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The Army's Search for Increased Vehicle Mobility

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MOBILITY has many definitions and assumes varying degrees of importance to many people. While we may not be able to present a precise quantitative or qualitative definition acceptable to all, I believe we shall all agree that mobility problems are universal. To the U.S. Army, mobility is the difference between winning or losing, living or dying. The best equipment in the world and the best fighting men can serve no useful purpose unless we can move men and materiel against the enemy. An immobilized army is not a fighting army: it is vulnerable and subject to destruction.

The U.S. Army is ever searching for increased vehicle mobility. Our wheeled and tracked vehicles exist to support our military forces in their execution of the mission, whatever it may be. They bring ammo and chow to the soldier, carry his weapons, and sometimes even carry him too. Our vehicles also carry impediments to support themselves; for example, fuel, parts, and maintenance tools. These do not contribute basically to the direct execution of the mission, but they enhance the worth of our equipment, which may be measured ultimately by what it does for our forces.

A second thought to be considered is just how good is our whole fleet of vehicles. The paramount assessments are not how many vehicles we have, but how well do we use them; not the size of the trucks, but their ability to deliver the loads; not initial acquisition cost, but ultimate final cost; not the types we use, but how well they fulfill the mission; not individual vehicle support requirements, but the total collective fleet support. Stated in another way, "If you owned the vehicle fleet, how would you run it?"

So, getting back to the definition of vehicle mobility, it boils down to the simple question, "Does it effectively do the job required?" The mission is foremost! Naturally it should be done efficiently and economically.

ENVIRONMENT

Military environment is another term often mentioned. What is it? It is where the job is to be done, in temperate, desert, arctic, subarctic, tropical environments of all types. The terrain varies from the superhighway to the impassable. Such features of terrain as mud, sand, marsh, ditches, gullies, woods, vegetation, and snow are to be reckoned with in the various environments.

MISSION

The U.S. Army is charged with the responsibility of overall logistics such as transport of troops, fuel, supplies, containers, and special equipment. It is also required to provide vehicle recovery systems, field maintenance shop vans, missile carriers, and many other special functions.

We must also fulfill combat requirements with such items as tanks, self-propelled guns, tracked cargo carriers, armored personnel carriers, and the like. Indeed a monumental mission is in our hands, and we must do it most effectively with a complete line of vehicles. Still we must do it with best economy and minimum field service support, that is, plan carefully, reduce the number of components, and use the same or similar components in both wheeled and tracked vehicles. If these objectives are not relentlessly pursued, it is conceivable that much of our automotive equipment would be used to transport the supporting parts, tools, and

ABSTRACT

This paper covers the complete scope of the U.S. Army activities in its search for vehicle mobility. It describes the Army's world-wide comparative operational evaluation program and progress toward increased mobility. A proposed future mobile fleet system for the military is also discussed.

similar maintenance requisites. Ultimately our mission in supporting the user's mission is to provide a mobile fleet at lowest cost with minimum support and supporting spares.

MILITARY REQUIREMENTS

A requirement is a definite statement of need by the military for a certain type, size, and characteristic of equipment. As you will see later, especially in our wheeled vehicles, a plan is offered wherein a range of vehicles are proposed, from which a user may satisfy his needs. Many other special purpose vehicles based on the components of the fleet of vehicles are readily attainable as special requirements dictate.

CURRENT VEHICLE STATUS

Before proceeding with what the U.S. Army is doing in its search for increased vehicle mobility, it is appropriate to summarize the current vehicle fleet status of our wheeled and tracked vehicles.

TRACKED VEHICLES - The current tracked vehicle fleet is briefly summarized in Table 1. As indicated in this table, there are 21 models of vehicles representing 10 basic types; this will be reduced to 9 types when the XM551 is available.

Table 1 - Current Tracked Vehicle Fleet

	BASIC TYPE	VARIATIONS	DIMENSIONS L X W (IN)	GROSS COMBAT WT (LBS)	PAYLOAD (LBS)	NET H/P	GROUND PRESSURE	STATUS
1	XM571, CARGO CARR	NONE	229 X 63	7,250	2,400	65	1.83	EXPERIMENTAL (FLOATABLE)
2	XM104, 105 MM, S P	NONE	156 X 69	8,700	—	58	3.6	EXPERIMENTAL (FLOATABLE)
3	M116E1, CARGO CARR		180 X 82	10,600	3,000	110	2.5	STANDARD (FLOATABLE)
4		T114 ARM'D RECONN	176 X 92	14,900	—	110	4.9	LTD STD (FLOATABLE)
5	M56, 90MM, S P	NONE	180 X 102	15,750	—	165	4.25	STANDARD
6	M50, 106 MM, S P	NONE	151 X 102	18,300	—	124	4.7	STANDARD (USMC ONLY)
7	M113, APC		192 X 106	23,000	3,000	180	7.3	STANDARD (FLOATABLE)
8		XM548, CARGO CARR	212 X 106	24,000	12,000	180	7.3	EXPERIMENTAL (FLOATABLE)
9		XM546, MISSILE CARR	228 X 106	24,000	10,000	180	7.3	EXPERIMENTAL (FLOATABLE) LIGHTLY ARMORED (ALSO XM474E2)
10	XM551, ARM'D RECONN	NONE	—	30,000	—	225	6.2	EXPERIMENTAL REPLACES M56 & M41
11	M41, LIGHT TANK		230 X 126	51,800	—	446	9.7	STANDARD
12		M42, 40 MM, S P	230 X 126	49,800	—	446	9.3	STANDARD
13	T195E1, 105 MM, S P		239 X 124	49,500	—	375	10.6	LTD. PROD
14		T196E1, 155MM, S P	239 X 124	54,200	—	375	11.6	LTD. PROD.
15	M107, 175 MM, S P		212 X 124	61,500	—	345	11.8	STANDARD
16		M110, 8 IN, S P	212 X 124	58,500	—	345	11.3	STANDARD
17		XM598 CARGO CARR	240 X 124	60,000	30,000	345	11.8	EXPERIMENTAL (FLOATABLE)
18		T120E1, RECOV VEH	250 X 124	54,000	—	345	10.0	EXPERIMENTAL
19	M60 TANK		320 X 143	102,000	—	643	11.0	STANDARD
20		M88, RECOV VEH	326 X 135	112,000	—	814	10.5	STANDARD
21		T118E1 COMB ENGR VEH	299 X 148	110,000	—	643	11.8	EXPERIMENTAL

SMOTA-RRD ● SKETCHES SHOWN ARE NOT TO SCALE PREPARED BY ARMY TANK-AUTOMOTIVE COMMAND

This table is intended to give you a broad picture of what we are doing in this area. It is notable that vehicle mobility is being increased here on a continuing basis through reduced weight, greater agility, aggressive tracks, and other refinements. Noteworthy also is the great weight reduction (approximately 40%) in the M110 and M107 SP's over their predecessors. The XM598, 15 ton cargo carrier is a vast improvement over the M8A1 cargo carrier; payload is doubled, and weight of the vehicle has been reduced by 33%. The XM548, 6 ton cargo carrier is also a great advance over the old 6 ton M85 in that the vehicle weight has been cut from 33,000 lb to 12,000 lb. These lightweight cargo carriers (XM548 and XM598) add real mobility to our combat forces and are capable of floating on inland waterways for greater versatility.

The XM551 will also be more mobile than its predecessor, the M41 tank, with its light weight and 30% reduction in ground pressure. These weight reductions also improve airportability and economy as well as mobility. Last fall, in Swamp Fox II operations in the tropical environment of Panama, the XM548 was indeed impressive.

WHEELED VEHICLES - The basic program and plans for the military wheeled vehicles are shown in Table 2. For additional descriptive data on some of these military vehicles, see SAE Paper S326, Feb. 5, 1962, entitled: "Ordnance Wheeled Vehicle Developments Today and Tomorrow," by T. J. Bischoff. Table 2 does not cover special purpose vehicles such as the M274 Mechanical Mule or the heavy tank transporters; it also does not cover the many types and sizes of trailers in use. Most of these current vehicles are produced in a variety of types such as vans, wreckers, ambulances, cranes, tractors, dumps, and tankers.

