Designing and Developing Armoured Vehicles: Technical and Industrial Challenges

by *William L. Machmer*

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Armoured vehicles have matured over the years to become extremely complex systems. With advances in communications, navigation, sensors, performance on the move and automotives, they are now a much more effective platform from an individual system point of view, but more importantly have a much greater capability when looked at from fleet level. One of the key enablers of this increased performance is due to Network Enabled Capability (NEC) connectivity and the availability of data to be shared at the lowest levels.

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Unfortunately, these advantages come with a cost. Many of the increases in platform performance can be attributed to advances in electronics, and many of these items have a lifetime of only several years before they are obsolete or parts are not available. If one wants to have a vehicle with an operational life of 30 years, the initial design must not only solve today's performance issues, but must address likely growth and how it could be accommodated in the basic platform design without having to replace significant pieces of the vehicle architecture to accomplish a mid-life upgrade.

With the complex integration of new and improved technologies, industry now has numerous new issues that must be satisfactorily resolved to provide the soldier with the best combination of integrated assets to allow him to execute his task quicker and more accurately as part of an integrated team and at a cost (through-life cost) that is affordable to the taxpayers. The key point to keep in mind is that this refers not only to costs and performance associated with getting the hardware deployed, but also those throughout the vehicle's useful life. Key issues are not only technical but are also about basic industrial participation in the wake of the Defence Industrial Strategy (DIS).

Industrial Issues

When armoured vehicles were much simpler, design, integration and test were typically accomplished by a single company. Even with upgrades, which in the past have been related to re-engining, up-gunning and re-armouring vehicles, the process was relatively straightforward. New families of vehicles, including the Future Rapid Effect System (FRES), have an anticipated complexity factor never seen before. Because armoured vehicles have gained substantial sophistication, we have reached the point at which a single company typically does not have the inherent capability to accomplish all details of the design, manufacturing and support. Teams of companies are required to produce the best product or, at times, international coalitions need to be considered to best meet the customer's goals.

For companies/partners based in the US, business is further complicated by the International Traffic in Arms Regulations (ITAR), which in some cases limit the distribution of US technologies outside the US. This has been a significant problem in the past on several major programmes, especially those dealing with software source code, low-observables technology and encryption techniques. However, careful consideration of the supply chain contributors will allow a team to be constructed that is not bound by previous ITAR issues, while being consistent with the DIS policy. The Lockheed Martin team successfully accomplished this effort in supply chain management in the execution of the FRES Electronic Architecture Technology Demonstrator Programme,

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with a solution totally compliant with DIS policy and without any source code issues with ITAR.

The formation of proper teams is further complicated by government-mandated issues, which put additional pressure on the proper supply chain management. These issues include the following:

- Vehicle programmes in the UK normally include through-life support partnerships approaching 30 years for the in-service lifetime of the vehicle.

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Many companies, due to future uncertainties, are not willing to make commitments for this period of time.

- Recently issued DIS policy for armoured vehicles mandates that software maintenance must reside in the UK as well as the overall capability to maintain and update vehicles. Several options exist for compliance with this policy as well as avoiding problems associated with the ITAR policies in this area.

- The UK Government almost never buys underlying rights on defence systems, so availability of data on interfacing systems is difficult. Data availability must be addressed early in the set-up of teams and relationships with the Defence Procurement Agency (DPA).

Technical Issues

The FRES programme, as it is currently being executed under the Systems House Guidance, is a series of technology maturation and risk reduction efforts. There is a conscious effort to keep options open during these programme phases as evidenced by the desired result of fleet review being a decision to down-select to three fleet options and corresponding procurement strategies.

The next project phase, or the end of the Technical Demonstration Phase (TDP), will have numerous technology challenges of integrating the results of the various TDPs into a realisable design with consistent systemic budgets. Key considerations in this process include the following major areas:

- Requirements migration. Certain requirements can be considered as absolute drivers in the derivation of potential FRES solutions. The number one driver was the requirement that the vehicle be C-130 capable, which limited vehicle options to the 20-ton category and put extreme demands on the packaging, while protecting volume and armour/vehicle protection solutions. This requirement has been deleted in favour of an A-300 compatibility requirement, which mandates vehicle options in the 28-ton category and substantially changes priority of the vehicle components. The second largest driver is unit production cost, which is closely coupled to force size, IOC dates and required production rates.

- Cost and Growth. An extensive analysis will need to be conducted to determine baseline designs and growth options with planned incremental upgrades. This effort will be bound by vehicle costs and force effectiveness upgrades in order to maintain performance margins over the anticipated threat. Certain capabilities may be too expensive or too high-risk to be integrated into the first tranche of vehicles, but may be mature enough in terms of both cost and risk to be installed perhaps five years later. Key to the success of such a preplanned upgrade process is an underlying architecture in terms of both hardware and software ability to accommodate future growth without the ripple effect of upgrade experienced in the past. Interwoven into the cost is the study of commonality of hardware modules between variant vehicles to minimise not only development and production costs, but more importantly the logistics footprint.

- Packaging. Packaging of an electronic architecture will ultimately be highly dependent on the platform from physical, power, and human factors points of view. Packaging options suitable for one vehicle may not be acceptable or even viable for others. If the FRES solution includes new build vehicles, it is vital that all of the design efforts are mutually undertaken to provide the greatest possible levels of commonality between vehicle variants to minimise overall support costs.

- Growth. Historically, mid-life upgrades have been limited due to the cost involved. Clever engineering can provide additional growth capability, but such a course of action has an impact today on unit production costs, and will minimise later growth options. Low-cost growth options that include additional processing capacity, either in terms of spare capacity or spare capacity for processor cards, will allow power to be inexpensively implemented today, scrapping mother boards,

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enclosures and boxes at a later date. Specific considerations must be given to installing hardware today that is not difficult to retrofit in the future. An example of this would be data bus and power routing throughout the vehicle. Careful planning will also result in combined upgrades to minimise the number of times a platform is pulled out of service for scheduled upgrades.

In Summary

In summation, for the technical effort to be successful overall, there needs to be a well thought out, totally integrated through-life plan that considers all vehicle sub-systems. ■