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REVIEW PAPER

Future Armoured Troop Carrying Vehicles

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ABSTRACT

Present-day reliance on wheeled and tracked armour personnel carriers (APCs) and infantry fighting vehicles (IFVs), may be changed in the future. Shaped charge grenades and impovised explosive devices (IEDs) represent a considerable threat, even to well protected main battle tanks (MBTs). Paradoxically, the crew of wheeled and tracked troop-carrying vehicles is numerically three to four times larger than that of MBTs, however, their protection in all aspects is significantly lower. Therefore, heavier vehicles may get more attention in the future, where sharing the chassis and a number of components with MBTs could provide significant reductions in procurement costs and maintenance, as well as a simplified logistics in relation to the latest tracked. Obviously, the IFVs mobility of heavy vehicles would be lower than that of lighter vehicles. However, by applying various degrees of modular armour protection, a significant rise in strategic, operational, and tactical mobility could be achieved. Such heavy tracked vehicles, built on a common chassis as MBTs, may equip the future heavy brigades, which will be in contrast to the lighter wheeled vehicles included in rapid deployment brigades. As a result, tracked personnel carrying vehicles may extinct in the future.

Keywords: Heavy armoured vehicles, protection, mobility, cost, logistics

1. INTRODUCTION

As is well established, there are three priorities in main battle tanks (MBT) design: firepower, mobility, and protection, also called the tank triangle. These priorities were differently treated by different users, giving various approaches in MBT design[1,2]. However, similar priorities can be established in the design of other armoured vehicles, such as armoured personnel carriers (APCs) and infantry fighting vehicles (IFVs), as two primary types of MBT support vehicles. Along the three priorities in MBT design, another, equally important is the fourth, the ability of the vehicles to carry troops, i.e., dismounting soldiers with their equipment. As is the case with MBTs, the priorities in APC and IFV design may vary, reflecting the specific requirements of the particular user, such as the terrain, the expected threat, etc[3].

During the Second world war, the Cold war, and after that, a Blitzkrieg-like doctrine of warfare relied on an intensive attack on a small section of the enemy front, penetrating deeply into the rear echelons. Two or more such attacks would meet in the enemy rear, encircling other sections of the enemy front. During these deep-penetration operations, urban, forrested and mountainous terrains, theoretically, would have been avoided, since in such environments, armour formations, which would have been on the spearhead of the attack, might become vulnerable to infantry in close-quarter combat. However, after the end of the Cold war, major armour operations became inceasingly less important. In local, low-intensity conflicts, such as recent conflicts in Lebanon, Iraq, and Afganistan, close-quarter combat became predominant. In these operations, large portion of coalition casualties were the result of improvised explosive devices (IEDs), as well as of individual, shoulder-launched anti-armour grenades, such as the well-known Russian RPG-7[4,5]. These threats are very different; some IEDs are specially detonated anti-tank mines, placed individually or in stacks, improvised mines using artillery or mortar shells, or even large, 100 kg class TNT devices, placed alongside the road, or burried under the expected route of armour formations. Improvised explosive devices, being improvised, can have a very different effect on armoured vehicles. Therefore, the determining of the vehicle resistance to IEDs is not an easy task. After many years of losses in Israel and Iraq, the first steps towards standardisation may be done in foreseeable future. The first standardised level of protection against IEDs may become the equivalent of 50 kg of TNT detonated at 5 m from the vehicle, which, the vehicle should not only survive, but be able to open the doors or hatches. This level of protection may become NATO STANAG level 4 and is integrated in the French Nexter Aravis 4 × 4 multipurpose heavily protected armoured vehicle[6]. On the other hand, even RPG-7 grenade launcher, the most proliferated weapon of that type in the world, can use different grenades, with increased penetration, representing a serious threat to the best armoured fighting vehicles. The penetration power can vary from the basic,

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PG-7Vs 330 mm, up to PG-7VRs over 600 mm[7]. Although these penetration figures are not sufficient to penetrate the front armour of the most modern main battle tanks, they are more than capable to penetrate their sides, rear or top – the areas where armoured vehicle of the future should have a much better armour protection. However, higher penetrating RPG-7 grenades, equipped with tandem shaped charge, may penetrate the front of the best armoured IFVs, such as the US M2A2 Bradley, equipped with explosive reactive armour (ERA). This way, the destruction of the vehicle may be hazardous not for three to four crew members like in MBTs, but rather up to ten crew members (commander, gunner, driver and seven dismounts). The loss of 10 soldiers inside an IFV can affect the public opinion much more effectively than an attack on a MBT with or without losses, making a serious blow to the country's willing to fight a war any further.

