SEP:
Multirole Armoured Platform

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Sweden is currently engaged in an interesting project relating to the next generation of combat and logistic vehicles. Initial studies, which began in the autumn of 1994, were pursued under the "multirole vehicle" epithet.

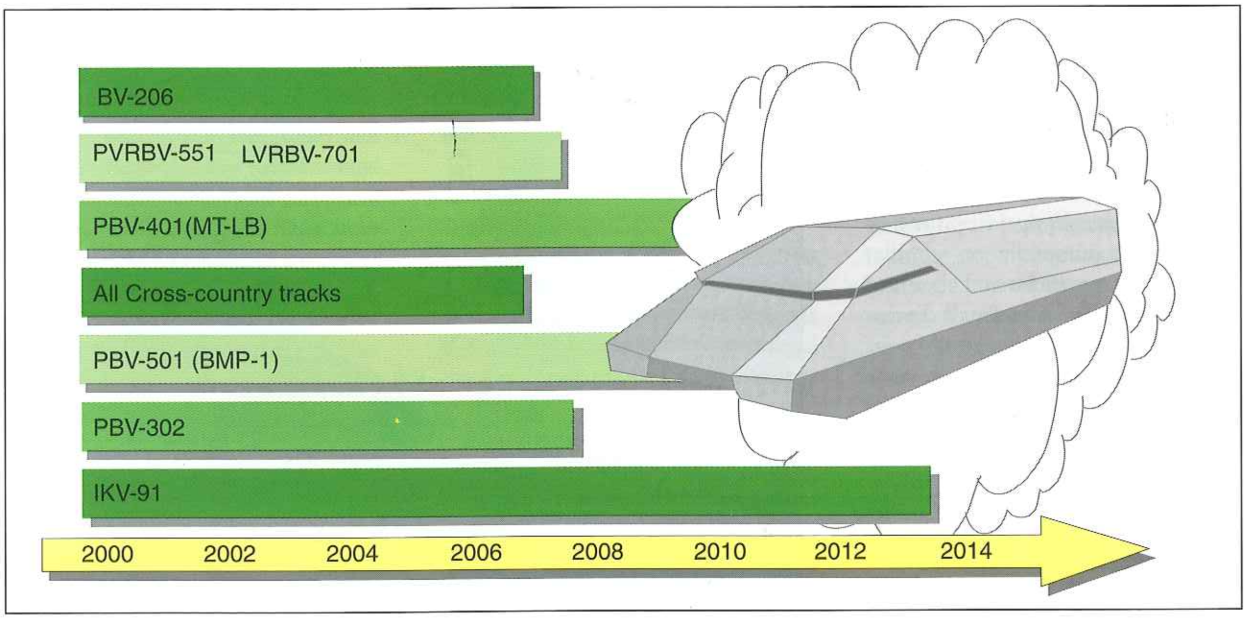
From this we can conclude that Sweden's Armed Forces are looking for a solution which will allow many of the different types of armoured vehicles in use today to be replaced with a "flexible" vehicle which has the capability to support a number of different roles and functions. At a more formal level, the project has been designated SEP – Splitterskyddad Enhetsplattform (which can be translated Multirole Armoured Platform).

During the period 2005-2015, a great number of Armed Forces vehicles need to be phased out because of age. Examples of this include both the current generation of cross-country and all-terrain vehicles, and the several different types of tracked armoured vehicles which date back to the early 1960s.

Even in Sweden's future slimmed-down force of only 12+4 mechanised battalions (or possibly even a smaller number of brigades) there is a significant requirement for many different types of vehicles – from troop and equipment transporters to more sophisticated vehicles with combat roles. These combat vehicles must be able to accompany the backbone of the mechanised units in the shape of the IVF 90 and MBT Leopard2.

The changing threat means that we are now starting to organise a new type of defence force with the capacity to adapt by means of retraction and growth. A new "sharper" organisation will reflect a new approach which among other things include units for combat in urban areas and for participation in international operations. It is the Swedish Government's assessment that the organisation of the Armed Forces must be able to vary its military preparedness in relation to acute crises and threats in our own immediate vicinity, and that there must be a level of basic readiness and a capacity to increase that level of readiness to meet

Figure 1. *During the period 2005-2015, a great number of Armed Forces vehicles will become obsolescent.*



