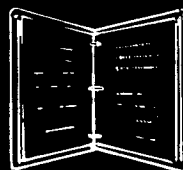


**ENGINEERING
TECHNICAL
INFORMATION
SYSTEM**

FIELD NOTES • TECHNICAL REPORTS
DATA RETRIEVAL • MANAGEMENT
PROFESSIONAL DEVELOPMENT

VOLUME 10 NUMBER 9

Field



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Washington Office News



FOREST SERVICE

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U.S. DEPARTMENT OF AGRICULTURE



ENGINEERING FIELD NOTES

Volume 10 Number 9

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**FOREST SERVICE
U.S. DEPARTMENT OF AGRICULTURE
Washington, D.C. 20013**

REVISION OF FORMULA FOR LOCATION ANALYSIS OF DISTRICT CENTERS

Z. Andrew Farkas, Economist, R-8

The author of the article, *Location Analysis of District Centers*, has submitted a revision of the formula that was published on page 18 in *Engineering Field Notes*, Volume 10, Number 7 (July 1978).

To assure that the correct formula is available when the techniques described in the article are being used, please cut out or copy the portion of this page as indicated, and attach it to page 18 of the July issue.

The analysis for location of the work center is based on the formula:

$$C_i = \sum_{j=1}^n (D_{ij} \cdot V_c + W_a \cdot S_{ij}) 2T_{ij}$$

Where:

- C_i = Total of transportation costs from a particular work center location, i , to all work sites, j
- n = Number of nodes; each node must be considered *both* a work center and a work site
- V_c = Vehicle operating cost per mile
- W_a = Average wage rate per hour for average number of crew members
- S = Travel time between i and j
- D_{ij} = Distance from i to j
- T_{ij} = Total number of trips from i to j

Thus, the formula takes into account the vehicle operating cost and the labor cost of work trips.

The first step in deriving values for the formula is to code the transportation network of the Ranger District into links and nodes (fig. 1). The second step is to determine the lengths and travel times of the links. The nodes correspond to road intersections and work sites. The third step is to determine the average wage rates, the average number of crew members, the vehicle operating costs, and the number of trips to each work site. This information can be obtained from District records that are estimated and projected over a reasonable time period.

A PROCEDURE FOR LAND MANAGEMENT INTEGRATED WITH TRANSPORTATION -- THE LAMIT MODEL

Peter Wong and Bob Swarthout
R-5

INTRODUCTION

Land managers in the Forest Service are realizing that the functions of land management and transportation planning ought to be performed simultaneously, rather than sequentially or iteratively. This is because a land management decision can influence the location and/or the standards of a road system, and -- conversely -- the configuration of a road network can affect the use of the land. This procedure for analyzing the land management/transportation problem by using the mathematical programming technique originally was proposed by Kirby¹. The procedure, called the *LAMIT Model*, has been applied successfully in the Jose Basin area of the Sierra National Forest². A similar model was used in the French Creek area in the Plumas National Forest, and this model is being evaluated currently by the Washington Office.

DESCRIPTION OF THE HYPOTHETICAL PROBLEM

An area of land within a National Forest is being considered for multiple-use development. The uses under consideration are recreation, range, and timber harvest. (See schematic map of the area, Figure 1.)

The Timber Staff indicates that the areas adjacent to nodes *e* and *h* are appropriate for timber harvest. Two logging systems -- cable and helicopter -- are being considered at node *h*. Practical considerations make the use of cable logging and helicopter logging mutually exclusive. In using cable logging, all logs will be piled at node *h* for truck transport. The logs are flown to the helicopter landing at node *i* for truck transport when helicopter logging is selected. Only tractor logging is being considered at node *e*.

Because there is easy access to the lake, the area adjacent to node *e* is chosen by the recreation specialists as being appropriate for campground development. Management feels that a portion of this area can be allocated to recreational development, while the remaining land can be used for timber harvest.