Some references state that the future of armoured vehicle protection lies in active defences, which use some kind of munitions to effectively shoot-down the incoming projectile. However, such systems are relatively easy to saturate and very expensive. Therefore, the price limits active protection application, since the new generation of tracked IFVs become more and more expensive, rising the cost of the active defence equipped vehicle to an unacceptable level[8].

2. THE ISSUE OF COST

A typical example of post Cold war cost rise is the Swedish CV90 family of tracked IFVs. In 2004, Finland ordered 45 CV9030 vehicles for € 2.67 million per vehicle, while the Netherlands ordered 184 CV9035 vehicles for € 4,07 millions per vehicle in 2004[9]. The latest German Puma IFV will be even more expensive at € 7.1 millions per vehicle ($ 9.2 million), even though a realtively larger number of vehicles is ordered, 410. Such prices, combined with the armour protection only against the basic PG-7V does not provide a sufficient cost-effectiveness. In turn, the vehicle's gross weight of 43 t with additional armour protection, requires a logistic footprint equal or marginally lower than that of MBTs[9].

Similar protection levels can be achieved using a wheeled armoured vehicle. While the protection against shaped-charges is similar or slightly lower than that of the tracked vehicles, anti-mine protection of wheeled vehicles is higher, due to their V-shaped hulls, as well as the possibility to leave the site after a blown wheel–if a tracked vehicle hits a mine, the track will most likely be thrown off, effectively stopping the vehicle, placing the occupants in great danger if targeted by shaped charge grenades. Such tactics has been widely used in Iraq and Afghanistan[10]. However, wheeled vehicles have other, fund-saving features. The first is the cost, which is considerably lower – among the most expensive is Patria AMV, with a price of € 1.5 million ($ 1.8 million)[9]. Furthermore, wheeled vehicles have a higher strategic and operational mobility, due to their lower weight, and their logistic footprint is much smaller, decreasing their operational costs by around 70 per cent. An additional benefit is a less aggressive appearance than that of a tracked vehicle, which makes these more suitable for peacekeeping operations. Their strategic mobility is higher, especially their air transportability, due to their lower weight than their tracked counterparts. As such, wheeled vehicles enjoy an increased popularity, inspite of their lower tactical mobility due to their higher specific ground pressure, which might achieve a twice the value of tracked vehicles – APCs, IFVs and MBTs[11]. Higher specific ground pressure limits the vehicle's mobility over soft ground such as sand or mud, however, when operating in urban environments, this drawback is less pronounced.

The third, the most cost-effective solution of the problem of transporting troops is a mine-resistant ambush protected vehicle (MRAP)-like concept, widely used particularly in Iraq, where it's natural environment is urban warfare. These vehicles have an even lower soft ground performance than that of 8x8 wheeled APCs and IFVs, due to their wheel configuration of 4 × 4 and 6 × 6, but their mine and IED protection is slightly higher[12]. However, their armament is very poor, comprising only of machine guns, and their shaped-charge protection is considerably lower than that of any other type of armoured vehicle. As such, although useful in specific environments, mine-resistant ambush protected vehicles can not be considered as an effective alternative to present-day APCs and IFVs for MBT support operations.

Therefore, neither too expensive tracked vehicles, nor wheeled vehicles, both of which have an insufficient survivability against, all threats, found in the hands of terrorists or insurgents, such as IEDs and older shaped-charge warheads in close quarter combat, can not provide a cost-effective response to modern anti-insurgent and anti-terrorist demands.

3. CREW PROTECTION PARADOX

The concept of IFVs appeared in the 1965, with the Soviet BMP-1 tracked vehicle. BMP-1 was capable of not only transporting eight dismounts in the area of oprations like APCs, but providing them with firing ports, enabling them to protect the vehicle with individual weapons. The onboard armament consisted of a 73 mm gun, capable of supporting the dismounted infantry and in addition, antitank guided missiles were carried, capable of penetrating any MBT at that time. As an answer, the West fielded a number of IFVs, such as the US M2 Bradley, the British Warrior, and the German Marder. However, armour protection of all these vehicles was considerably lower than that of MBTs. All these vehicles were intended to support, not only their dismounted infantry, but MBTs as well, even during breakthroughs. During these operations, they would have been faced with the best enemy anti-armour weapons, often capable of dealing with a much better armoured MBTs. These facts were in a strong contrast to the number of carried troops up to 10. As a comparison, contemporary MBTs, carried a crew of three (the Soviet) or four (the Western MBTs). This crew-protection paradox is still present on almost all Cold war-heritage tracked and wheeled APCs and IFVs.

