.

DLG data are available from USGS for 1:100,000, 1:2,000,000, and 1:24,000 (7.5' quadrangle) scale maps and at various scales for some 15' quadrangles. Entire coverage of the United States is available at the 1:2,000,000 scale. This information was digitized from the 1:2,000,000-scale National Atlas sectional base maps. Transportation and hydrography data will be available within 3 years for coverage of the entire United States at 1:100,000 scale. To a lesser degree, there are DLG data available covering certain areas for 7.5' and 15' maps. The USGS 1:24,000 scale, 7.5' quadrangle series is the major source for the Forest Service's

PBS. The USGS 1:100,000 scale series is similar to the Forest Service's SBS, though more generalized and limited in scope.

The data that USGS collects adhere to specifications inherent in their digital collection standards. These data are used to produce a high-quality map through a set of sophisticated software routines developed at GSC. DLG data also aid in the production of Primary Base, Secondary Base, Wilderness, and other special purpose maps used by Forest Service personnel. Digital map data can be expanded or condensed only within certain limits without compromising accuracy or causing generalization problems. By working within the limitations of the data, a high-quality map product meeting national map accuracy standards can be produced. For example, 1:2,000,000 DLG data can be used to produce a Regional map or other small-scale map product, but they are too generalized for larger scale maps.

CONSTRUCTION of a MAP PRODUCT FROM DLG DATA

DLG map data use a rather involved attribute-coding scheme. The coding scheme maintains flexibility so that the data can be used for various applications (map production, data analysis through the use of a Geographic Information System, and so on). Because of this, the data are structured differently than if they were collected explicitly for map production. GSC, on the other hand, collects and codes data specifically for map production. The program, which enables the use of the USGS's DLG data, restructures that data into the same format as the data collected by GSC. This format is the standard data format necessary for the series of programs called CAPS (Computer Automated Plotting System), which was developed by Forest Service personnel over a period of 8 years for producing cartographic products.

Using CAPS, GSC is producing newly constructed and updated materials for PBS and SBS line layers and derivative area layers. Six Secondary Base Series maps have been produced from digital (mostly Forest Service) data. They include the Black Hills, Bridger-Teton, Challis, Daniel Boone (Redbird), Fishlake, and Bankhead National Forests. The Comanche PBS maps and the San Juan SBS are now underway; the Comanche SBS will follow the PBS and data for several other Forests are being digitized. Index, key, and location maps and diagrams for most GSC map construction are now being produced from digital data.

The CAPS attribute-coding scheme is based on drafting specifications. They are referenced to a USGS publication, Standards for 1:24,000 and 1:25,000-Scale Quadrangle Maps; Part 6--Publication Symbols for 1:24,000-Scale Conventional Unit Standard Topographic Maps and to FSH 7109.13b, Cartographic Specifications and Symbols. In both of these publications, the symbols are referenced by number. These numbers are used as the attribute identifiers in data collection for CAPS processing.

Attributes used for DLG coding are more involved. The attributes used consist of a major and minor code. A line segment may have more than one major-minor code pair. Some of these major-minor codes have no bearing on what drafting specification should be used for drawing the line segment for a map product. The conversion from DLG- to CAPS-compatible data takes care of these problems. During the conversion process, the DLG attribute codes are resolved and the data are converted into a ground-coordinate system from the transformation variables supplied in the header portion of the DLG file. Once the conversion process is performed, the data can be processed by conventional procedures and used by the CAPS program.

The purpose of map projections is to portray the Earth's surface onto a two-dimensional or flat surface. Various projections handle this problem differently and each has its positive and negative points. To go from one projection to another, the known characteristics of the coordinate system are transformed to latitude and longitude coordinates. The projection for the final map product converts the latitude-longitude coordinates to the final projection coordinates. One of the features of CAPS is its ability to convert data from one coordinate system to another based on projection characteristics. Therefore, GSC can produce a map from data collected from several different sources, even if they are in different projections.

CAPS generates the final product by transforming the coordinates and resolving the attribute codes. The attribute codes determine the symbology and the plate on which the symbol is plotted (black, blue, green, red, brown, and so on). The attribute code first points to the plate it should be on, which in turn points to a table that describes the symbology. For example, the 412 (intermittent lake) references two plates; the blue plate and the blue tint plate. The line drawn on the blue plate consists of a dashed line, weight 0.005 inch, dash 0.07 inch, space 0.02 inch, on the blue plate; the symbol on the blue tint plate is an open window.

GSC recently constructed a map using DLG data for a project involving the grizzly bear ecology of the greater Yellowstone National Park area. The project was done in conjunction with Region 4 Geometronics. Because of time constraints on the Yellowstone project, using USGS 1:2,000,000 scale DLG data was the only feasible method. After conversion to the CAPS data format, these data were merged with other data sources, such as GSC's National Forest boundary file, and edited on a digitizing-edit system. After the edit, the data were processed through CAPS and plotted on the Kongsberg flatbed plotter. The entire project took about a week at GSC. Figure 1 shows a letter-size black-and-white plot of this 40- by 60-inch four-color map to illustrate the versatility and quality of this approach.

Automated products can be produced to at least the accuracy standards and essentially the same visual standards as traditional manually drafted maps. Rougher products also can be produced, when appropriate, at some savings in plotter time. User acceptance equals that of conventionally produced maps if the automated map products are designed appropriately. The advantages of automation vary with the project and these differences must be considered in the decision of the production method for a particular job. Where DLG data exist, they can reduce compilation and drafting time by 75 percent or more from conventional methods, with proportionate cost savings. Savings can be as little as $1,300 with a project like the grizzly bear map or as much as $5,600 with a more complex Regional map. When data must be collected, little labor time is saved and costs can double if special information is needed. However, production time can be less than that required for a traditional job, and the data will be available permanently for subsequent revisions or for other use in the same area, providing a promise of future savings.

CONCLUSION

The mapping process is being automated. Once the necessary digital data are available, automated cartography can make significant contributions both to standard map production and to special-purpose

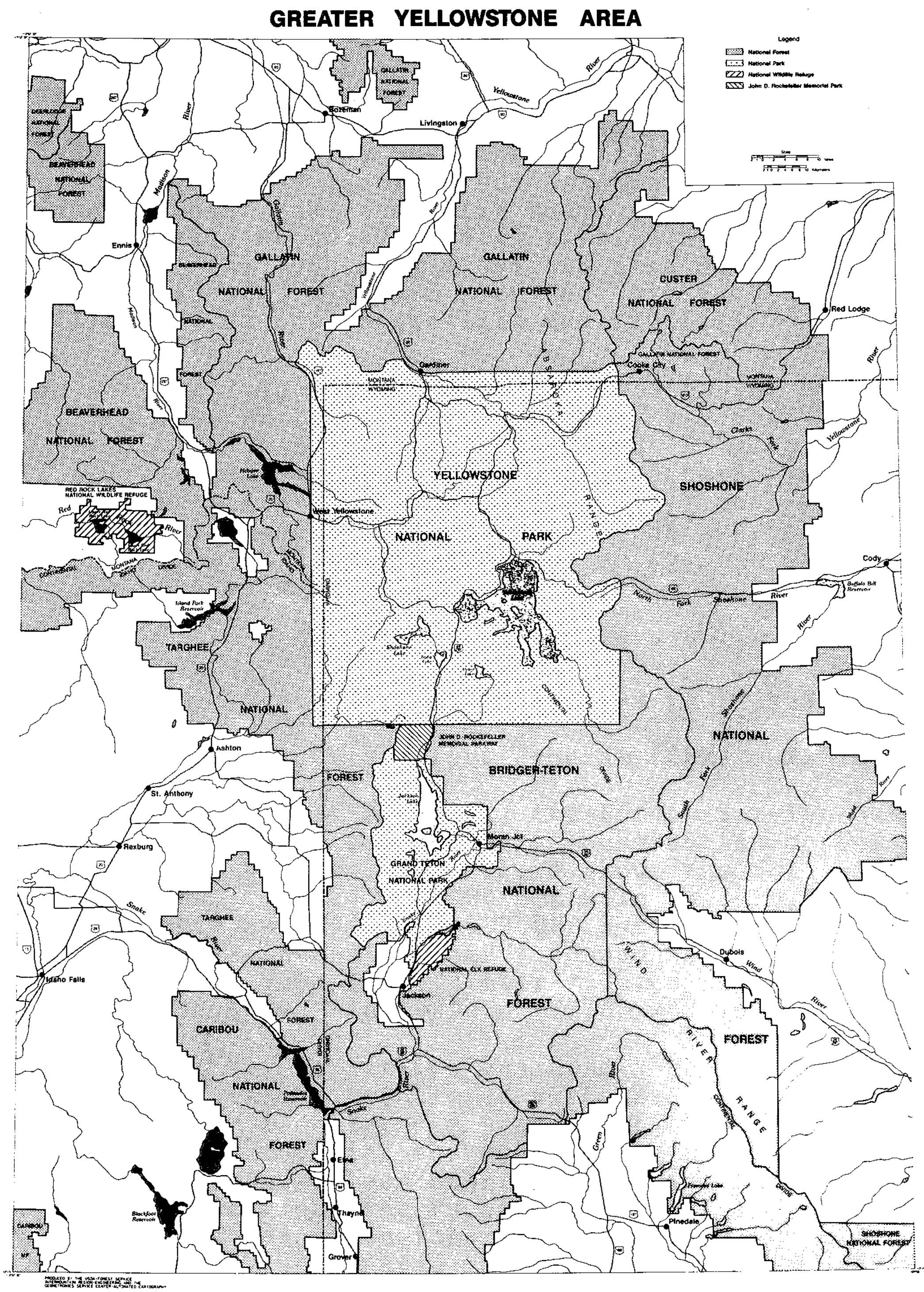


Figure 1.--GSC plot of the greater Yellowstone National Park area.

map construction. DLG data can be used for cartographic production of special-purpose and quick-response type maps through software at GSC. GSC also has produced base layers for Regional Base Series maps for Regions 2 and 3 from the same type DLG data as that used for the grizzly bear map, and has produced the National Forest Index Map, as well as the Carson Wilderness Map, from a combination of several data files. Using automated methods and DLG data available from USGS has saved both time and dollars. As more data are collected in digital form, applications will expand and savings will multiply.

Road Program Costs: Continuing Efforts Addressing the Issue

Clyde Weller
Chief Roads Structural Engineer
Washington Office Engineering

Ted Zealley
Chief Roads Preconstruction Engineer
Washington Office Engineering

INTRODUCTION

The total Forest Service roads budget has been reduced by 40 percent in the past few years. Even with this reduction, the Roads Program continues to represent the largest single program in the National Forest System budget. The total cost for the roads development program in 1986 was approximately $293 million, broken down as follows (figures are approximate):

Forest Road Program (FRP) = $180 million

Purchaser Credit Program (PCP) = $103 million

Purchaser Elect Program (PEP) = $10 million

In the past 10 years, the Forest Service has significantly reduced unit construction costs. In 1976 dollars, the record shows the following gross unit costs: $37,000 per mile in 1976, $34,000 per mile in 1980, and $27,000 per mile in 1985. Unit costs in dollars per thousand board feet ($/MBF) for roads supporting timber-related activities fell from $27.50/MBF in 1980 to $12.00/MBF in 1984.

WHAT HAS BEEN DONE

The Forest Service has done a great deal to address the issues associated with road program costs. Table 1 contains a summary of the national initiatives covering the years 1981 to 1986. In addition, there have been numerous Regional and local efforts. Regional Engineers working with the Washington Office Director of Engineering have closely monitored and often coordinated national initiatives and efforts. Systems Management Responsibility Improvement Program (SyMRIP) and Roads Technology Improvement Program (RTIP) efforts are good examples of Regional coordination of national work.

Table 1.--Summary of Forest Service Road Cost Control Initiatives, 1981-1986.

Year	Initiative
1981	Memo directed 10-percent reduction in road costs. Chief's memo to Regional Foresters directed that immediate measures be taken to reduce road costs by 10 percent for 1981. Regions responded by reducing or eliminating such items as paving and aggregate surfacing.
1982	Complete rewrite of Forest Service directives relating to road design standards. FSM and FSH rewritten to emphasize design standards appropriate for low standard roads. Provided significant flexibility to allow tailoring of standards to meet local needs. Eliminated most references to highway-type standards.
1982	Instituted Value Analysis (VA) in Regions 1 and 6 to be followed by all Regions implementing VA by 1984. The processes of Value Analysis involve systematic review of all major cost components of a road project by an inter-disciplinary team.
1982	Entered into Agreement with the Federal Highway Administration and the National Highway Traffic Safety Administration to exclude a large portion (70 percent) of our transportation system from the Highway Safety Act Standards. Excluding approximately 70 percent of our mileage from the requirements of the Highway Safety Act of 1966 permitted reduced standards in sight distance, passing clearances, hazard elimination, and signing, with resulting reductions in cost for these items.
1983	National Assessment of the Roads Planning and Design Process initiated. To be completed in 1988. Management and technical applications that relate to the road program were evaluated by all Regions. National, Regional, and Forest Action Plans were developed. Action items currently being addressed. To be subject of national and Regional reviews in 1986-1988.
1983	Initiated processes to identify cost centers for Forest Road Program expenditures. As a result of General Accounting Office suggestions to improve the Forest Service presentation and justification of road construction budget requests, the Forest Service implemented reporting requirements that divide (detail) FRP expenditures into planning and management, preconstruction

Table 1. (cont.)--Summary of Forest Service Road Cost Control Initiatives, 1981-1986.

Year	Initiative
	engineering, construction engineering, construction, and reconstruction. Efforts to improve this reporting process are ongoing.
1983-1985	Initiated Regional functional standards for Engineering functions (six for roads). Functional standards outline the Regional responsibilities for planning, managing, directing, and controlling specific Engineering activities such as preconstruction engineering, construction engineering, road maintenance, road program development, and execution. These standards are used in conjunction with the formal Program and Activity Review process to ensure uniform performance across all Regions. Most Regions have adopted these for reviews of Forest performance.
1983-1985	Brought on line four new Road Design Systems to reduce cost of Engineering services and road construction. Systems, such as Forest Level Road Design System (Lot 7), specifically developed to facilitate design of low standard roads. Use of systems reduce survey and design time and result in lower cost and lower impact road designs. These design systems incorporate the cost saving features of the revised Forest Service road design standards published in 1982 (nearly full benefits realized in 1986).
1984-1986	Initiated the Road Technology Improvement Program (RTIP). The Road Technology Improvement Program was initiated to identify those areas where technological improvements can result in the largest cost savings while still retaining road utility. Four areas were identified, including the following: (1) Clearing and Grubbing. (2) Base and Surfacing. (3) Road Operation and Maintenance. (4) Programming and Budgeting of Funds.

Table 1. (cont.)--Summary of Forest Service Road Cost Control Initiatives, 1981-1986.

Year	Initiative
	Technical teams were assigned to each area to identify specific actions that would reduce overall costs. A fifth team dealt with the problem of technology transfer to help ensure the findings and their applications become known Service-wide. The RTIP effort revealed a number of opportunities for cost savings, which have been implemented, and also identified some areas where additional technology/information may lead to further cost reductions. A national action plan consisting of 47 action items was developed and currently is being worked on.
1980-1984	Developed the Integrated Resource Planning Model (IRPM). IRPM is a computer model that permits the evaluation of entire road networks within relatively large areas (over 20,000 acres). Optimization of resource location and scheduling along with network analysis provide planners with alternatives for least cost development. Skilled users estimate that use of this model can reduce total transportation costs by 30 percent in large complex situations (full benefits will not be realized until 1987).
1985	Issued completely revised national road specifications. The new specifications were rewritten to eliminate unnecessary construction items and provide more flexibility to designers. Reviewed by construction and timber industry and finally subjected to value analysis by outside consultants. Specifications implemented January 1, 1986 (full benefit will not be realized until 1987).
1985	SyMRIP. Conducted a comprehensive review of Engineering Computer System needs to take advantage of productivity improvements available through increased and improved use of computers.
1986	Formed Roads Productivity Improvement Team (PIT). A team of line officers and engineers has been assigned the responsibility to take a wide-ranging look at the roads program to find opportunities for productivity improvement (task to be completed in October 1986 and full benefits will not be realized until 1988).