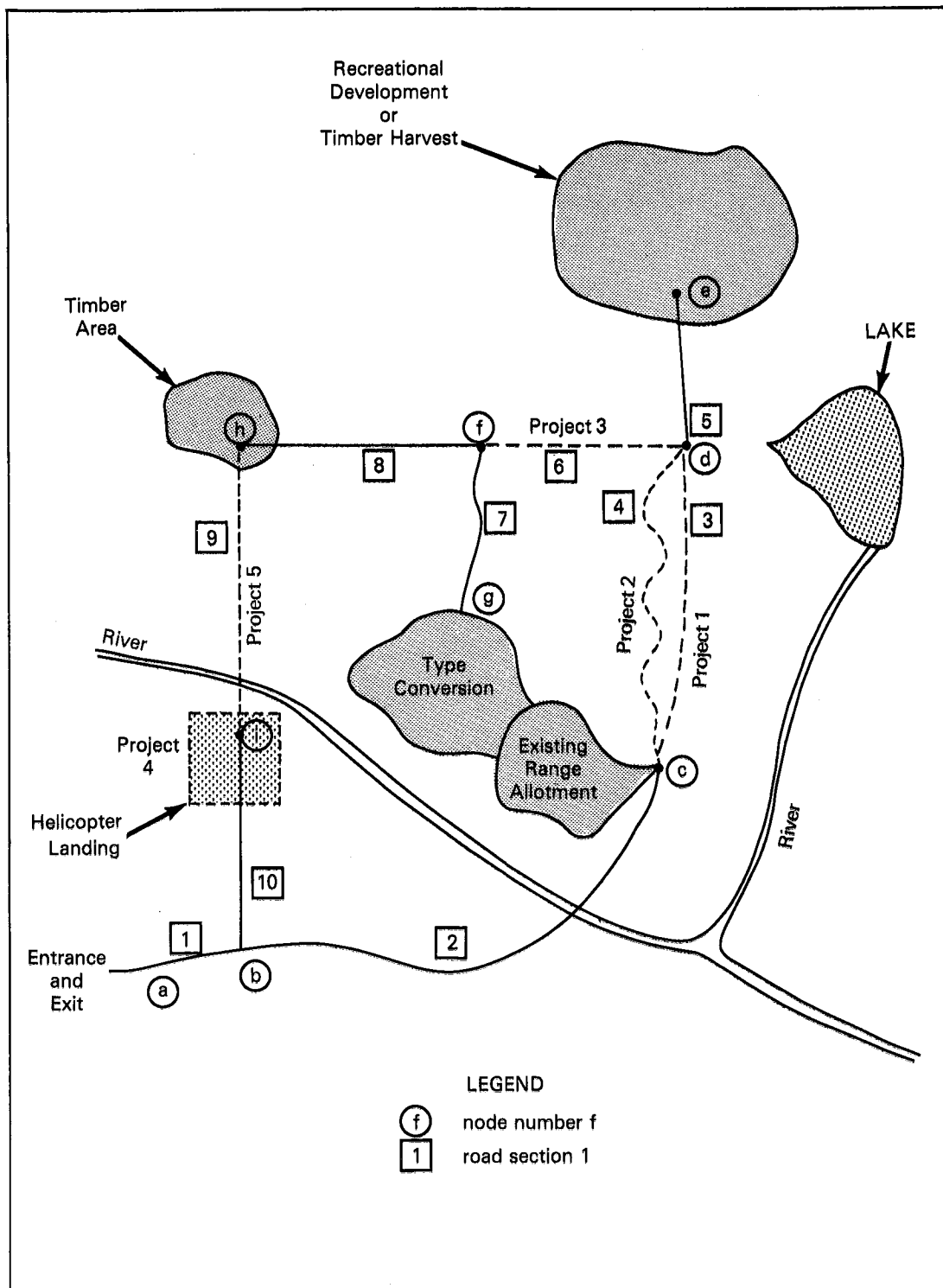


Figure 1.--Schematic map of the area

The area adjacent to node *c* is an existing range allotment. There is a desire to increase the range allotment in the area through type conversion. The area in the vicinity of node *g* has been proposed for type conversion by the range specialists.

There is an existing road system in the area, but some sections of it must be reconstructed for safe operation; those sections are 4, 6, and 9 (projects 2, 3, and 5, respectively). Road section 3, with a much better alignment than section 4, is proposed for construction. Reconstruction of road section 9 includes building a new bridge over the river.

Management would like to determine the best mix of activities and the associated road system from the area that will satisfy the management-specified requirement, while staying within the capability of the land.

DESCRIPTION OF THE MATHEMATICAL MODEL

The interrelationship between land use activities and the road system is described, using a linear mixed-integer program (MIP) formulation. We believe that the formulation described is a good starting point for this type of model; usually, it is not too difficult to modify the formulation to meet the user's needs. (The mathematical formulation can be obtained from the authors.)

Time Period

The total time horizon under study can be partitioned into several time periods of equal or unequal duration. The use of time periods may facilitate the scheduling of activities and the use of discounting to reflect the time value of money.

Timber Harvest

The areas selected as candidates for timber harvest are identified. The maximum amount of timber available from each area as a function of each proposed logging system is estimated; however, the actual amount of timber available for a specific logging system is directly proportional to the percent of each area used for timber harvest. The percent development of an area can range from 0 to 100 percent. Each timber area is represented as a point on the road network.

The timber value and logging cost at each point is calculated as a function of the amount of timber harvested; this may depend on the logging system that is used. A cost for developing the timber area for harvesting is estimated on the basis of the percent of the land being used for timber harvest.

We designate one or more timber destination points on the road network as the locations of timber mills or some point on the network through which the timber volumes from all timber origins must pass on the way to the mills. As management constraints, we can specify upper and/or lower bounds on the timber volumes to be harvested at each timber origin or destination point by time period or overall periods.

When two or more logging systems are defined at a harvest point, we have the choice of letting these systems be mutually exclusive, or they can be carried out jointly. In either case, we cannot allocate more than a total of 100 percent of the timber origin point for timber harvest. Any non-zero use of one system completely eliminates the use of the other systems when they are mutually exclusive. The treatment of multiple activities (such as recreational development and timber harvest) at a point of the network is analogous to that of multiple logging systems.

Increase in volumes over time resulting from different silvicultural practices could be considered, if this practice appears justified.

Recreation

The proposed and existing recreational sites are denoted as *points* on the road network; these points are referred to as *recreational supply points*. One *recreational demand point*, where the recreationists from a supply point enter and leave the area, is defined for each supply point. (We are making the simplifying assumption that a recreationist uses the same route to enter and to leave the area; however, this assumption can be relaxed by modifying the formulation.)

The number of *Recreation Visitor Days (RVD)* permitted at the proposed supply node during a time period is directly proportional to its level of development up to that time. These numbers are specified by the analyst, and they may vary from different time periods, even with the same level of development, because of the possibility of unequal period lengths. We allow the development of a site either partially or fully to span over several periods.