4. HEAVY TROOP CARRIER CONCEPT

During the eighties, the crew-protection paradox of APCs and IFVs was noticed by the Israel Defence Force, which was faced with probably the strongest anti-tank defences in the world on Golan heights, on the border with Syria. Israelis never fielded IFVs, instead, cheaper APCs were preferred. However, the US M113, although constantly uparmoured, was never considered capable of withstanding modern anti-armour weapons. As a result in 1983, obsolete Centurion MBTs were withdrawn from service and modified into heavy APCs. The turrets of MBTs were removed and this saved weight was used to add a notable superstructure and up-armour the vehicle from the sides, rear, and top. The result was a series of vehicles, beginning with NagmaSho't, Nagmachon, and finally Nakpadon. The main drawback of these vehicles was their lack of mobility and therefore, inability to support Markava MBTs.

In 1989, a new vehicle was fielded, the Achzarit. It was a modified T-54 or T-55 MBT, designated in Israeli use as Tiran 5, captured from Egypt and Syria during the 1967 six-day war. Along a much improved armour protection (T-54/55 tank weighted 34 t, while the turretless Achzarit 44 t), a new, more compact and more powerful engine was used, enabling the troops to enter and leave the vehicle through a rear door, a major improvement in relation to Centurion-based vehicles. In addition, a higher speed of Achzarit enabled it to support Merkava MBTs, and this feature kept these vehicles in front-line service even today[13].

After achieving a great success with their heavy APCs concept, Israelis fielded an ultimate vehicle of this kind, the Namer, in 2007. This vehicle used the obviously best choice for a modification, the Merkava MBT chassis, with front mounted powerpack. This left place for a considerable space in the rear for nine dismounts, but in addition, a remote weapon station with a heavy machine gun was mounted. A remote weapon station with 30 mm automatic canon may be used, effectively making this vehicle a true heavy IFV[3].

Other countries followed suit, such as Jordan with their Temsah, a Centurion-based heavy IFV and Russia with BTR-T, a T-55 derivative. Temsah was interesting since it was basically built on a reversed Centurion hull, allowing a wide rear ramp. The Russians opted for a very heavily armed IFV with a minimum changes on the tank hull, providing a less convinient top hatches for only five dismounts[13].

5. CONVERSIONS OF OBSOLETE MAIN BATTLE TANK

The development of heavy APCs and heavy IFVs, based on an obsolete MBT chassis, may offer an answer to the question how to protect the personnel in the present and future high-risk environments. The survivability of such vehicles is considerably higher than that of the most modern wheeled or tracked vehicles and even MBTs. These conversions are a very convenient way of using the obsolete MBT chassis. When an obsolete MBT is withdrawn from service, the cutting and recycling costs are slighlty more than selling the steel that is received from rendering of one MBT[14]. The donation of obsolete MBTs may give an answer to the problem of cost of cutting and recycling, but leaves the armed forces with a need for an APC or an IFV.

5.1 Issue of Mobility

However, conversions of obsolete MBT chassis into any kind of dismount carrying vehicle, intended for modern MBTs support, posseses some crucial limitations. The most important limitation is the mobility of a converted vehicle. Modern MBTs posess a higher maximum and rough terrain speed than obsolete tanks. For example, maximum speed of M1A2 Abrams MBT is 67 km/h, while cross-country speed is 48 km/h[15]. On the other hand, the same figures for the now obsolete M60 MBT[16] are 48 km/h and only 14.5 km/h. Therefore, if the turret of M60 is removed and the same weight is used for up-armouring, to bring the armour level to a similar level as that of M1A2, the converted vehicle will not possess the same mobility as the obsolete MBT. Installing a more powerful engine may partially solve the problem of mobility, but this rises other issues, such as the need for a new transmission and suspension, rising the conversion cost. This becomes increasingly challenging, since a rear ramp or doors are an absolute priority for providing the dismounts a safe and a relatively quick means of entering and leaving the vehicle. Therefore, converted vehicles may, in the future, be much more attractive as engineering vehicles, especially for mine-clearing operations, or clearing of IEDs. These operations do not require close interoperability with modern MBTs, but a high level of armour protection is still important. Currently, there are two vehicles intended to fulfill this role, the Israeli Puma[13], based on Centurion MBT hull and the Serbian Munja, based on T-55 MBT[17].

