

United States
Department of
Agriculture

Forest
Service

Engineering Staff

Washington, D.C.



Editors

Volume 15
October-December
1983

Engineering Field Notes

Engineering Technical Information System

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Engineering Field Notes

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1983 *Field Notes* Article Awards

Each year, based on a survey of readers' responses, we give cash awards and service certificates to the authors of three Engineering Field Notes articles.

Field Notes is published to provide useful information to Engineering personnel in the field as well as to those who manage or supervise projects from an office. Maybe you found an article particularly informative or applicable to your work. Perhaps an article helped save you time or money. Or maybe you were able to develop improved methods for accomplishing daily tasks based on suggestions from one of the articles.

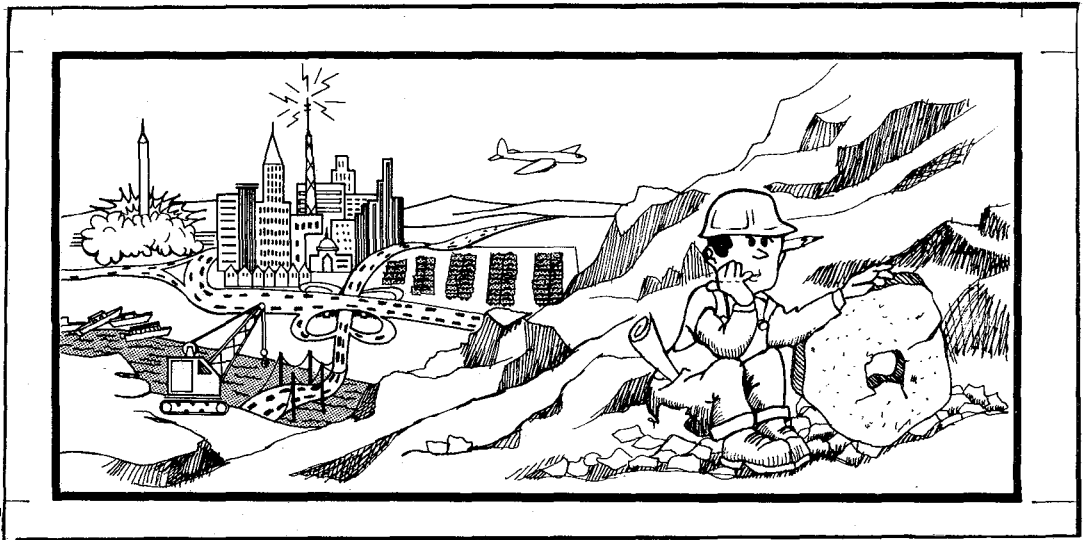
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When you have finished, cut the rating sheet along the dotted line, fold and staple it, and mail it to the Washington Office. All rating sheets must be delivered to the Washington Office by January 31, 1984.

Share your ideas--write an article for Field Notes. You may win \$100--at least you will gain the satisfaction of helping others in your field.

TIC — One Link in the Engineering Technical Information System

*Constance A. Connolly
Technical Information Specialist
Washington Office*



If our friend, Charlie, the Wheelmaker, were only aware of the experience and technology just over the hill and had access to it, he could save himself a lot of time, effort, and money. Unfortunately, he is aware only of his immediate problem, and is doing the best he can with it. If he knew whom to call for assistance, and could get down-to-earth, practical help when he did call, he could avoid "reinventing the wheel" and get on to bigger and better things.¹

Unfortunately, Charlie has not yet solved his problem; but there are signs that he is beginning to wonder what is over the hill and whether it would be worth the climb to find out. If, like Charlie, you have a problem and are unsure of the best way to solve it, one way to find a solution is to access

¹ A. L. Colley, "How to Stop Reinvention of the Wheel," Engineering Field Notes (June 1974) pp. 6-9.

reliable technical information sources through the Washington Office Engineering Technical Information Center (TIC). But before you contact TIC, you need to know what TIC's function is and how it relates to other Forest Service information sources.

TIC provides technical information on a timely basis to Forest Service Engineering personnel in the field and in the Washington Office. All procedures and facilities are geared toward providing the needed information as quickly as possible.

TIC maintains a basic collection of current engineering-related materials that are used frequently on a recurring, short-term basis. The collection consists of the basic engineering reference books, manuals and handbooks, specialized dictionaries and directories, indexes and bibliographies, current periodicals, microfilm copies of little-used materials, basic textbooks, and Forest Service Directives. The special collections include items about such subjects as low-volume roads, remote sensing, and water pollution abatement. These basic reference materials and access to literature through searches of various data bases provide materials that introduce the subject, define it, and identify additional information that is available elsewhere.

TIC receives requests for publications and information from the Washington Office Engineering (WO-E) Staff, field personnel, Forest Service personnel (other than Engineering), other government agencies (Federal, State, local, and foreign), as well as the private sector. The first obligation is answering WO-E Staff and field requests, but attempts are made to handle all requests promptly and courteously. TIC maintains files of WO-E publications for distribution and forwards requests for other publications to the proper supplier.

TIC maintains lists of phone numbers, addresses, and key contacts in the Forest Service, the U.S. Department of Agriculture, other government agencies, and outside organizations. The Technical Information Specialist stays in contact with counterparts in these agencies who are quite helpful in answering reference questions and obtaining needed materials.

The Forest Service is attempting to coordinate technology and information transfer internally, and with Federal, State, and local agencies and private

interests is following recommended or established policies and legislation related to technology transfer and scientific and technical information services. Technology transfer is the responsibility of State and Private Forestry (FSM 1320). Responsibility for scientific and technical information services is currently assigned to Information Systems (InS) in Administration, but the extent and direction of this responsibility is to be determined after further study.

The Department of Agriculture's National Agricultural Library (NAL) provides many services to TIC, including access to their collection through borrowing and free training in the use of NAL's online data bases.

Additional information sources include Forest Service Information Network Service Centers (WESTFORNET and SOUTHFORNET, the Forest Service's InS Staff, and other Department of Agriculture and Forest Service libraries and information centers, such as the Forest Products Laboratory Library). TIC cooperates and coordinates activities with these groups whenever possible; for example, TIC sends WESTFORNET four copies of publications that would interest Forest Service Engineers for input into the WESTFORNET data base and for answering publication requests made to WESTFORNET.

The InS Staff is currently financing the training of Forest Service scientific and technical personnel in the use of DIALCOM, an electronic mail system capable of transmitting all types of in-house information, newsletters, and work tips among libraries and information centers in the Department of Agriculture, Forest Service, and cooperators through the Cooperative Systems Information Resource Network. In the future, Engineers may be able to request a literature search on a specific subject (such as low-volume roads); have that search performed in an appropriate data base (for example, TRIS, Transportation Research Board); and have the results transmitted immediately, via DIALCOM, to the requestor's office in the field, if a dial-up terminal and trained operator are available. The service is fast, economical, and user-friendly. An operator can be trained over the telephone in less than an hour.

To give you a better idea of how the Forest Service information coordination system works, the following, which uses WESTFORNET as an example, summarizes the

services available to Forest Service employees in the West.

- (1) WESTFORNET Monthly Alert (current literature alerting service)--WESTFORNET announces new publications relating to forestry in the Western States. You may receive a loan or retention copy by calling or writing your designated Service Center.
- (2) General document delivery services--These services provide other published material not included in the Monthly Alert. WESTFORNET will attempt to borrow this material for you from Forest Service libraries, libraries of cooperating universities, or other libraries. This service is backed by NAL's Regional document delivery service, which means that the requested material will be delivered to your closest Regional library for pickup or mailed to your work address.
- (3) Reference service, bibliographies, and information retrieval--WESTFORNET has a computer-based literature searching capability, as well as reference resources in its own and cooperating libraries to help you plan new programs and projects.
- (4) Consultation with specialists--WESTFORNET can put you in touch with specialists and researchers both within and outside the Forest Service. Call your Service Center for help with your problem. It is important to note that you may obtain these services only from the Service Center designated to serve your Region or Station. The following is a list of the Region-designated WESTFORNET Service Centers:

Service
Center

<u>Location</u>	<u>Region</u>	<u>Station</u>	<u>Phone No.</u>	<u>Contact</u>
Berkeley Fort	5	PSW	449-3687	Bruce Yerke
Collins	2, 3	RM	323-1268	Frances Barney
Ogden	1, 4	INT	586-5445	Elizabeth Close
Seattle	6, 10	INT	399-1076	Dale Burke

SOUTHFORNET, located at the University of Georgia Science Library, performs services similar to WESTFORNET's for Forest Service personnel in the

South and Southeast. The contact is Ms. Virginia Rutherford, FTS 250-2477. At this time, there is no Service Center for personnel located in the North or Northeast, but personnel in these areas may receive services from NAL or TIC. Work through Dan Starr, who is the liaison between NAL and the Forest Service. He may be reached on FTS 344-3834. He knows NAL people, policies, and procedures and will expedite your request.