Upper and lower bounds (must be equal for an existing recreational site) on the number of RVD at each supply and demand point may be specified. The cost of developing the site is expressed in terms of the *percent development*. An economic benefit may be assigned to each RVD at each recreation site. Different benefit values can be used for different supply points as an indication of their inherent physical attractiveness. An economic tradeoff between the benefits and costs for site development and providing access can be studied.

The possibility of allowing a recreational area to be developed for other competing activities can be treated. These other activities can be defined either as *mutually exclusive* to recreational development, or as ac-

tivities that can be carried out *jointly* with recreational development. However, the total of economic values (expressed as percentages of development) assigned to a given area cannot exceed 100 percent.

Range

The procedure for handling proposed and existing range areas is similar to that used for recreational sites, except for some slight differences. The unit of measurement for range is *Animal Unit Month (AUM)*. A proposed range allotment is considered to be a result of type conversion which may increase water yield from the area. The analyst can specify a minimum increase in water yield for each time period. An economic benefit can be assigned for each unit increase in water yield. Range allotment receipts or value from red meat production can be included.

Transportation System

For the hypothetical area, we have identified all proposed and existing land-use activities and their locations. The next step is to describe the existing road network, together with any proposed road construction and reconstruction needed to provide accessibility, or improvement of accessibility for the activities shown in the schematic map.

The construction of a helicopter landing is considered part of the transportation system expense. Road sections are defined as portions of a road between two adjacent intersections or between an intersection and the end of the road (without intervening intersections), or two ends of a road (without any intervening intersections).

The cost of constructing or reconstructing any section of a road or a helicopter landing must be estimated. On each road section, round-trip vehicle operating cost per unit of traffic (including the portion of road maintenance cost that depends on traffic volume) has to be defined; the operating cost for *each type of traffic* included in the analysis must be defined. This round-trip cost may depend on the direction of travel for some types of traffic, such as logging trucks, in which they travel loaded in one direction and empty in the other. (In this formulation, only operating costs for logging trucks are included; operating costs for other types of traffic can easily be added.)

The flow of each type of traffic along the road system is controlled by conservation of flow equations, as in the "Transshipment Model" used by Kirby³ and Wong⁴. In effect, these equations require that the amount of traffic going into a road junction must equal the amount coming out of it for each time period, for any given junction which is neither an origin nor a destination point for that type of traffic. Also, the amount of traffic of a specific type and for a given time period leaving a road junction must equal the amount of traffic that originated from that junction. Similarly, the net amount of traffic of a specific type entering a

destination point for a given time period must equal the amount of traffic terminated at that point.

The model ensures that a construction or reconstruction road project is not activated (initiated) until the first time period during which the road is used by any type of traffic; it will not be activated if it is never used. These equations for "conservation of flow" allow all possible paths and combinations of projects to be evaluated. The model equations representing the construction of a helicopter landing site are initiated, similarly, only in the first time period that helicopter logging begins.

On some road sections, limits on the number of traffic units of each type or all types combined can be specified for each time period. These limits may represent the physical capacities of the roads, or a management decision to increase safety, or a need to reduce environmental impact on the area.

For each time period, a budget constraint on the total expenditure for road construction and reconstruction and helicopter landing construction can be specified. This constraint may be the predicted FR&T funding for each of the time periods.

In some cases, a user may want to consider building a road section by one of several standards. Generally, the use of higher standards for the road will result in a higher total construction cost, a greater traffic capacity, and lower vehicle operating costs than were developed for a road with the lower standards. In addition, consideration must be given to the varying degrees of environmental impact on the land that may result from use of the alternate standards.

When more than one standard is being evaluated, they are treated as mutually-exclusive projects. (A modification of the formulation will permit initial construction of a road to a lower standard, and subsequently to upgrade it to a higher standard.)

As previously mentioned, only vehicle operating costs for logging trucks are included in this sample formulation. Hence, economic tradeoff analysis between operating costs and road construction costs is restricted to logging truck traffic. Only accessibility is required for the other types of traffic besides logging trucks. (Operating costs for traffic other than logging can be easily incorporated into the model.)

Erosion

Three categories of erosion that generate sediment are considered for road construction (or reconstruction) and helicopter landing construction projects.

The first category is the erosion due to the initial construction of the project.

The second category is the erosion due to the mere existence of the project.

The third category is the erosion generated by the traffic using the road.

It should be noted that in the model no erosion is generated prior to the development of a project. Different values for different time periods are permitted for each project, in order to account for possible unequal period duration. In addition to road projects, we can include traffic-generated erosion on any road sections of the road network.

Erosion generated from the development of timber, range, and recreational areas is included in the model. The amount of erosion for a time period will be a function of the proportion of the area developed during that period.

A maximum amount of sediment resulting from all activities can be specified for each time period. Action to prevent erosion is included in the formulation to reduce the total generated sediment to less than or equal to the maximum allowed for each period. The erosion-reduction cost formulation provides for increased cost rates with the percent of reduction desired. For example: the cost may be \$0.20/UNIT for the initial 30 percent; \$0.30/UNIT for the next 50 percent; and \$0.40/UNIT for the remaining 20 percent. Restrictions can be specified on the amount of money that can be devoted to erosion prevention, for each time period.

ANALYSIS OF THE HYPOTHETICAL PROBLEM

The capabilities of the *LAMIT Model* are illustrated with the sample problem that includes three alternatives based on different management constraints or specifications for managing the area. Since all numerical values used in the analyses are completely arbitrary, the problem includes only the values essential to our discussion.

The maximum amount of resources available from all supply points are summarized in Table 1.