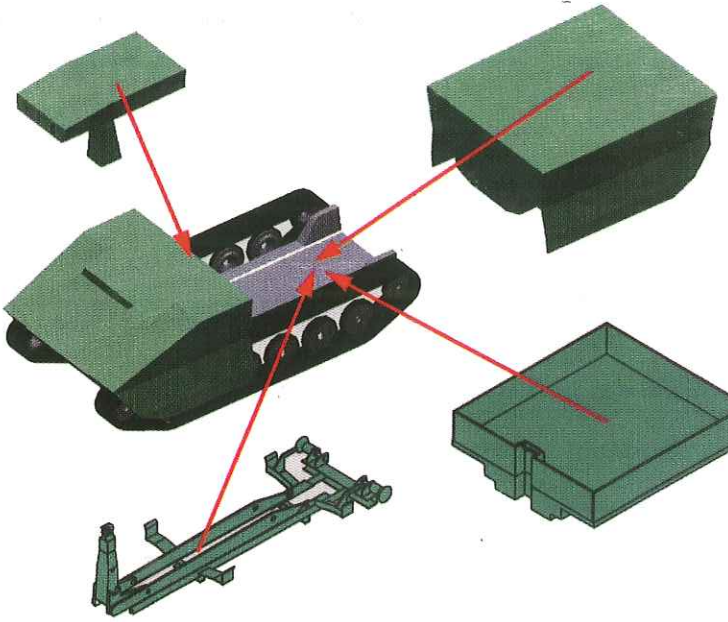


Figure 2. *SEP – a multirole armoured platform for many purposes.*

the threats which might arise within the space of a year.

SEP studies

In the context of the SEP studies which have been undertaken, a total of 24 different roles have been subjected to analysis. These studies have shown that the requirement for a specific volume will involve significantly more weight and unit cost than the requirement for loading capacity. The motive for the project has therefore been to identify those technologies which involve savings in weight, volume and cost throughout their lifetime. The objective has also been to produce a modular solution which permits the maximum number of roles to be applied to a basic platform without the need for a special and costly development in each individual case.

Generally speaking, all new technology must be balanced against the technical and financial risks which are involved. It is fundamental to a vehicle with SEP's orientation that new technology should bring improvements in cost-effectiveness and performance, initially in the following areas: net load, internal volume, flexibility in conjunction with a high degree of family relationship, signatures and survivability, internal environment, system cost.

The technologies in which FMV and Industry have chosen to intensify their interest are:

- electric transmission in combination with two powerful car diesel engines
- continuous band track of rubber (instead of tracks composed of steel links)
- decoupled running gear
- basic hull of composite fibre
- add-on ballistic protection (including protection against mines)
- multispectrum signature adaptation (especially in IR and radar wavelengths).

Electric transmission

The use of an electric transmission in a combat vehicle is not a new idea by any means. In 1916 the French demonstrated this in one of their first two tanks, and during the 2nd World War Ferdinand Porsche in Germany experimented with the technology in one of his many designs. It is now obvious that the electric transmission is the key to completely new concepts for combat vehicles. The need to do no more than run an electric cable to a drive wheel, serves to create considerable freedom in the layout of a vehicle.

Flexibility in the location of components brings significant savings in volume, and can also permit the selection of alternative components which bring additional advantages as regards weight and cost. In the case of a vehicle in the 15 tonne class, up to 25 hp/tonne must be aimed at in order to achieve the required degree of mobility. This requirement is usually satisfied by using a conventional diesel engine designed for a truck, but two modern car diesel engines, which are very light and compact, can solve the same problem. The electrical transmission permits considerable freedom in the location of these two powerful engines, for example the track sponsons in a combat vehicle may be preferred. The presence of two engines also increases the amount of redundancy in the vehicle, which is highly desirable in military applications. Batteries also permit travel in silent mode, which is an obvious advantage in a reconnaissance vehicle.

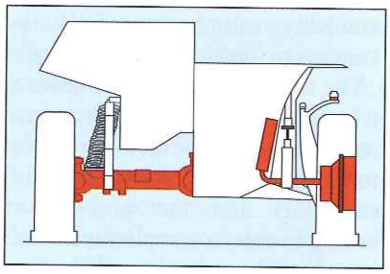


Figure 3. *Electric transmission for combat vehicles has many obvious advantages.*

Over the next ten years the efforts of the civil market to find an environmentally friendly source of power in the fuel cell will spur on the development of commercial electric transmissions – something which the Armed Forces will be able to exploit, not least as regards the low procurement costs which are an obvious advantage.