Another cooperative venture of TIC is membership in the FEDLINK network of Federal libraries, which has over 350 members in the D.C. area and throughout the country. This network is sponsored by the Federal Library Committee, which is part of the Library of Congress. The Federal Library Committee arranges contracts with vendors of information products, usually at lower group rates, which can be used for services such as literature searching, cataloging, and interlibrary loans. These contracts are usually handled by interagency agreements. For example, TIC now has agreements with the Federal Library Committee to access the following services: (1) Bibliographic Retrieval Services, a collection of about 60 data bases--those of particular interest to engineers are EIS (Environmental Impact Statements) and COMPENDEX (Engineering Index); (2) the Ohio College Library Center data base, which enables TIC to catalog current materials and to borrow materials from other libraries (government, university, and private) subscribing to the data base; and (3) the Lockheed DIALOG system, a collection of more than 100 data bases available for literature searching--those most valuable to engineers are TRIS (Transportation Research Board), AGRICOLA (the National Agricultural Library data base), and NTIS (the National Technical Information Service data base).

TIC also has an interagency agreement with the National Aeronautics and Space Administration (NASA), which, for a small fee, grants cooperators access to all unclassified NASA/RECON data files--reports, research in progress, and contracts. These files are especially good for accessing information on remote sensing or any other space-related engineering information, and they are not available through any private vendor.

TIC is involved in the ongoing project of micro-filming all Service-wide Forest Service Engineering publications and other Forest Service and non-Forest Service publications of interest to engineers, so

that, when paper stocks are depleted, these publications will still be available in a reproducible form. This project is accomplished through a blanket cooperative agreement with the General Services Administration for microfilm services.

TIC has deposit accounts with NTIS and the Government Printing Office for purchasing Government reports and also prepares material for input to NTIS upon request when the documents have been approved for national publication as public information. Work-related books and periodicals are purchased through contracts or blanket purchase arrangements.

Now that you know what TIC is and what services it offers, the next logical question is, How can TIC specifically help an engineer do a better job? Before listing the ways, we would like to remind those of you in the field to use the sources at hand before calling on us. Those sources are closer and will be able to respond more rapidly to your information needs. Work through your Regional Technical Data Systems Coordinators. If your Region has a Forest Service library or a Technical Information Center, use it. Obtain information and publications from a Forest Information Network Service Center if you have access to one. When you have exhausted these possibilities, contact us.

TIC can purchase information materials and services for you only if you are on the WO Engineering Staff. However, TIC can:

- (1) Advise you about how and where to obtain needed materials and services; how to set up a blanket purchase arrangement, deposit account, or interagency agreement; or how to microfilm or catalog your collection.
- (2) Give you cost estimates.
- (3) In some cases, make arrangements for the services you need.
- (4) Send you copies of engineering publications on paper or microfiche.
- (5) Try to obtain free publications for you from other government agencies.

- (6) Borrow materials not available from TIC or through another link in the Forest Service Information System or advise you about your nearest source.
- (7) Perform data base searches and acquire or tell you how to acquire the documents you select. (TIC has two qualified data base searchers.)
- (8) Put you in touch with an expert who may be able to help solve your problem if it is outside of your usual field of specialization.
- (9) Keep abreast of the latest state-of-the-art developments in information retrieval and pass them on to you.
- (10) Listen to your feedback. TIC will try to make the information you need available to you. Call or write--

Forest Service-USDA
Engineering Staff, TIC, RM 1113 RP-E
P.O. Box 2417
Washington, D.C. 20013 (FTS 235-3111)

Forest Service Engineer of the Year: Roger L. Tuomi

Roger L. Tuomi, Washington Office Forest Products Engineering Research, was named Forest Service Engineer of the Year at the Fourth Annual Awards Banquet sponsored by the National Society of Professional Engineers (NSPE). Since NSPE represents more than 80,000 engineers, this recognition is truly significant.

Mr. Tuomi has authored and coauthored several technical articles and has long been active in a number of professional societies, including the American National Standards Institute, the American Society of Civil Engineers, and the American Society for Testing and Materials.

A nationally recognized expert in wood structures, at the Forest Service Mr. Tuomi is responsible for wood products engineering research. One of his inventions is the Truss-Framed System, which is an engineered framing system used in light-frame and residential buildings. His system is a major contributor to lower home construction costs and will help meet the demand for more affordable housing in the future.

Roger L. Tuomi, P.E. (center), receives Forest Service Engineer of the Year Award from F. Dale Robertson, Associate Chief (left). NSPE President-elect, Louis A. Bacon, P.E., looks on. (Photo courtesy of NSPE.)



Sizing Hydropneumatic Tanks: A Better Method

*Herb Smallwood
Group Leader for Water
& Sanitation
Region 2*

Manufacturers of hydropneumatic tanks generally provide either charts or tables to assist designers in making their selection of a tank. Although these charts and tables provide only minimal information, generally they will enable a designer to make a selection that will serve the purpose, provided the designer knows enough about the system to use this information to its best advantage. But will this be the best selection? What if the demand is different from that anticipated by the designer? How much difference can be tolerated? If the selected tank requires a change in the building design, can another choice be made to serve the purpose, or will expensive redesign or alteration be required?

The following discussion is intended to provide insight into hydropneumatic tank operation and sizing and to provide a simple method for exploring how the tank will perform under a range of conditions. The designer can then exercise judgment in making the best choice to satisfy the projected needs of the water system.

BASICS of TANK SIZING

To evaluate the changes that might be made to accommodate the altered criteria, it is first necessary to understand the basics of hydropneumatic tank sizing from which the manufacturers' charts and tables are constructed. Since a hydropneumatic tank operates with air pressure, it is obvious that it responds approximately to Boyle's law: the volume of a gas at constant temperature varies inversely with the absolute pressure. Figure 1 shows the atmospheric pressures at various altitudes. Then

$$P_L V_L = P_H V_H \quad (1)$$

The subscripts L and H to the symbols for pressure (P) and volume (V) indicate the low and high absolute pressures of the operating range.