Work on road costs has not been limited to Forest Service personnel. Mr. John Fedkiw, a USDA Economist, conducted an extensive study of Forest Road Program (FRP) costs. His study, accomplished earlier this year, addressed the changes and variations in costs in construction, engineering support, and overhead in both the FRP and PC segments of the road program. The "Fedkiw Report" has had a significant impact on current initiatives addressing road program costs.

WHAT IS BEING DONE

Even before publication of the Fedkiw Report, the Road Technology Improvement Program (RTIP) addressed the issue of measuring and displaying the costs of the elements of the FRP and identified the following actions:

(1) Develop a unit cost and benchmark system to measure and display road costs.

(2) Develop a report that does the following:

 (a) Outlines the results of unit costs and benchmarks.

 (b) Evaluates the effectiveness and quality of the unit cost and benchmark data.

 (c) Identifies and corrects problems of the unit cost and benchmark system.

In March of this year, the Chief appointed a Roads Program Productivity Improvement Team (PIT) to identify ways to achieve significant cost savings within the next 2 to 3 years and to report to the Chief in October.

As of July, the team had identified five major areas to address:

(1) Implementation of policy and direction.

(2) Management information (road cost data).

(3) Construction costs.

(4) Engineering support costs.

(5) Road management costs.

Rather than repeat all the previous studies, the team has relied heavily on the work identified in table 1. Of particular note is the work done in connection with the National Assessment of the Roads Planning and Design Process and the RTIP studies covering road management, aggregate surfacing, and clearing and slash disposal. The PIT team is closely coordinating its activities with the RTIP team road costs work. The PIT report likely will highlight results from many previous studies that offer the greatest potential for cost savings.

In a 7700 letter on the Forest Service Roads Program dated May 19, 1986, the Chief directed "a national coordinated initiative to monitor and seek out new opportunities to achieve further efficiencies in our road program." The letter recognized previous efforts, particularly the RTIP, National Assessment, and PIT studies. A Roads Work Group, consisting of line officers and staff from all levels of the Forest Service, is establishing evaluation criteria for the Chief to measure road program efficiency.

At first glance, the various work groups and studies may appear disjointed or redundant, but such is not the case. As illustrated in figure 1, each study or team has had specific segments of the Forest Road Program to analyze. The most recent efforts are coordinating and focusing previous work to achieve the goal of increased efficiency in the Forest Road Program.

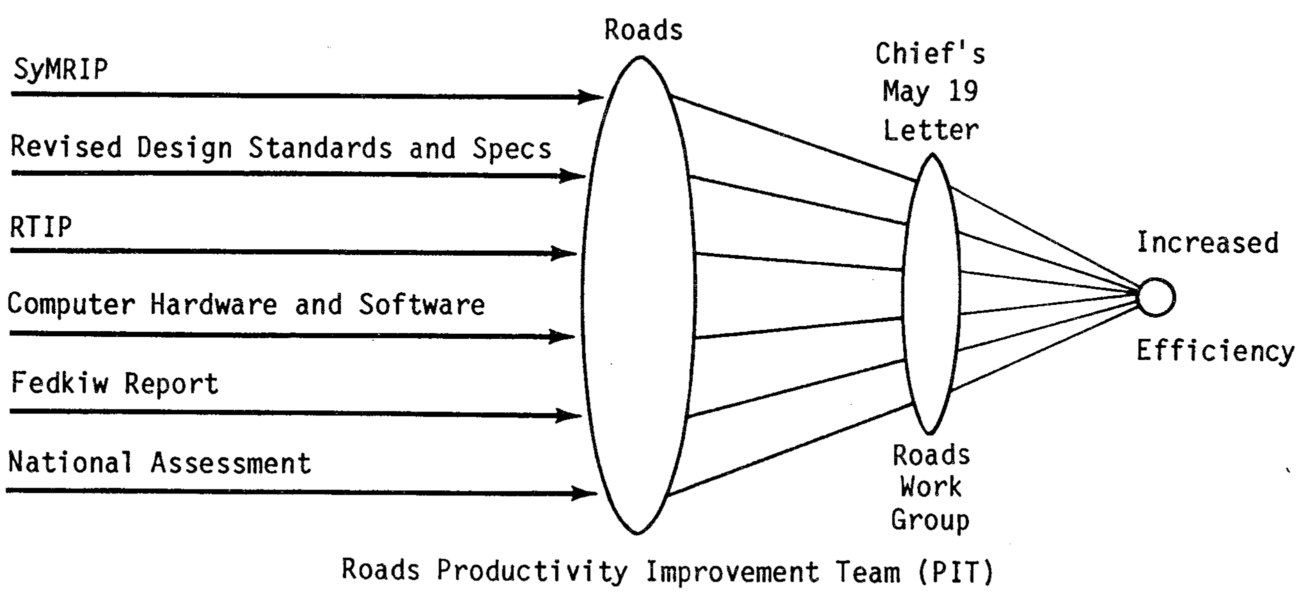


Figure 1.--Coordinating and focusing work to achieve increased efficiency.

SUMMARY

The Forest Service will continue efforts to improve total road program efficiencies. Much has been accomplished in improving construction efficiencies (and more remains to be done there), but current initiatives emphasize the need for efficient engineering support services and other functions supporting or affecting the FRP. Figure 2 shows that the greatest efficiency in the road program will result when the Forest Service addresses the total roads program, not just the segment dealing with direct project construction costs.

EFN

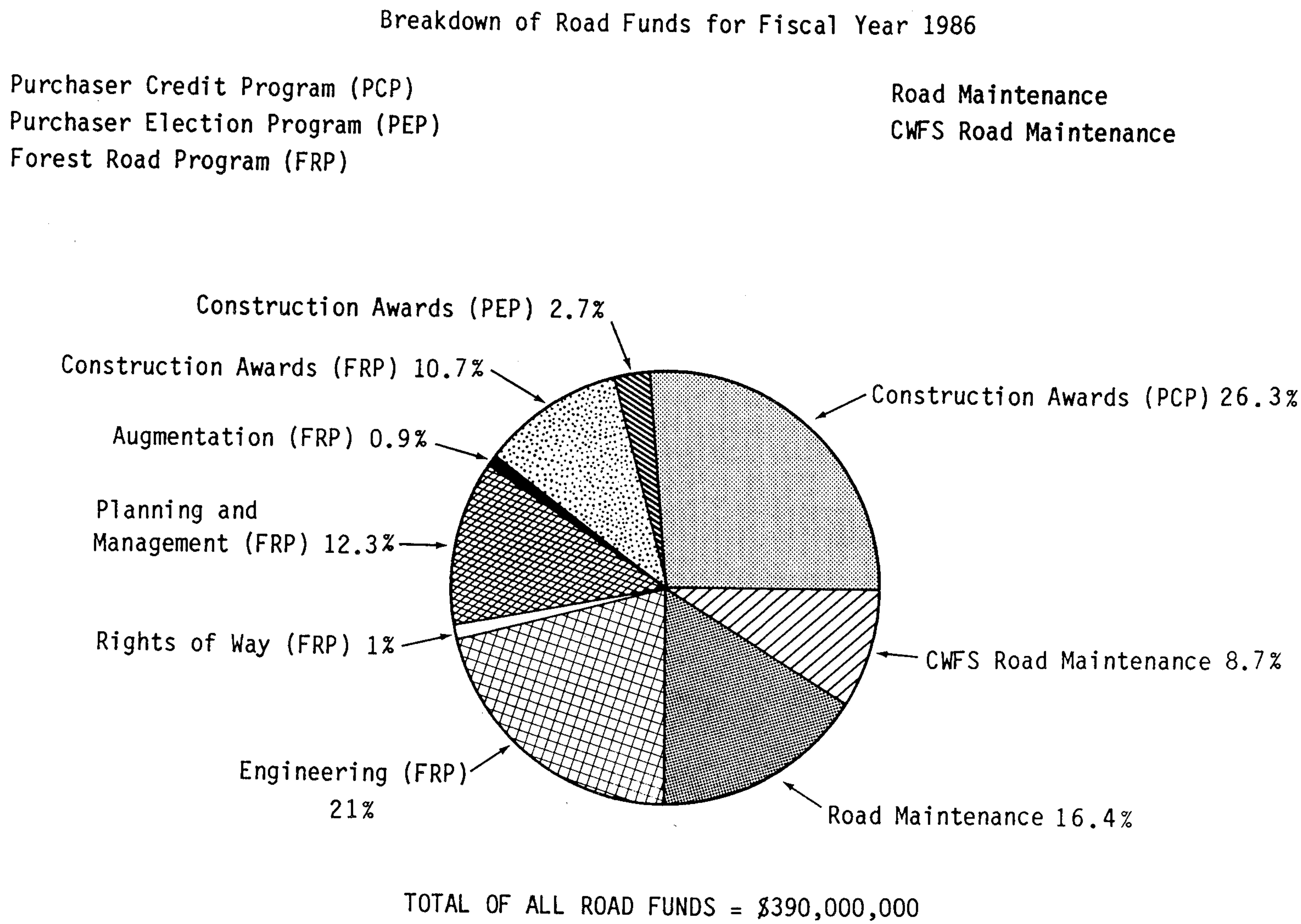


Figure 2.--Breakdown of road funds for fiscal year 1986.

Evaluation of Loran-C Radio Navigation Systems for National Forest Applications

Harold Humerickhouse
Forest Land Surveyor
Region 8

INTRODUCTION

This article describes a series of tests that were designed to evaluate the Loran-C Radio Navigation Systems for National Forest applications. Equipment involved included a Micrologic ML-7500 Loran-C navigator, II Morrow Inc. Apollo Loran-C receiver, and Arnav Systems Inc. Model R-40. The first series of tests, conducted during 1985-86, tested the maximum extent to which the Loran-C system could be used on a typical National Forest. Tests were conducted on the Ozark-St. Francis National Forests in Arkansas. The second series of tests described was requested through an unsolicited proposal by a Colorado firm, the Colorado Research and Prediction Laboratory, Inc. (CRPLi). CRPLi proposed to produce calibration factors to use with the basic Loran-C system so that the true points could be identified at ground level and at 2,500 feet above ground within a 30-meter radius, 95 percent of the time.

FIRST SERIES

From 1976 to 1980, several research projects (1, 2, 3, 4, 5) were completed on possible uses of the Loran-C tracking system over land masses. The results indicated that the Loran-C system could be used effectively for aerial photonavigation and that ground locations by vehicle could be identified to within a 200-meter radius. A 1982 study (5) indicated an improvement to a 30-meter radius for ground repeatability.

A decision was made to reevaluate the Loran-C system because of claims of technical advances that purported to bring the Loran-C ground accuracies into the 30-meter range and to lower Loran-C unit costs. A task force met on January 15 and 16, 1985, to determine the possible uses of Loran-C on the Ozark-St. Francis National Forests.

The Loran-C receiver is capable of receiving low-frequency radio waves and calculating the position of the receiver in latitude and longitude. (The documents listed in the References section provide a more detailed explanation of this system.) A three-phase plan was developed to test the accuracy and dependability of the receiver. Data from the tests would provide enough information to determine whether any identified potential uses of the receiver would be within an acceptable range of accuracy to justify use on this Forest. The order of the three phases was unimportant; weather was the controlling factor. Land surveying projects and triangulation stations on the Forest would be used as controls for the testing.

Phase I

Phase one involved the testing of two units against known areas, distances, and map-located State plane coordinate positions.

A relatively flat 80-acre tract of land located in the Mulberry Valley was selected as the test site. This tract has 26 monumented corners on it and is tied to a section $\frac{1}{4}$ corner. Two Loran units were calibrated to a known triangulation point and multiple readings then were taken at each corner monument. The latitudes and longitudes were converted to State plane coordinates and then the distances between monuments, various areas, and the coordinates were compared against known values. A second trip was made with the two units to test retrievability and consistency of computations.

Specifically, using a quad map, latitude and longitude first were established for one traverse point of the 80-acre tract, then converted to State plane coordinates, and projected to the rest of the traverse points. The total acres of the tract were computed, and the tract was then divided into 40+ subunits ranging from 0.4 acre to 60 acres.

On two different occasions, Loran-C units were taken to the same triangulation station and calibrated and then taken to the 80-acre tract of land. Multiple readings were taken at each of the 26 traverse points on both occasions. The multiple readings (longitude and latitude) were averaged and converted to State plane coordinates. The distances between traverse points were computed and the subunit areas were recomputed.

Acres then were split into five groups and evaluated against actual acres.

(1) Group 1 consisted of 10 units in the 0- to 10-acre range. The mean difference from actual was 1.5 acres with a standard deviation of 1.5 acres on the first visit and a mean difference from actual of 1.9 acres with a standard deviation of 1.3 acres on the second visit.

(2) Group 2 consisted of 10 units in the 10- to 20-acre range. The mean difference from actual was 2.6 acres with a standard deviation of 2.1 acres on the first visit and a mean difference from actual of 4.9 acres with a standard deviation of 2.4 acres on the second visit.

(3) Group 3 consisted of 9 units in the 20- to 30-acre range. The mean difference from actual was 3.8 acres with a standard deviation of 3.2 acres on the first visit and a mean difference from actual of 8.0 acres with a standard deviation of 1.9 acres on the second visit.

(4) Group 4 consisted of 6 units in the 30- to 40-acre range. The mean difference from actual was 3.7 acres with a standard deviation of 2.7 acres on the first visit and a mean difference from actual of 11.2 acres with a standard deviation of 1.0 acre on the second visit.

(5) Group 5 consisted of 5 units in the 40+ acre range. The mean difference from actual was 3.6 acres with a standard deviation of 1.9 acres on the first visit and a mean difference from actual of 16.2 acres with a standard deviation of 7.3 acres on the second visit.

The lengths of the traverse lines were computed and compared against actual line lengths. Compared were 26 lines having lengths of 20 to 500 feet. On the first visit, the mean difference from actual was 140 feet with a standard deviation of 119 feet, and a mean difference from actual of 122 feet with a standard deviation of 123 feet was recorded on the second visit.

A comparison of deviation from true position of the 26 stations produced a mean difference from actual of 1,052 feet with a standard deviation of 269 feet on the first visit and a mean difference from actual of 962 feet with a standard deviation of 228 feet on the second.

A comparison between first trip position and second trip position, that is, repeatability, produced a mean difference from actual of 214 feet with a standard deviation of 161 feet.

Phase II

Phase two was intended to test the two units against a large area with precisely known State plane coordinates for monuments encompassing 20- to 640-acre tracts located in a remote and mountainous area.

After calibration to a known triangulation point, latitude and longitude readings were to be taken on various monuments and converted to State plane coordinates for comparison against the known values. A second trip was to be made to test retrievability and consistency of computations. However, based on the results of phase one, phase two was cancelled.

Phase III

This phase involved testing the two units in airplanes to ascertain high-altitude (5,000 feet) ground-point determination, low-altitude (3,000 feet) ground-point determination, and on-ground location of airplane-determined points.

After calibration to a known latitude and longitude, high- and low-altitude passes were made over several points having known latitudes and longitudes. These same points were then identified on-ground by the same two units on two separate field trips.

Specifically, in the first step, two Loran-C units were calibrated and taken to six easily air-visible triangulation stations where multiple readings of latitude and longitude were taken and averaged. The coordinates produced by the Loran-C units had a mean difference from actual of 1,073 feet with a standard deviation of 606 feet from the true coordinates of the stations.

In the second step, the average of the coordinates produced by the two Loran-C units on the ground was computed for each station. The Loran-C was then mounted in an airplane and readings were taken over the triangulation stations at an altitude of

3,000 feet. The stations are at an average elevation of 2,000 feet. Several passes were made over the stations until the operator believed that he had the best positional reading. The readings were converted to State plane coordinates and compared to the averages produced by Loran-C on the ground. The six readings had a mean difference from the on-ground averages of 459 feet with a standard deviation of 210 feet.