Rubber band tracks

For a long time rubber band tracks for heavy tracked vehicles have been confined to the civil tractor market. Attempts to apply this technology to the design of military vehicles have yielded very promising results:

- the internal noise level can be reduced from 110 - 115 dBA to 90 - 95 dBA
- the level of internal vibration can be reduced, increasing the lifetime of a number of components
- the external acoustic signature can be reduced significantly
- the total weight of a track can be reduced by 40-50%
- total lifetime can be increased between 2 and 5 times, and procurement costs halved
- roll resistance (drag) can be reduced (improving fuel economy)
- mobility can be improved (by means of lower ground pressure)

The above points to an obvious selection of track type, but there remain a number of major problems to be solved (e.g. how to deal with careening, and the problem of having to carry a complete track as a spare). The technology is here to stay, however.

Figure 4. *Pbv 302 fitted with a conventional rubber band-track from Good Year.*

Decoupled runninggear

The idea of decoupling the running gear by separating the suspension system from the basic hull builds naturally on a patent taken out by Krauss-Maffei in Germany. This technology is also designed to reduce internal noise and vibration. The levels which can be attained are comparable with those achieved using rubber track.

The principle is to attach track frame components to a girder which is separated from the chassis. This means that any vibration which is produced during travel will not be transmitted to the chassis. This extra "hull side" is suspended by rubber to the basic structure, one on each side of the vehicle. This type of cushioning is excellently suited to modifications of existing combat vehicles, but involves the addition of 10 cm or so to the width and 500 kg to the weight.

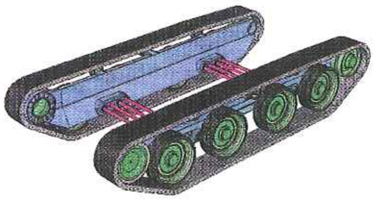


Figure 5. *Krauss-Maffei decoupled running gear.*

The cost of the system is obviously higher, but it is judged that a higher level of cost-effectiveness can be obtained during the course of its lifetime, since there will be a considerable improvement in the internal environment for components.

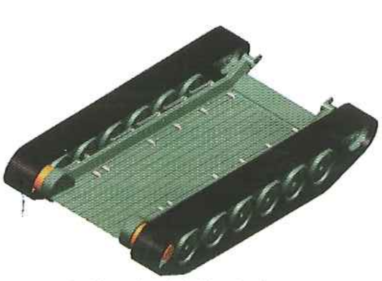


Figure 6. *Hägglunds Vehicle decoupling with a separate bottom.*

Another way to decouple the runninggear, instead of attaching a structure to the side, is to place the whole of the springs and suspension for the track frame in a separate base plate below the hull of the vehicle. A base plate of this nature is most effective with torsion bars, and when an electric transmission with hub-mounted motors is fitted. This solution, which is based on a brand new patent taken out by Hägglunds Vehicle, offers a number of interesting advantages:

- the basic hull is almost completely unloaded from the point of view of travel, and can thus be manufactured to advantage as a "minimum hull" in a variety of materials
- the floor pan contains areas (between the torsion bars) which can be used to increase mine protection (beyond the enhanced level which a double hull provides) or for fuel tanks.

Decoupling in conjunction with a rubber band track on a tracked armoured vehicle should mean that the internal environment can be compared in many respects with what is currently the preserve of wheeled vehicles. It will also probably be possible to meet the civil requirement for a maximum internal noise level of 85 dBA.

Fibre composite as a material for the hull.

Studies have shown that combat vehicles made of fibre composite constitute a realistic alternative to the use of conventional materials like steel and aluminium. The greatest advantage is that as much as 30% of the weight can be saved with the same levels of protection, which is of great interest at a time when vehicle weights are tending to grow to unmanageable levels. Material of this kind will also permit the incorporation of a radar-absorbent layer to reduce the signature.

Unfortunately the current cost of materials (S2 glass is the most interesting) and tools of this kind is a deterrent, and this makes it difficult to calculate the savings on weight which are possible on a quantity of vehicles in the 15 tonne class.

