COMPUTING ARRIVAL TIMES OF FIREFIGHTING RESOURCES FOR INITIAL ATTACK

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A national forest or planning unit consists of a variety of valuable assets to be protected by local fire agencies. In addition to these valued assets, and because of their importance to us, we have provided public road systems and firefighting resources.

The dispatcher of these resources to local fires must make instantaneous or precalculated decisions when a fire occurs in a given area. On smaller protection units, or those with few resources, travel times and resource availability are usually quickly available from personal knowledge, or from inspection of maps and other fire planning aids. If several protection agencies and many alternative resources are involved, choosing the "right" units for a particular tire dispatch is more difficult and time consuming.

This report describes a computer model for computing arrival times of firefighting resources for an initial attack on a fire. The model was developed to assist the fire dispatcher with the allocation of available resources quickly and efficiently.

The model requires a low-speed interactive terminal, available 24 hours, which the dispatcher can use to request a computerized list of possible resource arrivals on any fire within his area of responsibility. The resources are listed in order of arrival times, allowing the dispatcher to choose one or more resources to the fire location. The actual selection of resources from the listing will depend on local fire conditions and resource availability.

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Dispatching of firefighting resources requires instantaneous or precalculated decisions. A FORTRAN computer program has been developed that can provide a list of resources in order of computed arrival time for initial attack on a fire. The program requires an accurate description of the existing road system and a list of all resources available on a planning unit.

Retrieval Terms: Fire management, fire suppression programs; computer programs; simulation; travel time.

Two data files, describing the road system used by the planning unit and the resources available to the unit, must be kept at the computer site (*fig. 1*). The road network must be defined in terms of initial attack travel times between selected points (nodes) and all resources must be identified by name, getaway time, location, and average airspeed for air units. At the time the dispatcher requests a list of resource arrivals, he will need to specify the location of the fire in terms of longitude and latitude coordinates, the maximum initial attack time, and the off-road travel speed to approach the fire on foot.

ALLOCATION PROGRAM

The allocation program determines the total time required to reach a fire as follows:

a. For helicopters and fixed wing aircraft, the getaway time (delay) is added to the time required to fly in a straight line to the fire, using an average cruise speed.

b. For ground units, a search algorithm computes the shortest time-route to the fire. [1] This time includes

[1]Hillier, Frederick., and Gerald Lieberman. 1974. **Operations research.** p. 217, 220. Holden-Day, Inc. San Francisco, Calif.