Table 1.--Maximum resources available from supply points

Road Junction	Type of Resource	Amount of Resource Available		
		Period 1	Period 2	All Periods
c	Range (Existing)	2,000	3,000	--
e	Timber	--	--	200
e	Recreation	300	300	--
g	Range (Proposed)	1,000	2,000	--
h	Timber (Cable)	--	--	300
h	Timber (Helicopter)	--	--	350

Alternative A - Developing maximum present value without consideration of other management constraints.

Management is interested in how the land should be managed in order to obtain the maximum net discounted return from the area without consideration of various tangible and intangible constraints, such as acceptable erosion limits, minimum increase in water yield, road construction budget, minimum area for recreational site, or minimum development of range allotment.

This Alternative probably will not be adopted, but management would like to use this situation in comparison with other more desirable solutions.

In this case, projects 1, 3, and 4 are activated in the first period:

The area adjacent to node *e* is used entirely for timber harvest in the first period. This means that the economic return from timber at this point exceeds the recreational benefits.

Helicopter logging is selected for node *h*, thereby avoiding the construction of project 5, which includes a bridge construction.

The proposed range allotment is activated in the first period in order to realize the full benefits from water production and red meat production for both periods.

A large amount of sediment is produced in both periods.

The net present worth of this solution is \$40,400.

The traffic on the network is summarized in Table 2.

Table 2.--Traffic on network for Alternative A

Road Section	Timber Traffic		Range Traffic	
	Period 1	Period 2	Period 1	Period 2
1	550	--	3,000	5,000
2	200	--	3,000	5,000
3	200	--	1,000	2,000
5	200	--	--	--
6	--	--	1,000	2,000
7	--	--	1,000	2,000
10	350	--	--	--

Alternative B - Multiple-use management with environmental considerations.

In this Alternative, management emphasized the development of the area for multiple use, while preserving the environment. Management constraints on the amount of activities from each of the supply and demand points are shown in Table 3.

Table 3.--Management constraints at supply and demand points
for Alternative B

Road Junction	Resource Type	Period 1		Period 2		All Periods	
		Min.	Max.	Min.	Max.	Min.	Max.
a	Timber	--	--	--	--	--	400
c	Range (Existing)	2,000	2,000	3,000	3,000	5,000	5,000
e	Timber	--	70	--	--	--	150
e	Recreation	50	100	120	200	100	300
g	Range (Proposed)	500	--	400	--	1,000	2,500
h	Timber (Cable)	--	--	--	120	--	250
h	Timber (Helicopter)	--	--	--	150	--	300

In addition to the constraints cited in Table 3, management has also set limits for each period on the budgets for road construction, maximum sediment generated, maximum sediment erosion prevention, and minimum water yield. With all of the above restrictions, management would like to develop the maximum net discounted present worth.

The solution of this Alternative is as follows:

The area adjacent to node *e* is developed to the maximum extent allowed by the management constraint for period 1 for timber harvest (70 units), since timber has higher economic value than recreational use. Timber harvest consumes $70/200 = 0.35$ of the area in the first period.

The remaining 65 percent of the area can be allocated to recreational use in period 1. However, management constraints limit recreational use to less than 100 RVD or $100/300 = 0.33$ of this area.

The total development at node *e* during period 1 is 68 percent of the area.

There is no timber harvest requirement at this node for period 2, but it must provide for at least 20 RVD for recreation. To achieve this minimum requirement, we must increase the percent of this area allocated for recreation to $120/300 = 0.4$, or 40 percent. The remaining 25 percent of this area is used for timber harvest in period 2.

Helicopter logging is selected for timber area at node *h*. A timber volume of 280 units is cut during period 1, so that the greatest economic gain can be realized, but the total of units still stays within the maximum of 400 units over all periods of timber demand at node *a*. Since only 280 units (rather than the maximum of 300 units allowed by management) is cut from node *h*, the solution indicates that timber from node *e* has a higher appraisal price than that desired from node *h*.

The proposed range allotment is developed as much as possible (83.33 percent) in period 1, while satisfying the maximum restriction of 2,500 AUM allowed over all time periods. The total AUM for the two time periods is calculated as $(0.8333)(1,000 + 2,000) = 2,500$.

Construction projects 1, 3, and 4 are to be activated in the first period. The traffic on the network is summarized in Table 4.

Table 4.--Traffic on network for Alternative B

Road Section	Timber Traffic		Range Traffic		Recreation Traffic	
	Period 1	Period 2	Period 1	Period 2	Period 1	Period 2
1	350	50	4,667	2,883	100	120
2	70	50	2,833	4,667	100	120
3	70	50	833	1,667	100	120
5	70	50	--	--	100	120
6	--	--	833	1,667	--	--
7	--	--	833	1,667	--	--
10	280	--	--	--	--	--

The discounted net present worth for this Alternative is \$29,700; this is a reduction of more than 26 percent from Alternative A. The reduction would be the opportunity cost for choosing Alternative B instead of A.

Alternative C -Reduce conflict between logging truck traffic and other traffic.

Management is quite satisfied with the solution for Alternative B, except for the possibility of some hazardous driving condition on the low standard road (section 2) that is caused by the large volumes of traffic for timber, recreation, and range activities.

After a careful analysis, management decided to limit the logging traffic on this section to no more than 40 units for each time period. All other management restrictions are exactly the same as given in Alternative B.

The management objective is still to develop the maximum discounted net present worth under the above restrictions.