5.1.1 Costs

Although informations about the cost of such conversions are scarce[18], converting the ubiquites T-55 MBT, now largely obsolete, into the above mentioned heavy IFV BTR-T was $ 600,000 in 1997. This price, with inflation included would now most probably rise to $ 900,000–1,000,000. However, it is still considerably lower than that of contemporary IFVs, with a similar armament of a 25-30 mm autocannon. However, BTR-T transports only five, instead of six to eight dismounts, which is standard today. Another drawback is the lack of rear doors or ramp, a standard feature of other specialised vehicles. The dismounts leave the vehicle through roof hatches, a much slower and less safe process. On the other hand, the Ukrainian BTR-55, based on a reversed T-55 chasis with a new engine, explosive reactive armour (ERA) and remotely controlled machine gun costs only around $ 150,000[19].

6. MODERN MAIN BATTLE TANK CONVERSION

The development of heavy APCs and heavy IFVs on a modern MBT chassis has a number of advantages versus the conversion of obsolete MBTs. As is well known, the cost of new MBTs has risen in the past decade. For example, the cost of US M1A1 Abrams MBT rose more than double, from 1999 to 2006. In 1999, the cost of a single unit was \$ 4.3 million[20], while seven years later, built for Australia, has had a single unit price of \$ 9.3 million (\$ 550 million for 59 units)[21]. The similar price has been quoted for the latest and most capable up-armoured German Leopard 2 versions. 170 Leopard 2A6HEL, along with armoured recovery vehicles, armoured vehicle-launched bridges, driving and shooting simulators, had an overall cost of € 1.7 billion[22]. Compared to the latest German Puma IFV, these prices are very attractive, knowing the price structure of a typical MBT components. According to Way[23], the cost of the fire control system of the French Leclerc MBT is 22 per cent of the vehicle cost. Similarly, the component cost of the US M1A1 Abrams, according to the same reference is as follows:

- armoured hull 9.1 per cent,
- suspension 7.8 per cent,
- engine and transmission 32.8 per cent,
- auxiliary systems 7.1 per cent,
- turret 16.6 per cent,
- fire control system 21.3, and
- other systems 5.3 per cent. (Fig. 1).

From these figures, it can be noted that although Leclerc possesses a panoramic commander sight, not present on M1A1, the cost of the fire control system is almost the same in relation to the price of the MBT. Obviously, an IFV, based on the common hull with a MBT, would lack

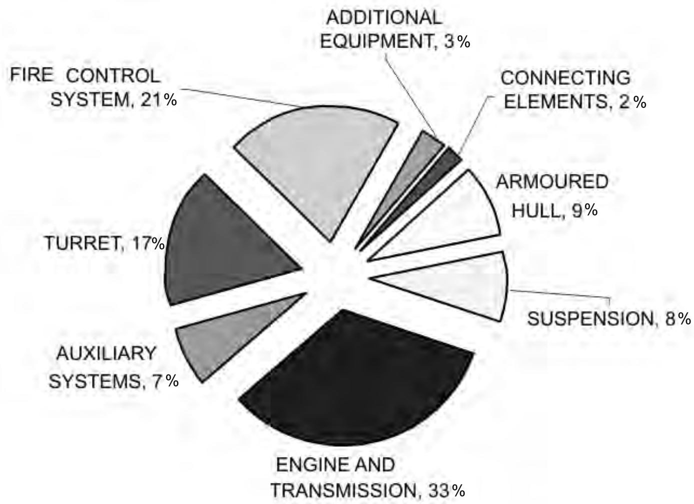

Figure 1. M1A1 Abrams price structure[23].

these expensive feature, as well as the turret with all the systems included, mainly the gun. In case of M1A1, these two components together cost 37.9 per cent of the MBT's unit price[22].