Please examine Table 2 carefully. It shows the current inventory to consist of 1/4, 3/4, 2-1/2, 5, and 10 ton trucks. It seems that these numbers have been with us such a long time that their replacement by the planned 1/4, 1-1/4, 2-1/2, 5, 8, and 16 ton trucks is often confused in certain areas. Let us explain in more detail. It is quite clear that the 1/4 ton M151 replaces the old M38A1. The new XM561 development will replace the 3/4 ton M37 series and will match it fairly well in gvw, performance, and size.

The XM410E1 is actually a new vehicle to the system and may fill the gap between the 3/4 ton M37 and the 2-1/2 ton M35 series. Its maximum gvw and power train (as represented by maximum drawbar pull) is in a class below the M35 series. It will fulfill only the duties at the low end of the M35 series.

The 5 ton XM453E4 series will actually replace the 2-1/2 ton M35 series as indicated by near equivalent gvw and drawbar pull. This new 5 ton does not replace the 5 ton M54 series except in the lower end of its capability scale.

By the same reasoning, the 8 and 16 ton GOER vehicles, respectively, should have to replace the current 5 and 10 ton vehicles.

There is a continuing need to improve mobility, military effectiveness, versatility, and (or) cost factors in the current and planned program. For example, the M151, while a good

Table 2 - Current Military Wheeled Vehicles

Current Inventory		Current Plans
1/4 Ton, 4x4, M38A1 Series Curb Weight, 2665 lb GVW, Cross-Country, 3465 lb Other Types in Series, Alternate long wheelbase type for front line ambulance and panel truck Max. gvw, Hwy/Spec. Purp., 4163 lb Max. Drawbar Pull, 2300 lb Max. Speed, 71 mph Max. Net hp, 61 Length x Width, 138-1/2 x 60-1/2 in.	To be replaced by	1/4 Ton, 4x4, M151 (Now in production) Curb Weight, 2325 lb GVW, Cross-Country, 3125 lb Other Types Planned, Various kit applications Max. gvw, Hwy/Spec. Purp., 3524 lb Max. Drawbar Pull, 2175 lb Max. Speed, 65 mph Max. Net hp, 61 Length x Width, 132 x 62 in.
3/4 Ton, 4x4, M37 Series Curb Weight w/o winch, 5700 lb GVW, Cross-Country, 7600 lb Other Types in Series, Long wheelbase types for maintenance truck and ambulance Max. gvw, Hwy/Spec. Purp., 9300 lb Max. Drawbar Pull, 6225 lb Max. Speed, 55 mph Max. Net hp, 81 Length x Width, 189-1/2 x 73-1/2 in. Cargo Area, 64 x 78 in.	To be replaced by	1-1/4 Ton, XM561 (Estimated) Curb Weight, 4800 lb GVW, Cross-Country, 7700 lb Other Types Planned, Various kit applications Max. gvw, Hwy/Spec. Purp., 8200 lb Max. Drawbar Pull, 6200 lb Max. Speed, 55 mph Max. Net hp, 80 Length x Width, 192 x 82 in. Cargo Area, 78 x 96 in.
2-1/2 Ton Lightweight None Available	To be replaced by	2-1/2 Ton, 8x8, XM410E1 (Estimated) Curb Weight, 11,000 lb GVW, Cross-Country, 16,400 lb Other Types in Series, Not determined but can perform other light duty functions GVW, Hwy/Spec. Purp., 18,400 lb Max. Drawbar Pull, 9600 lb Max. Speed, 55 mph Max. Net hp, 154 Length x Width, 247 x 92 in. Cargo Area, 80 x 147 in.
2-1/2 Ton, 6x6, Cargo, M35 Series Curb Weight w/o winch, 12,465 lb GVW, Cross-Country, 17,865 lb Other Types in Series, Three wheelbases offering dumps, crane 4 ton, wrecker, truck tractor, 1200 gal tank, 1000 gal tank, shop van and expandable van Max. gvw, Hwy/Spec. Purp., 27,810 lb GCW w/Semi, 35,170 lb Max. Drawbar Pull, 13,000 lb Max. Speed, 58 mph Max. Net hp, 127 Length x Width, 263 x 96 in. Cargo Area, 88 x 147 in.	To be replaced by	5 Ton, 8x8, XM453E4 Series (Estimated) Curb Weight, 14,000 lb GVW, Cross-Country, 24,400 lb Other Types in Series, Not determined, but this series will cover same functions as in the M35 series GVW, Hwy/Spec. Purp., 28,400 lb GCW, w/Semi, Not determined Max. Drawbar Pull, 15,500 lb Max. Speed, 58 mph Max. Net hp, 170 Length x Width, 260 x 96 in. Cargo Area, 88 x 168 in.

Continued

Table 2 - Current Military Wheeled Vehicles - Cont'd

Current Inventory		Current Plans
5 Ton, 6x6, Cargo M54 Series	To be replaced by	8 Ton GOER, XM520E1
Curb Weight, 21,000 lb		Curb Weight, 27,010 lb
GVW, Cross-Country, 31,400 lb		GVW, Cross-Country, 43,410 lb
Other Types in Series, Three wheelbases offering dump truck tractor, medium wrecker, and 2500 gal tanker		Other Types in Series, Planned 10 ton wrecker, 2500 gal tanker
GVW, Hwy/Spec. Purp., 49,230 lb		GVW, Hwy/Spec. Purp., 43,410 lb
Max. gcw, w/Semi, 84,260 lb		GCW, w/Semi, Not applicable
Max. Drawbar Pull, 21,000 lb		Max. Drawbar Pull, 38,000 lb
Max. Speed, 52.6 mph		Max. Speed, 30 mph
Max. Net hp, 196		Max. Net hp, 176
Length x Width, 297 x 96 in.		Length x Width, 375 x 108 in.
Cargo Area, 88 x 168 in.		Cargo Area, 104 x 196 in.
10 Ton, 6x6, Cargo, M125 Series	To be replaced by	16 Ton, GOER, XM437E1
Curb Weight, 32,550 lb		Curb Weight, 39,100 lb
GVW, Cross-Country, 52,950 lb		GVW, Cross-Country, 71,500 lb
Other Types in Series, Truck-tractor		Other Types, 5000 gal tanker and planned 20 ton wrecker
GVW, Hwy/Spec. Purp., 62,950 lb		GVW, Hwy/Spec. Purp., 71,500 lb
GCW w/Semi, 95,000 lb		GCW, w/Semi, Not suitable as semi
Max. Drawbar Pull, 31,750 lb		Max. Drawbar Pull, 43,000 lb
Max. Speed, 42 mph		Max. Speed, 31 mph
Max. Net hp, 255		Max. Net hp, 285
Length x Width, 332 x 114		Length x Width, 492 x 124
Cargo Area, 96 x 180		Cargo Area, 108 x 284

and reliable vehicle, still lacks floatability and is procured at a cost increment over its M38A1 predecessor. The new XM561 vehicle is expected to provide compliance with the aforementioned factors to a satisfactory measure. The XM 410E1 provides floatability and improved mobility; however, it is expected to cost more than the current M35 series.

The final 5 ton XM453E4 will essentially replace the 2-1/2 ton M35 series of vehicles and is expected to be very versatile in accomplishing the variety of functions presently fulfilled by the M35 series. In addition, it is floatable, has removable bodies, can be built with alternate wheelbases, will be more mobile, and may be procured at a reasonable cost.

The XM520E1 GOER has excessive axle loading over the legal 18,000 lb limit and is expected to have high procurement cost. Further, it is not suitable for tractor semi-trailer operations that are needed for economical massive resupply operations usually conducted in the communication zones (Com Z). It is floatable, and its articulated yaw steering does provide good maneuverability crosscountry and on water. Its mobility is judged to be superior to the M54 series. Reexamination of the 8 ton area is deemed desirable and is now in process.

The 16 ton XM437E1 GOER cargo vehicle also will be expensive to produce. This 16 ton machine has very high axle loads, about double the legal limits; its weight and excessive width will require special permits for any movement over the road. The mobility of this vehicle was not evident in environmental field operations conducted at operation Wheeltrack and Swamp Fox II. The usefulness of this vehicle needs further study and examination.

In the broad view, our new wheeled vehicle developments have increased mobility over the previous equipment in the respective weight classes; however, the best mobility features have not been exploited to the fullest extent across the spectrum of vehicles. Locking differentials are still not in use on the M151, and their absence was very evident in Swamp Fox II when diagonally opposite wheels spun out and failed to provide any traction in difficult situations.