The amount of resources generated or terminated at all supply and demand points for this solution are precisely the same in Alternative C as those given in Alternative B. The only difference is the path used by part of the timber from node *e*. In order to satisfy the capacity requirement on section 2, 30 units of timber are diverted to use Road Section 6 in period 1, as are 10 units in period 2. This shift in traffic pattern also forces the construction -- in the first period -- of road project 5, in addition to projects 1, 3, and 4 that were previously scheduled for construction in period 1.

The discounted net present worth for this Alternative is \$27,000, a 9 percent reduction from Alternative B. A traffic flow map of this solution is shown in Figure 2.

SELECTION OF ALTERNATIVES

The above analyses demonstrate the use of the *LAMIT Model* to generate desirable solutions to a land management problem. For a problem reflecting actual situations, the analysts probably would have to explore more alternatives. The primary objective of some of these alternatives may not be to obtain the maximum present worth under other management restrictions. Other objectives to develop maximum benefits can be specified for recreational use, timber harvest volume, range, or increased water yield, or to control erosion and thereby generate only a minimum of sediment.

Some alternatives may represent sensitivity analyses concerning the effect of changing some of the input parameters, such as project construction cost or timber volume from an area. This collection of all desirable solutions will have to be weighed against other intangible considerations in order to arrive at an overall management plan best for all parties concerned.

CONCLUSIONS AND RECOMMENDATIONS

The *LAMIT* technique uses a mixed-integer linear mathematical programming (MIP) model for land management which treats the transportation requirement as an integral part of the analysis of land management problems. A matrix generator for the model was developed using the *GAMMA 3* language of the Functional Mathematical Programming System available on the UNIVAC computer at Fort Collins Computer Center. With this matrix generator, an analyst can assemble computer runs for new alternatives very readily.

As was demonstrated in the discussion for Alternative B, it may not be an easy task to obtain an optimal solution when the management constraints are numerous; but using the *LAMIT Model*, the analysts can devote most of

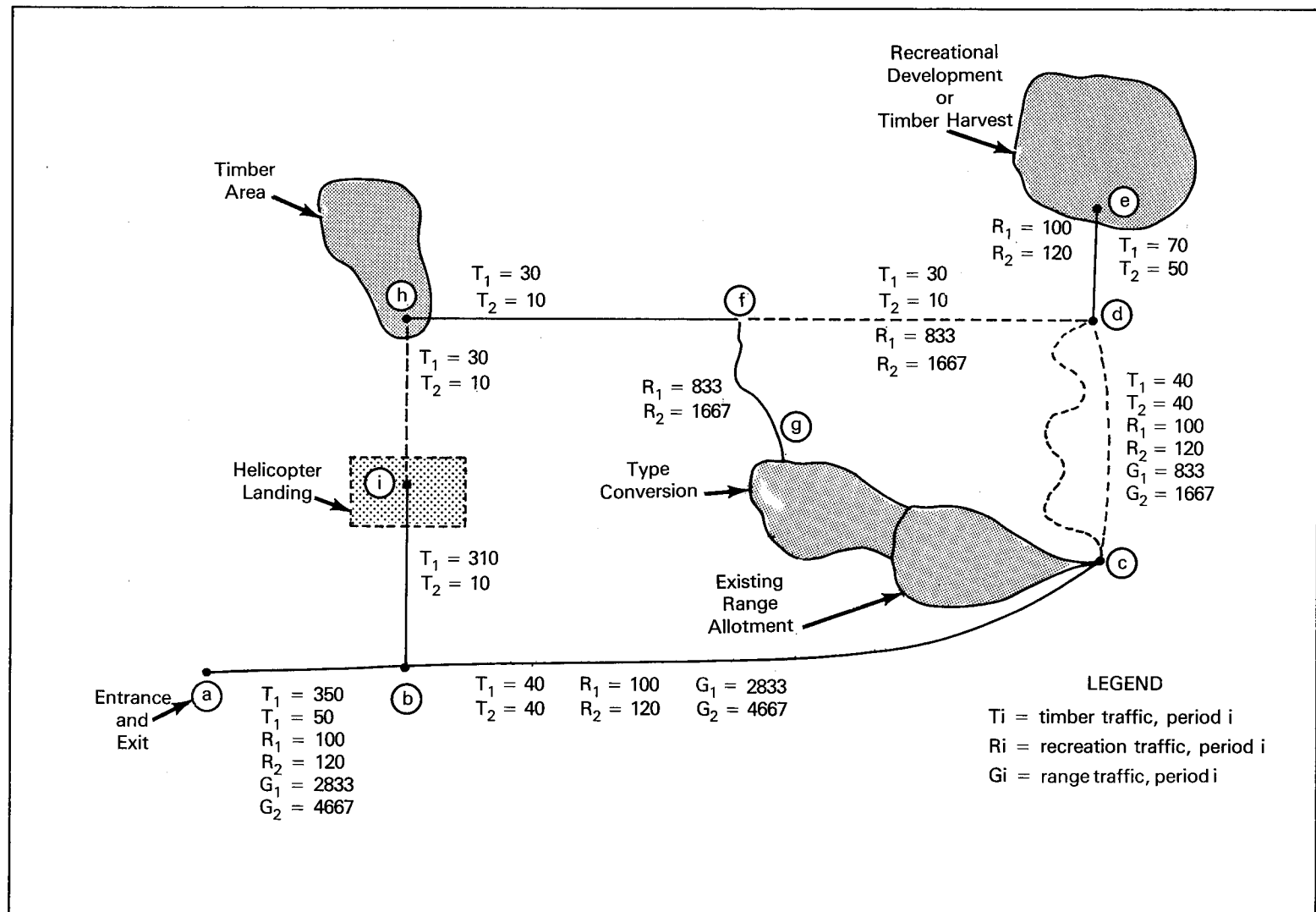


Figure 2.--Traffic on network for Alternative C

their efforts to defining and evaluating alternatives, and let the computer perform the tedious and time-consuming calculations. Since it is easier to develop solutions to alternatives with this model, a thorough analysis of a problem is encouraged, and should result in more effective decisions.