Although the individual component cost of the Leopard 2A6 is not known, it may be assumed that the turret and fire control system combined cost reaches a similar percentage of the MBT total cost. Therefore, it may be assumed that the hull, with all its components, needed for an IFV based on a modern MBT chassis would cost between \$ 6.2 million and \$ 6.8 million. These figures are both, \$ 2.4-3.0 million lower than that of the German Puma IFV. This difference in cost may be used for additional armour protection as well as a remote weapon station, armed with a 25-30 mm autocannon and antitank-guided missiles, enabling this hypothetic vehicle to become a true IFV in firepower aspect as well. Infantrymen would have obviously been placed inside the turet ring, of the diameter of almost 2 m, providing enough space for at least eight dismounts. This space is larger than that of older MBTs, as well as of the German Puma IFV, that carries only six dismounts. As a result, such a vehicle would have a much better armour protection than that of Puma IFV, even when Puma is fitted with additional armour protection, against all threats, especially from the front. Therefore, a converted IFV, based on a modern MBT chasis would provide a much safer transport for troops, particularly in urban areas where insurgent and terrorist groups operate.

However, it is highly unlikely that any ground forces would invest into an IFV based on most modern MBTs. One of the reasons is the rear engine and transmission compartment, existant on a vast majority of MBTs. This compartment completely blocks the rear of the hull, preventing the existance of a rear door or ramp. This does not allow a rear enter or exit for the dismounts, a standard solution, that has been used on all tracked vehicles of this type. As a result, a new, narrower powerpack is needed, which increases the costs.

However, if this matter is more closely analysed, it can be found that for example, Israeli Merkava MBT, that entered service in 1978, having a front-mounted engine (among other reasons, for additional protection), provided and still provides in its latest Mk 4 version, a rear door. This door is used, not only for a relatively safe enter and exit for crew members in case of disabling the MBT, but for additional ammunition for the main gun. Furthermore, in the most hazardous areas, up to six dismounts may be carried in the rear underarmour space, as well as few strechers for wounded troops, obviously, with the maximum possible armour protection[24]. Although Merkava has never been intended to be a specialised dual-role vehicle, but rather a MBT with additional, very useful roles, it has shown the potential of the idea of matching two kinds of armoured vehicle, unimaginable until recently. As a result, Namer APC uses slightly modified chassis of Merkava 4 MBT. Instead of converting older versions of Merkava, Israelis opted for building new vehicles. The cost of this vehicle is expected to be only \$ 1.5 million, which is much lower than any modern IFV[25,26]. This is the result of a low-cost remote-controlled weapon station armed with a heavy machine gun, obviously, of a much lower firepower than that of an autocannon, used on IFVs[27]. However, Namer has armour protection similar to that of Merkava 4, much higher than any other IFV.

7. COMMON CHASIS

The most effective common chassis, used for both MBT as well as an IFV, would have been envisaged from the beginning of the design process. This approach has been used by the US designers at the end of the eighties, in the form of armoured family of vehicles, or more specifically, heavy chassis[28,29]. Heavy chassis FV-1 would have been used for a MBT, designated as Block III, intended to be the follow-on to the M1/M1A1 Abrams (Future Armored Combat System – FACS); FV-2 as an IFV, intended as a replacement for M2 Bradley, while other vehicles from this family would have included Sapper Vehicle (SV), Future Reconnaissance Vehicle (FRV), Directed Energy Weapon Vehicle (DEW-V), Fire Support Team and Combat Observation Lazing System (FS/COLS), Armored Ambulance (AA) and Command Group (CG) vehicles. FV-3 would include line-of-sight antitank Kinetic-Energy Missile Vehicle (KEM-V), line-of-sight, forward, heavy Air Defence Vehicle (LOS-AD). FV-8 would have been Recovery Variant (RV), while FV-5 would have been the Advanced Field Artillery System, Cannon (AFAS-C). FV-10 would have been the armoured bridgelayer or Combat Gap Crosser (CGC). FV-11 included the Combat Mobility Vehicle (CMV) and the Combat Earth Mover (CEM). Such an ambitious programme, with a number of planned vehicles with totally new advanced components, at the end of the Cold War could not provide wider support, and it was cancelled in 1991. However, if this programme is evaluated from the perspective of present needs, more specifically, the need for a higher degree of IED and shaped charge (RPG-7) protection, not only from the frontal aspect, but from the side, rear and top, armored family of vehicles may be an attractive starting point for a future family of heavy armoured fighting vehicles. To stay within the topic of this paper, MBT and heavy APC or IFV of the future may be based on a common chassis.