Vehicle articulation (which ideally relates the vehicle's axles to the contours of the ground surface) has not been investigated in all classes of vehicles, including tracked vehicles. Maximum effective ground clearance has not been incorporated in some of our vehicles. The benefits of low axle loading, through use of the maximum feasible number of axles for a given weight class, need further consideration.

While the nondirectional military tire design is considered to be the best overall compromise, additional field evaluation is needed either to confirm this view or to lead to selection of better designs. Certainly in some cases, high mobility tires should be introduced where the terrain and environment demand it.

SEARCH FOR QUALITATIVE CRITERIA

In the past, our efforts have gone down a formal path of establishment of requirement, development, and test at various installations under controlled conditions and, finally, production. Mobility testing has been often conducted at these sites with a tendency toward proving a preconceived conclusion of superiority. Practically no direct mobility evaluation of the equipment (in comparison with all other comparable equipment) was conducted in the true environments and under realistic conditions that would be encountered in the field. Certainly the controlled test is vital to vehicle development, but so is the ultimate and true user test-in the field!

In our comparative operational evaluations, it is equally important to define the environment accurately and to record and analyze the results so as to ensure correct evaluative results. The value of operational evaluations is steadily improving through careful attention to this area.

EVALUATION PROGRAM - In recent years the search for increased vehicle mobility has turned increasingly to the medium of comparative operational evaluations. These involve the physical comparison, simultaneously and under identical environmental conditions, of military and commercial standard and prototype vehicles, both modified and unmodified.

Environmental exposure of military equipment has long been a standard practice and has been required when the applicable military characteristics specify acceptable performance under environmental extremes. Equipment has been subjected to desert conditions of dust, heat, and abrasion at Yuma Test Station, Arizona, and to subarctic conditions (primarily snow and cold) at Fort Greely, Alaska.

Unfortunately, and all too frequently, environmental exposure has been on a one-of-a-type basis and under the semicontrolled conditions of an experimental station located in a specific permanent military installation.

Occasional exposure has been achieved when vehicles have been placed in operational use with the Corps of Engineers in Greenland, with the U.S. Air Force along the Dew Line, or as a by-product of occasional field operations in areas of difficult environment.

All too frequently also the anticipated characteristics of equipment items have been compared empirically. As a result, sufficient deviations have existed between the conditions of tests or evaluations to affect adversely the validity of the results, and hence the deductions, recorded. In some instances, a newly introduced vehicle has been judged superior to the item it was designed to supplant when, in truth, the presumed superiority was based upon divergent, or controlled, evaluative conditions.

There are those who contend that comparative operational evaluations, particularly under actual conditions of difficult environments, are unnecessary. As recently as August, 1962, a senior officer made the following statement:

"This program represents an extensive and expensive evaluation of materiel performance in natural adverse terrain environments throughout the world. It is an extension of a program that has been in existence for over twelve years in the Transportation Corps, Corps of Engineers, and Ordnance Corps. Many configurations of materiel, currently under evaluation and projected for future evaluations, have been currently studied and found to be deficient. The findings of these later studies have added virtually nothing to previous knowledge of vehicle design parameters and are hence of limited value. The knowledge of natural terrain environmental factors throughout the world is of major value both to the tactician and the vehicle designer, but such information can be obtained and evaluated, without recourse to operation of a fleet of vehicles through it, by a much simpler and less expensive method of measurement of soil shear characteristics under dynamic loading."

Results and data acquired do not support this contention. The deliberate, carefully planned conduct of comparative operational evaluations in difficult environmental conditions, conditions that are scientifically observed and recorded, has led to a noteworthy advance in the study of vehicular mobility and in the recognition of those factors that bear upon increased mobility. In major part, the evaluation program has stemmed from increasingly close cooperation between the elements that now comprise U.S.A. Mobility Command and the U.S.A. Test and Evaluation Command. The combination of research and development with the capabilities of a field operating agency has resulted in improved capabilities for the planning and conduct of extremely detailed operations.

In addition to the work undertaken by these two agencies, extensive specialized study has been undertaken in the southeast Asia area by the Advanced Research Projects Agency of the Department of Defense. It is interesting to note that the general approach used by this agency has paralleled that discussed in this paper. Indeed, the interchange of information and data between the two field operating organizations has resulted in the elimination of duplication and has permitted rapid acquisition of essential and verifiable results.

As a matter of convenience, the various environmental areas, within which operational evaluations are (or will be) conducted, have been arbitrarily divided into generalized groupings. These groupings appear in Tables 3 and 4.

In passing, it should be mentioned that successive evaluative operations within the same environmental area are referred to by the same operational code name, the sequence being indicated by a roman numeral, that is, Swamp Fox I, Swamp Fox II, and so forth.

Experience has confirmed that valid results are best attained by a continuing series of comparative operational evaluations conducted in either the same, or substantially identical, environmental areas. By this rather simple device, a comparison can be obtained from year to year among the various items evaluated, product improvements can be verified, and a substantive check can be maintained on annual changes in the environmental conditions to be encountered in like areas world-wide.

A brief discussion of the various comparative operational evaluations conducted to date and planned for the future appears warranted.

Tropical Environment Series - These have been based upon a preliminary environmental expedition into the areas immediately adjacent to the Panama Canal Zone (Fig. 1) during the fall of 1960 (Operation Tropical Wet). The limited results attained led to the first of the Swamp Fox operations in the fall of 1961, when the area from El Chepo to Santa Fe, Republic of Panama, was successfully traversed by a selected group of wheeled and tracked vehicles. Results of this operation led to significant design modifications to the M113 and M116 series of vehicles and to a comprehensive reexamination of the military use of directional tread tires, low pressure, oversize tires, and other modifications to military standard and commercial, off-the-shelf vehicles. Profiting from the experience gained and data acquired, Swamp Fox II (Fig. 1) was conducted during August through November of this past year.

Unlike prior operations, this latest comparative operational evaluation has operated from a base camp complex, utilizing carefully surveyed and scientifically analyzed areas representative of the tropical environment. It is too early to comment upon the results attained, but they appear to be highly significant and a gainful return on the resources committed to the project.

Desert Environment - Evaluations under these conditions continue and extend those initiated in October, 1960, at Yuma Test Station, Arizona. Advanced planning has led to a new appreciation of the problems involved in an extended field operation within desert environments. While outstanding advances have been made by the petroleum industry in the field of desert transportation, such advances have been accomplished with equipment having inherent capabilities far beyond those of ordinary military equipment or of normal commercial vehicles.

Environmental analogs prepared by responsible sources indicate a requirement for extensive operation in certain desert areas outside the continental United States. A selected group of military and commercial vehicles, with accessory navigational and logistical support equipment, will be exposed to comparative operational evaluation under the extreme conditions of soil, terrain, and climate known to exist in the objective area. Unfortunately, diplomatic considerations preclude further detailed discussion of the area under consideration within the framework of this paper.

Arctic and Sub-Arctic Conditions - Our associates in Canada and the Corps of Engineers Waterways Experiment Station have taken the lead in defining and studying muskeg. This condition, occurring throughout the Arctic and sub-Arctic during the summer months, presents a far greater challenge to the vehicle designer than does the same terrain during the frozen winter. With Operation Bog Busters, in the summer of 1962, comparative operational evaluation of a limited number of commercially developed vehicles was undertaken.