Around the world studies are being carried out on vehicles "made of plastic". Most of the work is being done in the USA and the UK. The most familiar technology demon-

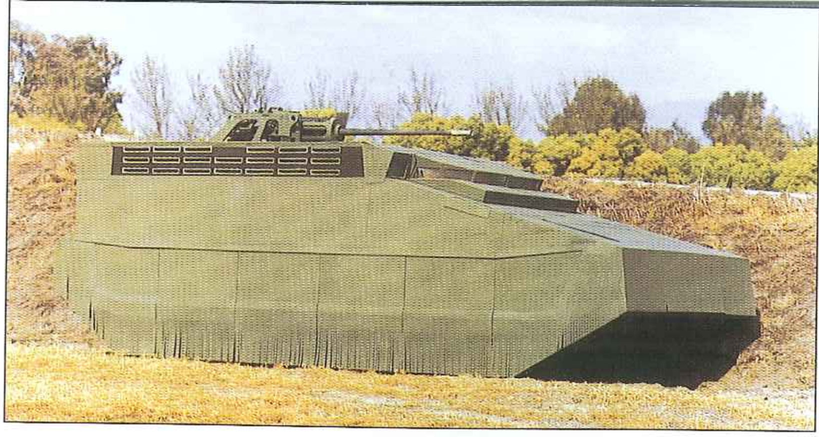


Figure 7. *Composite Armoured Vehicle (CAV) from United Defence.*

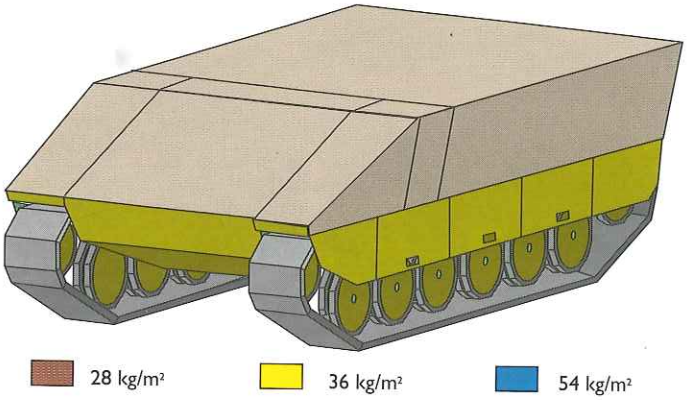


Figure 8. *SEP ballistic add-on armour from Ingenieurbüro.*

strators are the United Defence's CAV (composite armoured vehicle) and DERA's ACAVP (advanced composite armoured vehicle platform) (which is expected to be ready in the year 2000). Within the SEP project, the intention is to produce only the mission module built in fibre composite.

Add-on ballistic protection

Studies which FMV has commissioned from the German design bureau IBD (Ingeniuerbüro Deisenroth) have analysed the SEP concept on the basis of the high requirements specified for ballistic protection and in combination with what current technology permits. It has been shown that while retaining an overall weight of 15 tonnes, a vehicle can be provided with a basic level of all-round protection in the horizontal plane against a threat equivalent to 14.5 AP. Requirements for higher levels of protection (equivalent to a 30 mm APFSDS) can also be met.

One of the most difficult requirements for a light tracked armoured vehicle is to withstand different types of mines without injury to the crew. The basic design must allow a charge equivalent to 7 kg of TNT to be detonated beneath a track. Modern add-on protection must also withstand a pressure-effects mine of this type, as well as mines with aimed controlled effects (ACE) or KE effects (type TMP-6) under the belly. Add-on protection from IBD (à~160 kg/m^2), in combination with HSV's solution involving a separate baseplate, has shown that this is possible – a breakthrough for combat vehicles in this weight class!

Multispectrum signature adaptability

In parallel with the SEP project, joint service studies are underway on signature adaptation in a ground scenario known as the SAT/Mark project. As an initial technology demonstrator, the SAT/Mark project has commissioned the conversion of an MT-LB with the object of generating low target signatures within the thermal, infrared and radar wavelengths. The results show that multispectrum target signatures can be reduced significantly, though some of the materials selected is far from ready for active service.

The Project Office intends to base its next joint services technology demonstrator, known as the TD2, on a base plate from the Strf 90. A model of this demonstrator has been made in the scale of 1:3. Initial measurements indicate very low radar target signatures. FMV plans to place an order for the design and manufacture of the TD2 with a consortium comprising Hägglunds Vehicle, Bofors and CelsiusTech.

The SEP concept has adopted much of this "signature thinking". The basic design takes account of the tough requirements as regards low signature in the IR (for example, HSV's new proposal forsidemounted exhaust) and radar (angled sides add to weight, volume and cost) wavelengths.

Figure 9. *Technology Demonstrator based on MT-LB for low multispectral signatures.*

Design concept

A modular vehicle will increase flexibility and freedom without pushing costs through the roof.

