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The Military, Tactical, Eight-by-Eight Trucks

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ABSTRACT

Tactical trucks are trucks that can travel where the conventional commercial trucks are immobilized by adverse terrain conditions and, for military use, must be able to withstand misuse, abuse, and neglect, yet still perform their mission.

The eight-by-eight configuration evolved from the mobility requirements. Swimming capability, with payload, is a new requirement met by the trucks, 2-1/2 Ton, 8x8, XM410E1 and 5 Ton, 8x8 XM656.

Curtailment of military personnel has resulted in the availability of less maintenance and supply support. Consequently, these new 8x8's have been designed for a minimum of maintenance by using very durable components, sealed units, and lubed-for-life-bearings.

The Military, Tactical, Eight-by-Eight Trucks

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COMMERCIALLY AND MILITARILY many are all familiar with "trucks" of all kinds, shapes, and requirements.

A little less familiar in the commercial area is the term "eight-by-eight" which means the vehicle has eight wheels and all eight wheels are powered to contribute to the motivation of the vehicle.

Even less familiar is exactly what is meant by the term "tactical." Our military complex uses thousands and thousands of trucks. They are very obvious wherever they go because of their distinctive military olive-drab color. The military trucks you generally see on the public streets are pure commercial trucks with olive-drab paint, procured from the lowest bidder, to haul our military supplies here and there as necessary, on normal streets and highways.

A soft muddy field would immediately immobilize these commercial type logistical-supply military vehicles. In peace time there is no need for these vehicles to leave the highways and there is time to wait for the building of a good solid gravel road across a muddy field if it becomes necessary to move supplies and equipment to a site remote from a highway.

In time of war or emergency, the military cannot depend upon the availability of highways. Armies do not fight on highways and missiles, bombs, or artillery shells can soon make highways untenable and impassable for the conventional commercial trucks.

This is where the "tactical" truck becomes a necessity. It has to be capable of traversing wherever the military need or situation dictates and without time lost for extensive detours.

First let me emphasize that a "military tactical truck" is unlike anything in commercial industry. There are some who would try to argue that industry's "off-highway" trucks are the same as or encounter the same severity of terrain and use as our military tactical trucks. We've gone so far as to purchase some of these and test them alongside of our tactical trucks. In every case, commercial trucks of similar curb weight and carrying identical payloads have been unable to negotiate all the required courses and obstacles or have required too many repair parts, or both.

The tactical military truck has components, seals, and parts that are especially made to exclude or tolerate mud, water, heat, cold, abuse, and excessive demands and still function. That is the big reason why a military tactical vehicle seems so expensive when you compare it with a commercial truck of similar rating.

Also a new military tactical truck is developed once every 10-20 years and most of it is entirely new to the military whereas the commercial truck develops gradually and economically year after year by partial improvement of individual components and possible introduction of one or two really new features.

Since 1940, the military has relied almost exclusively upon 6x6 trucks and they have done an extremely good job. However, often was the time that a little more mobility would have been a tremendous advantage.

Mobility studies and tire developments indicated the possibility of obtaining much greater mobility for a truck of the same load carrying capacity by using eight approximately equally loaded wheels with single tires having a large foot print (Figs. 1 and 2).

There are some that feel that the introduction of an extra axle assembly--and all tactical vehicle's axles are driving axles--will increase the maintenance requirements on the vehicle. Now axles and suspensions (even steering-driving axles) are pretty reliable and durable; also, the low-air pressure wide-base tires developed for the military have actually resulted in reduced maintenance due to the softer ride. As you know, the commercial trucking industry was quick to follow the military and adopt wide-base, single, low-pressure tires and additional axles.