Finally, readings were taken over the triangulation stations at an altitude of 5,000 feet. The six readings had a mean difference from the on-ground averages of 1,098 feet with a standard deviation of 513 feet.

SECOND SERIES

In April 1985, the Colorado Research and Prediction Laboratory, Inc. (CRPLi) offered an unsolicited proposal for calibrating Loran-C over 2,000 square miles in Arkansas. The goal of this testing was to achieve an accuracy of 200 nanoseconds (1 foot per nanosecond) at a 2-sigma (95-percent) level of confidence for surface coordinates and at an altitude of 2,500 feet above the surface of the Earth.

The procedure for this testing was designed to include area precalibration survey, calibration predictions, and area calibration. The Forest Service was to use CRPLi maps to interpolate position corrections for the initial Loran-C readings and compare the adjusted positions to known coordinate locations. The Forest Service also was to supply CRPLi with field readings. CRPLi would then calculate corrected latitude-longitude positions based on their software package. CRPLi's adjusted positions would then be compared to the known coordinate locations by the Forest Service as the final step in the evaluation.

One complication occurred following the area precalibration survey by CRPLi on July 9, 1985, when the United States Coast Guard modified the Baudette transmitter (August 31, 1985). As a result, a new recalibration trip became necessary.

From October 1985 to November 1985, 40 sets of readings were taken over the calibration area using CRPLi equipment. These readings then were submitted to CRPLi in December 1985. CRPLi's predicted latitude and longitude of the test stations were compared to the known latitude and longitude. Both sets of latitude and longitude were then converted to State plane coordinates and compared. The radial distances between CRPLi-predicted State plane coordinate pairs and known State plane coordinate pairs were computed and compared. Several stations were visited more than once to provide a measure of repeatability. The first CRPLi-predicted State plane coordinates of a station were recorded and the radial distances to the CRPLi-predicted State plane coordinates of subsequent visits were compared.

The test results were submitted to the Contracting Officer's Representative (Hal Humerickhouse) in January 1986. They indicated that, of the true location comparisons, 20 of 31 readings were outside of the 200-foot limit. Of the returnability and/or repeatability readings, all were within 200 feet. (Figure 1 shows test data.)

Because CRPLi was unable to meet its claims on the ground, their system was not investigated from aircraft. When using the Loran-C system at ground level, there are two important points to keep in mind: any electrical power within 200 feet is cause for suspect data, and a shadow effect can block out reception on steep slopes.

CONCLUSIONS

The general conclusion from both series of tests is that the Loran-C system is still not reliable enough for use on this Forest other than for aviation uses, that is, airport to airport, aerial spray patterns, and aerial photography patterns, identified in the research conducted between 1976 and 1982. The transfer of aircraft-identified positions to ground units for location is still not reliable on this Forest.

Before the Loran-C Radio Navigation System can be used at the ground level on this Forest, further development of computer filters and a denser network of Loran-C transmitters will be required.

It should be noted, however, that these results do not conflict with the results of the 1982 research (5) performed on National Forests in Region 6 (Northwestern coast of the United States). Nor do these results negate the extension of the Region 6 results to cover National Forests in Region 5 (California). The results, however, point out that each area must be evaluated separately for on-ground receivability and available Loran-C network configurations.

The proposal from CRPLi called for measurements to be within 200 nanoseconds (200 nanoseconds = approximately 200 feet) of true position with an accuracy of 2 sigma (95 percent).

Twenty-five time difference readings (Malone and Baudette) were taken and averaged every time a station was visited to be used by CRPLi to produce the coordinates.

TRUE LOCATION COMPARISON

Several stations were not included in the calculations because of power lines in the vicinity.

DISTANCE FROM RECORD

Mean .... 256.60 feet

Standard Deviation .... 147.52 feet

THEREFORE 68 percent (1 sigma) fall within 109.08 feet to 404.12 feet
and 95 percent (2 sigma) fall within 00.00 feet to 551.64 feet.

20 of 31 readings (65%) were outside of the 200-foot limit.

RETURNABILITY AND/OR REPEATABILITY

DISTANCE FROM FIRST VISIT READING

Mean .... 90.97 feet

Standard Deviation .... 40.23 feet

THEREFORE 68 percent (1 sigma) fall within 50.74 feet to 131.20 feet
and 95 percent (2 sigma) fall within 10.51 feet to 171.43 feet.

Figure 1.--Test data for the second series.

Questions regarding the content of this article may be addressed to Harold W. Humerickhouse at the following address:

Ozark-St. Frances National Forests
P.O.Box 1008
605 Main Street
Russellville, AR 72801
Attn: Hal Humerickhouse

REFERENCES

1. Loran-C Radio Navigation Systems as an Aid to Southern Pine Beetle Surveys. USDA Handbook No. 567. (1974).

2. Dull, Charles W. and William H. Clerke. Development of Loran-C Radio Navigation System Applications for Southern Pine Beetle Survey Flightline Navigation, Ground-Crew Navigation, and Spot Position Determination. (1976-1980).

3. An Operational Flight Test Evaluation of a Loran-C Navigator for the U.S. Department of Transportation, U.S. Coast Guard, Office of Research and Development. Report No. CG-D-9-77. (1977).

4. Ball, William E., Jr. Evaluation of Loran-C for BLM Approximate Positioning Applications in Alaska. Division of Scientific Systems Development, Bureau of Land Management, Denver, Colorado. (1980).

5. Regional Aviation Group, Redmond, Oregon. Loran-C Field Test and Evaluations, Deschutes National Forest. (1982).

EFN

Guide for Selecting Clearing Widths

Art Marty
Construction Engineer
Road Technology Improvement Program
Region 3

Jack Weissling
Forest Supervisor
Road Technology Improvement Program
Pike & San Isabel National Forests

INTRODUCTION

This article provides a process for selecting road clearing widths (standards) and includes a worksheet to assist in using the process and documenting the decisions made. Without such a process or the knowledge of the considerations that affect clearing widths, road designers frequently base selections on widths traditionally used in a particular area or on other subjective criteria.

The person responsible for road design usually is the best qualified to complete the Clearing Width Worksheet because of his or her knowledge of the project and professional expertise. However, when clearing widths could be environmentally sensitive, an interdisciplinary (ID) team should be involved in the process. The responsible line officer then selects the clearing widths based on the results of the process and the team's recommendation.

DESIGN CRITERIA

Road design criteria are defined in FSH 7709.56, Section 4.1. In response to a questionnaire received from 5 Regional Offices and 14 Forests, two different categories of design criteria have been identified. The first category consists of land managers' objectives, which do not necessarily result in specific widths added or subtracted from the clearing limits. The second category includes criteria requiring specific clearing widths for resource protection and equipment use.

First Category—Land Managers' Objectives

The first category of design criteria places management's parameters on the end product. Although these management objectives are not specifically addressed in the Clearing Width Worksheet (figure 1), they should be considered during the process. The criteria are as follows:

CLEARING WIDTH WORKSHEET

FOREST ______________________ DISTRICT ______________________

ROAD(S) ____

APPROVED ROAD DESIGN CRITERIA

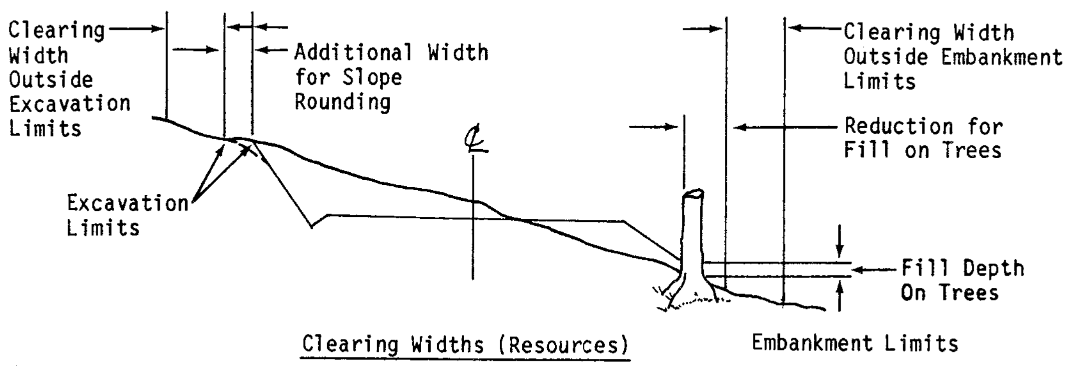
1. ____

2. ____

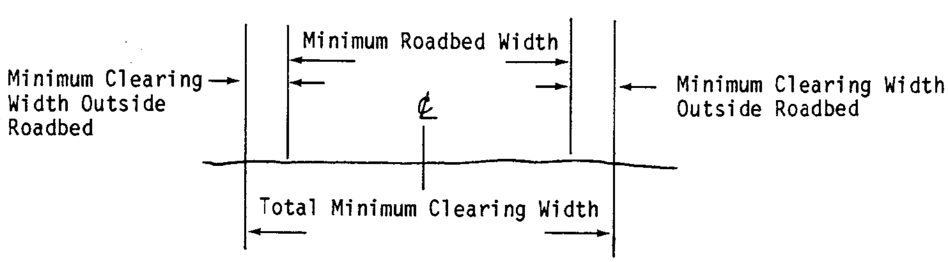
3. ____

4. ____

ROAD CLEARING WIDTH TEMPLATES



Clearing Widths (Resources)



Minimum Clearing Widths (Equipment Use & Construction)

Figure 1.--Sample clearing width worksheet.

CLEARING WIDTHS (Resources)

	Width	Remarks
1. Slope Rounding		
2. Distance Outside Excavation Limits a. Tree Stability ( ) b. Roadbed Drying ( ) c. Other ( ) Maximum Width (a, b, or c)		
3. Distance Outside Embankment Limits a. Slash Disposal ( ) b. Roadbed Drying ( ) c. Other ( ) Maximum Width (a, b, or c)		
4. Average Reduction for Fill Against Trees		

MINIMUM CLEARING WIDTHS (Equipment Use)

	Width	Remarks
1. Roadbed Width		
2. Distance Outside Roadbed a. Equipment Clearance: (1) Construction ( ) (2) Haul ( ) (3) Maintenance ( ) (4) Design or Critical Vehicle ( ) b. Other ( ) Maximum Width (a or b)		
TOTAL		

TOTAL MINIMUM CLEARING WIDTH (Construction)

1. Total Clearing Width Required: ______________________

Equipment Type: ______________________

____

REMARKS

____

____

____

Prepared: ______________ Date: ______________

Approved: ______________ Date: ______________

Figure 1. (cont.)--Sample clearing width worksheet.

Safety. The primary consideration in determining clearing widths is safety. Clearing widths must accommodate the road user. If the road has low standards that discourage, prohibit, or eliminate public use and is designated for low traffic volumes and speeds, clearing widths may be minimal. However, if the road is open to the general public without restriction, it is subject to the Highway Safety Act, and clearing widths must be wide enough to safely accommodate this type of use.

The information in this article pertains to Traffic Service Level C and D roads and to single-purpose use, such as log hauling. Use caution in applying the information in this article to roads with higher traffic service levels and mixed use.

Cost Minimizing. This also must be a primary consideration in evaluating clearing limits. Responses to the questionnaire mentioned above identified this as the most common concern of land managers.

Visual Impacts. This consideration becomes important when unacceptable visual impacts may result from clearing widths that are too wide.

Minimizing Area Taken Out of Production by Clearing. This appeared to concern land managers less than visual impact, but it should nevertheless be considered.

Second Category—Specific Clearing Widths

The second category of design criteria requires specific clearing widths. These criteria include two groups; the first group relates to resources and the second group relates to equipment use during and after construction. The criteria in this category should address the following considerations:

Resources.

(1) Slope rounding.

(2) Tree stability.

(3) Roadbed drying.

(4) Slash disposal area.

(5) Filling against trees (tree survival).

Equipment Use.

(1) Equipment clearance.

(a) Construction.

(b) Haul.

(c) Maintenance.

(d) Design, or critical, vehicle.

(2) Total minimum clearing width.

CLEARING WIDTH WORKSHEET

The Clearing Width Worksheet shown in figure 1 leads the preparer through a selection process for road clearing widths. The information provided in the remainder of this article may assist you in preparing the worksheet. That information is only a guide and should not take precedence over information developed by good judgment or local experience.

Figure 2 shows a completed Clearing Width Worksheet.

APPROVED ROAD DESIGN CRITERIA

List the approved road design criteria that affects clearing limits in this section of the worksheet. Normally, the first step is to research applicable environmental and planning documents to extract and document design criteria. These criteria then are approved by the responsible line officer before they are used to develop design standards.

ROAD CLEARING WIDTH TEMPLATES

The two road templates in this section of the worksheet display the various road clearing widths and the total minimum clearing width.

Clearing Widths (Resources)

This template displays resource-related clearing widths. These are shown as distances from the excavation and embankment limits.

Minimum Clearing Widths (Equipment Use & Construction)

This template shows the minimum acceptable road clearing width necessary on each side of the roadbed to accommodate equipment use during and after construction. It also displays the total minimum clearing width. This total minimum width shows whether the road is adequate for efficient equipment operation during road construction.

CLEARING WIDTHS (RESOURCES)

This section of the worksheet assists the preparer in determining the minimum acceptable clearing widths outside the excavation and embankment limits

CLEARING WIDTH WORKSHEET

FOREST PINETOP DISTRICT SPRINGDALE

ROAD(S) 1047, 1048, 1073, 1107 & 1127

APPROVED ROAD DESIGN CRITERIA

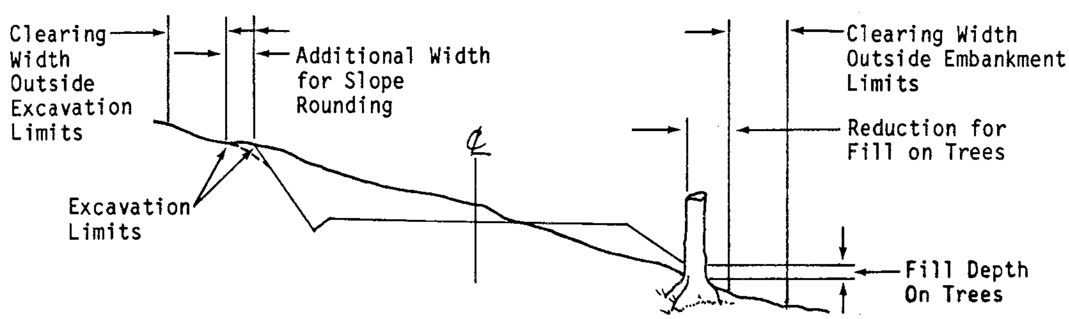
1. CLEARING AND GRUBBING REQUIREMENTS SHALL MINIMIZE COST.

2. CLEARING LIMITS SHALL MINIMIZE LAND TAKEN OUT OF PRODUCTION.

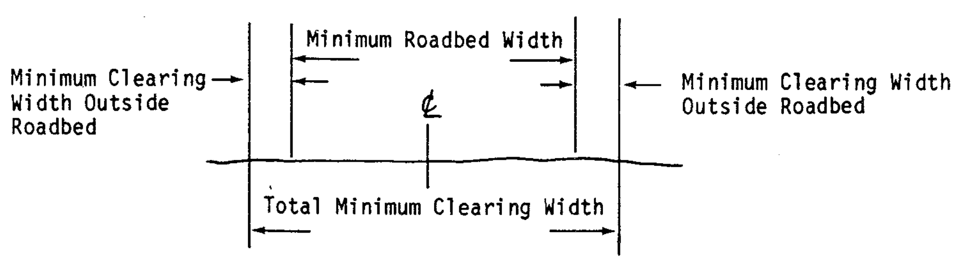
3. NO CONSTRUCTION SLASH SHALL BE ALLOWED WITHIN 100 FEET OF STREAMS.

4. UNMERCHANTABLE MATERIAL 3 INCHES IN DIAMETER & 3 FEET IN LENGTH OR LARGER SHALL BE SCATTERED INSIDE THE CLEARING LIMITS FOR FUELWOOD USE.