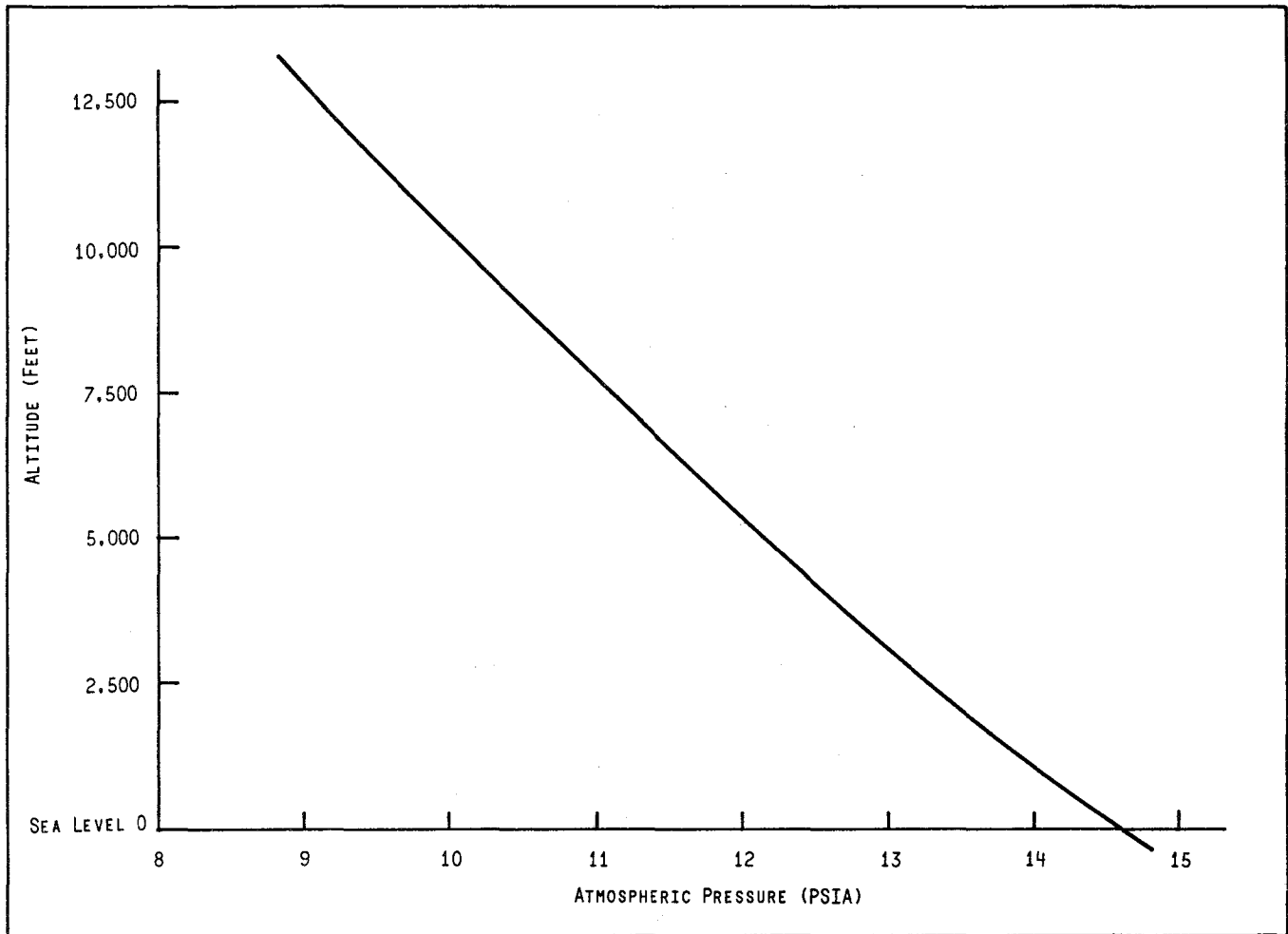


Figure 1.--Altitude versus atmospheric pressure.

Figures 2 through 5 illustrate the development of the basic equations used in analyzing the tank performance. Manufacturers of tanks containing either bladders or diaphragms usually consider there to be no water in the tank at the low operating pressure. Manufacturers of tanks not employing diaphragms or bladders generally leave about a 10-percent reserve to keep from blowing air into the system and losing the air charge in the tank. If the reserve, R , is expressed as a percentage of the tank volume, V , then the volume of this reserve is RV as shown in figure 3. The volume of air, V_L , left in the tank at this low pressure point is $V - RV$, or $V(1-R)$. If more water is pumped into the tank, raising the pressure to P_H , the volume of air, from equation 1, is

$$V_H = \frac{P_L V_L}{P_H} = \frac{P_L}{P_H} V(1-R)$$

as shown in figure 4.

Figure 5 shows the volume of usable water to be the difference between the volume of air at P_L and the volume of air at P_H :

$$V_L - V_H = V(1-R) - \frac{P_L}{P_H} (1-R)V = V(1-R)\left(1 - \frac{P_L}{P_H}\right).$$

Dividing this expression by V , the usable water volume is found as a percentage of the tank volume. This is the tank efficiency, E , and

$$E = (1-R)\left(1 - \frac{P_L}{P_H}\right) \quad (2)$$

Then the volume of the usable water is EV . Note that the lower the pressure ratio, the better the efficiency. A 30- to 50-pounds-per-square-inch-gage (psig) pressure range (ratio = 0.6) is not as efficient as a 20- to 40-psig range (ratio = 0.5). A 20- to 50-psig range (ratio = 0.4) is even more efficient, but a 30-psig pressure range often is not tolerable.

The cycle time, CT , is the time needed to exhaust the usable water plus the time needed to replace it while the demand still exists. If the inflow to the tank is Q_i and the outflow or demand is Q_o , then

$$CT = \frac{EV}{Q_o} + \frac{EV}{Q_i - Q_o} \quad (3)$$

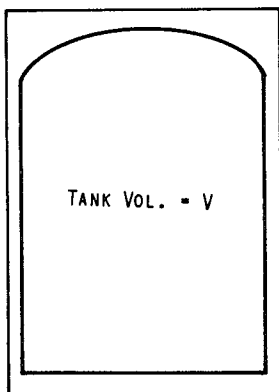


Figure 2

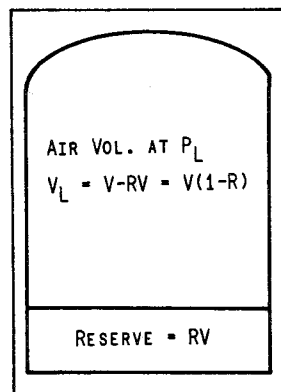


Figure 3

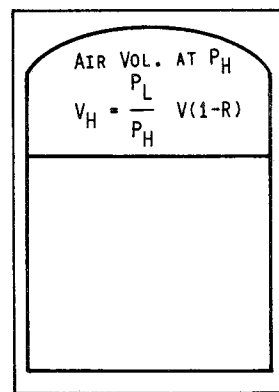


Figure 4

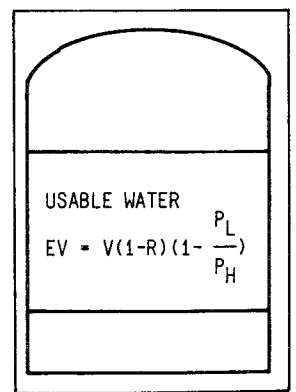


Figure 5

Equation 3 can be manipulated to obtain a single term on the right-hand side, but it is better to keep the physical significance of the terms apparent, and it is also easier to program on a pocket calculator. The first term of the right-hand side represents the drawdown time, while the second is the pump-up time.

Solving equation 3 for the tank volume results in

$$V = \frac{CT(Q_0)(Q_i - Q_0)}{EQ_i} \quad (4)$$

Equations 2, 3, and 4 have now exposed the elements of the tank operation and can be used to explore many of the possible conditions that may be encountered. But more than this, equations 3 and 4, together with figures 3 and 5, arouse some curiosity. If the outflow becomes larger than the inflow, can the reserve be used to supply a short-term peak? What does this do to the operation at normal design conditions? Conventional procedures require a design condition that can be sustained indefinitely, but if the reserve can be used for short-term peaks, then can the normal operation be designed for smaller out-flows? Or conversely, if the tank is sized for a 3- or 4-hour demand, what magnitude short-term peak can be sustained, and for how long?

If Q_0 is greater than Q_i , equation 3 becomes meaningless. However, if the demand exceeds the supply, the reserve in the tank will be drawn down and equation 3 can be modified to calculate the time this excess demand can be met. This peak flow, Q_p , can be sustained for a period, designated as T_p , equal to the time required to draw down the normal working capacity of the tank plus the time it takes to deplete the reserve with the pump running. Then

$$T_p = \frac{EV}{Q_p} + \frac{RV}{Q_p - Q_i} \quad (5)$$

Each term on the right-hand side of this equation represents the times described above.

Now a pressure range can be fixed, a reserve chosen, and the tank efficiency calculated from equation 2. If a cycle time is selected for the normal design

condition, the required tank volume can be calculated from equation 4. This then can be adjusted to an available or desired size and the actual design cycle time calculated from equation 3. Using this volume and assuming a range of values for reserve and peak demands, both normal cycle times and peak flow times can be determined using the applicable demands in equations 3 and 5. The designer then has a choice of conditions from which to select the combination that will best and most economically satisfy the system needs.

One precaution must be observed in using the reserve to meet peak demands. When the tank is empty, the pressure must be sufficient to meet the low-pressure needs. This pressure is the precharge pressure, P_p , and is found from the expression

$$P_p = P_L(1-R)$$

Again, pressures are absolute.

These equations can be programed into any pocket calculator with modest storage capacity. Without any step-saving measures, all alternatives have been programed into an HP-67 in 125 steps.

To illustrate the use of the procedure, the following example shows some of the alternatives that may be explored.

AN EXAMPLE

A campground uses 20,000 gallons per day (gpd) of potable water, which is to be supplied by a hydro-pneumatic system. The hydrograph from FSH 7409.11, 28.3, is to be used as a guide. From this it is determined that the peak flow is 27 gallons per minute (gpm), but this is a 3-hour peak, and it is probable that the short-term peak will be greater. It is desired to operate on a 20- to 40-psig pressure range with 4 cycles per hour; the pump capacity is 40 gpm, and the absolute atmospheric pressure is 10 pounds per square inch absolute (psia). The plan is to use a bladder type tank, so no reserve is assumed for the normal operation.

From equation 2: $E = (1-0)(1 - \frac{20 + 10}{40 + 10}) = 0.40$

For equation 3, the cycle time has been selected as 15 minutes.

From equation 4:
$$V = \frac{15(27)(40-27)}{0.40(40)} = 329 \text{ gallons}$$

Suppose an existing structure is to be used, or that a standard plan is desired and there is only room for three 87-gallon tanks connected in parallel. Table 1 (computed with the HP-67 program previously mentioned) shows the calculations made to explore the alternatives.