An unexpected advantage was the obtaining of more ac-

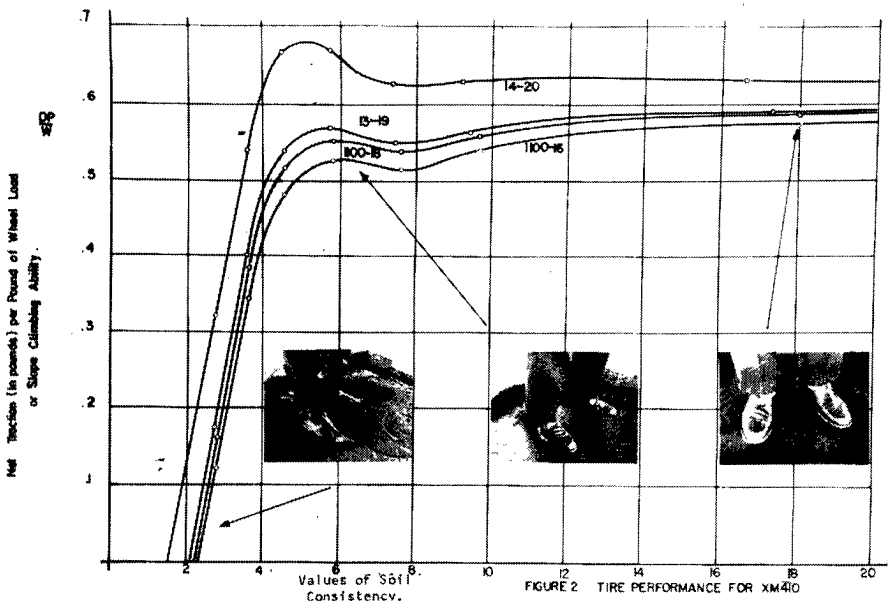

Fig. 1- Tire performance for XM410, 8 x 8 truck under varying soil consistencies

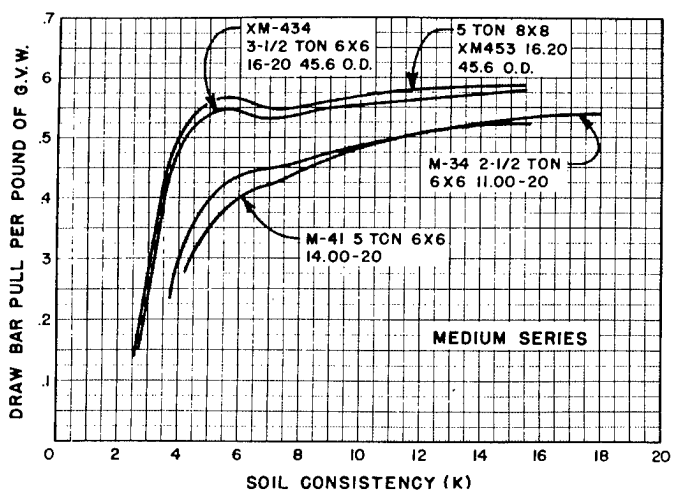

Fig. 2 - Predicted vehicle mobility comparison of medium series trucks with current standard trucks

tual miles per tire. The military truck did not benefit so greatly in this respect because of our NDCC tread ("Non-Directional, Cross-Country" tread design). It is a compromise design, developed during World War II, which is supposed to make it a better tread design for any given condition than some certain other available tread. in other words, it is not an ideal tire for any terrain condition and, at best, it is mediocre in performance and/or mileage anywhere. Even then, we are realizing a 25% mileage advantage with these new military wide-base, low-pressure tires.

In the history of motor vehicles in the United States the military doubtless have used more eight-wheeler all-wheel-drive vehicles than the total of all commercial use.

With the constant curtailment of military personnel coupled with the gradually increasing average age level of military vehicles, supply of repair parts for, and maintenance of military vehicles has become an ever increasing problem. From this problem has evolved the new durability requirements goal for wheeled military vehicles of a 90% capability of operating 10,000 miles with no more than "unit support" (using troop) and 20,000 miles with no more than "direct support." This means no major component failure in 20,000 miles of MILITARY TYPE OPERATION.

This seemed like an unattainable goal with the status of the state-of-the-art of vehicle manufacturing in 1960. However, this goal was followed by a document Military Standard 1228 (dated Sept. 27, 1962) "Maintainability Criteria for Tank-Automotive Material," which, to meet the military vehicles shall require a maximum of only 7% timewise for scheduled plus unscheduled maintenance. Let's interpret this 7%: 20,000 miles at an average speed of 20 mph would take 1000 hr. This gives you 70 hr allowance for all maintenance for that 20,000 miles of tough military usage. The old familiar military vehicles need more than 7% timewise for their regularly scheduled greasing, adjusting, oil changes, filter changes, and inspections. This 7% sounded ridiculous and totally unattainable with current know-how. But any future war will be so fast and furious that there won't be any time for maintenance--every vehicle must perform or be abandoned. Therefore, at the Army Tank-Automotive Center we immediately interpreted it into our specifications as a guide and goal.

The rest of the specifications for military trucks are developed as a result of additional requirements peculiar to various individual government agencies, more stringent human engineering factors, light weight necessity (for overall reduced logistical demand), and general acceptance of sophistication such as comfort and safety features formerly considered as nice-to-have but not required in a military vehicle.