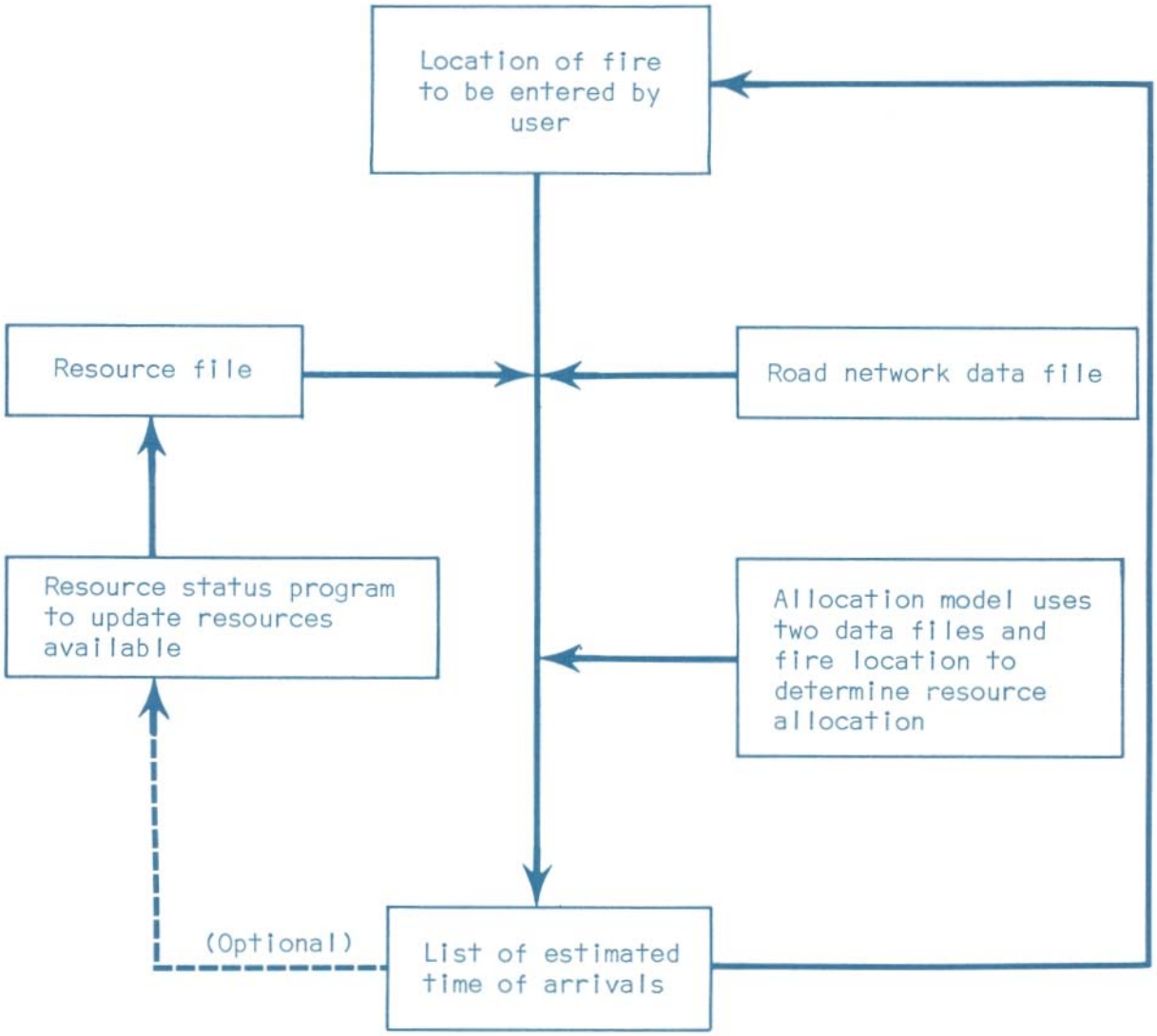

Figure 1—A computer program provides for allocation of resources to afire followed by a possible update of the resources.

the getaway and off-road time required to approach the fire on foot at a rate which takes into account the local terrain conditions.

An interactive dispatch model can be used in two ways:

a. Some time during the course of dispatch actions taken, or at the earliest possible time thereafter, the dispatcher may want to dial the computer, enter the fire coordinates, and obtain a listing of all initial attack resources with arrival times less than some specified time limit.

b. The dispatcher or fire planner, at any given time, may run the program to assist him in calculating standard dispatches for areas on the planning unit. These planned responses are basic to dispatching resources to any fire occurring in one of the "preplanned" dispatch areas.

The listing of initial attack resources consists of all units dispatchable to the fire within a specified time limit. These resources are listed in order of increasing time (*table 1*). The time listed in column 1 includes getaway (delay) time, actual travel time on the road or in the air, and off-road travel time computed at an average walk speed, subject to local terrain conditions and is provided by the dispatcher. The off-road time needed to approach the fire on foot is computed as the product of the off-road travel speed and the length of sections L or S (*fig. 2*). A resource will arrive at either point B, located between nodes 5 and 6 or point A, located between nodes 1 and 2. The time required to travel the straight line, section L or section S, will be added to the minimum travel time represented by either point B or point A. If there is a barrier on the left-hand side going from node 6 to 5, the program will locate point B between another pair of nodes.

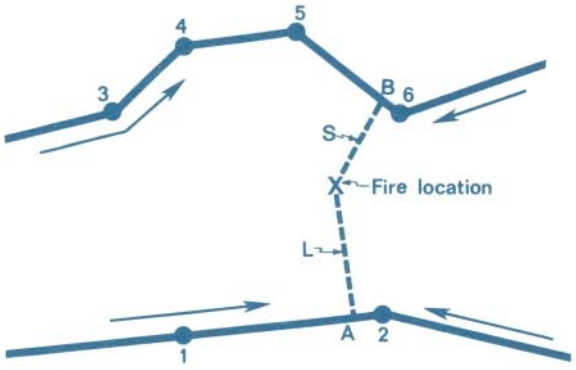

Figure 2—The off-road travel time via sections S and L is added to the time required to get to points B and A.

The nonzero numbers in column 2 (*table 1*) are the computed bearings from the aircraft or helicopter unit to the fire. The last column lists the getaway times initially input by the user. The remaining columns are used to further identify the ground or air unit by name, location, capacity in gallons, and number of persons on the firefighting unit.

The road network data must be up to date to provide current road travel times. The definitions, formats, and requirements are the same as for the road network described in the FOCUS simulation program.[2] Nodes must be placed at intersections, bridges, sharp curves

[2]User's Manual for FOCUS (*F*ire *O*perational *C*haracteristics *U*sing *S*imulation). (Manuscript in preparation).