7.1 Protection Paradox Resolved

Using the common chassis, the protection of IFV would be the same, or even better than that of a MBT, since the turret could have been replaced with a considerably lighter remote weapon station. Even if the protection would have stayed the same, present needs for protection may, in the majority of cases, be fulfilled. Future needs, for an all aspect protection against most modern anti-armour weapons should be satisfied by additional armour panels. The turret of the US M1A2 MBT, has a weight of 23 t, leaving the weight of the hull at 40 t. Therefore, over 20 t, left after the remote weapon station is installed, may be used for additional armour protection at the sides, bottom, top, and to a smaller extent, the rear. This distribution does not affect the centre of gravity of the vehicle, so the fitting of such heavy additional protection should be straightforward. Two or three crew members of an APC, as well as eight to ten dismounts, so from 10 to 13 soldiers would have a higher degree of protection than three to four crew members of MBTs. This way, by increasing the protection of the vehicle that carries more people, the protection paradox would not exist anymore.

The most attractive concept for protecting the vehicles may be modular armour protection. Future heavy APCs, IFVs and future MBTs would have been fitted with various levels of additional armour protection modules. This way, a basic, relatively lightly armoured vehicle, may be adapted to various, specific threats. The basic additional protection level would provide all-aspect protection against PG-7V grenades of the well known RPG-7, to a higher level of PG-7VR grenades, for urban and anti-insurgents operations. The highest level of protection may protect the vehicles from armour piercing fin stabilised discarding sabot rounds (APFSDS) and the most effective antitank guided weapons (missiles) from the front, allowing typical mechanised warfare missions, against enemy MBTs and a strong, organised antitank defences. Roof and floor modular armour may be added against state-of-the-art top attack antitank missiles and antitank mines, respectively. This way, the resulting common chassis, with modular armour, used for future MBTs and amoured personnel carriers, as well as IFVs, may have interesting implications on mobility.

7.2 Mobility of Military Vehicles

7.2.1 Strategic Mobility

The mobility of military vehicles has different connotations as its nature varies with the scope or scale of operations, which results in more than one kind or level of it. There are three clearly identifiable kinds or levels of mobility: strategic, operational, and tactical. Strategic mobility involves considerable distances and is not executed by vehicle's own power. In most cases it is done by rail, ships and air. Generally, as the vehicle is lighter, its strategic mobility is higher, but, the differences, if transported by air and road, are higher. Transporting armoured vehicles by cargo aircraft is the fastest, so it is very popular in the force projection concept of operations, but the most expensive. However, this way of transport is of limited value when heavy vehicles, such as MBTs should be moved to great distances. As an example, one US heavy transport aircraft, such as C-17 Globemaster III, can carry only one 63 t MBT like M1A2 Abrams. Alterantively, the aircraft can transport two classic 30 t up-armoured M2A3 Bradley IFVs, or four M1126 Stryker wheeled APCs. Therefore, compared to a heavy IFV of roughly the same weight as MBTs, both classic tracked and wheeled vehicles of the same kind have a considerable advantage[30]. However, by adopting modular armour protection, the weight of the stripped-off vehicle would allow the transport of more vehicles in one cargo aircraft. Armour modules may be transported in separate airplanes, alowing the equipping the transported vehicles in the field. Nevertheless, transport by air is the privilege of world powers, while other nations rely on road transport by specialised trucks. Modularity of armour protection will be beneficial in this case as well. If rail or more importantly, ship transport is considered, the physical dimensions of the vehicles are more important than their weight, so the advantage of lighter vehicles is minimal, due to a much smaller differences in dimensions in relation to heavier vehicles.

7.2.2 Operational Mobility

Operational mobility implies the ability of vehicles to move in the zone of operations. This is the matter of vehicles moving under their own power, mainly on roads, but often also cross-country. Therefore, the speed with which these can do this depends primarily on their power-to-weight ratio. This ratio of heavy APCs and heavy IFVs is rougly the same as that of classic tracked vehicles of lower weight. Wheeled vehicles have an important advantage over both standard and heavy troop-carrying vehicles due to their higher road speed. However, off-road, wheeled vehicles have some limitations, especially on soft ground. On the other hand, weight can have an adverse effect by restricting the number of road bridges that armoured vehicles can use. However, a classic APC or IFV, having a limited armament and armour is of little value if faced with a competent and well-equipped enemy, so in most occasions, MBTs must be brought into action, with their weight penalty.