The military trucks described below comprise the military vehicle backbone--the 2-1/2 ton and 5 ton trucks.

In November 1956, a set of military characteristics was established for a new series of vehicles in the intermediate

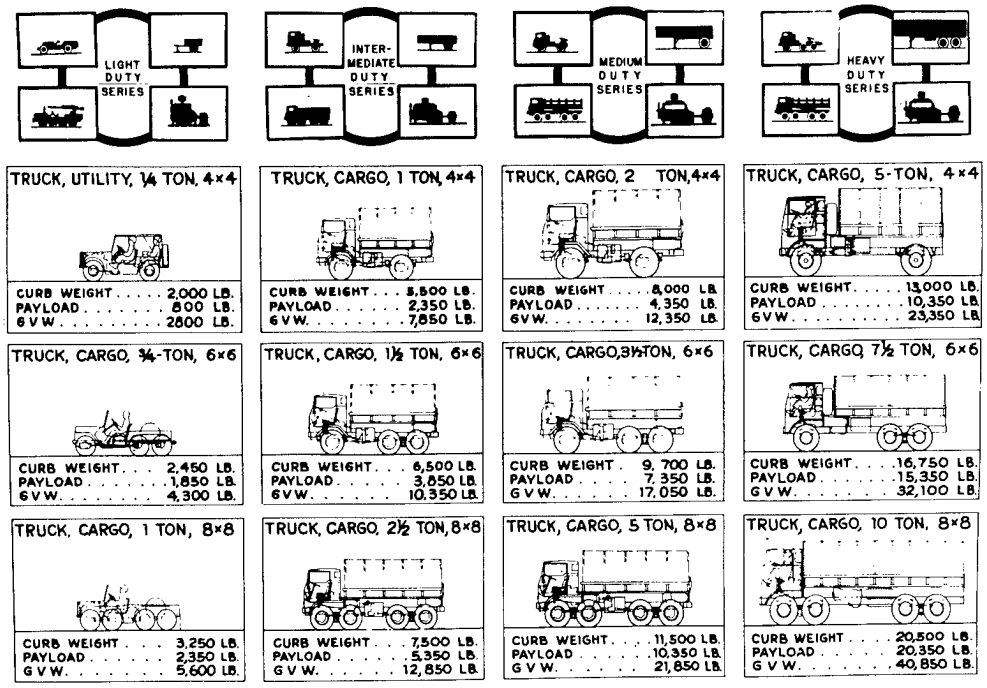

Fig. 3 - Wheeled tactical vehicle—general purpose truck series

duty series to consist of a 1 ton, 4x4, a 1-1/2 ton, 6x6, and 2-1/2 ton, 8x8 truck with maximum interchangeability of these vehicles' components (Fig. 3). Preliminary design studies were carried out in the early part of 1957 and a contract awarded to the Chrysler Corp. in July 1957 for the design and development of the 2-1/2 ton, 8x8 version of this series. It was designated the XM410.

This vehicle was developed under requirements which empahsized tactical and airborne operations as well as outstanding cross-country mobility. Minimum overall dimensions and silhouette were also to be provided with maximum reduction in vehicle weight.

The prototype truck designed to meet these objectives was operational in November 1958 and then redesigned to reduce the curb weight. It was the first army truck to be floatable with payload, without advance preperation, and able to swim with propulsion only by the wheels turning in the water.

It was capable of air delivery, with its payload, without disassembly or special component support and was, therefore, ready for action immediately upon landing. Its independently sprung torsion-bar-suspension gave the vehicle excellent riding qualities over rough terrain and the automatic transmission and power steering made it an easy vehicle to operate.

The new durability requirements and a new requirement for multifuel capability engines necessitated an extensive redesign to what is called the XM410E1 (Fig. 4) which is currently undergoing Military Engineering and Service Tests at six test sites.

The 5 ton, 8x8 truck development program was actually initiated in 1957 when it bacame apparent that our standard 5 ton truck needed to be replaced with a more modern vehicle having lighter weight, better performance, more versatile capabilities, better mobility, better fuel economy,

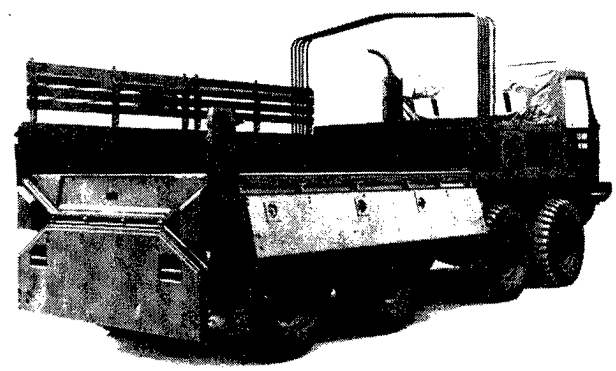

Fig. 4 - Truck, cargo, 2-1/2 ton, 8 x 8, XM410E1—right rear view with side and tailgate open

more reliability and durability, and surprisingly to the public, be capable of floating on inland waters without prior special preparation and while carrying its rated payload.