The results indicate that the military designer has much to learn from his commercial counterpart. Stimulated by the oil and mining industries, and to a more limited extent

Table 3 - Comparative Operational Evaluations

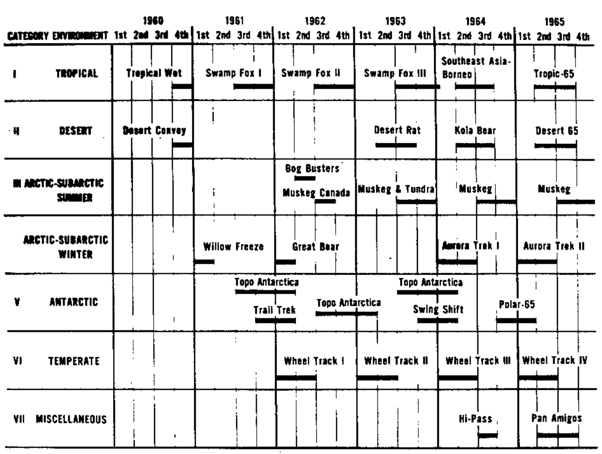

Table 4 - General Groupings of Environmental Areas

Category	Environmental Area	OPNL Code Name
I	Tropical	Swamp Fox
II	Desert	Desert Rat
III	Arctic/subarctic, summer	Bog Busters
IV	Arctic/subarctic, winter	Aurora Trek
V	Antarctic	Swing Shift
VI	Temperate	Wheeltrack

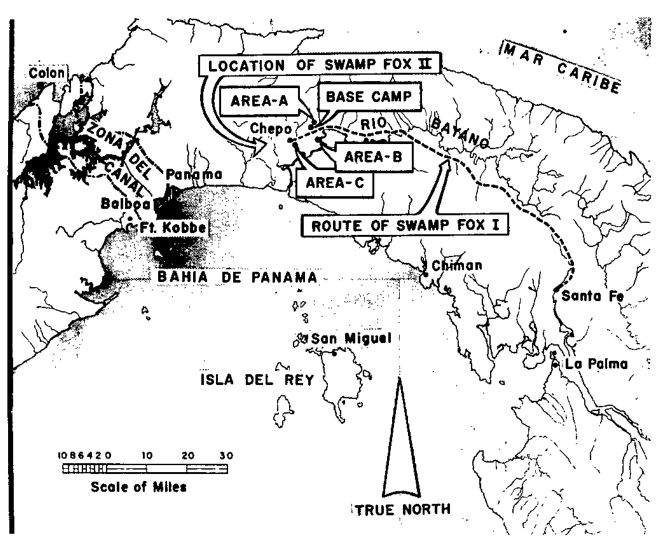

Fig. 1 - Swamp Fox II operation

by the paper pulp companies, commercial fabricators have developed a number of highly versatile, simple yet sturdy, logistical carriers that possess superior operational characteristics in muskeg and marsh. Motivated by the profit motive and the need to sell against competition, these vehicles are available at only a fraction of the cost of special military vehicles designed to operate in the same environment.

Increased attention must be given to these developments and care must be exercised to preclude duplication of effort and ensure maximum exploitation for military uses of the advances already achieved. Future operations will further explore the capabilities of military standard, military prototype, and commercial vehicles, both modified and unmodified, in this environment.

The requirement for increased vehicle mobility in the Arctic and sub-Arctic has been largely generated by U.S. Army, Alaska, with the objective of ensuring accomplishment of that command's operational mission. Evaluation of equipment by other agencies has been aimed, in large part, at the conduct of cold weather tests on test ranges associated with established military installations.

Such tests undoubtedly produce highly significant results and influence military equipment designers to a major degree. However, the relatively tender loving care of the test project director, under the circumstances associated with this form of test, varies considerably from the more severe evaluation of equipment when exposed to an extended environmental operation cut off from a secure base of operations. At the same time, so much of the actual terrain traversed remains unexplored, or traversed only by the occasional Eskimo or indigenous hunter, that an urgent requirement exists to acquire additional scientific environmental data regarding the area and its associated terrain.

In successive operations of the Aurora Trek Series (Fig. 2), it is contemplated that comparative operational evaluations will be combined with extensive scientific investigation of the feasibility of overland routes of communication within Alaska and adjacent Yukon Territory, Canada. Results of these operations are expected to make significant contributions to military preparedness as well as to general knowledge of the areas involved and their potential for economic development.

Commercial entrepreneurs have conducted several unusual overland logistical operations in the areas to the east, but their results have been permitted to lie fallow and little has been deduced from their experiences. Commercial heavy duty trucks have successfully moved overland during the winter months from Circle, Alaska, to the Beaufort Sea; a commercial version of the Overland Train series of large wheeled vehicles moved with relative freedom over a semicircular course from Circle via the Mackenzie River delta to Great Bear Lake and return.

However, military installations north of the Brooks Range continue to be supplied by expensive and dangerous sea lift or by even more expensive air lift. Prior operations in this area, Operation Willow Freeze in 1960-1961 and Operation Great Bear in 1961-1962, suggest that significant advances can be achieved in the evaluation of mobility and the exploitation of land transportation routes by continued operations in the area.

Antarctic operations (Trail Trek, Swing Shift, and so forth) are unusual in that the series involves operation of Army helicopters and associated accessory equipment in the Antarctic in association with U.S. Navy Task Force 43 and in support of the National Science Foundation. The operation and the results obtained to date have been highly successful, but do not bear directly upon the subject of this paper.

Temperate Climatic Influences - Designers have always paid special attention to the peculiar demands of the extreme environments. Operational evaluations, comparative with empirical, have been conducted in such areas, but less attention has been paid to the mobility hazards encountered in the temperate climates of the world. Yet, Operation Wheeltrack (Fig. 3), conducted in the salubrious climate of

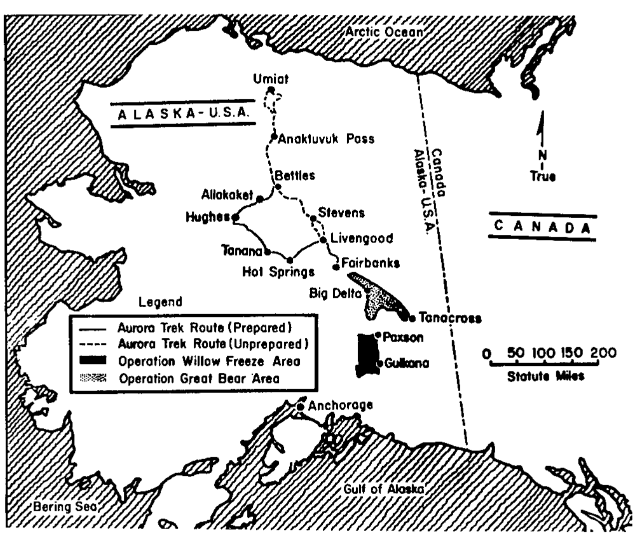

Fig. 2 - Operations Willow Freeze and Great Bear

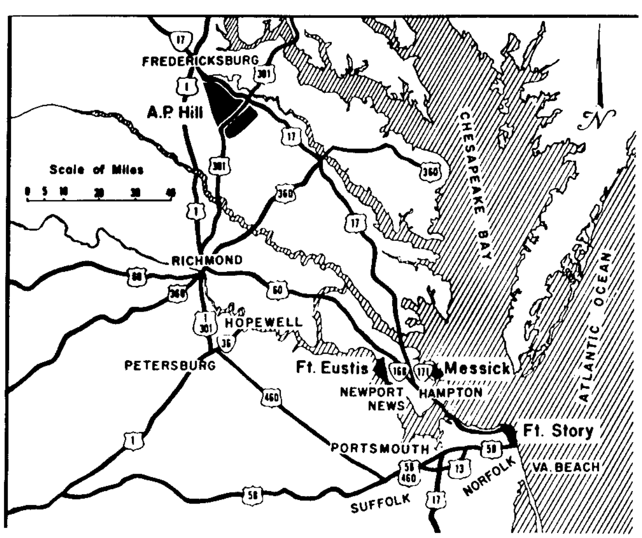

Fig. 3 - Operation Wheeltrack

peninsula Virginia, highlighted the fact that vehicle mobility in such a commonplace environment has not yet been fully achieved.

Most interesting among test results was the revelation that equipment previously judged highly mobile, such as the 16 ton GOER, was not actually capable of movement in much of the environmental conditions encountered within a radius of 100 miles from Fort Eustis, Virginia (Fig. 4). This immobility confirmed data resulting from the prior application of empirical formulas based on mobility evaluations. It also contravened an evaluation of the item, conducted under semi-controlled test conditions, which had predicted mobility, and was held to negate any requirement for actual exposure to the physical environment involved. It has become obvious that additional comparative operational evaluation under temperate environment conditions is urgently required to provide guidance to designers and fabricators.

UTILIZATION OF EVALUATION DATA - With this rather lengthy introduction, we can now consider the results attained from our evaluation program and the effect that such results have upon the achievement of increased vehicle mobility. In passing, we suggest that there are other substantial benefits that accrue from the evaluation program and, if time permits, we may offer a few of these for your consideration.