Table 1.--Calculations used in the example.

No.	P _L	P _H	Vol.	Q _i	Q _o	R	E	CT	T _p	P _p
1	20	40	329	40	27	0	0.40	15.0	--	20
2			261			0		11.9	--	
3						0.10	0.36	10.7	--	17
4						0.20	0.32	9.5	--	14
5					41	0.20	0.32	9.5	54.0	14
6					45	0.20	0.32	9.5	12.3	14
7	30	50	395	40	27	0	0.33	15.0	--	30
8			261				0.33	9.9	--	30
9					41	0.10	0.30	8.9	28.0	26
10					45	0.10	0.30	8.9	7.0	26

Line 1 of the table bears out the previous calculations. In line 2, the three 87-gallon tanks are substituted, and equation 3 yields the normal cycle time of 11.9 minutes. Trying various percent reserves, calculations using equations 3 and 5 show the cycle times for the normal outflow of 27 gpm and the times the peak demand, T_p, can be sustained. Line 6 shows that the normal cycle time is 9.5 minutes with a reserve of 20 percent (the tank is precharged to 14 psig) and that a demand of 45 gpm can be sustained for 12.3 minutes.

Beginning with line 7, the calculations are repeated for a pressure range of 30 to 50 psig, assuming the 14 psig at tank empty is not acceptable. Line 7 shows the tank sized conventionally at 395 gallons, 15-minute cycle time, and no reserve. Substituting the three 87-gallon tanks reduces the cycle time to 9.9 minutes when the demand is 27 gpm. Line 10 shows that with a 10-percent reserve the precharge pressure is 26 psig, the normal cycle time is reduced to 8.9 minutes, and 45 gpm can be sustained for 7 minutes. If the designer is confident that the pump location results in better than normal

cooling for the pump motor, he or she may wish to continue the calculations with a 20-percent reserve to see if the normal cycle time can be endured for the 3-hour peak estimated from the hydrograph in FSH 7409.11, which was one of the original assumptions.

The same philosophy and basic calculations are used in this development as has been the traditional practice. Only their derivation, rationalization, and proper ordering have been added to permit the designer to examine the performance of the system and to better select the combination of tank size, operating range, reserve capacity, and demands that will most economically and reliably serve the purpose.

Reducing Road Costs Through Engineering Studies & Development

Ed Gililland

*Staff Assistant for Forest Roads Program
San Dimas Equipment Development Center*

The Forest Service has made great progress in reducing road costs over the past several years, though we have often done so through a conscious sacrifice of road quality. Since road costs continue to be a substantial portion of the Forest Service budget, we must continue to search for ways to control these costs.

The Forest Service has established the Road Technology Improvement Program (RTIP) at the San Dimas Equipment Development Center (SDEDC) to explore ways of controlling road costs through engineering studies and the development of new technology. The first RTIP task is to develop a 5-year program of engineering studies and development projects to address those aspects of roadwork that require a large work force and consume substantial amounts of money.

Before mapping out a comprehensive 5-year program, it was apparent that we needed adequate input from the field. Contacts with field personnel thus far have made two things apparent. First, a substantial amount of engineering study and development is currently under way, and there is an obvious need to share results and raise awareness that these projects exist. Second, to obtain good field-level input, specific questions must be addressed to encourage field personnel to think in terms of the types of studies and development projects that should be undertaken.

WHAT IS GOING ON
& WHAT SHOULD
BE GOING ON

Although by no means complete, table 1 indicates the type of work now being done. The people listed in the final column of the table may be contacted by anyone wishing further information about the ongoing studies or the results of efforts so far. The RTIP questionnaire (below) is being used to gather information from field personnel regarding needed engineering studies and development projects.

The questionnaire is designed to stimulate the respondent to think about his or her job with respect to the following:

- (1) What activities are involved in performing your job?
- (2) What materials, equipment, systems, processes, techniques, and procedures are needed to accomplish tasks?
- (3) What contract items are needed to provide an end product?
- (4) What development work may be needed to address high-cost work activities, materials, and equipment?

If your field unit has not received a copy of the questionnaire, and you believe your group has something to contribute to the effort to control road costs, please--after coordinating with your appropriate supervisor--answer the 17 questions in the questionnaire. Add your name(s), job title(s), work address, and phone number(s), and send the responses to the following address:

Forest Service-USDA
San Dimas Equipment Development Center
RTIP Coordinator
444 East Bonita Avenue
San Dimas, California 91773

Any questions, comments, or ongoing technology efforts that should be added to the list should be directed to Ed Gililland at SDEDC (FTS 793-8000 or (714) 599-1267).

Table 1.--Some ongoing Forest Service road technology efforts.

Project	Location	Contact
Forest Penetrating Radar for Ground Profiling From the Air	Siskiyou National Forest, Region 6	Roger Crystal RO Geometronics FTS: 423-4165
Study of Cost Savings and Efficiency of Hydraulic Backhoes for Clearing, Excavation, and Culvert Installation	Region 1	Ted Zealley RO Preconstr. FTS: 585-3308
Use of Lime, Pozolime, Fly Ash, and Bottom Ash for Road Base and Surface Stabilization	Region 8	Doug Scholen RO Geotechnical FTS: 257-3061
In-place Pressure Treatment of Wooden Structures	Region 8	Tom Smith RO Preconstr. FTS: 257-3367
Epoxy Injection of Deteriorating Wood Structures	Region 8	Tom Smith RO Preconstr. FTS: 257-3367
Disposal of Right-of-Way (ROW) Slash as a Berm To Hold Excess Excavation on Steep-Slope, Full-Bench Sections	Region 8	Tom Smith RO Preconstr. FTS: 257-3367
Cooperative Project With NASA To Inventory Aggregate Sources Through High-Altitude Infrared Photography	Region 8	Doug Scholen RO Geotechnical FTS: 257-3061
Development of a Graphic Information System (GIS) Utilizing Landsat and Other Information Bases and an Image Processing System To Substantially Reduce Engineering Field Time for Transportation Planning, EAR Preparation, Logging Systems Analysis, and Road Preconstruction	Flathead National Forest, Region 1	Stan Beene Geometronics 406/755-5401
Use of Preformed Aluminum and Wooden Box Culverts	Region 8	Tom Smith RO Preconstr. FTS: 257-3367
Use of ADS Pipe (Corrugated Polyethylene) for Culverts	FHWA and Gifford Pinchot National Forest, Region 6	Don Huffman SO (FHWA Coord.) FTS: 422-7801
Use of 8-in. Deep Expandable Plastic Grids for Sand Stabilized Road Base (Plastic From Milk Carton Waste)	Vicksburg, Miss., Waterway Experimental Station, Corps of Engineers	Ed Gililland SDEDC FTS: 793-8000
Use of High-Strength Polyester Styrene Concrete for Bridge Deck and Thin-Pavement Structures (1 in. = 4 in. to 6 in. hot mix)	California Department of Transportation	Ed Gililland SDEDC FTS: 793-8000