In 1959 and 1960, the so-called medium duty series truck program (see Fig. 3) consisting of a concept of a family of vehicles was started with three manufacturers--the Ford Motor Co., GMC Truck & Coach Div., and the Lansing Div. of the White Motor Co. Each contractor produced 3-1/2 ton, 6x6 trucks, XM434 and 5 ton, 8x8 trucks XM453 for competitive evaluation by the Army.

These vehicles were tested at Aberdeen Proving Ground where it soon became apparent that none of the vehicles were satisfactory from the new durability and reliability standpoint. Each manufacturer's vehicles had some particularly desirable military characteristics which the others did not have and all contained certain design shortcomings. This phase of the program was terminated.

At this time a "Mover" (Motor Vehicle Requirements) study of military vehicle requirements of the Army in the

field confirmed the continuing need for the 5 ton vehicle but eliminated the requirement for the 3-1/2 ton truck.

Changes in the military vehicle concept, experience, and progress dictated that a new set of military characteristics were needed for the new 5 ton truck. These were compiled and finally approved in October 1961. The major requirements (in their order of priority) of the new 5 ton truck were to be: performance, reliability, durability, minimum and ease of maintenance, configuration, transportability, and kit requirements.

Only the same previous three manufacturers of the medium trucks were invited to submit proposals because it was felt that this new vehicle would be a "second generation" development of the previous medium, 5 ton truck, thereby conserving and capitalizing on the time and money previously spent. This new 5 ton truck was designated the XM656 (Fig. 5).

Due to the complexities added by the requirement of the Defense Dept. for an incentive-fee type of contract and the resultant extended contractual negotiations, a contract was not obtained until March 1963. This was with the Ford Motor Co., and called for the manufacture and test of two "Test Rigs" prior to finalization of the design for nine prototype vehicles.

This was the first truck development contract that provided for and stated that funds would be expended for test rigs whose sole purpose would be for evaluation of design, determination of prototype details, and provisions of visual hardware which could be operated by personnel who were responsible for making the decisions on the characteristics to be finally included in the prototypes. The total extra cost of these two test rigs has been minimal and will be more than offset by the improvement in prototype design, durability, and reliability and the resultant savings in prototype test time, travel of personnel, shipment of repair parts, and cost of repairs.

The end result of authorizing the manufacture of test rigs and their testing will be a substantial reduction in test time and will actually result in an earlier type classification date which is official standardization and approval of a vehicle for production for military use. Also, type classification will be accomplished more confidently because the vehicle will be more fully and reliably developed in the same period of time than was ever heretofore possible.

Primarily, the truck, cargo, 5 ton, 8x8, XM656 was developed to replace the M54 standard 5 ton truck. Comparison of the features of the two vehicles is impractical because the XM656 surpasses the M54 in so many characteristics and the MX656 has so many features that are not in the M54 at all.

The dimensional limitations of the XM656 coupled with all the required military features resulted in a somewhat complex and very compact package. The truck is legal width-96 in., 276 in. long overall, and is 114 in. high (reducible to 81 in.).

Curb weight of the vehicle is 15,415 lb, and it is designed to carry 10,400 lb of cargo or troops over adverse

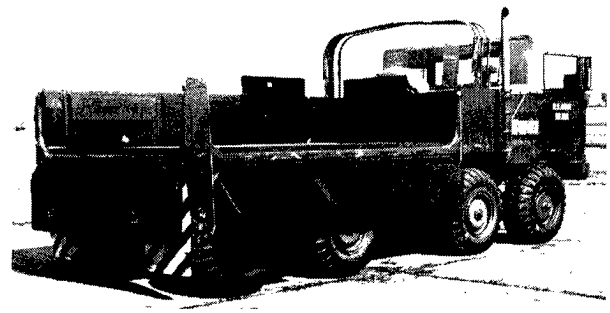

Fig. 5 - Truck, cargo, 5 Ton, 8 x 8, XM656—right rear view with side and tailgate open

cross-country terrain and at higher speeds than predecessor vehicles without damaging the vehicle components or causing undue discomfort to the riding troops. With this cross-country ability, the necessary built-in ruggedness of the vehicle components makes the XM656 capable of carrying highway payloads similar to the M54. It is intended to conduct some tests later in this program to determine the optimum highway load for this vehicle.