Basically the evaluation program offers an opportunity to compare, under similar environmental conditions, varied items of equipment. Such items may possess similar or widely diverse characteristics; they may be wheeled, tracked, air cushioned, or of other form. The important objective is the acquisition of performance data that can be correlated with scientific classification of the environment, to establish design parameters. Comparison can be drawn between existing vehicles and prototype vehicles, and advances in operational capabilities can be easily and visually observed.

This leads to the second objective of comparative evaluation, simply stated as: Is this design worth further development? If we are to reduce the research and development lead time in military design and procurement, then it becomes as important to kill an unproductive approach as it does to exploit a breakthrough. If at any stage in the research and development cycle, we can show conclusively that a line of attack should be abandoned or that a development does not constitute a significant advance over predecessor vehicles, then we have ample reason to teminate a potentially wasteful effort.

By the evaluation of new concepts prior to commitment to large scale programs, we save time, money, and effort, and preclude creation of the designer's dream project, that is, one that will carry him on the payroll from womb to tomb! A collateral benefit is the complete avoidance of unsuitable programs, since each evaluation project should

Fig. 4 - Operation Wheeltrack equipment

further refine and delineate the parameters of design that can be regarded as acceptable for increased mobility.

Evaluation on a comparative basis under natural environmental conditions permits savings in overall development time. By observing relative performance of varied vehicles with dissimilar configurations, it is possible to visualize and subsequently incorporate in designs the best features of each individual vehicle. Were the vehicles to be evaluated alone, isolated from their counterparts, such integration of rewarding design features might well not be visualized and would never come to fruition.

Guidance to the combat development agencies in the formulation of new qualitative materiel requirements and small development requirements flows endlessly from comparative evaluations. Answers are forthcoming as to the design characteristics required to overcome environment and increase mobility. Overstatement of requirements can be avoided, based upon actual field experience; requirements may be significantly reduced, with consequent reduction of development and production costs, by on-the-ground exploration of the characteristics required to perform a given job. Overdesign and "too many gadgets" can be countered by maximizing simplicity, durability, and capability.

As a direct offshoot of any comparative operational evaluation, there is a vast amount of technical information acquired on performance, durability, economy of operation, and mobility. Evaluations should not be conducted in lonely isolation, but should be accorded attention by all the disciplines to the end that simultaneous observations, subsequent deductions, and interpretations may be made from which common agreement can be reached and design parameters defined. Indeed, the interchange of test information and experience data among scientific, professional, technical, and military personnel assigned to an evaluation will provide a medium through which the capabilities of the personnel thus engaged are vastly increased.

The old saying, attributed to Confucius, that, "one picture is worth a thousand words," holds true during the course of an evaluation program. What you see for yourself, what you deduce for yourself, what you decide on the basis of visual observations often has a more enduring effect than like material read in a paper or text. The entire field of knowledge relating to man and his environment is expanded through the media of field evaluations, and the overall impact of data accumulated has effects reaching far beyond increased vehicular mobility. However, such effects are a by-product and not a primary consideration.

FIELD TRIALS - It is a trite observation that "experience is the best teacher," yet it is a remarkably true statement. Experience with comparative operational evaluations of equipment during the past two years have tended to counter the statement previously quoted. We take serious issue with the individual who stated that "The findings of these later studies have added virtually nothing to previous knowledge of vehicle design parameters and are hence of limited value." Our design of vehicles for increased mobility has been profoundly influenced by the observations made and the data acquired by this type of operation. This has been particularly true in the area of field correlation work versus prediction, as developed by the Land Locomotion Laboratory of the U. S. Army Tank-Automotive Command.

Field correlation data versus ATAC Land Locomotion Laboratory mobility predictions (in the form of drawbar pull/weight) was gathered at projects Wheeltrack and Swamp Fox II, but detailed results and analyses were not available in time for inclusion in this paper. However, in general, their mobility predictions have correctly assessed the relative mobility of various designs to the degree that their evaluation of new designs is actively sought by engineers and designers.

A great variety of equipment has been and (or) will be evaluated in the scheduled environmental evaluation program. There are easily 40-50 vehicle items; however, all will not be described here, in the interest of keeping this paper to a reasonable length. Suffice to say, of course, that all current military wheeled and tracked vehicles are included in the programs. A few of the more interesting items are:

1. Several off-road motor scooters were evaluated. These included the Harley Scat, the Nethercutt Trailbreaker, the Bonham Tote Gote, and the Cushman Trailster. These were only recently operated in Swamp Fox II, and it is too early to indicate any evaluation. (Fig. 5 is a composite photo of these vehicles.)

2. The MI51 (Fig. 6) with Terra tires was evaluated at Wheeltrack and Swamp Fox II. The modification was made

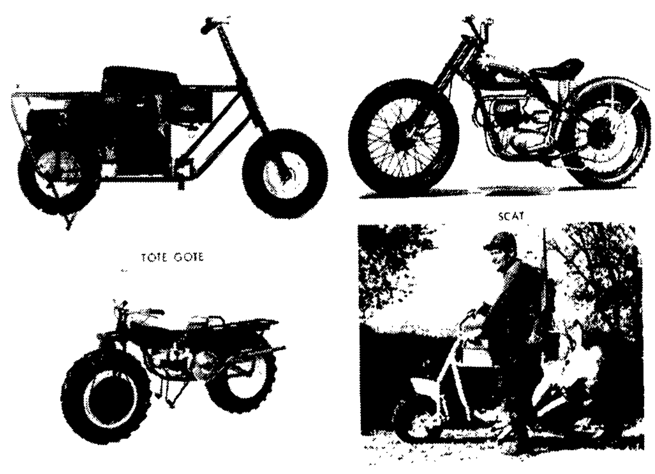

Fig. 5 - Motor scooters

Fig. 6 - M151 W/Terra tires

by the Transportation Board at Fort Eustis, Virginia. Evaluation to date indicates the vehicle to be too small for the tire. Smaller size Terra tires for the MI51 will be investigated as a direct result of this program.

3. The Dodge W-300 Power Wagon (Fig. 7) with a GM 3-53 diesel engine, 5-speed transmission, power steering, and 48 in. Terra tires was about the best and most mobile wheeled vehicle tested at Swamp Fox II. Incidentally this agrees with ATAC's Land Locomotion Laboratory's prediction. Further durability and reliability testing is needed on this equipment to determine if its chassis is capable of sustained operation with this set of components, especially the large Terra tires. It is interesting to note that this concept of vehicle was built and modified to its present form in exactly three weeks through the superb cooperation and efforts of Chrysler, General Motors, and Goodyear.

4. The XM453 series of vehicles (Fig. 8) was evaluated at Wheeltrack and in Panama and were impressive in obstacle crossing and traversing marshy ground.

5. The XM520E1 and XM437E1, 8 and 16 ton GOER, vehicles (Figs. 9-10) were also evaluated at Wheeltrack and Swamp Fox II. Their heralded mobility was not evident in these operations, whereas up until that time, their mobility testing, conducted under controlled conditions, concluded that their mobility was superior to all wheeled vehicles and equivalent to the best tracked vehicles. This wide diversion of results reaffirms our need for actual in-the-field evaluations, not only for mobility, but also for performance factors such as fuel economy, durability, and reliability.

6. The 12 ton M52/127 tractor semi-trailer (Fig. 11) with special 14.75 x 20 tires was most surprising in its performance at Project Wheeltrack in that it was able to negotiate deep ditches and firm but rough ground with ease. This combination with its interunit articulation was quite agile; however, its lack of powered trailer axles limited its performance in soft ground. This same M52/127 combination, equipped with 48 in. Terra tires, performed well (beyond expectations) over ice and snow in Great Bear maneuvers (January, 1962).

7. The Durakat vehicle (Fig. 12) arrived late for the Swamp Fox II operation, and therefore information is not yet available on its capability.

8. The Thiokol Trackmaster vehicles (Figs. 13-14), Models 105 and 201, were particularly mobile in Swamp Fox II. Their wide and aggressive tracks permitted them to perform well through the tropical grass lands and under the jungle canopy.

9. The 6 ton XM548 tracked carrier (Fig. 15) was recently tested in the tropics in the Swamp Fox II operation and has proved to be a good performer. The rubber grousers were removed from the steel tracks and the needed aggressiveness for this type of operation was provided.