ROAD CLEARING WIDTH TEMPLATES



Clearing Widths (Resources)



Minimum Clearing Widths (Equipment Use & Construction)

Figure 2.--Sample clearing width worksheet (filled in).

CLEARING WIDTHS (Resources)

	Width	Remarks
1. Slope Rounding	0	
2. Distance Outside Excavation Limits a. Tree Stability (0) b. Roadbed Drying (0) c. Other (0) Maximum Width (a, b, or c)	0	ROADBED DRYING WILL NOT BE A PROBLEM
3. Distance Outside Embankment Limits a. Slash Disposal ( ) b. Roadbed Drying ( ) c. Other ( ) Maximum Width (a, b, or c)	0	SLASH DISPOSAL WILL BE SCATTERING
4. Average Reduction for Fill Against Trees	3'	FILL 2 FEET ON TREES

MINIMUM CLEARING WIDTHS (Equipment Use)

	Width	Remarks
1. Roadbed Width	12'	
2. Distance Outside Roadbed a. Equipment Clearance: (1) Construction (0) (2) Haul (2) (3) Maintenance (2) (4) Design or Critical Vehicle (2) b. Other ( ) Maximum Width (a or b)	2'+2'	WASHINGTON IRON WORKS SKYLOK 78 (12' ROAD WIDTH)
TOTAL	16'	

TOTAL MINIMUM CLEARING WIDTH (Construction)

1. Total Clearing Width Required: 18'

Equipment Type: CRAWLER TRACTOR WITH 14-FOOT BLADE & GRADER WITH 14-FOOT MOLDBOARD

REMARKS

PROVIDE 18' MINIMUM CLEARED WIDTH (9' FROM ROAD ℄ BOTH SIDES), 2 FOOT FILL ON TREES, 0 WIDTH FROM TOP OF EXCAVATION.

Prepared: Tim Campbell Date: 7/31/85

Approved: Ken Blair, District Ranger Date: 8/2/85

Figure 2. (cont.)--Sample clearing width worksheet (filled in).

as well as the reduction of clearing width to within the embankment area when filling against trees is acceptable. To assist in determining these widths, the sections below summarize information provided by Regions and Forests in the questionnaire. When these minimum widths have been established, enter them on the Clearing Widths (Resources) template.

Slope Rounding

Slope rounding is a technique used in some soils to reduce erosion of the cutbank and to round the intersection of the cutbank slope and original ground to provide a more natural earth form. However, slope rounding adds the distance at the top of the rounding to the clearing width. This is usually a minimum of 2 feet and may vary up to 5 feet on Forest roads. There should be obvious benefits to using slope rounding, because even the minimum 2-foot distance at the top of the rounding can add 10 percent to the total clearing width on a local road. Slope rounding is included in this worksheet to emphasize the need for evaluating the merits of this treatment in relation to the additional clearing width it requires.

Distance Outside Excavation Limits

The Road Technology Improvement Program (RTIP) Team has requested that the San Dimas Equipment Development Center (SDEDC) research and provide information on tree stability and roadbed drying. Until this study is completed, the following information may serve as a guide:

(1) Tree Stability. The stability of trees near road cutbanks may be a problem in some areas. The evaluation to determine the width needed for tree stability should include considerations such as wind firmness, tree species and size, soil type and moisture, and cutbank slope.

  (a) This width varies from 0 to 5 feet, with the exception of one Forest that uses a standard as wide as 10 feet.

  (b) The standards for 50 percent of the Forests responding to the questionnaire allowed this clearing width to be zero.

(2) Roadbed Drying. Roadbed drying is a problem in areas where some species of trees tend to canopy over the road, creating a tunnel-like effect. The evaluation to determine these widths should include considerations such as tree species, aspect, slope, and climate. As the factors

affecting these widths are extremely variable, determine them on the ground. They likely will be different on segments of the same road.

(3) Other. These are widths needed for purposes not listed above, such as fuelwood storage, snow storage, and slash disposal. Document the purpose and need for these widths.

Distance Outside Embankment Limits

This width varies from 0 to 10 feet. Most Forests specify clearing limits at the toe of the embankment unless additional width is needed for other purposes, such as the following:

(1) Slash Disposal. The usual method of slash disposal within clearing limits is by windrowing. However, some Forests dispose of slash by spreading it on the embankment slopes or burying it under the embankment. Factors that affect the width needed for slash disposal within the clearing limits include the amount of slash to be stored, ground slope in the disposal area and, if windrowing is specified, which of the three methods of windrowing is required.

(2) Roadbed Drying. See "Roadbed Drying" in the previous section.

(3) Other. See "Other" in the previous section.

Average Reduction for Fill Against Trees

The RTIP Team has requested that EDC research and provide information on the effects of filling against trees.

The concern with filling against live standing trees is their survival. Filling against trees can cause problems such as cutting air off to the root system, damaging the trees during embankment placement, and pushing small trees over during filling operations. When considering filling against trees, consider tree species and size and type of embankment material.

Approximately 60 percent of the Forests allow some fill against trees. This depth varies from 6 inches to 3 feet.

MINIMUM CLEARING WIDTHS (EQUIPMENT USE)

This section of the worksheet assists the preparer in determining the minimum clearing widths from the edge of the roadbed that will accommodate equipment use during and after construction. This section also may be used to determine the total minimum clearing width required for equipment operation during road construction. These widths are needed to ensure the safe and efficient use of construction, hauling, and maintenance equipment. The information summarized below comes from the questionnaire and from recommendations from preconstruction and construction Engineers in seven Regions.

Tree density affects widths needed for equipment use, not only for maneuverability but also from the operator's psychological standpoint. A crawler tractor operator may be able to construct a road efficiently with a total clearing width of 16 feet in a sparse stand of pine but may find it difficult to maneuver in a dense stand of lodgepole pine. Similarly, a log truck driver may have no difficulty hauling logs over a road with a narrow clearing width in a sparse stand of timber, but the driver may encounter problems when a dense stand of trees creates a "wall" effect.

Enter the following widths, when established, on the template:

Roadbed Width

The roadbed width is the width of the road subgrade. This width is needed to determine the total minimum clearing width.

Distance Outside Roadbed

Equipment Clearance.

(1) Construction. This is the minimum clearing width necessary beyond the excavation and embankment limits that allows efficient equipment operation during road construction and that prevents resource damage such as tree scarring. Do not consider tree stability and total clearing width needed for efficient equipment operation in this evaluation.

(a) Excavation. Most Forests do not provide for additional clearing width at the top of the cut for excavation purposes.

(b) Embankments. Most Forests do not provide for additional clearing width from the toe of fill for construction of embankments.

(2) Haul. This is minimum clearance distance required from the edge of the roadbed for the safe use of hauling equipment frequently using the road. Do not consider sight distance in this evaluation.

Forests allow an additional clearing width of 0 to 4 feet from the edge of roadbed (or shoulder, if the road is surfaced). Many Forests do not see a need for additional clearing beyond the edge of the roadbed for low-volume and low-speed roads.

(3) Maintenance. This is the minimum clearing width from the edge of the roadbed necessary to prevent tree damage and to avoid a berm of material in the tree line.

(a) Tree Damage. Forests provide a 0- to 3-foot clearing width from the edge of roadbed. The most commonly used width is 2 feet.

(b) Preventing Berms. Forests provide a 0- to 6-foot clearing width from the edge of the roadbed. This is to allow recovery of material pushed off the roadbed during maintenance. Most Forests specify at least 2 feet.

(4) Design or Critical Vehicle. The minimum clearing width from the edge of the roadbed needed to accommodate the design vehicle (the size vehicle that frequently uses the road) and the critical vehicle (the largest size vehicle that has limited use of the road). Equipment that may need extra widths are large yarding equipment and lowboys. Research equipment supplier manuals and technical publications for information on the specific equipment expected to be used.

Other. These are widths needed for purposes not listed above, such as sight distance. Document the purpose and need for these widths.

TOTAL MINIMUM CLEARING WIDTH (CONSTRUCTION)

Determine the total minimum clearing width when the clearing widths developed for the two clearing width templates may result in some sections of the road being too narrow for efficient construction equipment operation. For example, the "Clearing Widths (Resources)" template may show that clearing 1 foot beyond the excavation limits is acceptable. However, on a 12-foot roadbed on flat ground and with no ditches, this total width would be only 14 feet. If this width was not adequate for the type of equipment used to construct the road, the contract should provide the total minimum clearing width required for this equipment. Forests provide 12- to 26-foot minimum clearing widths for crawler tractors and graders, and the most common widths are from 16 to 20 feet. Equipment suppliers frequently recommend 4 feet on both sides of the blade (blade width plus 8 feet) but admit that this may be more than necessary. Some equipment efficiency may be lost when this width is less, but the cost of lessened efficiency may not offset the cost of the additional clearing width. Widths of from 14 to 18 feet may be more acceptable in sparse tree stands where tree damage and berms of material around trees are more easily controlled. Some Forests allow as much as 30 feet for hydraulic backhoes, but more research is needed before we can give guides for this type of equipment.

EFN

Project Management Software Review

Team Members

Chris Schwarzhoff
Sponsoring Engineer
Washington Office Engineering

Martin J. Hanson
Region 9

Andy Scheible
Olympic National Forest

John Zirkle
George Washington National Forest

INTRODUCTION

Many project management techniques have been developed, enhanced, and refined to assist managers in scheduling activities within a project. Many Engineers have encountered the project management technique of critical path scheduling. The thought probably brings nightmares of mainframe computers, boxes of computer cards, and reams of unintelligible reports--with an end result of less time to accomplish the actual work! Those experiences can be replaced with more friendly ones by using new microcomputer project management software.

Project management requires a systematic approach to planning work. Considering the interrelationship of the workload, determining the personnel and resources required to accomplish the tasks, and recording the information for future planning use can all be accomplished easily using microcomputer project management software.

No one needs to be reminded that the Forest Service is facing reductions in budgets and personnel. The cries for increases in efficiency and productivity can be heard whenever a group meets to discuss the problem, but how does one accomplish more work with less money and fewer people? Part of the answer is using available resources in the most efficient manner--planning and scheduling efforts to accomplish more with less. The objectives of this report are, first, to inform readers that user-friendly software is available and, second, to give potential project management software buyers some information to consider in their evaluation.

The process involves identifying the work components or tasks, determining the personnel and resources necessary to accomplish the tasks, estimating the time and cost required to complete each task, and arranging the tasks and resources to achieve the best project results. Microcomputer software can help the manager formulate, evaluate, refine, and display this information. A work plan can be constructed and analyzed to schedule available resources. Some of the software packages have a resource leveling feature that enables the computer to reschedule work to eliminate overloaded resources.

To be useful, the packages must allow easy input and rapid updating and editing. In addition, the reports and graphic information features must be simple to produce and must provide pertinent information. This is important for communicating the results of your project management effort.

This article summarizes a team review of several available project management software packages. The summary is based on a 1-week experiment with the software packages listed. Although we do not claim to have performed the most comprehensive testing, we feel confident in presenting general findings and recommendations from our effort.

EVALUATIONS

Microsoft Project (MP), by Microsoft

This convenient software package has an easy-to-understand set of menus. The screens are easy to follow and the entry/edit process is straightforward. The program has excellent tutorials, which describe the software operation better than the manual. Unfortunately, in our opinion, the program has one major flaw: the resources are input as a percentage of the activity duration. The problem is further complicated by the limitation to tenths of the duration. This means that a person who is called on to provide some specialized help for an activity that lasts 2 months cannot be allocated to any less than 6 days (1 tenth of 60 days). This was considered unacceptable in managing the Engineering workload at the Forest level.

Project Manager Workbench (PMW), by Applied Business Technology Corporation

This package was evaluated even though it could be considered a high-end package ($1,150) because of its possibility for the HP 150. Data entry is accomplished through direct entry into the Gantt chart. The relationships of specific activities are entered through a dependency diagram. The dependency diagram must be completed before the PERT chart can be displayed, and the diagram can become confusing and hard to work with as the number of activities increase. The PERT chart cannot be rearranged and can be sent to a hardcopy output device only while it is being displayed on the screen. There is no support for plotters. The package did contain a resource leveling routine.

Project Scheduler Network (PSN), by Scitor

This package can operate on both IBM and HP 150 systems. The display of the PERT chart is one of the best of the packages reviewed. This is true for both the screen and the hardcopy. This package does support plotters and has many built-in graphic reports for tasks, costs, and resources. The graphs have many options and several are displayed and printed/plotted in three dimensions. The standard reports can be customized by selecting output parameters. The missing part of this package is resource leveling.

A mouse is required to operate this application efficiently (both IBM and HP 150 versions). Unless your system already has a mouse, this would add an additional $200 (for IBM systems) or $300 (for HP 150 systems) to the start-up costs. The mouse is used for menu selection and choosing items on the screen. PSN also uses special function keys to assist data entry and report generation.

Project Scheduler 5000 (PS5), by Scitor

This package is a scaled-down version of the Project Scheduler Network application. PERT chart generation and resource leveling are not included, and the lack of these two basic functions limits the package's usefulness. The Gantt chart was clear and data entry and report generation are very similar to Project Scheduler Network. The package contains a very useful custom report generator for both printers and plotters.

SuperProject (SP), by Sourcim/IUS

This program was considered the most versatile in terms of data entry and updating. The program uses the "pulldown" menu concept with control codes available to shortcut the menu selections. The information can be updated from the activities or resource screen or modified directly on the Gantt or PERT charts. The graphics are adequate and the program supports a variety of printers and plotters.

The only concern the reviewers had about the program was the excessive flexibility of input. The variety of ways a user can input data was overwhelming at first. But after the initial introduction, the user will find the versatility a blessing.

Total Project Manager (TPM), by Software Publishing Corporation

TPM was one the easiest packages to learn. Its PERT chart was better than most and could be viewed entirely on one display screen. Unfortunately, the negative aspects outnumbered the positive ones in this package.

Task durations and resource allocations may be assigned to each activity as the PERT chart is constructed on the screen or after the entire network has been designed. This is a nice feature; the manager can sit down at the terminal with nothing and build a PERT chart right on the screen. However, constructing the chart is more difficult than it should be. Whenever concurrent activities are planned, milestones must be created whether they are needed or not. Data entry and editing took longer with this package than with any of the others.

TPM, like MP, allocates resource quantities as a percentage of the total planned task duration, which is cumbersome to work with. For example, suppose you wanted to allocate one Engineer to design a bridge in a 12-week period. The Engineer can complete the task in 1 week, but TPM will not permit you to enter 1 week as the task duration. The user has to express the 1 week as a percentage of the total 12 weeks and enter 0.083. The better software packages permit you to enter task durations (days, weeks, and so on) directly. That would be faster and much easier to work with.

TPM will show when a resource has been overallocated but has no built-in resource leveling features. The use must reallocate resources by editing data accordingly. The reporting features of this package also are limited. For example, costs cannot be listed by resource and predecessors/successors cannot be shown for each task.

High-End Packages

High-end packages, for the purposes of this report, are applications that generally cost more than $1,000 and that serve a more complex project scheduling environment. We briefly evaluated two application programs to determine the relative advantages and disadvantages:

(1) Primavera Project Planner, by Primavera Systems, Inc. This is very large and sophisticated package with many capabilities. The review package that was supplied included only Part 1 of the manual and demonstration project and graphics files. This high-cost package serves the high-end project management community. It produced the best single graphic display of information in a time-scaled PERT chart. With the great number of capabilities in this application comes a greater degree of complexity in the operation.

(2) PMS80, by Pinnell Engineering. This also is a package that supports very large and complex project configurations. The data base aspect allows sort and query capabilities for custom report generation. The package supports both printed text and plotted graphics and has macro capabilities to simplify long processes. The manager can monitor subcontractor and materials handling. Data entry/edit and project updating are done with online forms. (After the testing was completed, a company representative indicated that Pinnell also has a smaller, far less expensive version that should be evaluated in future comparison testing.)