The eight wheels on conventional bogies and axles, equipped with wide-base, low-pressure tires, give excellent mobility over soft terrain and obstacles. Only the tires propel and steer the truck when it is in the water. Its water speed is consequently minimal--only 1.6 mph. Surprisingly, the turning diameter in still water is almost exactly the same as on concrete.

Remember that this swimming capability is with the vehicle carrying its entire rated payload. The cab and cargo body are of aluminum water-tight construction. The entire chassis, suspension, and power train, including the engine and its components, are submerged when the vehicle swims. Some parts of the vehicle are pressurized with 4-6 psi of air to prevent entry of water.

Although the extra wheels create an optical illusion of length both the 2-1/2 ton, XM410E1 and the 5 ton, XM656 are respectively shorter than the present standard vehicles which they will replace, the 2-1/2 ton M35 and the 5 ton M54, but each new vehicle has a larger cargo floor.

Some of the pertinent characteristics of these vehicles are compared in Table 1.

By actual tests over an extremely rough test course and carrying identical payloads as their predecessors, these new 8x8's could operate at twice the speed for the same "g" loadings in the cargo and/or crew area.

What does this indicate? Faster movement of a pile of given material from point A to point B? Yes, and with more safety and less load damage. The hidden factor is that the better ride qualities contribute to less maintenance requirements on the vehicle. This, in turn, means less repair parts supply and, finally, less personnel required to operate, to supply, and store spare parts for and maintain these vehicles.

The big economy factor in these new 8x8 vehicles is their scheduled maintenance. For 12,000 miles of operation per year, the number of lubrication operations--whether it be

Table 1 - Pertinent Characteristics of Vehicles

Characteristic	*M35 (6 x 6)	XM410E1 (8 x 8)	*M54 (6 x 6)	XM656 (8 x 8)
Weight, lb				
Curb	12465	11250	19231	15415
Cross-country payload	5000	5000	10000	10000
Operating personnel allowance	400	400	400	400
GVW	17865	16650	29631	25815
Cross-country towed load	6000	8325	15000	13000
Dimensions, in.				
Length	263	258	297	276
Width	96	96	97	96
Height (w/60 in. bow ht.)	111	110	116	114
Lowest Operable Height, in.	79-11/16	70	85-5/8	81
Cargo Body				
Length, in.	147	147	168	179.9
Width, in.	88	90	88	88
Floor area, sq ft	90	92	102	110
Swimmable	No	Yes	No	Yes
Brakes	Conventional	Disc-type within hull	Conventional	Sealed/ self-adj.

*The gasoline engine trucks, M35 and M54, are rapidly being replaced in our current military truck fleet with multifuel trucks designated M35E1 and M54A2. This increases the curb weight of those vehicles by another 700 lb. These same multifuel engines are presently in the XM410E1 and the XM656, respectively.

Table 2 - Number of Lubrication Operations

Truck, 2-1/2 Ton, 6 x 6, M35	- 498
Truck, 2-1/2 Ton, 6 x 6, M35A1	- 205*
Truck, 2-1/2 Ton, 8 x 8, XM410E1	- 57
Truck 5 Ton, 6 x 6, M54	- 885
Truck, 5 Ton, 6 x 6 M54A2	- 421*
Truck, 5 Ton, 8 x 8, XM656	- 54

*In accordance with new lubrication orders as revised within the past year.

through a grease fitting, changing a filter, checking gear oil level, changing oil, or repacking a bearing--are shown in Table 2.

This tremendous reduction in scheduled maintenance on these new 8x8's is possible through lubed-for-life bearings, delrin inserts, sealed self-adjusting brakes (on the XM656), and other features that require no attention and will last as long as the truck does. This means savings in man-hours, less military maintenance and supply personnel required, and that the new 8x8's will thus save more than their original cost in a very few years by simply replacing a predecessor 6x6 vehicle on a one-for-one basis.

Also, because of their minimal maintenance requirements, their almost constant availability for use makes it possible for two or three of these vehicles in some cases to do the work formerly allocated to four or five of their predecessor vehicles.

These new military 8x8's and their new durability and reliability features will provide the troops with better, more durable and more capable vheicles that can be depended upon to perform their missions.

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