7.2.3 Tactical Battlefield Mobility

The third level of mobility is tactical, or battlefield mobility. This level of mobility is the ability to move when in actual imminent contact with enemy forces. It involves movement over various types of terrain, the most difficult being soft soil and negotiating natural and man- made obstacles. Heavier vehicles generally have a higher specific ground pressure, so their soft-ground performance is lower than that of lighter tracked vehicles. However, this can be avoided by stripping off the additional armour protection of heavy APCs and heavy IFVs, making these as well armoured as the MBTs. This level of protection is still considerably higher than that of classic wheeled and tracked vehicles of this kind.

Wheeled vehicles are handicapped in tactical mobility, since they do not have tracks to effectively spread their weight over a larger area, giving a much higher specific ground pressure. Being in contact with the enemy, armoured vehicles can not avoid being under fire, so armour protection is of crucial importance. If the armour is immune to all or the majority of enemy weapons, the tactical mobility of the vehicle is higher.

And finally, the last aspect of tactical mobility is the endurance, or how long can the vehicle operate, before these have to be refuelled. Although heavyer tracked vehicles consume more fuel than lighter ones, their fuel capacity is higher, so their endurance is the same. On the other hand, wheeled vehicles have a smaller rolling resistance, so their fuel consumption is unproportionally lower, giving a higher endurance. The endurance can be increased by using hybrid engines (combined diesel-electric) with a lower fuel consumption, but this technology is still at the experimental level[31].

7.3 Costs and Logistics

Common chassis for MBTs and heavy APCs or heavy IFVs, may give many logistic simplifications and cost reductions. This way, two vehicles that the whole armoured force would have relied on, share the same engine, transmission, the whole suspension system, as well as a large portion of armour components, such as non-metallic inserts, type of armour steel, fire extinguishing system, hatches, periscopes, seats, drivers instrument panels and the whole driver area in general, etc. With such concept, many cost reductions can be made, not only in procurement costs, but in maintenance and training as well.

The reduction of procuring cost is obvious, due to a large number of components that are shared, increasing the production, and at the same time, lowering the cost of the individual component. This is done through spreading the research and development costs on more units produced, lowering not only the cost of the heavy IFV, but the MBT as well. Logistics would have been largely simplified, since the servicing procedured and spare parts of automotive components would have been identical. This implies the use of the same recovering and repairing vehicles. It is in contrast to present-day fleet, where two different vehicles of the same type are used for repairing and recovering of MBTs and classic APCs or IFVs. In case of the US M1 Abrams MBTs and accompanying M2 Bradley IFVs, even the welding rods used in production and damage repair are different, since their hulls are made of armour steel and aluminium alloy, respectively. Driver training would have been the same, using common simulators and driving training vehicles. The only problem would have been a higher fuel consumption, compared to other, lighter tracked vehicles. However, the latest tracked IFVs became considerably heavier than the vehicles of the same type during the Cold war. Their weight reached 43 t in case of the German Puma, which, combined with a state-of-the-art powerpack, provides a relatively low-fuel consumption. Using the same generation of advanced diesel engines, the fuel consumption may be kept at an acceptable level. By adoption of hybrid powerpack, fuel consumption may be further brought down[31].

8. CONCLUSIONS

According to the results of the analysis presented in this paper, the future of tracked personnel carrying vehicles, such as APCs and IFVs lies in vehicles that share the same chassis with MBTs. Although there are some negative implications regarding air and road transportability, the advantages outweigh the drawbacks.

- First, armour protection may be even higher than that of MBTs, giving the highest possible immunity facing the enemy anti-armour weapons to the crew and dismounts, lowering the possible losses.
- Second, the interoperability with MBTs is the highest possible as well.
- And the third, procurement and maintenance costs are lowered due to a number of common components with MBTs.

Therefore, classic, specially designed tracked APCs and IFVs may simply extinct. For equipping heavy brigades, heavy APCs and IFVs may replace classic vehicles of the same type. On the other hand, for equipping light, rapid deployment brigades, wheeled vehicles offer lower weight, cost, and maintenance, while keeping the same level of armour protection as classic tracked troop-carrying vehicles.

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