Primavera Project Planner and PMS80 each cost approximately $2,500. PMS80 varies with software configurations. Both packages are suited for large projects that one would normally not encounter at the Forest level. Part of the value in these programs is the support of rather expensive plotters (HP 7580 series) that are not available on most National Forests. Considering the larger initial investments and greater complexities of use, these packages were not reviewed in depth for typical Forest Engineering applications. These programs should be considered for large complex projects with large numbers of tasks and resources over time, such as a Forest Plan.

RECOMMENDATIONS

Table 1 displays the general hardware requirements for each of the packages with the relative capacities and figure 1 shows graphic comparisons of the criteria listed in table 1. Some of the systems are limited in the amount of activities and resource data they can process because of disk size. This is particularly true where subprojects are loaded from disk for processing. We recommend that, whichever system you will be using, the memory be 640K.

Table 1.--Project management software review.

Criteria[a]	Microsoft Project	Project Manager Workbench	Project Scheduler Network	Project Scheduler 5000	Super Project	Total Project Manager	Average
Screen Display:							
Gantt Charts	4	3	4	4	5	2	3.7
PERT Network	3	2	4	0	4	4	2.7
Graphic Reports:							
Gantt Charts	3	3	5	5	5	2	4.0
PERT Network	1	1	4	0	3	3	2.0
Test Reports:							
Rating	2	3	5	5	4	1	3.3
Pre-Defined	12	3	7	5	3	6	
User Defined	N	b	c	Y	c	N	
Data Entry	4	4	4	4	5	2	3.7
Edit/Move/Change	3	4	3	3	4	1	2.7
Features/Options	2	4	4	3	5	3	3.7
Ease of:							
Learning	3	3	3	4	2	3	3.0
Use	4	4	4	3	4	3	3.3
Error Messages	3	1	3	2	3	3	2.7
Tutorial	5	2	3	2	3	2	2.3
Manual	4	3	3	4	4	2	3.3
Computers:							
IBM (compatibles)	Y	Y	Y	Y	Y	Y	--
HP 150	N	Y	Y	Y	N	N	--
Minimum Memory	256	384	320	256	320	384	--
Approx. Activ.	200	100	850	750	100	100	--
List Price	$250	$1,150	$500	$395	$495	$495	--
Resource Leveling	N	Y	N	N	Y	N	--
Data Interchange:							
Import	N	Y	N	N	Y	N	--
Export	Y	Y	Y	Y	Y	Y	--
Plotter Support	N	N	Y	Y	Y	N	--
Subproject(s)	Y	N	Y	Y	Y	Y	--
Even Weight Summary	41	37	49	39	51	31	40.3

Table 1. (cont.)--Project management software review.

[a]The following descriptions are provided as explanations of the criteria. All items were rated from 0 to 5, with 5 being the highest. A 0 was given for packages that did not contain the particular feature. Note that the summary totals are unweighted. You may wish to assign weights to the various criteria and recompute the summary.

Screen Display	Rating is based on the clarity of information presented on the display screen for the various charts.
Graphic Reports	Rating is based on the clarity of information presented on hard copy reports. Packages that supported plotter graphics were scored higher than those which produced dot-matrix graphics.
Text Reports	Rating is based on the clarity of information presented on hard copy reports. The more flexibility for creating reports, the higher the rating.
Data Entry	Rating is based on the ease of data entry for tasks, resources, and costs. Packages with more than one method of data entry were rated higher.
Edit/Move/Change	Rating is based on the ease of data manipulation after data entry.
Ease of Learning and Use	Rating is based on the relative ease of learning and operating the package.
Error Messages	Rating is based on the information supplied at error locations. Place-marked error messages were scored higher.
Tutorial	Rating is based on the usefulness of the tutorial. Disk based and interactive tutorials scored higher.
Manual	Rating is based on organization and indexing of manual.

[b]This package includes a text editor that can be used to modify/annotate the standard reports.

[c]The 3 standard reports can be modified by choosing data elements to be reported.

[d]Price shown is list price and does not include any additional hardware or software. The price normally paid is less than that shown.

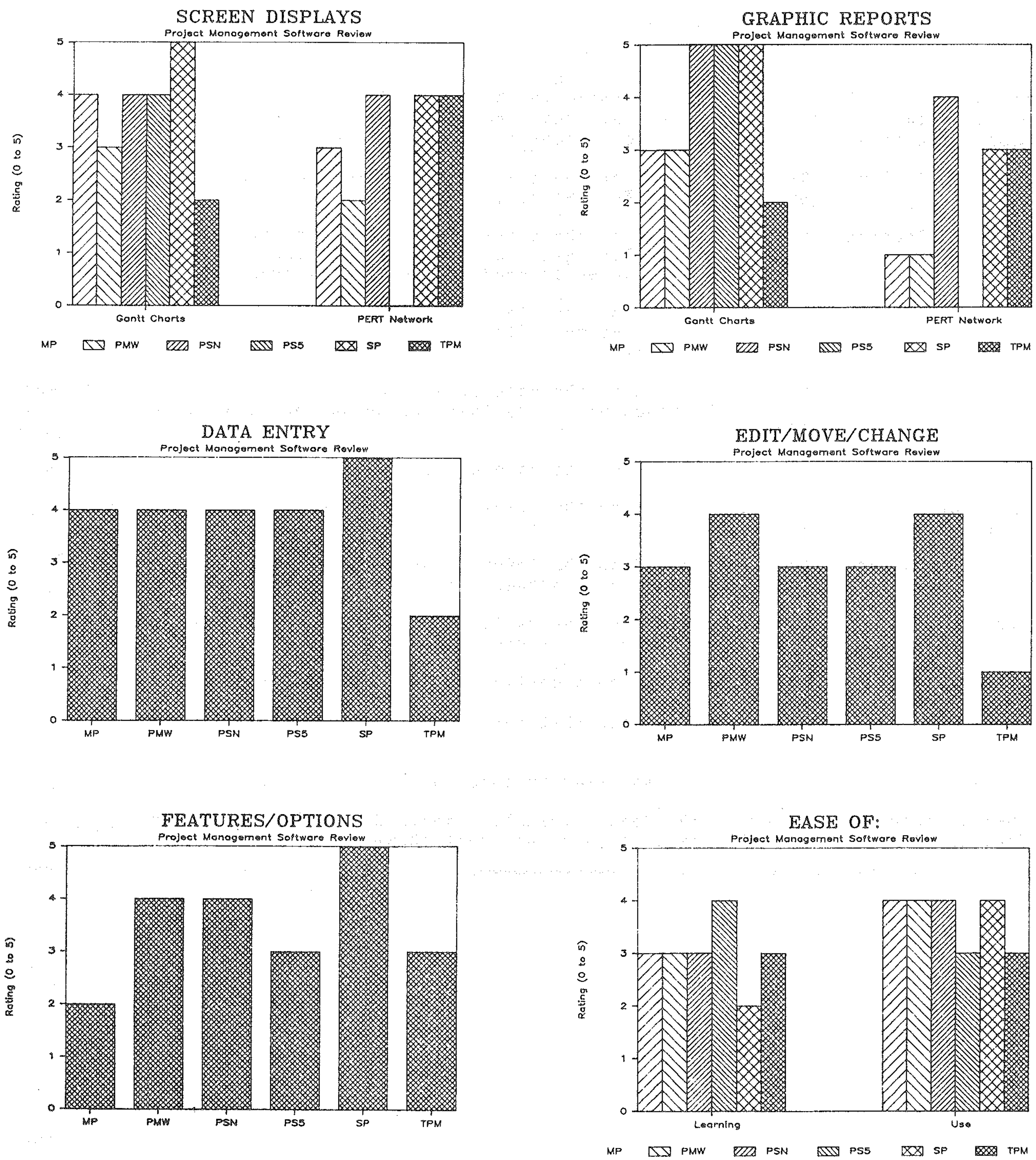


Figure 1.--Graphic comparisons of the criteria.

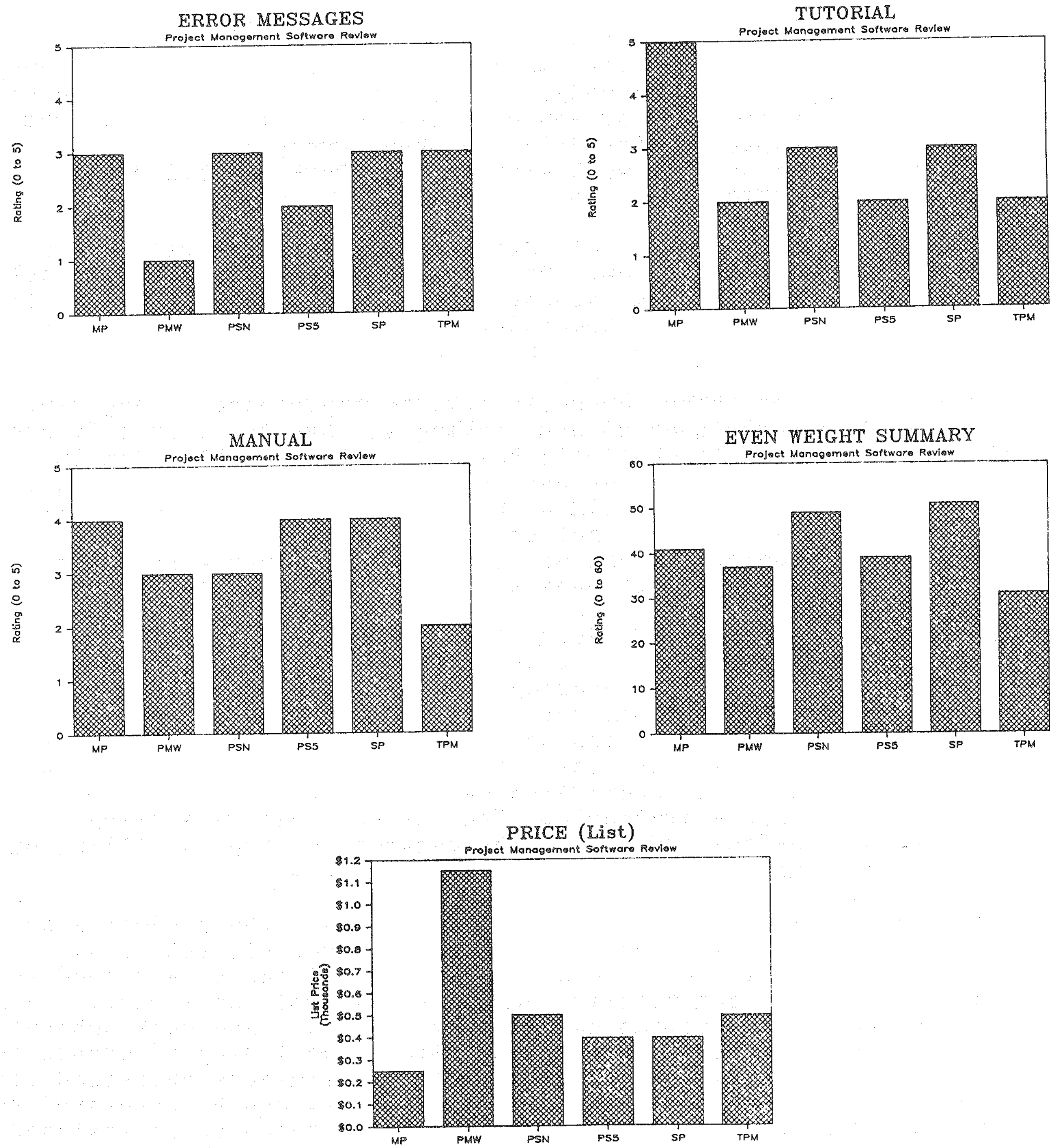


Figure 1. (cont.)--Graphic comparisons of the criteria.

None of the applications requires a hard disk system. Since many of the applications use several program or data files during execution, a hard disk would eliminate disk swapping (repeatedly inserting floppy disks as needed). Since data usually are stored on floppy disks, you may wish to consider the maximum capacity disk drive for your system. All applications will work with the IBM 360K and 1.2 Mbyte formats.

All of the application packages listed will run on an IBM system. Only PSN, PMW, and PS5 are available in HP 150 versions. There are hard disks available for the HP 150, and the 3.5-inch disk capacity is 710K.

For those who would like to try project management techniques without making an investment in software, the RTIP Bulletin Board contains a public domain project management package. You can download this software to IBM or HP 150 systems. Although this package does not contain many features of the commercial packages, it will give you a feel for what project management software can do for you.

IBM Systems

The Super Project Plus scheduling package is considered the best software tested for use by Forest Service Engineering units. Its flexibility will handle almost any form of tracking a manager may want. Data can be input easily and modifications made at any time. Very little prework is required and the information can be expanded as details become available. The software allows setting default values so the manager can bypass filling out information if desired.

The resource handling features of the project also are excellent. Resources (personnel, vehicles, equipment, computers, and so on) can be assigned to any activity in increments as small as 1 hour. Each resource can have its own calendar and work schedule. The resource leveling allows the timing of events to be adjusted automatically to eliminate overscheduling resources. Graphics and reports can be generated to show the activities to which a resource is assigned, a Gantt chart can be displayed for each resource, and cost summaries are maintained for the resource.

The graphics features were not the best of the software evaluated, but they adequately present schedules and relationships between tasks. The Gantt charts use color and symbols well to display information, and the time axis can be compressed or expanded to display time from hours to years on a single screen. The PERT chart does not allow much display flexibility; however, when the chart is compressed to display a large portion of the project, only the task numbers are visible to the user. The software can output the charts and reports to a printer and also will generate the charts on a variety of plotters for a more polished display of the projects.

The greatest disadvantage (or advantage!) is the flexibility of the package. The numerous ways to enter the data may confuse the user at first. The novice user may find it difficult to decide how to proceed in setting up a schedule. However, that flexibility soon can become the user's advantage in convenient data input and editing. Super Project Plus can develop a system that is as simple or as complex as a user may wish as easily as any of the software tested.

NOTE: The list price of this software is $495, but it is available from a number of sources ranging from $237 to $290. Care should be taken to avoid the previous version of Super Project (without the Plus), which has considerably fewer features.

HP 150 Systems

The HP 150 system is not only limited in selection but also is subject to higher costs for both software and hardware upgrades. The cost of additional memory for the HP 150 is $660 for 256K and $910 for 384K. In some cases, this costs more than the software to implement some of the project management packages. However, other applications, such as Lotus 1-2-3, also can use additional memory. It may not be fair to assess the full cost of memory upgrades against one application.

Although Project Scheduler Network generally is featured less than SuperProject, it produces some of the best hard copy reports on both printers and plotters, which is an advantage for display and presentations. The package is relatively easy to learn and operate and flexible in generating both printed and plotted reports.

The disadvantages include the lack of resource leveling and the start-up cost. Because PSN does not have resource leveling, it relies on the user to identify the correct resource overloading. Implementing the system to capacity requires a $910 memory board, a

$300 mouse, and $500 of software, for a total of $1,700. Project Manager Workbench, which includes resource leveling, at full capacity would require $900 for the memory board and $1,150 for the software, for a total of $2,050. In this price range, you will need to evaluate your particular needs carefully in terms of features, such as resource leveling, and cost.

Project Scheduler 5000 will run on the standard HP 150 (256K) for a startup cost of $395. If you do not plan on making any memory upgrades, this may be an economical starter package. The capacity of this package increases with available memory. Note that neither the PERT chart nor resource leveling are available. The package does include both printer and plotter support for an impressive array of text and graphic reports.

CONCLUSIONS

Selecting a given software package for project management on a microcomputer requires careful consideration of existing hardware capabilities, information management needs, project complexity, and the cost of implementation. Because of the variability of these and other factors, different Engineering units might select different programs. This evaluation of project management software assumed typical construction and administrative task force managing by Engineers on a National Forest with a medium workload.

Evaluation Report—Computer-Aided Drafting/Design for Use by Forest Service Architects & Structural Engineers

Robert Sandusky
Regional Architect
Region 5

Nelson Hernandez
Structural Engineer
Region 5

Maurice Hoelting
Architect
Region 8

Steve Sichau
Electrical Engineer
Region 6

EDITOR'S NOTE

This is another in the series of articles regarding CAD systems for producing architectural and structural engineering drawings. Earlier articles were included in the September-October 1985 issue of Engineering Field Notes.