ROAD TECHNOLOGY IMPROVEMENT PROGRAM

QUESTIONNAIRE

METHODS TO IMPROVE EFFICIENCY AND REDUCE COST

1. WHAT WORK ACTIVITY (E.G., CALCULATING, EARTHWORK, SURVEYING, DRIVING TO JOBSITE, ETC.) TAKES THE MOST TIME FOR YOUR JOB?
2. WHAT OTHER WORK ACTIVITIES TAKE A LARGE AMOUNT OF TIME?
3. WHAT ACTIVITIES TAKE A LARGE AMOUNT OF COWORKERS' TIME TO SUPPORT OR COMPLETE THE WORK YOU ARE DOING?
4. ARE THERE ALTERNATIVE METHODS TO ACCOMPLISH THESE WORK ACTIVITIES? IF SO, WHAT ARE THEY?
5. ARE THERE ALTERNATIVE APPROACHES TO THESE WORK ACTIVITIES (E.G., CONTRACTING OUT, NOT PERFORMING THIS PARTICULAR ACTIVITY, ETC.)? IF SO, WHAT ARE THEY AND HOW FEASIBLE IS EACH?
6. WHAT TYPE EQUIPMENT WOULD HELP DO THESE WORK ACTIVITIES BETTER, FASTER, OR MORE ECONOMICALLY; OR WOULD ELIMINATE THE NEED? WHAT ARE THE OPERATING REQUIREMENTS AND COST CONSTRAINTS?
7. WHAT DIFFERENT TYPE MATERIALS WOULD HELP? (GIVE OPERATING REQUIREMENTS AND COST CONSTRAINTS.)
8. WHAT TYPE SYSTEM, PROCESSES, TECHNIQUES, OR PROCEDURES WOULD HELP?
9. ARE THERE OTHER WORK ACTIVITIES THAT CAN BE IMPROVED OR ELIMINATED? IF SO, WHICH ACTIVITIES AND HOW CAN THEY BE IMPROVED?
10. WHICH MATERIALS AND SUPPLIES USED IN YOUR JOB REQUIRE THE LARGEST ANNUAL EXPENDITURE? (LIST THREE OR MORE.)
11. ARE THERE ALTERNATIVES TO THESE? IF SO, WHAT ARE THEY?
12. SHOULD NEW MATERIALS AND SUPPLIES BE ANALYZED OR DEVELOPED TO IMPROVE QUALITY OR REDUCE COSTS? IF SO, WHAT ARE THE OPERATING REQUIREMENTS AND COST CONSTRAINTS?
13. WHAT CONTRACT ITEMS ACCOUNT FOR THE LARGEST ANNUAL EXPENDITURE IN YOUR AREA (E.G., EARTHWORK, CULVERTS, ETC.)? LIST THREE OR MORE WITH RANGE OF ANNUAL EXPENDITURE FOR EACH.
14. ARE THERE ALTERNATIVES (E.G., METHODS, MATERIALS, ETC.) TO THESE ITEMS? GIVE LIMITATIONS OF ALTERNATIVES.
15. WHAT NEW MATERIALS, EQUIPMENT, SYSTEMS, PROCEDURES, TECHNIQUES, OR PROCESSES SHOULD BE ANALYZED OR DEVELOPED TO IMPROVE THE QUALITY OR REDUCE THE COST OF THESE CONTRACT ITEMS? GIVE OPERATING REQUIREMENTS AND COST CONSTRAINTS.
16. ARE THERE OTHER WAYS TO ACCOMPLISH THE OBJECTIVES MET BY THE PRODUCT YOU WORK ON, OR SHOULD OTHER WAYS BE ANALYZED OR DEVELOPED (E.G., LOG TRANSPORT SYSTEMS, WHICH DO NOT REQUIRE ROADS)? EXPLAIN ALTERNATIVES, OPERATING REQUIREMENTS, AND COST CONSTRAINTS.
17. ARE THERE ANY OTHER MATERIALS, EQUIPMENT, ETC., THAT MIGHT BENEFIT THE FOREST SERVICE THAT SHOULD BE INVESTIGATED?

Photogrammetry for Forest Service Cadastral Programs: Experience, Barriers, & Potential

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INTRODUCTION

The Forest Service has one of the largest--possibly the largest--cadastral survey programs in use by a Government agency. The Northern Region has used cadastral surveys for more than 20 years. Originally, work in this area focused on corner recovery and perpetuation. Recently, this Region has been expanding its cadastral survey program to dependent resurvey, section subdivision, and boundary line marking and posting.

BACKGROUND

The Northern Region contains approximately 24 million acres of National Forest System lands, extending across Montana, northern Idaho, North Dakota, the northwest corner of South Dakota, and a small area in eastern Washington. The 15 National Forests of the Northern Region have more than 31,000 miles of boundary lines, defined by more than 88,000 individual corners. More than 6,100 individual sections need to be subdivided.

The program for marking and posting these boundary lines has been accelerating over the past 7 years. In fiscal year 1982, at a cost of about \$2-1/3 million, approximately 500 miles of line were marked and about 2,000 corners were monumented. The budget for this work was slightly smaller in fiscal year 1983, and there were proportionate decreases in the accomplishment goals. One-third of the work is being done through contracts with private surveyors. Bureau of Land Management (BLM) and Forest Service personnel are completing the remainder of the work. In addition to regular boundary surveys, Cadastral Surveyors are making right-of-way and other easement surveys and locating wilderness boundaries, as well as some quasi-legal boundaries. Congress has directed that the National Forest boundary location, marking, and posting be completed within the next 40 years.

Federal land boundaries can be located under State or Federal authority. At this time, BLM is the only Federal agency with authority to locate Federal boundaries. When possible, the Forest Service has worked through BLM. However, since BLM is unable to handle all the Forest Service's land boundary location needs, the Northern Region has had to use State authority to conduct the major part of its survey program. Boundary location work under State authority is done by Forest Service employees or private surveyors licensed by the State. The BLM Manual of Survey Instructions is the procedural guide for land boundary location in the Northern Region because all States in the Region are Public Land States.

PHOTOGRAMMETRY for CADASTRAL ENGINEERING

The Northern Region has used photogrammetry for cadastral engineering as much as any other Forest Service Region. Since 1965, when we first used photogrammetry for a cadastral survey, we have always been quite satisfied with the results. In addition to using it for regular land surveys, we have used photogrammetry for right-of-way surveys. The technique is also well adapted to surveys of easements acquired for existing roads.

The importance of using photogrammetry in searches for original corners is often overlooked. From the best available maps, corner search areas are projected onto mapping photography. This process is essentially the reverse of the usual photogrammetry procedure, which is map-to-photo rather than photo-to-map transfer. These photos permit field crews to use their time more efficiently. Often, corners can be found without using expensive retracements.

A typical photogrammetric cadastral survey requires field control, pretargeting of control stations and existing property corners, and project photography. We normally fly 1:12,000 black-and-white photography using a Zeiss RMKA-15/23 camera with a 6-inch lens. Panels can be offset from corners that would be obscured by trees, but we try to limit the offset as much as possible. Natural image points are unsatisfactory for Forest Service accuracy.

Regional standards for field control for photogrammetry require a 1:8,000 minimum closure when using traverse procedures. This is between Class I and II, National Geodetic Survey (NGS) third order. Usually, much better closure is achieved than Forest Service standards require, but we do not comply

fully with all NGS procedural requirements for second order. Our experience has shown that the 1:8,000 standard is acceptable for photogrammetric control for cadastral surveys, although Forest Service field crews usually achieve raw closures of 1:30,000 or better. In considering field control requirements for photogrammetry, it is important to remember that uniform scale error does not affect the placement of section subdivision corners because, by law, these corners are placed at proportionate distances, usually the midpoint, between controlling corners. The proportion remains the same regardless of the photo scale.

Typically, field control is performed with theodolite and electronic distance measuring equipment; our units prefer "total station" instruments. Several units have systems with field data recording capability that permits dumping data into a specially programed desk-top computer for reduction. The systems expedite field work and reduce data recording and transmission mistakes.

Aerotriangulation is performed with the Zeiss C-8, equipped with Altek linear encoders. The root mean square error of bridging is typically less than 0.6 to 0.7 feet, using the SIMBA adjustment program. Errors of this magnitude meet the Region's standards for cadastral work, which specify a 2-foot positional tolerance for section and quarter-section corners set, and a proportionally smaller tolerance for other section subdivision corners.

The aerotriangulation provides coordinates of existing corners. The Land Surveyor then computes the positions of corners to be set and the bearings of lines to be surveyed and posted. Field crews start from targeted positions and run known courses to set intermediate corners, closing on other known positions. In the past, targets were placed on temporary points near the corners to be set, then the corner position was established by computed offsets from the temporary station. However, this practice has been largely abandoned. All the property lines are physically located anyway; the extra work involved in placing temporary stations would not pay off in increased production or accuracy.

To find corners needed for cadastral surveys, search areas are placed on a stereo pair of photos, using the best projected position, usually from a U.S.

Geological Survey quad map. The search area is usually plotted using a paper print plotter, such as a K.E.K. or S.M.G.-4, and map control. With the advent of orthophotos, however, corner positions can be transferred by inspection with sufficient accuracy to establish corner search areas. Using Digital Terrain Models and Photo Resection, projected corner positions can be precisely placed on aerial photos. A computer program in DTIS II uses the terrain model to establish photo coordinates of corner points when the map position of the corner is known.

PERCEIVED
BARRIERS to
the USE of
PHOTOGRAMMETRY

Despite demonstrated cost savings, efficiency, and accuracy, photogrammetry is used in only a small percentage (estimated at less than 10 percent) of all Forest Service land surveys. This is frustrating to those of us who know the potential of photogrammetry because it reflects a resistance to its use by engineers and surveyors who seem to have a number of misperceptions about the technique.

During the time we have been using photogrammetry, we have identified some of these misperceptions, which range from a lack of basic understanding to the belief that photogrammetric surveys are legally unacceptable.

Big Projects Only. It is a common perception that photogrammetry is efficient and effective only on large projects that involve multiple townships or at least more than a dozen sections. This notion has been inadvertently reinforced by the "experience" articles in professional literature. Recently, for example, Karns, Lafferty, Brown, and Lucas reported the success of several large photogrammetric cadastral or control projects. However, we have not seen any recent articles regarding the successful and economical use of photogrammetry in small projects. Our experience in Region 1 has demonstrated that photogrammetry can be used successfully and economically for projects as small as a one-section subdivision. It is important to realize that with a small job, as with any survey, careful planning and management are essential to achieving the economic potential of photogrammetry.