In this connection the European

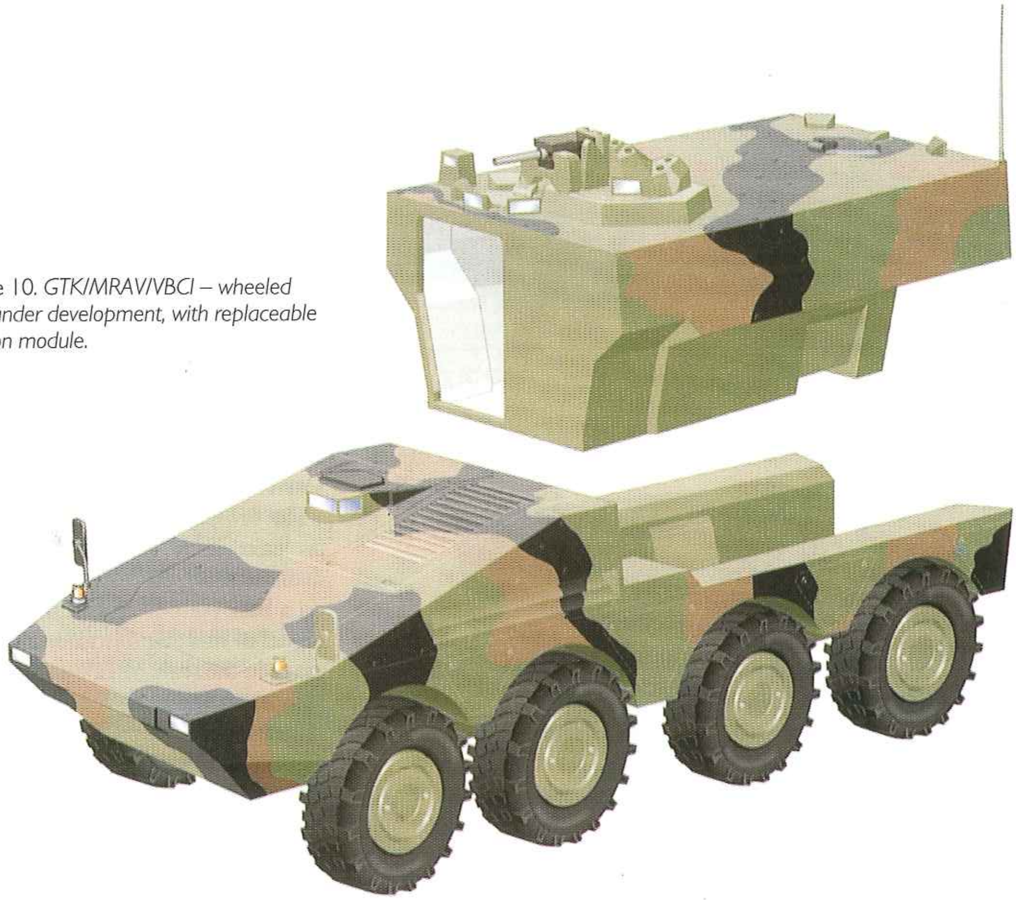


Figure 10. *GTK/MRAV/VBCI – wheeled APC under development, with replaceable mission module.*

GTK/MRAV/VBCI collaborative project between Germany, the United Kingdom and France exemplifies the new thinking – the aim of this trilateral development being to produce an multirole armoured vehicle with all-wheel drive – but unfortunately political forces seem to have got the upper hand to the detriment of logic and new technology.

In reverse order the decision seems to have been taken that the vehicle should be a wheeled vehicle. The diagram to the right shows the model which best guarantees that the design work will result in a successful military product.

The illustration must be interpreted as follows:

- Analyse the role which the vehicle will be designed for. This will determine the capacity which the vehicle must have as regards volume and loading capacity in particular.
- Ensure that the vehicle's subsystems and components are selected and located as effectively as possible from the point of view of volume, weight and cost. This will determine the basic dimensions of the vehicle.
- Analyse the requirement for protection which must be specified (in particular from the point of view of ballistics). This will determine the basic weight of the vehicle.
- Analyse the requirement for mobility which must be specified from the point of view of strategical and tactical, operational and battlefield mobility (cross-country capability). This will determine the type of vehicle to be selected – i.e. wheeled or tracked (only exceptionally should the choice be a point of contention) – after which it is recommended that the process be repeated.