Table 1—*Initial attack times for a fire located at longitude 117.537, latitude 33.879, maximum time of 30 minutes and 3 mi/h walk speed*

Time (*min*)	Bearing (*degrees*)	Name[1]	Unit No.	Persons	Capacity (*gal/persons*)	Type[2]	Base No.	Delay-T (*min*)
4	0	Corona FS	1	5	300	12	2GD	2
5	0	Corona CDF	1	4	500	22	1GD1	5
5	0	Corona CDF	2	4	500	22	1GD2	5
10	0	Corona (M) FS	1	5	300	12	62GD	2
18	276	Ryan	2	0	800	7	7OAR	10
18	276	Ryan	3	0	800	7	71AR	10
19	143	Ont	1	0	2000	7	72AR	15
19	311	El Cariso	1	2	13	5	73HT	7
20	0	Temescal FS	1	5	500	12	6GD	2
22	276	Ryan	1	0	1400	7	69AR	12

[1]FS = Forest Service units; CDF = California Department of Forestry.

[2]Type 5 = helitack; Type 7 = air tanker; Types 12, 22 = ground units.

in the road, resource locations, and travel times between nodes must indicate initial attack travel times for up to three class sizes of vehicles.

RESOURCE-STATUS PROGRAM

The resource file and status program can be used to update all resources (*fig. 1*). However, it is run independently of the resource allocation program and serves as an input to the actual allocation of resources.[3]

The resource file should contain information on all existing or proposed units with initial attack responsibility for the planning unit. The dispatcher has the responsibility of using the status program to update the status of each unit, and to add, update, or delete units from the file.

[3]Mees, Romain M. A resource status keeping model. (Manuscript in preparation).

APPLICATION

The Cleveland National Forest in southern California has used a version of the program to reevaluate their preplanned dispatch areas. Included for each unit in their resource file are: base number location, status, days off, unit number, name of base, normal duty hours, crew (unit) leader, location, fire (division, sector) working on, and getaway time. These items can be updated, displayed, added to or deleted, using the status program. The allocation and status program run independently, but changes made in the resource file may affect the initial attack timing and allocation of resources.

The resources shown in *table 2* are dispatches made to further illustrate the output of the allocation program and are based on a road network consisting of approximately 1112 nodes needed to describe the Cleveland's road network. The resource file consists of 106 ground

Table 2—*Two 30-minute dispatch lists for the Cleveland National Forest with an off-road walk speed of 3 mi/h*

Time *(min)*	Bearing *(degrees)*	Name[1]	Unit No.	Persons	Capacity *(gall persons)*	Type[2]	Base No.	Delay-T *(min)*
	Longitude, latitude, maximum time, walk speed 117.543, 33.879, 30, 3							
12	0	Corona FS	1	5	300	12	2GD	2
13	0	Corona CDF	1	4	500	22	1GD1	5
13	0	Corona CDF	2	4	500	22	1GD2	5
18	0	Corona (M) FS	1	5	300	12	62GD	2
18	276	Ryan	2	0	800	7	70AR	10
18	276	Ryan	3	0	800	7	71AR	10
19	145	Ont	1	0	2000	7	72AR	15
19	310	El Cariso	1	2	13	5	73HT	7
22	276	Ryan	1	0	1400	7	69AR	12
28	0	Temescal FS	1	5	500	12	6GD	2
	Longitude, latitude, maximum time, walk speed 117.507, 33.810, 30, 3							
14	0	Temescal FS	1	5	500	12	6GD	2
16	0	Corona FS	1	5	300	12	2GD	2
16	307	El Cariso	1	2	13	5	73HT	7
17	266	Ryan	2	0	800	7	70AR	10
17	266	Ryan	3	0	800	7	70AR	10
20	143	Ont	1	0	2000	7	71AR	10
21	0	Corona CDF	1	4	500	22	1GD1	15
21	0	Corona CDF	2	4	500	22	1GD2	5
21	266	Ryan	1	0	1400	7	69AR	12
26	0	Corona (M) FS	1	5	300	12	62GS	2

[1]FS = Forest Service units; CDF= California Department of Forestry.

[2]Type 5 = helitack; Type 7 = air tanker; Types 12, 22 = ground units.

and air units. The total cost (not including monthly storage charges for the required data files) to produce the three samples shown in *tables 1* and *2* was $5.75. The cost to compute initial attack calculations will rise rapidly with increased maximum initial attack time and also with the number of nodes used to define the road network.

The allocation and resource status-keeping programs were written in FORTRAN for operation on the General Electric Tymesharing System.[4] Copies of the programs are available upon request from the Director, Pacific Southwest Forest and Range Experiment Station, P.O. Box 245, Berkeley, California 94701, Attention: Statistical Services Group.

[4]Trade names and commercial enterprises or products are mentioned solely for information. No endorsement by the U.S. Department of Agriculture is implied.

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