Lack of Understanding. Surveyors with limited experience with photogrammetry seldom understand the performance or product. Admittedly, the term "photogrammetric survey" can be somewhat misleading because in the conventional sense, a survey is not

really performed. Rather, relative positions of points are determined by photogrammetry. This concept is somewhat foreign to those with a "traverse" mind set, and the mental connection or relationship to a conventional survey may not be readily apparent.

Unfortunately, it seems that many surveyors are only vaguely aware of the laws of probability that describe positional accuracy or tolerance. These concepts must be understood by anyone who uses photogrammetry. One must understand such concepts as the significance of standard error, standard deviation, and statistical expressions of confidence to make intelligent use of or accurately assess photogrammetric measurements.

Legal Acceptance. Another deterrent to the use of photogrammetric surveys is the belief that they are not legal and will not be accepted in court. But photogrammetry is merely another means of taking measurements. Courts of law have long recognized that survey measurements are, at best, refined estimates, and courts usually place low significance on actual measured values. Court cases are based on the evidence, rules, and procedure used by the surveyor--not on the quality of measurement. Recent court cases have gone unchallenged as far as the photogrammetry procedure is concerned. The erroneous notion that photogrammetry is not legally acceptable belongs in the dust bin.

Ironically, photogrammetry provides more consistent accuracy than direct methods. When using direct methods, the locus of points is determined from a series of measurements, each tied to a previous measurement, so that if one error is made, that error is propagated throughout the series. Each individual measurement has its own specific level of accuracy that differs from all the other measurements in the series. Thus, the position of each point in relation to all others is not determined consistently. In photogrammetry, however, each point is located within the same absolute coordinate reference frame, and each pointing is of the same degree of precision as all others.

Too Complex To Use. Yet another barrier to the widespread use of photogrammetry is the belief that its "inner workings" are too complex. This belief probably comes from the arcane terminology that is often used to describe the technique. Yet the

theoretical framework of photogrammetry is easy to grasp. The approach is to focus on results, rather than on the process. Most of the "inner workings" are irrelevant to the survey, and undue attention to them only serves to heighten the perceived mystique of photogrammetry. There is a similar mystique about using computers. While few surveyors are computer experts, all surveyors now use computer-calculated results, although they do not necessarily understand how computers work.

Photogrammetry Takes Too Long. Another misconception arises from the common tendency to confuse activity with progress. Assigning a crew to a project and observing their daily comings and goings is much more psychologically reassuring than idly waiting 2 weeks for photography. But it is the total time that is important. Usually, photogrammetric surveys can be performed as fast as ground-method surveys. Often, photogrammetry is much faster.

We Can Only Fly During (Spring, Summer, Fall, High Noon, CAVU, Etc). Unfortunately, most photogrammetrists have a perfection bias that can get in the way of providing users with what they really need. When it comes to the photography--being cartographers at heart--they often delay flying until conditions are optimal for mapping. Yet, on most cadastral projects, mapping is not a priority, if it is considered at all. As long as the targets show up, cadastral photography can be flown in conditions that are totally unsuitable for mapping--for example, with snow on the ground, under cloud cover, during low sun angle, or in haze. Photogrammetrists need to understand this, if they are to adequately serve the surveyor.

It Did Not Work the Last Time I Tried It. Perhaps the last time the surveyor tried using photogrammetry was 15 years ago. Maybe control was inaccurate and poorly placed, targets were invisible, or some were not even in the photo coverage. Neither the surveyor nor the photogrammetrist understood what they were doing or what results they were trying to achieve. But we've come a long way--try it again!

TRY IT AGAIN

When you do try using photogrammetry again, make sure the surveyor, photogrammetrist, and photographer consult with one another before beginning the job. Examine the scope of the project. Determine which corners are found, which to search for,

which are lost, and which must be set. Plan your control scheme by spotting likely station locations. If possible, include some of the found corners in the control net. But do not let corner positions influence your control placement. Put the control where it will do the best job for the photogrammetric solution.

Then, and only then, plan the photography. Establish the survey accuracy requirements and determine the photo scale accordingly. Any realistic level of accuracy can be achieved. But higher accuracy requires lower flight elevations, more photos, and more control; and it will result in higher costs. Plan your flying according to the established accuracy requirements. Adequate coverage must include all required stations, with plenty of excess to allow for misflying--that is, missing the planned line of flight. Plan the targeting. Spot targets that "see" the airplane--out of shadows and on the right side of hills. Dense canopy may have to be cut out for some corners or stations; note this in your planning. Targeting has to be coordinated with the flying. Be sure that all targets are in place and are undisturbed by animals, people, or the elements. Fly the photography on a day that meets the cadastral project needs and that provide good contrast for the targets. Examine the negatives as soon as possible to determine if any targets are lost. Lost corner targets must be rephotographed or tied into the control survey. Both the laser and tracer range poles are invaluable for establishing positions on lost targets in heavily timbered, mountainous country. When used in the triangulation mode, both have advantages, but this is a subject that deserves separate consideration.

After completing these steps, proceed with the field control survey. While field control usually consists of closed traverses, radials or "sideshots" can be used since the photogrammetric process will detect any blunders. The closure should be computed and assessed against the established accuracy requirements. Field control can be performed at any convenient time after the planning stage. It can be obtained before or after the photography is flown, but it is preferable to wait until the photography is flown in case some targets are missed.

Photogrammetry has one big advantage over conventional surveys: control requirements are less

stringent for photogrammetric surveys. However, the control must be carefully planned and be of high quality. As a check on the quality of the photogrammetry, the surveyor can withhold coordinates of one or more points to compare with the photogrammetric solution. If you follow these simple hints, the photogrammetrist will deliver coordinates of all the unknown targets to the surveyor at low cost, with consistent quality, and in a short time. If requested, the photogrammetrist can compile a map of features to add to the plat. This can enhance the usefulness of the plat.

The survey will be "proved" during marking and posting line, by traverse between known corners.

Most of the perceived obstacles to photogrammetry do not exist in reality. Those that do are readily amenable to treatment. By increasing the understanding of photogrammetry, there can be better utilization of the technique by the surveying community.

POTENTIAL of
PHOTOGRAMMETRY
in FOREST
SERVICE
CADASTRAL
ENGINEERING

After extensive analysis and investigation, a team of distinguished Forest Service experts concluded that photogrammetry has the potential for increasing the productivity of the Forest Service Land Line Program as much as 15 percent to 50 percent. The Chief of the Forest Service endorsed the study team's recommendation for increased use of photogrammetry. The Forest Service program includes establishing a national advisory team, publication of several demonstration projects, developing national "how-to" handbooks with specifications, and other action items to assist in technology transfer. The following is a list of the potential benefits of using photogrammetry in the Land Line Program:

- (1) Photogrammetry offers the best way to immediately increase production and lower costs.
- (2) Photogrammetry integrates well with recent advances in survey technology. Both inertial systems and global positioning systems are ideally suited for photo control.
- (3) Photogrammetry can contribute meaningfully to the cadastre so every photo project is money in the bank when the National Cadastre is implemented.

- (4) Photogrammetry, coupled with digital terrain models, can, by aerial photo resection of the boundary line, significantly reduce line location costs for remote boundaries.
- (5) Photogrammetry provides homogeneous accuracy and meaningful, understandable estimates of accuracy.
- (6) Photogrammetry allows the surveyor to do a more thorough, professional job of evaluating ground conditions and evidence, thus yielding more comprehensive solutions to cadastral survey problems.

Although photogrammetry has been proven efficient and effective, its potential has not yet been realized in the Forest Service. The lack of its full and effective use in the Forest Service is largely a result of barriers formed from misperceptions about photogrammetry. Overcoming these erroneous perceptions should stimulate greater use of this technique.

The Role of Equipment Development in the Forest Service

*Tom Kerns
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INTRODUCTION

Shakespeare said, "The evil that men do lives after them; the good is oft interred with their bones." This is frequently the case with Equipment Development. A development project is a major success when a solution to a problem is found and a commercial manufacturer markets the technique; however, such solutions quickly lose their identity as Equipment Development projects. During the past 5 years, Equipment Development has:

- (1) Completed and published reports on 176 projects.
- (2) Published 47 Equip Tips on ways to do our job more efficiently with less manpower.
- (3) Developed 20 films and slide tapes to help implement new technology.