One drawback of the MIP technique may be the amount of computer time required to reach an optimal solution for large problems. A *yes-no* decision variable is defined for each problem and each time period, and 10 such variables would require $2^{10} = 1,024$ combinations to be searched to develop the best scheduling for activation of all project elements. When the number of decision variables is less than 20, the solution time would not be too excessive; this would also depend on the total number of variables and equations in the model. When the number of decision variables is from about 20 to 50, guidance from someone with a fair knowledge of mathematical programs is advisable; but when there are more than 50 decision variables, the analysts should solve the problem under close supervision from an expert in mathematical programming.

If this type of process is adopted for general usage, it is probably cost-effective to have an expert develop a special solution algorithm for the model. The most desirable algorithm is one that can find the optimal solution, yet requires little computer time. If such an adjustment is not possible, then a heuristic procedure -- that guarantees close to optimal solutions with high probability -- would suffice. Since the matrix generator is written using *GAMMA 3*, it is very much machine-dependent. The use of a generalized matrix generator written in some standard computer programming language, such as *FORTRAN*, may be more desirable.

We hope that this description of the *LAMIT Model* meets the need for integrating transportation planning within the land management process, and that land management and transportation analysts will use these techniques in working together toward establishing a unified procedure for overall land management.

REFERENCES

1. Kirby, Malcolm. *An Example of Optimal Planning for Forest Roads and Projects*, presented at the Symposium on Planning and Decision Making as Applied to Forest Harvesting at Oregon State University, School of Forestry, September 1972.
2. Swarthout, C.D. and Taber. *Jose Basin Transportation System and Land Use Analysis*, Sierra National Forest, June 1977.
3. Kirby, Malcolm; Wong, Peter; and Cox, Wallace. *Optimization of Rural Road Networks -- An Application of the Timber Transshipment Model*, to be published by USDA, Economic Research Service, Washington, D.C., 1978.
4. Wong, Peter and Cox, Wallace. *Minimum-Cost Network Design for Timber Transport*, Forest Service, USDA, Engineering Technical Information System, *Field Notes*, Volume 9, Number 7, July 1977.

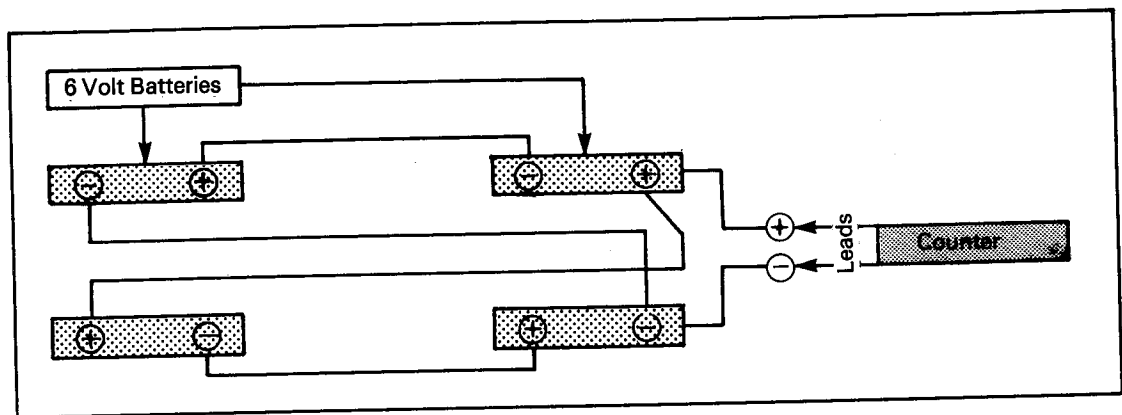
STYROFOAM ICE CHEST CORRECTS BATTERY FAILURE PROBLEM

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Civil Engineering Technician
Coconino National Forest
R-3

A winter traffic count was needed to establish correct road design volume data for a road leading to one of Arizona's major ski areas -- the Arizona Snow Bowl, located near Flagstaff. To obtain the essential data, a *Leupold & Stevens Print-Punch Traffic Recorder* was installed.

We found that the unit would not operate properly because the low temperatures caused the battery voltage to drop, and the counter would print a zero even when traffic was evident. The location only permitted the counter to be checked periodically, and there was no AC power source available. A simple and inexpensive solution was found in using a 2-gallon (7.57 liters) styrofoam ice chest to insulate the batteries from the low temperatures.

To make the installation, we used about 10 feet (3.05 meters) of lamp cord to wire the four *Neda 918* 6-volt batteries in series-parallel, and to connect the battery assembly to the plugs spliced to the wiring harness of the counter (see diagram). We cut small notches in the ice chest and in the counter's case to prevent the cord from being crimped when the lids are closed, and additional styrofoam packing material was placed around the batteries before placing the lid, which was sealed with duct tape. The ice chest battery assembly and counter unit were installed side-by-side.



Battery Wiring Diagram

The print-punch tape was collected at weekly intervals, and the batteries were replaced every 2 months. During the past winter, the installation operated without any battery failure, even when temperatures dropped to 0° F.