10. The Nodwell RN-200 (Fig. 16) has been a good performer in all areas of evaluation (Great Bear, Swamp Fox II,

Fig. 7 - W-300 W/Terra tires

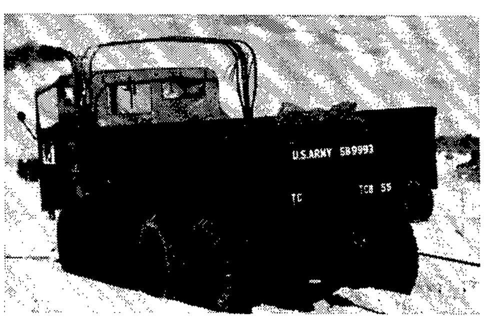

Fig. 8 - XM453E2

Fig. 9 - XM520E1 GOER

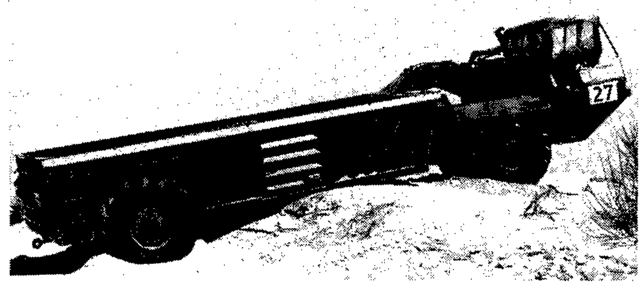

Fig. 10 - XM437E1 GOER

Fig. 11 - M52/127

Wheeltrack, and others). Its high reduction gearing in the power train provides great pulling power.

11. The M60 medium tank (Fig. 17) was evaluated in Swamp Fox II and Wheeltrack and proved to be quite mobile. However, the very slippery conditions of the terrain in Panama during the wet season made its rubber grousered track less effective. A real problem with these very heavy vehicles is indicated in the tropical environment because it requires a major effort to recover them from mired conditions.

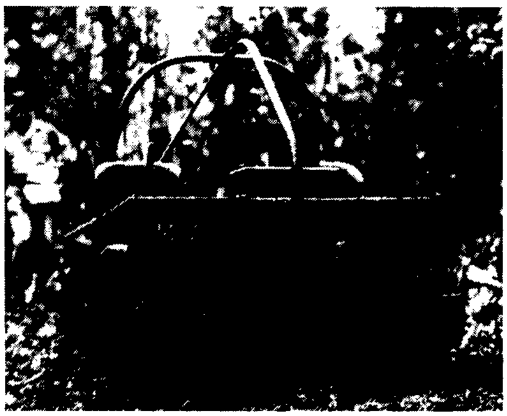

Fig. 12 - Durakat

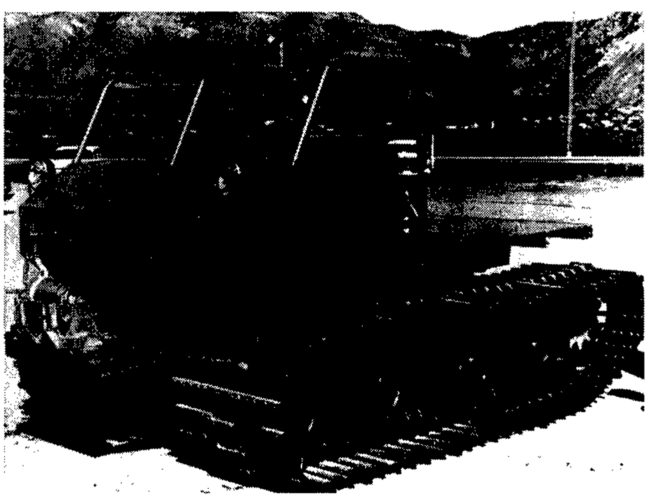

Fig. 13 - Thiokol 105

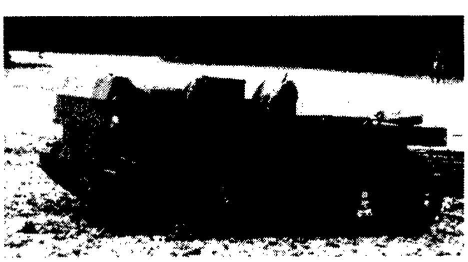

Fig. 14 - Thiokol 201

FUTURE MOBILE FLEET SYSTEM

We have discussed the background and requirements for military vehicles, where we stand today on wheeled and tracked vehicles, and how we are searching for increased vehicle mobility through the direct field evaluation program. We sincerely believe that this direct operation of trying concepts and ideas, new equipment and old equipment, and various modifications thereof will definitely lead us toward a truly mobile fleet of equipment for the future.

Our experience to date has led us to formulation of an unofficial, proposed, future mobile fleet system for military wheeled vehicles, which is described in Table 5. This plan covers a complete range for expected payloads and functions in seven categories, each rated according to maximum gvw:

1. Command and Reconnaissance, 2900 lb.
2. Utility, 8200 lb.
3. Light Duty, 15,400 lb.

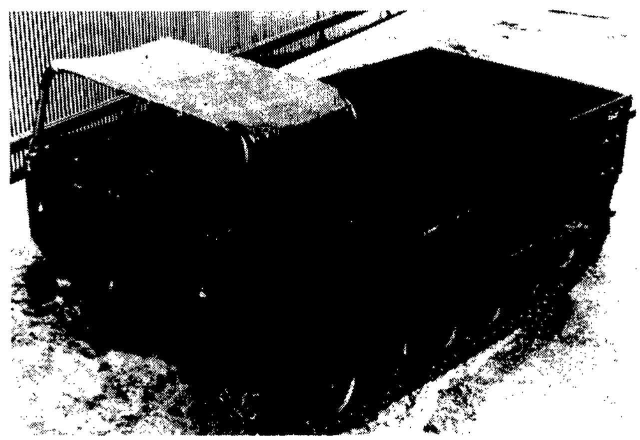

Fig. 15 - XM548 cargo carrier

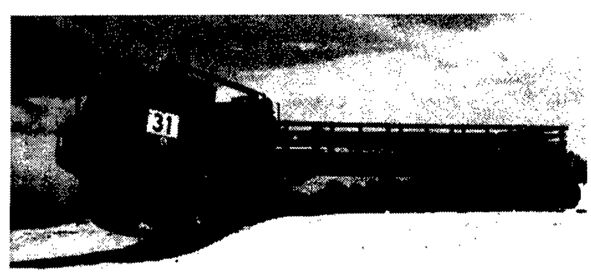

Fig. 16 - Nodwell RN-200 carrier

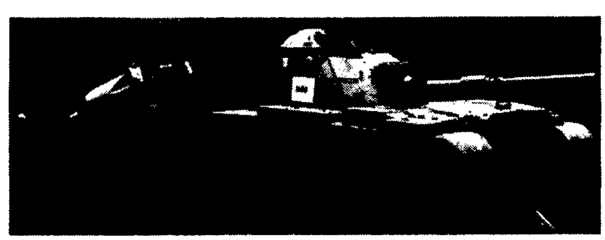

Fig. 17 - M60 tank

4. Medium Duty, 36,400 lb.
5. Heavy Duty, 56,400 lb.
6. Transport, 76,400 lb.
7. Heavy Equipment Transporter, 160,400 lb.

The above listing does not include extremely specialized equipment such as mechanical mules, motorcycles, and the like.

Previous studies and known requirements indicate a broad future need for vehicles capable of carrying payloads of any and all ratings from less than 1/4 ton to at least 40 tons. It scarcely needs to be noted that the load requirements and mission assignments are so numerous that they defy complete analysis.

Of course it is not practical to furnish vehicles specifically designed and tailored to every individual load and mission, but vehicles reasonably suitable for any or all loads within the stated range, and for any and all special purpose and special equipment needs, must be provided. No objectionable gap can be allowed between the capabilities of each vehicle in series, for it is in these gaps that nonstandard vehicles are introduced to complicate the field support for the military fleet of vehicles. The plan, accordingly, gives primary consideration to the entire payload range, and then adjusts the principal vehicle programs to the specific user requirements of the moment.