In addition to this type of ongoing project work, Equipment Development has:

- (1) Developed and maintained 113 specifications and standards for high-volume purchase items--most often for General Services Administration (GSA) purchase.
- (2) Tested numerous spark arrestors and maintained and published the approved list of spark arrestors. This list now contains 1,324 different spark arrestors, varying from those for small multiposition engines to locomotives.
- (3) Tested numerous different brands of firehoses and fire retardants.

SAMPLING of SIGNIFICANT ACCOMPLISHMENTS

Equipment Development usually has from 75 to 120 projects under way at one time and completes from 25 to 40 projects each year. Records are kept on the cost of each project but not on its long-term benefits. This, coupled with the fact that benefits

continue to increase as implementation increases, makes it extremely difficult to develop an overall cost/benefit ratio for Equipment Development. However, the following sampling of projects with their costs and estimated benefits may provide an indication of the overall picture.

Aviation & Fire Management

Fire Shelters. Since development and implementation of this project in 1974, at least 20 lives have been saved. Total development cost was under \$100,000. At an estimated value of \$250,000 per life, the cost/benefit ratio is 1:50.

Tool Sheaths. Tool sheaths were redesigned using plastic rather than the standard leather and metal. This change in material reduced the cost from \$4.80 to \$1.80 each--a savings of approximately \$250,000 per year. The total cost of the project was \$105,000. Over a 10-year period, a cost/benefit ratio of 1:24 will be realized.

GSA Specifications. The Forest Service spends \$20 million per year on safety and fire suppression equipment. Purchases are made on a competitive bid based on specifications developed and maintained by Equipment Development. The cost to develop and maintain these specifications is \$100,000 annually. GSA and military procurement specialists state that the cost of an item is reduced 15 percent to 25 percent by competitive bidding using specifications instead of open-market purchases. This is a savings of about \$5 million annually. This cost/benefit ratio is 1:50.

Timber

Dewinger. Wings must be removed from tree seeds to facilitate storage, cleaning, and planting. Methods used in the past were slow and costly. Equipment Development built a faster mechanized process that also reduced seed damage. There is now at least one dewinger in every Federal nursery. Each year, the Forest Service processes 30,000 pounds of seed, which is valued at \$100 per pound. The dewinger reduces seed damage by 10 percent. This makes the value of the seed (previously lost through damage) \$300,000 annually. The total project cost was approximately \$60,000. Over a 10-year period, this yields a cost/benefit ratio of about 1:50 for the reduction in damaged seed, and this does not take into account the increased efficiency.

Cone Harvesting. Past methods of cone harvesting included robbing squirrel caches, shooting cones out

of trees, and climbing trees. These methods were slow, costly, and, in many cases, not genetically selective. Equipment was developed to shake cones from trees, allowing us to harvest cones from genetically superior trees and to economically harvest cones during years of poor cone crops in wildland environments. Other equipment was developed to harvest cones mechanically from seed orchards. The Forest Service spends an estimated \$500,000 per year on cone harvesting. Technology developed by Equipment Development has reduced the direct cost by approximately 10 percent and permitted harvesting during poor cone-production years. Annual savings of at least \$3.65 million are generated with development costs of approximately \$450,000. Over a 10-year period, this results in a cost/benefit ratio of 1:81. This does not include the indirect benefit of obtaining genetically superior seed and the resulting higher growth rates.

Seedbed Thinning Equipment. Nurserymen now thin tree seedlings by hand. However, Equipment Development is completing work on both a tractor-mounted and hand-operated, mechanized seedling thinner. By the end of fiscal year 1983, there will be one tractor-mounted and 15 hand-operated machines in operation. Tests show the hand-operated machine reduces the person-hours required for thinning by 10:1, and the ratio for the machine-operated thinner will be much greater. Annual savings are \$275,000, with project costs of \$135,000. Over a 10-year period, this results in a cost/benefit ratio of 1:20, with a potential for reducing employees.

Clearwater Yarder. This machine was originally developed to cost effectively remove logging residues from steep slopes. This application was successful, and then Region 8 used it to reintroduce cable yarding to the south. They purchased one and planned to use it as a demonstration unit on Forests for a 2-year period, and then sell it. That was 3 years ago, and they still have 2 years of future demonstration scheduled. As a result, Region 8 now has 15 purchaser-owned machines--all modeled after the Clearwater Yarder.

Safety

Prevention Measures for Poison Oak and Poison Ivy. The greatest cause of Workmen's Compensation claims in the United States is poison oak and poison ivy. The Forest Service averages more than 500 reported cases per year. Equipment Development has found ways to reduce the exposure and help prevent the

rash, which will reduce the number of accidents by approximately 10 percent for an annual savings of \$40,000. Total project costs to date are \$48,000. Over a 10-year period, this will result in a cost/benefit ratio of 1:8. Work on this project is continuing with development of a sensitivity test and personal protective equipment, which should reduce the number of cases further.

Chain Saw Chaps. Existing chain saw chaps are heavy and hot, and they retard the workers' mobility--all of which reduce production. Equipment Development has completed a new chap design made of Kevlar fiber, which weighs 40 percent less and provides 50 percent more protection. The new chaps are expected to reduce chain saw accidents, increase production, and save at least \$250,000 per year. Total project cost was \$45,000. Over a 10-year period, the cost/benefit ratio will be 1:55.

Engineering

Rock Rake. This new hydraulic rock rake can be controlled entirely from the cab of a truck and can materially reduce road maintenance costs. It not only removes rocks from the road, but can be used to make the last few passes generally required by a grader. On many low-volume roads, it can be substituted for the grader. At this time, there are 10 rakes operating on seven National Forests in six Regions. If, when fully implemented, the rake reduces surface maintenance costs by only 1 percent, the annual savings will be in excess of \$300,000. Project cost was approximately \$100,000. Over a 10-year period, this will result in a cost/benefit ratio of 1:30.

Traffic Control Device Placement Guide. The National Forests contain 250,000 miles of roads with signs valued at \$100 million. There currently are \$30 million to \$40 million of outstanding tort claims, and at least half of these can be attributed to improper road signs. Therefore, it is important that roads be properly signed and marked to ensure safe travel. Traffic control devices must be properly placed to be effective. Improper placement of pavement striping and marking, delineators, or signs can contribute to misdirection and accidents. Unfortunately, no single complete document for proper placement existed until completion of this project. Demand for this guide has been high, and 8,500 have been distributed so far.

COST/BENEFITS

A conservative estimate for the overall cost/benefit of Equipment Development is 1:5. In other words, every dollar spent on development saves \$5 through increased efficiency, decreased accidents, increased resource production, or just being able to do some jobs we could not do previously.

SKILLS

Equipment Development has a mix of personnel with skills unique to the Forest Service. These people include mechanical, agricultural, civil, sanitary, electrical, and aeronautical engineers; foresters; textiles and softgoods specialists; specification writers; graphics specialists; writer/editors; and fabrication experts. Many of the people have unique skills and knowledge and are recognized experts within a broader area, such as aerial spray applications and aircraft effects on spray patterns; nursery equipment, methods, and problems; explosives; wildland tree seed harvesting and tree planting; range revegetation, and smokejumping.

If these skills were not available from the Equipment Development Centers, they would have to be made available through outside contracts. Unfortunately, when we try to contract for skills of this type, we spend a major portion of the contract period educating the contractor about specific Forest Service needs and problems, which is expensive. In addition, various Forest Service Staffs do not have employees who are qualified in engineering and related technical fields to administer the contract and get what we need from the contractor. Therefore, a group of trained and skilled people must be maintained in Equipment Development.

SUMMARY

Money used to develop specialized equipment to increase efficiency has an estimated cost/benefit ratio of at least 1:5 over an extended period. That is, for every dollar spent, at least five are saved to offset budget decreases or to be made available for other work. This equipment also reduces manpower needs, which makes employees available for other higher priority work or to offset declining personnel ceilings. In addition, such equipment increases resource management options and allows the management of some previously unmanaged areas, or better management of others. Because of these factors, Equipment Development serves an important, ongoing need in the Forest Service.

. . . Serious Writing Problems

The following short report was submitted as the final assignment in the Graduate School, USDA, Correspondence Course in Writing for Government & Business. The writer is a young professional who has worked for the Government for about 4 years and was employed professionally outside the Federal System for 4 years.

OUTDATED IDEAS

From 10 to 20 years ago, the schools that I attended were still teaching that the "classical" style was the only way to write. If students wrote long reports that were filled with flowery language, they were "writers"; those of us who could not, or would not, write in that style were not 'A' students.

This course in Writing for Government & Business brought my writing education and my thinking up to the 1980's. "THE" writing style has changed; now, "THE" style is that which best suits the purpose of the message and the audience.