INTRODUCTION

The following report is presented in two steps:

(1) Evaluation Team Findings. This section is a summary of the panel discussions presented by evaluation team members at the National Facilities Workshop, held in San Francisco, California, April 7, 1986.

(2) CAD Users Group Recommendations. Figure 1 at the end of this article shows the notes from the discussion by the CAD Users Group formed at the workshop. This group provided, based on the evaluation team's findings, recommendations for Service-wide use of CAD's for Architects and Structural Engineers.

The evaluation was requested by Washington Office Engineering to provide guidance on the use of computer-aided drafting and design for specific disciplines and specific design applications. The software and hardware used in the evaluation were selected based on other related studies. These related studies show that many of the CAD programs are designed to support specific types of usage. Most software vendors direct their design, marketing, and support efforts to this end as well.

As a host of software packages are commercially available, an indepth review of system types and softwares was commissioned before the team's evaluation. This study, by Lee Wan Associates, concluded that Forest Service architectural and structural engineering CAD systems should be operated on dedicated personal microcomputers. This study recommended the three software programs studied by the team.

The issue of whether to use the Forest Service Data General (DG) system was investigated before the team's evaluation. CAD software programs available for the DG minicomputer are inferior to and considerably more expensive than those available for use with personal computers, in particular IBM and IBM-compatible programs. In addition, architectural and structural engineering programs require considerable computer capacity for the program even before design data are generated. These facts, along with the need for rapid response and priority use of the DG system for office automation, led to the conclusion that CAD use for design production and DG system use were incompatible.

DG generic CAD software is not practical for the aforementioned uses because it requires considerable additional programming. Quality, discipline support software is available for a fraction of the cost to convert DG software for production drawing. Customized software requires maintenance. Again, this is normally available from the original vendor with full compatibility between old and new drawing data.

CADD EVALUATION TEAM FINDINGS

The Computer-Aided Design and Drafting (CADD) Evaluation Team gave a preliminary presentation of their evaluation efforts of CADD hardware, software, and operations to the National Facilities Management Workshop in San Francisco April 7 through 10, 1986. The following is a summary of that information.

Hardware

Recommended hardware would be a microcomputer that is MS-DOS-compatible with minimum read-only memory (ROM) of 512K (640K is preferred for larger drawing files at an additional cost of approximately $150). A random-access memory (RAM) disk could be added, giving 4 megabytes and increasing processing speed. This enhancement would cost approximately $1,800.

The system also should include expansion slots to accommodate cards for peripheral equipment.

The AT&T 6300 machine is too slow for CADD and the 6300+ is not compatible; therefore, they probably should not be required as the microcomputer for this type of Forest Service use.

IBM PC and XT are acceptable, but clones are less expensive. IBM AT with math chip and 640K is an optimum standard. IBM-AT clones (for example, Compac) are 40 percent faster than the AT without compatibility problems. However, because of the fast rate of hardware improvements, it may not be advisable to select a "standard" machine with the limits it might impose on users in the future.

Software compatibility with the hardware must always be verified.

Disk drives are recommended and should be a minimum of one 20-megabyte hard disk (to accommodate approximately 10 to 12 project drawing files) and a 1.2-megabyte high-density floppy disk drive to backup and to run various programs not stored on the hard disk.

A suggested enhancement would be a Bernoulli box plug-in card to provide additional portable storage (approximate cost: $2,500). Drawings require about 150K to 200K per sheet and the software will use about 1.3 megabytes of storage. A Bernoulli box works well for archive storage because cartridges ($50 each) can be used to store approximately 150 to 200 drawings. Similar storage by tape runs $30 but has no memory enhancement.

Cards slots should be available in the computer to allow interface with peripheral devices. A graphics card will be needed to operate a medium- or high-resolution color monitor and must be compatible with the computer, software, and monitor. Other cards, such as expanded memory cards, special use cards, and serial and parallel interface cards, are selected based on the needs of the individual user and the equipment. Cards for output devices are required and should be compatible with the modems, plotters, and printers that will be used.

The keyboard should be compatible with the system and keys should be available for any special functions provided; therefore, it is probably advisable to use the keyboard provided by the computer manufacturer.

Cables are important for properly interconnecting the system components. Cables must have compatible configuration and number of pins and/or sockets at each end to match the equipment being linked together. A "smart cable" product is available to locate bad pins and connections for quickly fixing cabling problems. The approximate cost is $60.

Power conditioning should be provided for spikes, surges, transient currents, and voltage fluctuation to prevent system shutdowns and data loss. Various "plug-in" products are available on the market.

Tapes can be used for backup and archive disks for data and drawings. They are temperature-sensitive and must be removed from the machine when not in use. They will, however, provide a means to store data and prevent lost time in case of a breakdown or frequent use. If a Bernoulli box is available on the system, it can accomplish the backup, and a tape system will not be necessary.

Video monitors should be medium-resolution color for the drawing screen (640 by 400 pixels and a 19-inch diagonal preferred because it reduces eyestrain and the number of required zooms and pans). A second, yellow-and-green monitor with an 11-inch diagonal, low-resolution screen (300 by 200 pixels) may be necessary for some CADD software systems and desirable to run non-CADD software. Redraw time increases as the number of pixels increase, so high-resolution screens may not be worth the tradeoff.

Input devices will be dictated by the CADD software and personal preference. Nearly all systems will accommodate a mouse, digitizer tablet, and pen or puck. The keyboard is also an input device sometimes used in conjunction with the others. A Lot 7 digitizer can be plugged into and used with the IBM PC.

Digitizers that are 24 by 36 inches and larger can be used to input drawings to be traced from existing documents as well as site plans and topography. The cost of a digitizer is in the $4,000 range. The "COGO" software package reduces survey data into CADD software directly, eliminating the need for a large digitizer.

The primary output devices are the plotter and printer. Plotters range in size from the small "A" size (8.5 by 11 inches), which is unsuitable for CADD, to the larger "D" size (22 by 34 inches) and "E" size (34 by 48 inches). The "D" size probably is adequate for nearly all work unless larger sheets are used frequently. Pens used by these devices generally are felt-tip for rough use and Rapidograph-type technical ink pens for final drafting. Multiple pens give a variety of line width and color but increase the cost by about $600. The Lot 7 plotter can be used if available.

Print spooling allows you to print and still use the computer at the same time. This feature may be an added item to the system. Printers are the dot-matrix type or the letter-quality type. Each one can have either a letter-size or wide carriage. Since letter-quality printers are slower and do not do graphics, a wide-carriage dot-matrix printer is recommended for any CADD system.

The drives available with the software package must be compatible with the printer or plotters used. This should be verified when a manufacturer and model are selected.

Software

Structural analysis software is available from many sources and should be selected on the basis of the work being done. "SAP-80" is produced by the University of California in Berkeley for approximately $9,000 and is used frequently on the West Coast. A less expensive program, called "STAAD-3," is available for $3,500; it has an ACI and ASC code-checking feature. Freeware also is available at little or no cost from various sources.

Few, if any, of the structural analysis programs currently are integrated with the CADD systems, however. This may take place in the future and should be explored when software is purchased.

Structural design software such as Enercalc comes as a template for use with such integrated programs as Symphony or spreadsheet programs such as Lotus 1-2-3. Lotus templates are available for $50 to $100. The initial costs are reasonably low and updates or replacements are easy to do. A word of caution about all software: if it isn't ready to go when you are ready to buy it, don't buy it.

Some general thoughts on software:

(1) Manuals and training are important to understanding how to use the software. Use their availability as part of the selection criteria.

(2) IBM has 30,000 programs available for its machines. Try one out with a demonstration before purchasing, if possible.

(3) Integrated software will output data into a file that can then be read by the CADD software. Check out the CADD software for this feature when buying.

(4) MEGACADD-3D is a good program for three-dimensional drawing and perspectives. Others may only provide three-dimensional perspectives such as Isometric or Axnometric without true perspective, which has vanishing points and total viewing from all angles.

(5) COGO is a good program for surveying conversion to site plans and topography plots.

(6) The Data General Comprehensive Electronic Office (CEO) system can be up- and downloaded with IBM using software called CEO Connect Version 2.

(7) Symphony is a good general-purpose spreadsheet for engineering analysis and cost estimating.

(8) Norton Utilities is useful for recovering lost files. When files are erased, only the index is lost; therefore, the file can be retrieved unless it has been written over.

(9) 1-DIR is a utility program that allows you to customize and organize MS-DOS as you wish for your own convenience.

Operational Issues

One of the first, most basic questions to be answered is "Do I NEED a CADD system?" Analyze your work. If you have busy drafters doing repetitive work, you probably do. However, you may need a computer to meet other needs as well, and that may help to justify a system, since the software is not a major cost item compared to the rest of the components.

Multiple use of the system may cause scheduling problems and limit production as well. Since Regions have funding discretion up to $100,000, CAD system purchases can be handled within the Regional Forester's authority. Match the features of the system to the work to be performed and the funds available.

In choosing the system, two of the primary criteria should be support and service. Since there is such a long learning curve, know what kind of training is available. Downtime should be minimized and system problems should be promptly rectified, so be sure the vendor is capable of providing a high level of competent, timely service.

If you purchase from a dealer, try to get a turn-key installation with training included. If a single contract is used, a 20-percent premium will probably be paid, but compatibility of system elements and vendor support can be achieved. In the case of individual purchase of items, a 30-percent discount is possible, but you will be on your own for service, support, and training. Support will be needed either by the vendor (good the first time out) or by separate contract. Purchase the software through the vendor for compatibility, and use a local vendor.

A system costs $10,000 to $30,000, but time spent learning can approach the cost of the system. Be prepared for spending as long as 6 months to become productive with the machine. Commitment to the learning curve should extend up and down the management ladder to ensure time allotted to learning. Complete a project with a real deadline to ensure progress along the curve. Get regularly involved with the system, and be tenacious. Community colleges can be a training resource.

To be successful, you must get management support and commitment and motivation of the users, but the benefits could be helpful with reduced staffs and could eliminate the need for some architectural engineering contracts. Detailers and architectural engineering or services contracts can be used in the short term to free people to start learning the system. Don't lose sight of the fact that quality and production are related. A good learning exercise can be to establish libraries for future use, either as a separate activity or with the project being produced.

CADD is not separate from broader issues, such as workload, budget, and individual skills, so it is necessary to plan for the changes CADD will make and determine how the system will fit in the big picture. The following are some issues and thoughts to consider:

(1) A computer that is truly "personal" should be available as a tool for use by the individual as needed. Sharing may be inefficient.

(2) Electrical drawings have been produced on contract CADD in Region 6 at a cost of $160 per sheet plus prep costs and review time.

(3) Electronic scanning of existing drawings is a coming technology.

(4) CADD may or may not afford centralization in the future depending on what develops organizationally. It may also influence what takes place in the future as regards greater or less centralization in certain disciplines.

(5) A common user base may be developed. Smaller Regions may become more dependent on resources developed by the larger ones and may need the ability to access and edit information.

(6) Translators, that allow the transfer of one software type into another, exist and are becoming more common. The skills required for one particular software carry over very well into another. The differences aren't all that significant.

(7) Look at the system in terms of access by other skills. Architectural and engineering applications will probably integrate well. Interface between units (laterally and vertically) will be determined mostly by DOS and software compatibility. Interchange of parts would be a benefit of systems that are the same.

(8) Both floating point and integer based systems should integrate with each other with proper translators.

(9) Systems require management. This includes maintenance and repair, security, document backup, organization of work, training, and updating of hardware and software.

(10) A&E Contractors and consultants may be required to provide compatible documents with the CADD system you are using.

(11) A CADD system will not make a good design, it will only do it faster...good or bad.

CADD Software Comparative Analysis

Cadvance. Cadvance, as well as the other systems, has no spelling checker.

Function-to-function comparison among systems is difficult without complete timing, and number of operations required to do an operation are considered.

Cadvance uses an integer system, which has a limited number of points in its drawing universe but is adequate to the tolerance limit of the plotter. Integer has the advantage of speed in redraw, panning, and zooming operations.

Nested commands allow Cadvance to switch between commands quickly. For example, changing layers requires 2 keystrokes versus as many as 11 in other systems.

Editing drawings can be done quickly and intuitively. A user can move vertexes, cut, and fill by breaking a segment. Doors and windows can be inserted without cutting and placing.

Cadvance has a translator that allows third-party support and can use AutoCad and VersaCad files.

Mirrored text is not reversed as in AutoCad.

Scales can be mixed on a drawing, allowing the scale to be set up as it would appear on the drawing. It can be queried for dimensions.

Cadvance uses "smart macros" to repeat selected functions by prompting for input of data, location, and so on, and by asking for verification before execution.

Cadvance provides data base extraction by giving a symbol an attribute that can be extracted later and numerically combined.

Cadvance is 30-percent faster than other systems Region 8 uses for architectural work and bridges.

Symbols scale in only one direction. Two would be preferable.

Text appears only at the bottom of the screen status line. A duplicated text line at the location on the drawing would be preferable.

Having drawing and menu commands on the same screen reduces the amount of head and eye movement.

Cadvance provides 13 letter fonts, as well as expanded, compressed, and slanted type.

Cadvance costs approximately $2,500. Region 8 has had the system on site for a year and a half.

<u>AutoCad</u>. Electrical control drafting contracts requiring the use of the microcomputer CADD system resulted in 10 bids on AutoCad at a final cost of $100 per sheet. A later service contract was established at $160 per sheet plus $10 per sheet for plotting.

Limited support for VersaCad and Cadvance in the Portland area at the time of purchase led to the choice of AutoCad.

A committee selected AutoCad from among others in the field and was trained in its use. Internal studies then coincided with non-Forest Service consultants using AutoCad. Not much work has been done with non-Forest Service architects yet.

The system has been enhanced with Intel "Above Board" to increase drawing regeneration time.

Architectural Engineering CADD is an enhancement macro for operations such as squaring corners or inserting for doors and windows that are not a part of the base software. The cost for this macro is about $1,000.

Region 6 Electrical Engineering uses symbols frequently and therefore has developed a large library. In general, it will be necessary to edit and create new symbols with each software system.

AutoCad can do schematic work in a day and a half that previously took a full week.

The interface with other users weighed heavily in the selection of AutoCad.

Sanitary Engineers in Region 6 are using standard details that were put on CADD by contract. Designing is done in the Regional Office. All standards are going on CADD.

Auxiliary programs and symbol library are available with AutoCad. More than 150 programs exist.

LIST, an auxiliary program, allows design data to be converted into drawings.

VersaCad. Once a user becomes familiar with this system, it becomes comfortable and easy to use, even though it has some features that are not preferred over other systems. The ability to handle drawing portions selectively as groups is a very powerful tool.

VersaCad has the advantage of third-party vendors that have programs to fit.

The initial impression of the system is that a person can be on his own and drawing in 2 hours and can feel comfortable after 1 month of regular use. In 6 months, a person should be at the breakeven point.

Startup is difficult with VersaCad when a big workload already exists, and that is complicated by fear of failure or crashing. People will have to be pulled out of production so that they can practice with no production pressure and become productive later with CADD.

The report supplied by Lee Wan Associates recommended tests of three systems. AutoCad and Cadvance were already in Region 6 and Region 8, so Region 5 became the test site for VersaCad. No comparative study was done before purchase.

Individual purchase of hardware was set aside for a turnkey, total system on sole-source procurement to meet Washington Office requirements and to get better service and a workable final product. Training was provided by vendor by contract. The manufacturer has a good tutorial.

Going for a low bidder probably would work, and compatibility would be not so much of a problem if in-house expertise was available.

The need to share should be balanced against individual requirements. Define the job to be done, determine if the system will do the job, decide if you will be a sharer or independent user, then dive into the CADD environment.