It is felt that the basic, overall plan must minimize the disruption, the costs, and delays incident to change or reversal of user requirements. Yet it must advance with every improvement in the state of the art, and must provide increased military effectiveness as rapidly as possible. Each element of the plan must be carefully positioned to avoid unnecessary duplication of effort or scrapping of costly projects when a change in emphasis occurs.

The plan must be adaptable to all new concepts such as PENTANA, MOMAR, MOVER, or others, which are certain to follow; and it must consider the needs of all users, in all theaters of operation, with a minimum of specialization for any one area of interest. The proposed plan recognizes these conditions and attempts to establish an orderly program from which may be selected the essential items on which effort then may be concentrated.

This proposed mobile fleet covers a complete range of

Table 5 - Proposed Mobile Fleet System

MILITARY WHEELED VEHICLES

PROPOSED FUTURE MOBILE FLEET SYSTEM

	GROUP	GENERAL PURPOSE	SPECIAL PURPOSE	DIMENSIONS (IN) OVERALL L X W	DIMENSIONS (IN) CARGO AREA W X L	ESTIMATED WEIGHTS IN POUNDS CURB	CROSS-COUNTRY PAYLOAD (HIGHWAY)	CROSS-COUNTRY GVW / GCW (HIGHWAY)	MAX. PAVED ROAD AXLE LOADING
I	COMMAND & RECONN.	1/4 TON 4X4		138 X 62	—	2,000	900 (900)	2900 (2,900)	2,000
			1/2 TON 6X6	172 X 62	—	2,650	1,600 (1,600)	4,250 (4,250)	2,000
II	UTILITY		3/4 TON 4X4	162 X 82	78" X 6-1/2'	3,700	1,900 (2,400)	5,600 (6,100)	3,500
		1-1/4 TON 6X6		192 X 82	78" X 8'	4,800	2,900 (3,400)	7,700 (8,200)	3,500
III	LIGHT DUTY		1-3/4 TON 6X6	212 X 88	80" X 10'	6,000	3,900 (4,900)	9,900 (10,900)	5,000
		2-1/2 TON 8X8		236 X 88	80" X 12'	8,000	5,400 (7,400)	13,400 (15,400)	5,000
IV	MEDIUM DUTY		3-1/2 TON 6X6	236 X 96	88" X 12'	11,500	7,400 (9,400)	18,900 (20,900)	8,000
		5 TON 8X8		260 X 96	88" X 14'	14,000	10,400 (14,400)	24,400 (28,400)	8,000
			7 TON - SEMI	400 X 96	88" X 18'	18,000	14,400 (18,400)	32,400 (36,400)	8,000
V	HEAVY DUTY		6 TON 6X6	262 X 102	88" X 15'	16,000	12,400 (16,400)	28,400 (32,400)	12,000
		8 TON 8X8		298 X 102	88" X 18'	20,000	16,400 (24,400)	36,400 (44,400)	12,000
			12 TON - SEMI	490 X 102	90" X 26'	26,000	24,400 (30,400)	50,400 (56,400)	12,000
VI	TRANSPORT	12 TON 8X8		346 X 102	88" X 22'	27,000	24,400 (36,400)	51,400 (63,400)	18,000
			16 TON - SEMI	550 X 108	96" X 30'	36,000	32,400 (40,400)	68,400 (76,400)	18,000
VII	HEAVY EQUIPMENT TRANSPORTER	40 TON TRANSPORTER		700 X 120	—	60,000	80,400 (100,400)	140,400 (160,400)	25,000

current and possible future requirements. It is not intended that they all be produced. Only those will be used for which there is an indicated need.

The problems associated with wheeled vehicle development should not be oversimplified. Initial and operating costs, producibility, maintainability, reduction in fuel consumption, standardization of components, reliability, and ruggedness, as well as other characteristics, should be approximately emphasized within the individual projects. Of more specific concern to the development of the overall plan are the following:

1. Military effectiveness of each vehicle for its intended mission; including mobility, performance, and general suitability for its intended purpose.

2. Reduction of spare parts required for logistical support of the vehicles in all theaters of operation.

3. Transportability regulations and limitations.

At the heart of the plan, and perhaps the one feature that integrates the program and distinguishes it from a random development of individually designed vehicles, each tailored to a specific user statement of requirements, is the determination of the minimum number of parts and components or "bucket of parts" capable of satisfying the total needs of the entire plan.

If you examine Table 5 carefully, you will note that there are basically seven "buckets of parts" that will permit us to build a variety of vehicles to fill all probable needs and demands. At this time, we point out that we fully expect to have components, primarily the engine-transmission combination, utilized from the next lightest category in the next heaviest special purpose vehicle. For example, the engine-transmission combination from the light duty 2-1/2 ton, 8 x 8, could very well be transferred over to the special purpose 3-1/2 ton, 6 x 6; the engine-transmission combination of the 1-1/4 ton utility vehicle could be transferred over to the 1-3/4 ton special purpose, light duty vehicle; and the power package from the 1/4 ton vehicle could be utilized in the 3/4 ton, 4 x 4, utility vehicle.

This cross use of components between various categories will call for industry statesmanship when different facilities are working on the different categories. This, we are sure, the industry will readily provide. These seven buckets will permit us to build more than just the 15 vehicles indicated to meet the specialized needs of some users.

For example, the 5000 lb axles of category III could very well be utilized in the category II (4 x 4), when it is desired to install extremely large tires such as the Terra tires, to obtain vehicles such as the modified W-300 shown in Fig. 7 for tropical environments. The same is true for uptiring of vehicles in the light duty and medium duty categories; in this case, higher rated axles could be installed in these lighter vehicles. A 4 x 4 special purpose vehicle, using both light and medium duty components, might appear similar to the Marmon Herrington modified truck shown in Fig. 18.

Although the many combinations of components make possible the development of many different, basic chassis types, it must be remembered that not all are offered, nor should be considered as general purpose vehicles. The remainder will be available for special purpose and special equipment needs when the general purpose type cannot satisfy an essential requirement. The general purpose types under this plan are suggested for consideration.

The major components included under this "bucket of parts" plan are the engines, transmissions, transfer cases, axles, and tires. Chassis, suspensions, cabs, and sheet metal must remain peculiar to each vehicle, but standardization of these items is increased under the mobile fleet approach.

The specific components remain to be selected as a result of current development and testing programs, with several gaps to be filled under future projects. Of special significance, however, to the development of the overall plan are limitations placed on axle loadings and the capacity range over which each individual axle may be reasonably and economically applied.

The maximum axle loading limit of 16,000 lb, or 18,000 lb in CONUS only, is of particular importance. This limit, 18,000 lb, generally applies to legal restrictions for civilian highways. Such vehicles as the 16 ton GOER type and heavy transporters cannot operate loaded over civilian highways without special permits. All vehicles with lesser axle loads will provide less than maximum economy and manpower savings when utilized for mass transportation.

While the plan includes a 16,000-18,000 lb capacity axle as a component, and a 12-18 ton, 8 x 8 vehicle derived therefrom, current programs have not recognized such a vehicle. The major anticipated usage would be in Com Z, rear support operations. In addition to truck applications, the 16,000-18,000 lb axle, and the vehicle based thereon, are essential for mass transportation, truck tractor, semi-trailer operations. A 6 x 6 version will be most suitable for this need.

The 25,000 lb maximum axle limit guides heavy transporter design to multiple axle vehicle combinations for payloads up to 50 tons. The current requirement for 55 ton payloads is expected to disappear, with the lower value of 40 tons applicable to future combat equipment.

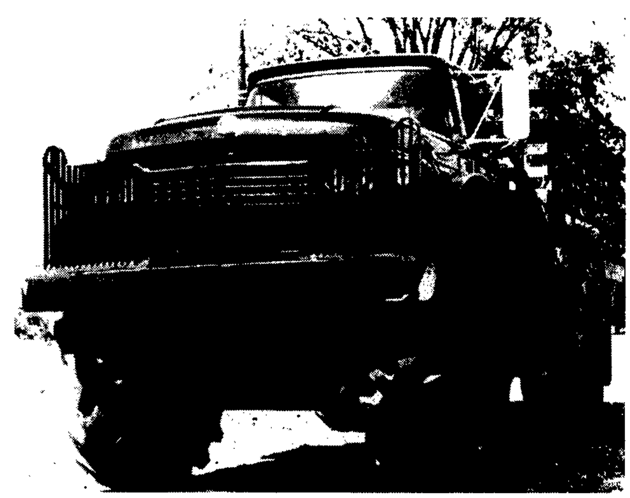

Fig. 18 - Marmon Herrington Jumbo

To simplify the data on Table 5, only cargo, truck tractor, or basic general purpose types are shown. Within the separate program of the overall plan, development will be initiated on the various other types, including van, tank, dump, wrecker, command post, and other special equipment vehicles. This development generally follows within the year following type classification of the basic type and determination of requirements for each additional type.