Business writing should not be stilted, or formal beyond the requirements of courtesy and mandatory style guides; it should be more like daily conversation. The purpose of writing business letters is to convey business information, not to impress the readers with unnecessary or fancy words. Today's business people are busy; they don't have the time to wade through complicated and uncommunicative words and phrases. They need, and appreciate getting, information which is expressed in simple, to-the-point, readable terms.

ORGANIZATION

Until I took this course, I thought that outlines were only for long reports, and that anyone who was a "good writer" could dump words on the page when they were writing short reports or letters, without outlines or drafts, and have a final product from the first effort. By going through the process of jotting down facts, organizing those facts in an outline, and writing more than one draft, I found that the writing process becomes simpler, and that the products are more coherent. For instance, by

using the outline, I can quickly find logical places for starting paragraphs.

Paragraphs. I learned that paragraphs are the author's means of separating and grouping ideas; paragraphs should be developed where the author thinks that they best present the salient points. I also learned that short paragraphs (sometimes, of only one sentence) may be preferable to long ones; the paragraphs provide more blank space--time in the reader's mind--to absorb the information on the lines above.

Openers & Closers. Business letters and reports should begin with a brief paragraph which states as simply as possible the purpose of writing. And the material should close on a short paragraph that restates or reinforces the opening statement . . . presented as much as possible in the same manner as in talking face-to-face or on the telephone.

RESULTS

I have mentioned a few concepts that, before I took this course, I thought were problems. I learned that my real problem was NO SELF-CONFIDENCE, based on experience with out-dated methods of presenting ideas.

I have learned that anyone who can read CAN LEARN to write.

Some of the problems and impressions described by the author may be similar to experiences--and unexpressed thoughts--of some Engineers, or our Specialists and other supporting Staff. If so, this description of the problems may be helpful; at least, it is a strong endorsement of the Graduate School, USDA, course for personnel who seek a resolution for those problems.

If you want information on this Correspondence Course or others offered by Graduate School, USDA, contact your local Personnel Management Staff, or write to:

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--G. L. 'Scotty' Rome
Editor

Reorganization of Transportation Engineering Handbooks

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The Transportation Engineering Handbooks have been reorganized so they will be more convenient to use. Handbook materials now will be easier to find because the revised codes assigned to each are sequenced according to the classic engineering process of planning, preconstruction, construction, operation, and maintenance. The change also will result in smaller handbooks that can be used easily in the field and will be readily accessible in the office.

Table 1 lists the titles and codes of the Transportation Engineering Handbooks that are being reorganized. Codes remain unchanged for the following Handbooks:

7109.11	Signs
7109.11a	Sign Catalog
7109.11b	Sign Specifications
7109.17	Certification
7109.31	MUTCD
7709.12	Trails
7709.13	Airfields

INPUT FROM the FIELD

A considerable amount of Region, Forest, and District input was obtained and used to determine whether the Handbooks should be reorganized and, if so, how. Seventy-five evaluation packets were sent to the Regions and Forests. Each Unit evaluated six alternatives against four evaluation criteria. Ninety-four percent of the evaluations were returned, which is an excellent response rate.

Forest, District, and Zone personnel favored the alternatives that resulted in a minimum number of Handbooks, while Regions preferred alternatives that provided for Handbooks for each topic. There was strong support for a topical index regardless of how the Handbooks are organized. Some evaluators specifically suggested maintaining Road Design Systems as a separate Handbook. There also were comments to

Table 1.--Titles, codes, and implementation status of reorganized Transportation Engineering Handbooks.

New Code and Title	Former Code and Title	Implementation
7709.54--Transportation System Management. This Handbook contains the decision process that coordinates planning, preconstruction, construction, operation, and maintenance. The Handbook also contains transportation index and definitions of common terminology. (To be written.)	7709.16--Terminology Handbook	Code for Terminology Handbook will remain the same (7709.16) until the new Handbook is written.
7709.55--Transportation Planning. This Handbook provides technical reference material and procedures on the transportation planning process.	7709.11--Transportation Engineering, Chapter 10	Chapter 10 is currently issued as an Interim Directive and will be issued under the new code by November 1983.
7709.55a--Computer Systems for Network Building. (To be written.)	7709.51a	Reserved.
7709.55b--Manual Techniques--Network First Cut. (To be written.)	7709.51b	Will be issued under the new code when updated.
7709.55c--Traffic Surveillance. (To be written.)	7709.52a	Reserved.
7709.55d--Timber Transport-Computer Model. This Handbook describes the benefits, analytical process, and data constraints of the Timber Transport Model.	7709.53a	Will be issued under the new code when updated.
7709.55e--Timber Transport--Manual Techniques. This Handbook provides a technical process for analyzing timber haul networks by manual methods.	7709.53b	Will be issued under the new code when updated.
7709.55f--Timber Transport--Manual Techniques for Skidding Distance/Road Density. (To be written.)	7709.53c	Reserved.
7709.56--Road Preconstruction. This Handbook establishes procedures and guides for the location, design, and cost estimating for Forest Development Roads.	7709.11--Transportation Engineering, Chapter 20	Currently being updated. Will be issued under new code by November 1983.

7709.56a--Surfacing. This Handbook is to serve as an aid in the determination of the thickness of the various pavement layers.	7709.11--Transportation Engineering, Chapter 50	Currently being updated and will be issued under new code by March 1984.
7709.56b--Drainage Structures. This Handbook provides technical material for design and layout of culverts and bridges. (To be written.)	7709.11--Transportation Engineering, Chapters 70 and 80	Reserved.
7709.56c--Road Design System. This Handbook instructs the user in submitting road design data and in interpreting computer printouts.	7109.16--RDS	Currently being updated and will be issued under new code by April 1984.
7709.57--Road Construction. This Handbook provides guidelines for construction engineering for roads.	7709.11--Transportation Engineering, Chapter 30.	Currently being updated and will be issued under new code by November 1983.
7709.57a--Sampling and Testing. This Handbook contains instructions and guides for construction materials sampling and testing.	New Handbook	Handbook completed and will be issued under new code by February 1984.
7709.58--Road System Maintenance. This Handbook describes a process for planning, scheduling, and evaluating maintenance activities for Forest Development Roads.	7709.15	Will be issued under a new code when updated.
7709.59--Road Operation. This Handbook provides the procedures for establishing road rules, administering permits, and recovering costs. (To be written.)	FSH 7709.21 Regional Handbook	Reserved.

establish Section 24 of FSH 7709.11 as a separate Handbook.

While there was support for changing the organization of the Handbooks, some evaluators commented that obsolete material and the volume of material was a bigger problem than organization of materials. There were mixed feelings about combining or keeping three sign Handbooks.

RATIONALE for the DECISION

No changes were proposed for the Sign Handbooks, FSH 7109.11, 11a, and 11b. The Handbooks are organized around three different primary users. FSH 7109.11 should be updated and reduced in size. The MUTCD Handbook, 7109.31, must remain separate because it is an external handbook.

A larger number of Handbooks is being proposed in order to separate materials by user and to limit the size of the books. The Road Preconstruction, Road Design System, and Surfacing books would be too big for convenient desk use if combined into one Handbook. Combining the Construction and the Sampling and Testing Handbooks is not being proposed because many who will use the Construction Handbook will not need the Sampling and Testing Handbook, and vice versa. It is also possible that Sampling and Testing will be printed as a pocket-size handbook. The Certification Handbook was not combined with the Construction Handbook because the Construction Handbook will be used in the field as well as in the office, but the Certification Handbook is used only in the office.

Because they contain outdated material, Chapters 70 and 80 of FSH 7709.11 will be eliminated and rewritten in the new FSH 7709.56b, and FSH 7709.14 will be eliminated in its entirety.

IMPLEMENTATION

It is neither possible nor practical to change all the Handbook codes at one time. The Handbooks will be converted to the new codes as materials are updated or as restocking takes place. To aid users during the transition period, FSM 7709 will be amended to provide a cross reference between the new and old titles and codes.

Several of the current Handbooks, which have been revised recently or are in the process of being revised, will be distributed under the new codes.

Distribution lists for current Handbooks will not be an accurate listing of the new codes. Staff Units

will be requested to update the number of new codes needed. Please share this article with your directives staff to ensure that you will have an opportunity to provide input for determining the number and type of Handbooks that will be needed.

The Washington Office Information System staff will be requesting personnel in the field to update the number of Handbooks needed. The request also will include direction to Unit directives coordinators to canvass users. You should be prepared to respond by evaluating which handbooks are needed and by whom.



Engineering Technical Information System

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Volume 15
October-December 1983

**Engineering
Field Notes**