CAD Users Group - Discussion and Recommendations

BRAINSTORMING ISSUES

1. Assistance/support for non-owners.
2. Common design concepts.
3. Uniformity hardware/software
   Networking/FLIPS for specifications.
   Peer review (aid to others).
4. Sharing shortcuts, tips, etc., inter-Regional.
5. Data management (disposition of data/site specific).
6. System management--uniformity
   file data store, etc.

Yes or No for a CAD is a Regional decision.

Lot 7 isn't to be considered.

- Dedicated to roads, not facilities.

ASSISTANCE & SUPPORT FOR FUTURE CAD OWNER/USERS

- Provide backup help between Regions to even out workloads.
  - Maximize use of systems.
- Exchange of data, designs information, details, etc.
  - Data (drawings) may not always be best transferred electronically.

DESIGN CONCEPTS

- Reference source (repository of design ideas/concepts).
- Design solution bulletin board or basket.
- Requires strong advocate.
- Focused audience.
- Interested users.
  - Can FLIPS be used to transfer graphics? Assume yes.

Figure 1.--CAD Users Group discussion and recommendations.

- Why use FLIPS? (Capacity? Cheaper?) Systems management approval of FLIPS environment.
- Ft. Collins have a role? Storage use FLIPS to access through Ft. Collins.

UNIFORMITY OF HARDWARE/SOFTWARE

Hardware

- MS DOS compatibility necessary.
- Suggested minimum capacity 512 K.
- Suggest minimum 10-megabyte hard disk.
- Rest of hardware up to the individual user.
- Modem--2,400 BAUD minimum $600±.

Software

- Assume non-uniform software.
- DXF translator may provide necessary interface between CAD systems costs one-quarter of $500.

NETWORKING

- Use FLIPS for SPECS (CEO)
  - CSI format.
  - User notes for explanation and aid to spec writer.
  - [Bracket] information that should be changed with each use. Use CEO search to find.
  - Cost examination of using FLIPS or IBM or other for inter-Regional transfer.
  - DG mailing list for auto sending ideas to each architect at the Region.
  - Step 1. Give Architects a mailbox and Password and Account on FLIPS.
  - Peer review of drawings and specs for errors, omissions, etc.

Figure 1. (cont.)--CAD Users Group discussion and recommendations.

- Within Region by COR, Insp., and others technical review.
- Interregional review where disciplines are thin. Second opinion/ck.

- CAD requires 1-day plot-time and manpower.
  - Mail requires printing and transit time--further research and cost study needed.
- Process is desirable and resources (equipment, people, and time) should be identified and utilized.

DATA MANAGEMENT

- Handling of data within Region specifically.
  - Drawing file discipline.
    - How to organize varies somewhat depending on software used.
    - Varies on how you do business.
    - Common DB management techniques may evolve as result of similar hardware, file capacity.
    - Setup could be arrived at by mutual agreement (of users committee).
      - By electronic meeting.

ACTION ITEMS

- Establish user group for CAD-related issues.
  - Set up mailing list.
  - Maurice will initialize.
  - System to be informal.
    - Ask questions.
    - Request help (peer review).
    - Offer ideas.
  - May expand scope in future.

Figure 1. (cont.)--CAD Users Group discussion and recommendations.

- Inter-Regional network.

- Recommend to CAD Evaluation Team:

  1. Systems be MS DOS-compatible.

  2. Minimum capacity be 512K.

  3. 10-megabyte hard disk minimum.

  4. Suggest hardware selection be up to the individual user.

  5. System have 2,400 baud (minimum) modem.

  6. Systems software should have DXF translator.

- Select group leader and suggest steps to start.

  - Leader will be Maurice Hoelting, who will--

    - Set up mailing list for network.

    - Establish data handling panel and begin operation.

    - Initiate investigation of FLIPS role and costs and equipment software/hardware. Pass on results.

    - Do similar thing with Fort Collins.

Team: Robert Sandusky
Maurice Hoelting
Sam Fischer
Jim Milner
Dave Dercks
Thad Schroder
Wilden Moffett

Figure 1. (cont.)--CAD Users Group discussion and recommendations.

Bibliography of Engineering & Equipment Development Publications

This bibliography contains information on publications produced by the Washington Office Engineering Publications Section and the Equipment Development Centers.

The listing is arranged by publications series and includes title, author/source, document number, and date.

This issue lists material published from November 1985 through December 1986. For a listing of previously published material, refer to Engineering Field Notes, Volume 17, November-December 1985. Copies of Engineering Field Notes and Engineering Management Series publications listed herein are available to Forest Service personnel through the Engineering Staff Technical Information Center (TIC). Copies of the Project Reports, Equip Tips, and Special and Other Reports are available from the Equipment Development Center listed as the source.

Forest Service-USDA
Engineering Staff, TIC
P.O. Box 2417
Washington, DC 20013
703/FTS 235-1424

Forest Service-USDA
San Dimas Equipment
Development Center
444 E. Bonita Ave.
San Dimas, CA 91773

Forest Service-USDA
Missoula Equipment
Development Center
Fort Missoula, Bldg. 1
Missoula, MT 59801

This publication is a bimonthly periodical that supplies the latest technical and administrative engineering information and ideas related to forestry and provides a forum for the exchange of such information among Forest Service personnel.

FIELD NOTES by TITLE

"Determining the Critical Thaw-Weakened Period in Asphalt Pavement Structures"	Hanek, Gordon. Field Notes 18 (January-February 1986): 73-88.
"Device To Measure Road Dustiness--1985 Summer Field Evaluations"	Taylor, Deborah. Field Notes 18 (January-February 1986): 5-8.
"Device To Measure Road Dustiness--1985 Summer Field Evaluations"	Irwin, L.H., Prof. Field Notes 18 (January-February 1986): 5-8.
"Discussion Regarding Policy and Procedures for Economic Analysis of Buildings and Related Facilities"	Lippert, George J. Field Notes 17 (November-December 1985): 5-8.
"Electronic Navigation Systems May Offer Accurate Field Coordinate Location for Resource Management Activities"	Gasvoda, David S. Field Notes 18 (March-April 1986): 21-28.
"Engineering Expert Systems"	Ou, Fong L. Field Notes 18 (September-October 1986): 43-53.
"Evaluation of Loran-C Radio Navigation Systems for National Forest Application"	Humerickhouse, Harold. Field Notes 18 (November-December 1986): 21-28.
"Evaluation of Microcomputer Hardware Features for Engineering Applications"	Ou, Fong. Field Notes 18 (May-June 1986): 51-58.
"Evaluation Report--Computer-Aided Drafting/Design for Use by Forest Service Architects and Structural Engineers"	Hernandez, Nelson. Field Notes 18 (November-December 1986): 53-68.
"Evaluation Report--Computer-Aided Drafting/Design for Use by Forest Service Architects and Structural Engineers"	Hoelting, Maurice. Field Notes 18 (November-December 1986): 53-68.
"Evaluation Report--Computer-Aided Drafting/Design for Use by Forest Service Architects and Structural Engineers"	Sandusky, Robert. Field Notes 18 (November-December 1986): 53-68.
"Evaluation Report--Computer-Aided Drafting/Design for Use by Forest Service Architects and Structural Engineers"	Sichau, Steve. Field Notes 18 (November-December 1986): 53-68.
"Facilities Maintenance Management"	Lippert, George. Field Notes 18 (September-October 1986): 65.

"Federal Engineer Liabilities"	Toffenetti, Kathryn. Field Notes 17 (November-December 1985): 19-28.
"Fence Failures at Dog Legs and What To Do About Them"	McKenzie, Dan. Field Notes 18 (July-August 1986): 13-19.
"Fence Failures at Dog Legs and What To Do About Them"	Eisiminger, Bret. Field Notes 18 (July-August 1986): 13-19.
"(The) First Nationwide Forest Service Remote Sensing Workshop: A Significant Step Into the Future"	Greer, Jerry D. Field Notes 18 (July-August 1986): 33-37.
"Floating Field Camps in Region 10: An Alaskan Solution to an Alaskan Problem"	Garcia, Don. Field Notes 17 (November-December 1985): 13-17.
"Forest Service Map Products Produced From USGS DLG Data"	Beus, Daniel L. Field Notes 18 (November-December 1986): 7-12.
"Forest Service Map Products Produced From USGS DLG Data"	Eggli, Robert J. Field Notes 18 (November-December 1986): 7-12.
"Gradeability and Cost Considerations in Vehicle Operations on Steep Roads"	Anderson, Paul. Field Notes 18 (May-June 1986): 19-27.
"Gradeability and Cost Considerations in Vehicle Operations on Steep Roads"	Sessions, John. Field Notes 18 (May-June 1986): 19-27.
"Ground Penetrating Radar: A Review for Resource Managers"	Greer, Jerry. Field Notes 18 (September-October 1986): 1-8.
"Guide for Selecting Clearing Widths"	Marty, Art. Field Notes 18 (November-December 1986): 29-40.
"Guide for Selecting Clearing Widths"	Weissling, Jack. Field Notes 18 (November-December 1986): 29-40.
"I Rip 'Em Flexes Its Muscles"	Cox, Wallace R. Field Notes 18 (September-October 1986): 29-34.
"Identifying Haul Speeds Controlled by Grade and Surface Type or Horizontal Alignment and Road Width for Forest Development Roads"	Evans, Max. Field Notes 18 (September-October 1986): 55-64.
"Keeping Beavers From Plugging Culvert Inlets"	Fisher, Philip H. Field Notes 18 (January-February 1986): 9-13.
"Lost River Ranger Station--Breaking New Ground"	Moffett, Wilden W. Field Notes 18 (September-October 1986): 9-13.
"(The) Mammoth Alternate Exit Road Aerial P-Line Survey"	Salsig, Gerry. Field Notes 18 (January-February 1986): 15-20.
"Mel Teigen--Forest Service Engineer of the Year"	Editor. Field Notes 18 (May-June 1986): 2-3.
"Microcomputer Programs Available on the RTIP Bulletin Board"	Schwarzhoff, Chris. Field Notes 18 (March-April 1986): 29-36.

"Modeling and Testing Two-Stump Anchor Systems for Skyline Yarders"	Toupin, Richard. Field Notes 18 (May-June 1986): 5-12.
"Modeling Running Skyline Performance Based on Mechanical Capability of the Yarder"	Wilbanks, Samuel J. Field Notes 18 (May-June 1986): 29-42.
"Modeling Running Skyline Performance Based on Mechanical Capability of the Yarder"	Sessions, John. Field Notes 18 (May-June 1986): 29-42.
"Network Analysis Using Microcomputers for Transportation Planning"	Sessions, John. Field Notes 18 (January-February 1986): 49-59.
"Potential for Engineering Cost Savings With Analytical Photogrammetry"	Valentine, Wayne. Field Notes 18 (January-February 1986): 29-37.
"Project Management Software Review"	Hanson, Martin. Field Notes 18 (November-December 1986): 41-52.
"Project Management Software Review"	Schieble, Andy. Field Notes 18 (November-December 1986): 41-52.
"Project Management Software Review"	Zirkle, John. Field Notes 18 (November-December 1986): 41-52.
"Region 3 Crew Quarters Standard"	Archambault, Louis. Field Notes 18 (March-April 1986): 7-11.
"Report on the Photogrammetric Survey on the Kaibab National Forest Hearst Mountain Project in FY 1983 and 1984"	Mouland, Dennis J. Field Notes 18 (March-April 1986): 13-19.
"Report on the Photogrammetric Survey on the Kaibab National Forest Hearst Mountain Project in FY 1983 and 1984"	Stephens, William E. Field Notes 18 (March-April 1986): 13-19.
"Road Program Costs: Continuing Efforts Addressing the Issue"	Weller, Clyde. Field Notes 18 (November-December 1986): 13-20.
"Road Program Costs: Continuing Efforts Addressing the Issue"	Zealley, Ted. Field Notes 18 (November-December 1986): 13-20.
"RTIP Bulletin Board--What's New?"	Schwarzhoff, Chris. Field Notes 18 (July-August 1986): 39-42.
"Selecting Construction Slash Treatment Methods"	Weissling, Jack. Field Notes 18 (July-August 1986): 21-32.
"Selecting Construction Slash Treatment Methods"	Marty, Art. Field Notes 18 (July-August 1986): 21-32.
"Solar-Powered Water-Pumping Systems for Remote Sites"	Kringler, Harry. Field Notes 18 (May-June 1986): 45-50.
"Study of Quality of Aerial Photography"	Lachowski, Henry M. Field Notes 18 (January-February 1986): 61-72.
"(The) Technology of Technology Transfer--A Blueprint for Success"	Connolly, Connie. Field Notes 18 (September-October 1986): 15-28.

"Terrain Profiles for Cable Logging in Region 1 With Analytical Photogrammetry"	Valentine, Wayne. *Field Notes* 18 (March-April 1986): 3-6.
"Underbody Blade Truck"	Bassel, James R. *Field Notes* 17 (November-December 1985): 9-12.
"Using HP-41C for Preliminary Road Cost Estimation"	Ou, Fong L. *Field Notes* 18 (January-February 1986): 21-28.
"Using HP-41C for Preliminary Road Cost Estimation"	Durston, Thomas A. *Field Notes* 18 (January-February 1986): 21-28.
"Washington Office Engineering Staff Update"	Editor. *Field Notes* 18 (July-August 1986): 1-12.
"Water Well Monumentation"	Wisehart, Richard. *Field Notes* 18 (May-June 1986): 43-44.
"1985 *Field Notes* Article Awards"	Editor. *Field Notes* 17 (November-December 1985): 1-4.
"1986 *Field Notes* Article Awards"	Editor. *Field Notes* 18 (November-December 1986): 1-4.

FIELD NOTES by AUTHOR

Anderson, Paul. *Field Notes* 18 (May-June 1986): 19-27.	"Gradeability and Cost Considerations in Vehicle Operations on Steep Roads"
Archambault, Louis. *Field Notes* 18 (March-April 1986): 7-11.	"Region 3 Crew Quarters Standard"
Bassel, James R. *Field Notes* 17 (November-December 1985): 9-12.	"Underbody Blade Truck"
Beus, Daniel L. *Field Notes* 18 (November-December 1986): 7-12.	"Forest Service Map Products Produced From USGS DLG Data"
Coghlan, Skip. *Field Notes* 18 (September-October 1986): 35-42.	"Aggregate Design Considerations"
Connolly, Connie. *Field Notes* 18 (September-October 1986): 15-28.	"(The) Technology of Technology Transfer--A Blueprint for Success:
Cox, Wallace R. *Field Notes* 18 (September-October 1986): 29-34.	"I Rip 'Em Flexes Its Muscles"
Davis, Carl. *Field Notes* 18 (September-October 1986): 35-42.	"Aggregate Design Considerations"
Durston, Thomas A. *Field Notes* 18 (January-February 1986): 21-28.	"Using HP-41C for Preliminary Road Cost Estimation"
Editor. *Field Notes* 18 (May-June 1986): 1.	"Awards for the 1985 *Field Notes* Articles"
Editor. *Field Notes* 17 (November-December 1985): 29-46.	"Bibliography of Engineering and Equipment Development Publications"

Editor. Field Notes 18 (November-December 1986): 69-84. "Bibliography of Engineering and Equipment Development Publications"

Editor. Field Notes 18 (May-June 1986): 2-3. "Mel Teigen--Forest Service Engineer of the Year"

Editor. Field Notes 18 (July-August 1986): 1-12. "Washington Office Engineering Staff Update"

Editor. Field Notes 17 (November-December 1985): 1-4. "1985 Field Notes Article Awards"

Editor. Field Notes 18 (November-December 1986): "1986 Field Notes Article Awards"

Eggli, Robert J. Field Notes 18 (November-December 1986): 7-12. "Forest Service Map Products Produced From USDA DLG Data"

Eisiminger, Bret. Field Notes 18 (July-August 1986): 13-19. "Fence Failures at Dog Legs and What To Do About Them"

Evans, Max. Field Notes 18 (September-October 1986): 55-64. "Identifying Haul Speeds Controlled by Grade and Surface Type or Horizontal Alignment and Road Width for Forest Development Roads"

Fisher, Philip H. Field Notes 18 (January-February 1986): 9-13. "Keeping Beavers From Plugging Culvert Inlets"