Although our solution to the problem worked well for this location, it relies on the sun's radiation during the daylight hours to offset the much lower nightly temperatures; consequently, this method may not be as efficient in some of the more northern regions.

WASHINGTON OFFICE NEWS

CONSULTATION AND STANDARDS

W.C. Clementson
Engineering

IMPROVE THE FS HOST IMAGE

On June 5, the Chief initiated the *Forest Service Host Program*. He asked all employees to take an objective look at how we can be more responsive to the wants and needs of the public using the National Forests.

A good signing program can be an excellent tool in serving these goals, and communicating to our guests that they are welcome, and that we have their welfare and safety in mind. Our signs can be an invitation to Forest users to enjoy their visit. A poor signing program, on the other hand, can make people feel unwelcome, or that we are unconcerned about their needs. There have been several deterrents to good signing programs in the past; our inability to get timely delivery on sign orders from Federal Prison Industries (FPI) is a good example. The chore of ordering signs from our old *FS Sign Handbook* is another. In addition, we have had problems with quality control during the manufacture of signs.

Much has been done to correct those problems during the past year. A memorandum of understanding between FPI and the Forest Service established limits on delivery time of sign orders. If the specified delivery times cannot be met, FPI is required to issue a waiver for the ordering unit to purchase the signs from a commercial source. FPI will go a step further regarding waivers; they are willing to explore the possibility of granting the Forest Service a blanket waiver. In return, the FS would guarantee them a fixed volume of business. This type of agreement would have to be renewed at the beginning of each fiscal year in order to comply with fiscal regulations. If you agree with this proposal, let us know by contacting Willard Clementson in the WO.

A new *FS Poster and Sign Catalog* (FSH 7109.11a) is being published, and this handbook should simplify the ordering of signs. We have also developed and are publishing new specifications for the manufacturing of signs, (FSH). These specifications are to be used by *all* manufacturers of signs, including FPI, commercial shops, and force account shops. FPI at Atlanta is currently manufacturing signs according to the new specs, and is doing very well; FPI at Lompoc will begin work this fall. The quality of signs

will continue to improve as we get better acquainted with the new specifications.

There are other areas where service to the field can be improved. We need to work together; if you have recommendations you feel will improve the signing program, please let us know in the WO. We hope a better sign program will translate into better service to the public, which -- in turn -- will improve the Forest Service "Host" image.

OPERATIONS

Harold L. Strickland
Assistant Director

GEOMETRONICS DEVELOPMENT PROGRAM, WHERE WE ARE

The mission of the Washington Office Geometronics Development Group is to investigate, develop, and distribute information on new or improved methods and equipment for recording, handling, and displaying resource, terrain, and cultural data used in support of Forest Service activities.

During the past year, most of the effort has been in investigating and developing graphic display systems for Service-wide application. The concentration of this effort was with the *Resource Information Display System (RIDS)*, automated cartography's *CALPLOT PAC*, *Digital Terrain Information System (DTIS)*, *Digital Image Analysis Display System (DIADS)*, and the *Resource Data Map Transfer System*. These systems are developed basically and in some stage of field test or demonstration, and users' guides and other documentation are being prepared.

Each of the five systems was developed with a particular user group in mind; i.e., resource manager, unit planner, engineer, etc.

The group working on *RIDS* has been assessing the commonly-used computer systems that provide graphical representation and statistical information about functional data such as soils, vegetation, timber types, etc. Programs that allow for the manipulation of one layer of information against another, as well as production of a graphical representation of the results, fall into two general groups or options: polygonal and grid cell. The programs for the polygon option are in the final stages of testing and evaluation. The *Resource Analysis Procedures (RAP)* program for the grid cell option has been selected and tested. Training Forest Service personnel to use this system will start this fall.

CALPLOT PAC, a computer oriented system for collecting, manipulating and displaying cartographic data, was developed for use at the Geometronics Service Center (GSC). This system will give the Forest Service a cartographic data base that is compatible with other Forest Service systems, as well as being tied to the U.S. Geological Survey's *National Mapping Program*. The acquisition of support equipment and the training of GSC personnel is now underway.

DTIS is a system for obtaining terrain and resource data by photogrammetric techniques to develop models in those topics. *DTIS* extracts, manipulates, and displays information from those models with sufficient accuracy to support engineering activities that include road design, transportation planning, mining, etc. The basic system has been developed and reviewed by a user group, and a contract is being negotiated to incorporate recom-

mended changes to the system, and to produce user's guides and system documentation.

A cooperative effort has been initiated with *Surface Environment and Mining (SEAM)* in Region 4, and the Simplot Corp. of Idaho to demonstrate the use of computer-assisted photogrammetric and graphic tools in mining operation. The demonstration project encompasses all phases of developing both area- and site-specific mining plans and graphics that illustrate the impact on an area during mining operation, as well as developing rehabilitation plans when mining is completed. The information will help land managers determine in advance the results of decisions affecting the land surface. A report on this demonstration project will be published by the fall of 1979.

DIADS is a computer-assisted system for the extraction, analysis, and map transfer of image data. The effort is to improve techniques in both photo interpretation and photo-to-map transfer by use of an automated scanning device, as well as image enhancing and processing techniques. *DIADS* will be used by the land manager in change detection and quantification, in addition to being an accurate and cost-effective mensuration tool. The hardware that supports the system has been installed, and the control software is written.