Familiarity with the basic objectives and with the reasons justifying continued development in all wheeled vehicle programs is assumed. The major improvements and new requirements, however, are discussed on a general basis in the subsequent listing.

Increased Military Effectiveness -

1. Improved mobility, reduced shock and vibration, and better cross-country ride, speed, and control; these result from tire and suspension improvements and, where applicable, from the 8 x 8 configuration.

2. Better air transportability through reduction in vehicle weights and dimensions.

3. Floating capabilities for applicable types; provided by new designs.

4. More reliable performance through increased durability; emphasis on qualified elimination of maintenance for specified mileages.

5. Reduction in fuel requirements by utilization of compression-ignition engines.

Improved Maintainability

1. Ease of maintenance through added emphasis on accessibility, simplification of design, modular features, ease of removal and replacement, and minimizing servicing and adjustment.

2. Improved standardization of parts and components.

3. Reduced need for maintenance.

Better Costs and Producibility

1. Improved usage of latest commercial components and tooling.

2. Increased reproduction rights and supporting data where attainable.

3. Better "value engineering" during development phase.

ADVANTAGES OF INDUSTRIAL TECHNOLOGY - This proposal for a highly mobile fleet is based upon utilizing our country's great peacetime truck production facilities and their enormous know-how in volume production. We must stay "married" to our truck industry, to take full advantage of its capabilities and to obtain a truly effective and economical truck fleet. In the past military conflicts, our wheeled military vehicles were produced in such great quantity and high quality that it startled our allies and enemies alike. This fleet supported our vast fighting forces all over the globe.

We'd like to quote K. T. Keller's* article, "The Truck Makers and the Soldier," which appeared in the Combat Forces Journal in March, 1953. His statements added up to a lot of common sense. Let us quote a few excerpts:

"What is it about our automobile industry that has enabled it to help our Army to attain its commanding lead in military transportation . . . the answer essentially is that America has within its boundaries means no other country possesses to turn out, fuel and maintain military vehicles by the hundreds of thousands and of all needed varieties, so that it alone can truly put our ground forces on wheels . . . the idea on how a military vehicle should be designed and employed is meaningless unless it can be developed into thousands of high-quality tough able vehicles."

K. T. Keller further described ways in which our automotive industry works with the military and cited the four basic needs that the truck industry can furnish, which are:

1. Experience.

2. Productive capacity.

3. Research and development.

4. Peacetime investment in productive capacity that industry has already made.

Let us quote Mr. Keller, further:

"I do not believe I could over emphasize how important it is that designs for military vehicles continue to be guided so that they will fit as closely as practicable into commercial vehicle designs, practices and facilities with all due regard, of course, for the specialized needs of the Using Services. The more closely this can be done, the more quickly the industry will be able to provide quality vehicles in quantity at lowest possible costs . . . the automobile industry in its turn actively seeks every possible way it can to adapt and adjust its productive machinery and engage its energies toward producing the best possible vehicles in the quantities the Armed Forces need. This is the industry's aim. Nothing is more important than that to the American automotive industry."

This proposed fleet system is suggested as a starting point for a military-industry joint effort to provide a real mobile fleet system that can be produced.

There are seven categories shown in Table 5. Light specialized items, such as the M274, are not included in the truck fleet; however, it may interest you to note that we are currently investigating a new design called the "Economite" to replace the M274. The seven categories are aimed primarily at a truck fleet system and not at specialized peculiar vehicles.

1. Category I, the command and reconnaissance type, is currently being filled by the M151 vehicle. A special purpose 6 x 6 version of the M151 was experimentally fabricated and subsequently rejected by the Army, since they had

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*K. T. Keller was formerly Chairman of the Board of Chrysler Corp. and Director of Guided Missiles for the Secretary of Defense. An automotive production man since 1906, he came up through the ranks, so to speak. His early experience was with Westinghouse engines, Maxwell and Hudson motor cars. He then moved to the General Motors Corp. and later became a GMC vice president. In 1926 he went to the Chrysler Corp. as a vice president in charge of manufacturing. He became president of Chrysler in 1935 and Chairman of the Board in 1950.

expected a vehicle of greater capability than it displayed. We often run into this problem of trying to get a vehicle to stretch too far and cover a variety of needs with the result that it is ineffective in its basic mission.

2. Category II, the utility group, will be initiated soon with the development of the new 1-1/4 ton XM561 truck. No plans have been made to formulate designs for the special purpose 3/4 ton 4 x 4.

3. Category III, the light duty series, needs further design investigation for reduced cost, and it is our intent to pursue this area on a study basis this year.

4. Category IV, medium duty, is well on its way in the form of a new 5 ton XM453E4. This design can be produced as a truck-tractor semi-trailer combination, and a smaller 3-1/2 ton 6 x 6 truck could also be produced. As said earlier, it will also be capable of accepting various special items such as vans, wreckers, dumps, and tanks.

5. Category V, the heavy duty series, is currently being investigated under contract by ATAC with the Chrysler Corp. Numerous design studies are under way to ensure that a good final product in this area will be mobile, floatable, lightweight, economical, and producible at competitive cost.

The area to be filled by this category is that presently filled by the 5 ton M54 series, which has a 10 ton and up-highway capability. These functions can be more satisfactorily met by this new 8 ton vehicle than by the planned 8 ton XM520E1.

6. In category VI, we plan this year to conduct a design study program to explore this area. The transport type includes two new vehicles not previously given general recognition in development programs. These include a 6 x 6 truck tractor and a 12 ton cargo truck, 8 x 8, both based on the maximum axle load normally permitted by Department of Defense regulations and by most civilian highway legal limitations. This axle capacity (16,000-18,000 lb) has not been required for the lighter weight family series, even up to the 8 ton, 8 x 8.

Maximum economies in mass transportation, coupled with freedom of movement over the highways, and general suitability for all loads and all densities of loads, are offered only in a vehicle of conventional type in this capacity range. Therefore early recognition of this requirement and early initiation of development of the truck tractor and cargo transport types are recommended.

7. In the heavy equipment transporter, category VII, a 40 ton transporter will be available if the military determines that there is a need. Immediate requirements for a 55 ton heavy equipment transporter are being met by procurement of a commercial type truck tractor and semi-trailer combination, with performance capabilities limited primarily to highway and secondary road operation.

For future requirements, a reduced capacity of 40 tons appears adequate for the main battle tank and other future heavy equipment. A transporter suitable for highways and secondary road operation, with optimum off-road capabilities, generally of conventional type, is most practical.

At this point, we might re-emphasize that our proposed future mobile fleet system (Table 5) is unofficial and only an estimate of what can be done in consonance with industry capabilities and their requirements. It may be revised from time to time as the results of our design investigations and development programs are brought to fruition.

CONCLUSION

This overall wheeled vehicle fleet proposal covers the complete range from 1/4-40 ton capacity, with no open areas. It is based on an orderly and progressive development to ensure minimum burden on the military supply system. There is adaptability and flexibility to permit selection of any number of types for any current or future concept of requirements; and to suit field Army and rear support operations in any theater.

Improvement in performance, mobility, reliability, air transportability, and economy are significant. The vehicles offered provide maximum compliance with transportability regulations and limitations; other special purpose types are available to satisfy more completely the off-road performance or special purpose requirements where the demand is more exacting. New capabilities, particularly floating capabilities, add to the military effectiveness of these vehicles. The success of the plan, however, will vary with effort provided, and on the adequacy of the supporting research and development program.

ACKNOWLEDGMENTS

We wish to acknowledge the support effort and guidance by M. C. Morrison and P. T. Garland of ATAC in the preparation of this paper. Their suggestions and long experience in the automotive field contributed in a large measure to this paper.