Garcia, Don. Field Notes 17 (November-December 1985): 13-17. "Floating Field Camps in Region 10: An Alaskan Solution to an Alaskan Problem"

Gasvoda, David S. Field Notes 18 (March-April 1986): 21-28. "Electronic Navigation Systems May Offer Accurate Field Coordinate Location for Resource Management Activities"

Gleason, Karl H. Field Notes 18 (May-June 1986): 13-18. "(A) Computer Simulation Program To Estimate the Speed and Productivity of Tracked Skidders"

Greer, Jerry D. Field Notes 18 (July-August 1986): 33-37. "(The) First Nationwide Forest Service Remote Sensing Workshop: A Significant Step Into the Future"

Greer, Jerry. Field Notes 18 (September-October 1986): 1-8. "Ground Penetrating Radar: A Review for Resource Managers"

Hanek, Gordon. Field Notes 18 (January-February 1986): 73-88. "Determining the Critical Thaw-Weakened Period in Asphalt Pavement Structures"

Hanson, Martin. Field Notes 18 (November-December 1986): 41-52. "Project Management Software Review"

Hernandez, Nelson. Field Notes 18 (November-December 1986): 53-68. "Evaluation Report--Computer-Aided Drafting/Design for Use by Forest Service Architects and Structural Engineers"

Hinshaw, Bob. Field Notes 18 (September-October 1986): 35-42. "Aggregate Design Considerations"

Hoelting, Maurice. Field Notes 18 (November-December 1986): 53-68. "Evaluation Report--Computer-Aided Drafting/Design for Use by Forest Service Architects and Structural Engineers"

Humerickhouse, Harold. Field Notes 18 (November-December 1986): 21-28. "Evaluation of Loran-C Radio Navigation Systems for National Forest Applications"

Irwin, L. H., Prof. Field Notes 18 (January-February 1986): 5-8. "Device to Measure Road Dustiness--1985 Summer Field Evaluations"

Johnson, Steven D. Field Notes 18 (May-June 1986): 59-70. "Cadastral Surveying--Photogrammetrically"

Kanno, Lynn. Field Notes 18 (January-February 1986): 1-3. "ASNAP: Administrative Site Needs Assessment Process"

Kolzow, Bill. Field Notes 18 (September-October 1986): 35-42. "Aggregate Design Considerations"

Kringler, Harry. Field Notes 18 (May-June 1986): 45-50. "Solar-Powered Water-Pumping Systems for Remote Sites"

Lachowski, Henry M. Field Notes 18 (January-February 1986): 61-72. "Study of Quality of Aerial Photography"

Lippert, George. Field Notes 17 (November-December 1985): 5-8. "Discussion Regarding Policy and Procedures for Economic Analysis of Buildings and Related Facilities"

Lippert, George. Field Notes 18 (September-October 1986): 65. "Facilities Maintenance Management"

Marty, Art. Field Notes 18 (November-December 1986): 29-40. "Guide for Selecting Clearing Widths"

Marty, Art. Field Notes 18 (July-August 1986): 21-32. "Selecting Construction Slash Treatment Methods"

McBane, Jim. Field Notes 18 (January-February 1986): 73-88. "Determining the Critical Thaw-Weakened Period in Asphalt Pavement Structures"

McKenzie, Dan. Field Notes 18 (July-August 1986): 13-19. "Fence Failures at Dog Legs and What To Do About Them"

Moffett, Wilden W. Field Notes 18 (September-October 1986): 9-13. "Lost River Ranger Station--Breaking New Ground"

Mouland, Dennis J. Field Notes 18 (March-April 1986): 13-19. "Report on the Photogrammetric Survey on the Kaibab National Forest Hearst Mountain Project in FY 1983 and 1984"

Ou, Fong L. Field Notes 18 (November-December 1986): 5-6 "Cost Reduction in Washington Office Engineering Systems Operation and Maintenance"

Ou, Fong L. Field Notes 18 (September-October 1986): 43-53. "Engineering Expert Systems"

Ou, Fong. Field Notes 18 (May-June 1986): 51-58. "Evaluation of Microcomputer Hardware Features for Engineering Applications"

Ou, Fong L. Field Notes 18 (January-February 1986): 21-28. "Using HP-41C for Preliminary Road Cost Estimation"

Pertile, Bob. Field Notes 18 (September-October 1986): 35-42. "Aggregate Design Considerations"

Salsig, Gerry. Field Notes 18 (January-February 1986): 15-20. "(The) Mammoth Alternate Exit Road Aerial P-Line Survey"

Sandusky, Robert. Field Notes 18 (November-December 1986): 53-68. "Evaluation Report--Computer-Aided Drafting/Design for Use by Forest Service Architects and Structural Engineers"

Scheible, Andy. Field Notes 18 (November-December 1986): 41-52. "Project Management Software Review"

Schwarzhoff, Chris. Field Notes 18 (March-April 1986): 29-36. "Microcomputer Programs Available on the RTIP Bulletin Board"

Schwarzhoff, Chris. Field Notes 18 (July-August 1986): 39-42. "RTIP Bulletin Board--What's New?"

Sessions, John. Field Notes 18 (January-February 1986): 49-59. "Network Analysis Using Microcomputers for Transportation Planning"

Sessions, John. Field Notes 18 (May-June 1986): 19-27. "Gradeability and Cost Considerations in Vehicle Operations on Steep Roads"

Sessions, John. Field Notes 18 (May-June 1986): 29-42. "Modeling Running Skyline Performance Based on Mechanical Capability of the Yarder"

Sichau, Steve. Field Notes 18 (November-December 1986): 53-68. "Evaluation Report--Computer-Aided Drafting/Design for Use by Forest Service Architects and Structural Engineers"

Stephens, William E. Field Notes 18 (March-April 1986): 13-19. "Report on the Photogrammetric Survey on the Kaibab National Forest Hearst Mountain Project in FY 1983 and 1984"

Stuart, Ted. Field Notes 18 (September-October 1986): 35-42. "Aggregate Design Considerations"

Suhr, John. Field Notes 18 (January-February 1986): 39-48. "Decisions...Decisions... Decisions"

Taylor, Deborah. Field Notes 18 (January-February 1986): 5-8. "Device to Measure Road Dustiness--1985 Summer Field Evaluations"

Toffenetti, Kathryn. Field Notes 18 (November-December 1985): 19-28. "Federal Engineer Liabilities"

Toupin, Richard. Field Notes 18 (May-June 1986): 5-12. "Modeling and Testing Two-Stump Anchor Systems for Skyline Yarders"

Valentine, Wayne. Field Notes 18 (March-April 1986): 3-6. "Terrain Profiles for Cable Logging in Region 1 With Analytical Photogrammetry"

Valentine, Wayne. Field Notes 18 (January-February 1986): 29-37.	"Potential for Engineering Cost Savings With Analytical Photogrammetry"
Weissling, Jack. Field Notes 18 (November-December 1986): 29-40.	"Guide for Selecting Clearing Widths"
Weissling, Jack. Field Notes 18 (July-August 1986): 21-32.	"Selecting Construction Slash Treatment Methods"
Weller, Clyde. Field Notes 18 (November-December 1986): 13-20.	"Road Program Costs: Continuing Efforts Addressing the Issue"
Whitmill, Leland. Field Notes 18 (March-April 1986): 1-2.	"Close-Range Photogrammetry"
Wilbanks, Samuel J. Field Notes 18 (May-June 1986): 29-42.	"Modeling Running Skyline Performance Based on Mechanical Capability of the Yarder"
Wisehart, Richard. Field Notes 18 (May-June 1986): 43-44.	"Water Well Monumentation"
Zealley, Ted. Field Notes 18 (November-December 1986): 13-20.	"Road Program Costs: Continuing Efforts Addressing the Issue"
Zirkle, John. Field Notes 18 (November-December 1986): 41-52.	"Project Management Software Review"

Engineering Management Series

The Engineering Management Series contains publications serving a special purpose or reader and publications involving several disciplines that are applied to a specific problem.

ENGINEERING MANAGEMENT SERIES by TITLE

Aggregate Base and Surfacing Self-Study Course. March 1986.	EM-7115-504-100
Bridges Self-Study Course. March 1986.	EM-7115-508-100
Concrete Self-Study Course. March 1986.	EM-7115-505-100
Corner Search Perpetuation and Recordation. October 1986.	EM-7150-4
Facilities Maintenance Management--A Framework for Efficient Maintenance of Buildings. October 1986.	EM-7310-3
Forest Service Remote Sensing Summary. November 1986.	EM-7140-14
Geometronics Digital Terrain Modeling Products and Related Software. September 1986.	EM-7140-13
Mentor Self-Study Course. March 1986.	EM-7115-516-100
Roads Self-Study Course. March 1986.	EM-7115-501-100
Water and Wastewater Self-Study Course. July 1986.	EM-7115-511-100

ENGINEERING MANAGEMENT SERIES by NUMBER

EM-7115-501-100	Roads Self-Study Course. March 1986.
EM-7115-504-100	Aggregate Base and Surfacing Self-Study Course. March 1986.
EM-7115-505-100	Concrete Self-Study Course. March 1986.
EM-7115-508-100	Bridges Self-Study Course. March 1986.
EM-7115-511-100	Water and Wastewater Self-Study Course. July 1986.

EM-7115-516-100	Mentor Self-Study Course. March 1986.
EM-7140-13	Geometronics Digital Terrain Modeling Products and Related Software. September 1986.
EM-7140-14	Forest Service Remote Sensing Summary. November 1986.
EM-7150-4	Corner Search Perpetuation and Recordation. October 1986.
EM-7310-3	Facilities Maintenance Management--A Framework for Efficient Maintenance of Buildings. October 1986.

Equip Tips

Equip Tips are brief descriptions of new equipment, techniques, materials, or operating procedures.

TITLE	SOURCE*	CENTER NUMBER	DATE
Cable Scarifier for Site Preparation	MEDC	8624 2302	4/86
Firefighters Field Pack**	MEDC		9/86
Four-Hook Carousel and Light Cargo Net System for Helicopters	SDEDC	8657 1303	7/86
Helitorch Retrofit Kit**	MEDC		8/86
Improved Firefighter Clothing**	MEDC		9/86
New Briefcase Design	MEDC	8651 2301	3/86
New Spray for Poison Oak/Ivy Dermatitis	MEDC	8661 2304	7/86
Night Vision Goggle Flip-Up Mount	SDEDC	8657 1301	7/86
Personnel Gear Carrier**	MEDC		9/86
Portable Hose-Rolling Machine Update	SDEDC	8651 1302	7/86
Tractor-Mounted Scalpers for Site Preparation	MEDC	8624 2303	4/86

*Missoula Equipment Development Center (MEDC); San Dimas Equipment Development Center (SDEDC).

**Expected to be published by the end of 1986.

Project Reports

Project Reports are detailed engineering reports that generally include procedures, techniques, systems of measurement, results, analyses, special circumstances, conclusions, and recommendations rationale.

TITLE	SOURCE*	CENTER NUMBER	DATE
Camera Mounts for Small Target Identification	SDEDC	8657 1202	4/86
Catalog of Driver Training Material (A)	SDEDC	8667 1205	5/86
Evaluation of Nonmetallic Culverts	SDEDC	8671 1201	6/86
Guidelines for Evaluating Mechanical Tree Planters	SDEDC	8624 1207	9/86
Implementation of a Lighting System for Helicopter Night Operations	SDEDC	8657 1203	4/86
Operational and Laboratory Evaluation of Mass Flowmeter Retardant Measurement System	SDEDC	8651 1204	7/86
Slash Harvesting System	SDEDC	8651 1204	7/86
Survey of Motorcycle Use in the Forest Service (A)	MEDC	8667 2201	5/86

*Missoula Equipment Development Center (MEDC); San Dimas Equipment Development Center (SDEDC).

Special & Other Reports

Special & Other Reports include papers for technical society meetings and transactions, descriptive pamphlets, bulletins, and special purpose articles.

TITLE	SOURCE*	CENTER NUMBER	DATE
Equipment Need Survey: Timber Sale Preparation and Administration	MEDC	8624 3805	3/86
Experimental Study of Aircraft Wakes in Forest Canopies	MEDC	8634 2811	4/86
Manufacturing Submission Procedures for Qualification of Other Fire Chemicals	SDEDC	8651 1802	2/86
Manufacturing Submission Procedures for Qualification of Wetting Agents	SDEDC	8651 1801	2/86
Off-Highway Tire/Road Damage and Healing Mechanisms	SDEDC	ASAE 86-1060	6/86
Protecting and Managing Resources Through Engineering, Equipment Development Program	SDEDC	8571 1803	12/85
Range Structural Improvement Handbook, Part I	MEDC	8622 2810	4/86
Range Structural Improvement Handbook, Part II	MEDC	8622 2812	6/86
Reforestation and Timber Stand Equipment Needs Survey	MEDC	8624 3808	6/86
Report From Ad Hoc Committee on Equipment Need Survey--Timber Sale Preparation and Administration	MEDC	8624 2801	1/86
Report to the Forest Regeneration Committee on Equipment Needs	MEDC	8624 2803	2/86
Smokejumper Aircraft Evaluation Plan	MEDC	8651 2804	2/86

*Missoula Equipment Development Center (MEDC); San Dimas Equipment Development Center (SDEDC).

Specifications of Agricultural Aircraft Being Used by Cooperators as Airtankers	SDEDC	8557 1802	10/85
Supervisor and the Work Crew Student Study Guide (The)	MEDC	8667 2806	3/86
Supervisor and the Work Crew Facilitator Discussion Guide (The)	MEDC	8667 2807	3/86
Timber Tips	MEDC	8624 2813	7/86
User Manual Extension for the Computer Code AGDISP MOD 3.0	MEDC	8634 2802	2/86
User Manual Extension for the Computer Code AGDISP 4.0	MEDC	8634 2809	4/86
User/Procurement Manual for Retardant Measurement System Mass Flowmeter	SDEDC	8651 1801	2/86
VREW 39th Annual Report	MEDC	8522 2801	12/85
VREW 40th Annual Report**	MEDC		8/86
Your Fire Shelter	MEDC	8651 2501	6/86

**Expected to be published by the end of 1986.

Engineering Technical Information System

The Series:

THE ENGINEERING FIELD NOTES SERIES 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. Articles are usually less than six pages, and include material that is not appropriate for an Engineering Technical Report, or suitable for Engineering Management publications (FSM 1630 and 7113).

Distribution:

Each Field Notes edition is distributed to the Engineering Staff at Regional Offices, Forests, Stations, and Area Headquarters, as well as to Forest Service Engineering Retirees. If your office is not receiving the Field Notes, ask your Office Manager or Regional Information Coordinator to increase the number of copies for your location. Copies of back issues are available in limited quantities from the Washington Office Engineering Technical Information Center.

Submittals:

Every reader is a potential author of a Field Notes article. If you have a news item or short description about your work that you wish to share with Forest Service Engineers, we invite you to submit the article for publication. Field Personnel should send material to their Regional Information Coordinator for review by the Regional Office to assure inclusion of information that is accurate, timely, and of interest Service-wide; short articles and news items are preferred. Type the manuscript double-spaced; include original drawings and black-and-white photographs (if only color photographs are available, send transparencies or negatives), and two machine copies of the manuscript.

Inquiries:

Regional Information Coordinators should send articles for publication and direct questions concerning format, editing, publishing schedules, etc., to:

FOREST SERVICE—USDA
Engineering Staff—Washington Office
Attn: D.J. Carroll, Editor
M.J. Baggett, Editorial Assistant
P.O. Box 2417—Washington, D.C. 20013

Telephone: Area Code 703—235-8198

Regional Coordinators:

R-1 Jim Hogan	R-4 Ted Wood	R-9 Fred Hintsala
R-2 Ray Ollila	R-5 Larry Gruver	R-10 Ron Hayden
R-3 Art Marty	R-6 Homer Chappell	WO Al Colley
	R-8 Jim Gilpin	

Volume 18
November-December 1986

Engineering Field Notes