The *Resource Data Map Transfer System* is a by-product of *DIADS*. The Forest Service is currently exploring the use of optical bar photography (high-resolution panoramic photography) that requires special instrumentation for photogrammetric transfer of imagery to a map. The *Resource Data Map Transfer System* provides a means of transferring resource data using equipment available in the Regional Offices and the Fort Collins Computer Center; it produces two grids of equal acreage that are registered to both the photography and the map. This system not only allows the transfer of data on a block-by-block basis, but it provides data in a form compatible to the *RIDS*. The computer programs are being converted for use in Fort Collins Computer Center, and will be operational this fall.

Our concentration of effort to date has been on the *development* of new systems for Service-wide use, and we will continue to explore new development areas in which the potential for use and probability for savings (in both manpower and dollars) will be high. However, our concentration of effort will increasingly address: (1) the transfer of the developed technology to users; (2) making developed systems compatible in terms of being able to use common data, being able to "cross walk" between systems, using common output formats, etc.; and (3) producing savings cost by increasing the efficiency of developed systems assisting users.

TECHNOLOGICAL IMPROVEMENTS

Heyward Taylor
Assistant Director

CHAIN SAWS

In the past few months, chain saws have become a popular topic of conversation, especially in the West, largely because of some new regulations that have gone into effect within the last year. Originally, emphasis was on operator safety, and involved such things as anti-kickback devices, vibration control, "deadman" switches, etc. These items caused concern to both users and procurement in the FS. Most recently, the emphasis has shifted to the temperatures of chain saw exhaust systems. Because this subject is now covered by regulations and standards, we will look at it first; then, we will discuss where we are with the safety items mentioned previously.

The fire-starting potential of chain saws has been a longstanding concern to land management organizations. Originally, particles from the exhaust system were the primary source of ignition. Screen-type muffler/arresters were installed in an attempt to resolve that problem; however, the restriction offered by the screen often caused the shell temperature of the exhaust system to rise to unacceptable levels. Despite many precautionary measures, i.e., small fire extinguishers, requirements for fire control apparatus to be supplied by contractors, small shovels carried by sawyers, etc., fires that were started by chain saws developed into a major problem, especially in the Northwest.

About 10 years ago, research was begun to determine the ignition temperatures of various forest fuels. Almost simultaneously, Federal and State Agencies and private industry began working together to develop criteria for a standard which would define maximum allowable exhaust system temperatures. The staff at San Dimas Equipment Development Center (SDEDC) were leaders in the activity. As more information became available on realistic fuel ignition temperatures, and as refinements in chain saw design surfaced, reasonable requirements on exhaust system temperatures began to gel. The chain saw manufacturers were major contributors to these efforts and they were able to meet the new requirements for temperature control without sacrificing any features, performance, or safety.

Two documents resulted from this cooperative work: one was *SAE Recommended Practice J 335(b) -- Multiposition Small Engine Exhaust System Fire Ignition Suppression*, and the other was the Northwest Forest Fire Council's *Chain Saw Exhaust System Standard*. The two are virtually identical. The use of *J 335(b)* became effective July 1, 1977, for the Forest Service (FSM 511332a), as did the *Standard* for the States of Oregon and Washington; California has a similar regulation which went into effect July 1, 1978.

SDEDC has been testing chain saw exhaust systems for well over a year; over 100 models have been tested and qualified during that period. The primary concern of all Agencies has been the saws that are used by professional sawyers, but all models that are submitted to SDEDC are tested, as there is no practical method for differentiating between professional models and those intended only for casual use. We should also note that the California regulation covers *all* multiposition, handheld engines; but regulations of the Forest Service and those of Oregon and Washington apply only to chain saws. Therefore, the SDEDC testing is restricted at this time to chain saw engines only. However, San Dimas is cooperating with California to process other small engines.

Now, about safety features! Some 6 years ago, chain saws with new safety features added -- such as anti-kickback protection, chain brake, vibration isolation, new hand protection, and others -- began appearing on the market. Unfortunately, foreign manufacturers were the first to emphasize these new features. This complicated the procurement procedure, of course, because field personnel wanted to buy and use the safest saw that was available. However, no one really knew how good the safety devices were, so there was a reluctance to attempt strong justification for the purchase of a foreign article. So a project was initiated at Missoula Equipment Development Center (MEDC) to determine adequate procedures for evaluating the various safety features. Also, the intention was to work toward a safety standard for chain saws, if -- in fact -- none existed.

Since MEDC started the project, improvements in safety features have been coming about rapidly; now, there are even second generation refinements developed within the last 2 years. Also, efforts are underway to develop a voluntary industry safety standard for chain saws. About 3 years ago, the *Chain Saw Manufacturers Association (CSMA)* -- formerly the *Power Saw Manufacturers Association* -- drafted a safety standard that was widely circulated for comment; although it had many deficiencies, it was a good start. Most recently, a second draft was sent out by the *American National Standards Institute (ANSI)* in the form of an *ANSI Standard*; the draft standard is now at the Institute for promulgation. It was a great step forward, as it now covers all of the safety items that had been identified by MEDC's work. Of course, we hope that the final version will be a document that we can recommend as a criteria for safety in FS procurement actions.

Throughout this whole process, the Washington Office Equipment Development Group has maintained close coordination with CSMA, OSHA, and other interested Agencies.

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Material submitted to the Washington Office for publication should be reviewed by the respective Regional Office to see that the information is current, timely, technically accurate, informative, and of interest to Forest Service Engineers (FSM 7113). The length of material submitted may vary from several short sentences to several typewritten pages; however, short articles or news items are preferred. All material submitted to the Washington Office should be typed double-spaced, and, ideally, all illustrations should be original drawings, glossy prints, or negatives.

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