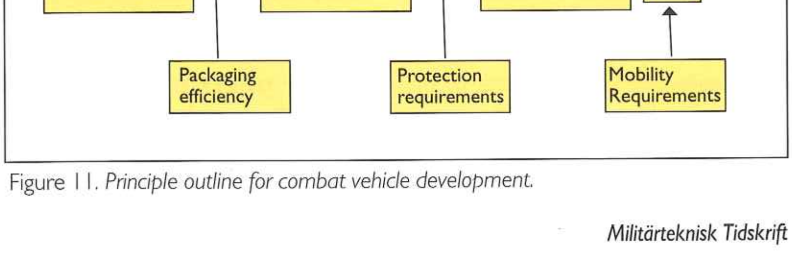


Figure 11. *Principle outline for combat vehicle development.*

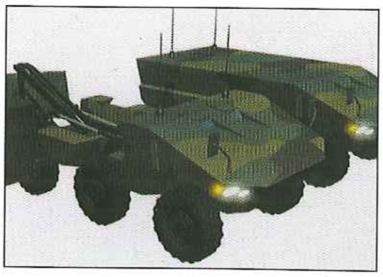


Figure 12. *SEP-wheels with a loadhandling system.*

Figure 13.*A model of SEP as a mortar carrier (with the AMOS system).*

Compared with GTK/MRAV/VBCI, SEP indicates that almost the same requirements can be met as regards volume in the mission modul (~10 m^3) and level of protection, but at half the cost and with half the weight.

Wheels or track?

The advantages of wheeled vehicles have long been known, and can be summed up as follows:

- wheeled vehicles possess greater operational mobility, since they can travel at higher speeds for greater distances with a lower probability of breakdown
- the maintenance and operating costs of wheeled vehicles are lower
- wheeled vehicles offer a more comfortable ride thanks to lower levels of noise and vibration inside the vehicle; the vehicle is also usually even quieter for a listener on the outside.

These advantages must be set against some significant disadvantages:

- cross-country capability in terrain with poor carrying capacity (e.g. mires) and deep snow (60-70 cm) is very limited (in most cases non-existent); this must be combined with the great difficulty in getting off roads with high (~1 m) walls of cleared snow
- requirements for interior volume and a specified level of cross-country capability will increase the size and weight of the vehicle, and with them the cost of procurement.

Our studies and tests indicate that only marginal improvements are feasible in the vehicle's mobility alongside roads, especially in deep snow and on soft ground. Because of their large turning circles, wheeled vehicles also have great difficulty manoeuvring on small roads and in urban areas. With new technology, on the other hand, track-steered vehicles exhibit a significantly greater potential, which means that the differences can be reduced considerably.

The modular design of the SEP means that it is not actually necessary to adopt a position. Studies carried out by Patria in Finland have shown that an SEP with wheels can be based on the same solution – i.e the exchangeable effective module can be switched between a wheeled vehicle and a tracked vehicle in the SEP family. This also applies to the whole of the frontal crew module and the two engine modules. A solution of this kind will obviously increase the level of serviceability considerably, and also facilitate co-operation with other countries. Meeting the unique requirements of different countries (which can present problems) in this way should also give the family of vehicles a healthy export potential.

International cooporation

The opportunities for international cooporation have been examined both within interest groups (WEAG, Norden) and bilaterally. In the context of a "pre-study" Nordic group for armoured vehicles it has been possible to harmonise both staff requirements and timetables. There is a significant level of interest in Sweden's SEP project, and there are strong indications that SEP may be the subject of further study as a collaborative project between the Scandinavian countries.

Conclusion

A SEP test rig is being manufactured at Hägglunds Vehicle AB, and will be delivered in mid-2000. The rig will be used for basic concept trials, especially in respect of its driving and mobility characteristics. The test rig will also illustrate the many new technologies which are included in the balanced integration of systems which constitute the platform .

In the long term the interface with different test systems will be analysed in greater detail. A weapon system of some kind (beyond basic armaments in the shape of a heavy machine gun or grenade launcher) will be added, and there are indications that the role of mortar (AMOS) will be evaluated.

Rickard O. Lindström, chief engineer, Project Manager for SEP, previously responsible for the development of protection in major combat vehicle projects (CV 90, MBT 2000, MBT NEW) within the Swedish Defence Materiel Administration (FMV). Further details about SEP and much more: http://home4.swipnet.se/~w-41874 /stridsfo2.htm