Arms Acquisition – Why is it So Difficult?

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Summary

There are several examples of failed arms acquisition programs, where costs have been underestimated, and unproven technology misunderstood.

Arms acquisition programs seem to suffer from particular difficulties, judging from the results obtained. This is not only a U.S., and to some extent U.K., phenomenon, although the debate is by far most active in those two nations. The problems express themselves as cost overruns, delayed deliveries, and fundamental, sometimes insoluble, technical challenges. The term "acquisition" is here used for the complete life cycle process of a system, covering concept generation, design phase, prototypes, volume production, operational use, various upgrades, and disposal. The problems are typically, but not always, encountered in the design phase.

Is military acquisition inherently more difficult than similar programs in non-military business areas? The fact that these programs are usually paid for by public money, that large sums of money are involved, and that programs often are not competed, all contribute to making these programs much more prone to extensive media coverage, in particular concerning any failures, compared to similar big-money, high-tech programs in the private sector.

In this paper we will examine the technologies involved and their sometimes extraordinary pace of development, some inherent difficulties with big military programs, the fundamental difficulties with cross-border collaboration and the funding challenges in times of austerity, and we will propose some remedies.

We believe that the conclusions of this paper are relevant e.g. for the ongoing negotiations for Sweden-Brazil military cooperation and arms acquisition

Technologies for warfare

Technology development for military purposes was a driver for many innovations in society during most of the 20th century, while, since the 1980s, the civil consumer-oriented technology sector has gradually replaced military-specific development activities, and is now pioneering many technology areas.

The United States remains the world's top spender on research and development (R&D), and also in terms of military budget size, resulting in its Armed Forces equipment in many areas being superior to that of all other nations. During the last five to ten years, the financial austerity in most European nations have led to decreased R&D, and also to reduced military spending, resulting in what seems to be a trend shift where more cost-efficient equipment is demanded and sought for.

Platforms like fighter aircraft, submarines, surface ships and armored vehicles have evolved into being extremely complex but also very expensive systems. As famously claimed by the Chief Executive Officer of a major United States defence company (Augustine 1986, 143), if the present trend of ever-rising unit cost is extrapolated, the United States, by the year 2050, can afford to buy just one state-of-the-art fighter aircraft.

At the same time, the development of consumer related technologies, where production volumes can compensate for high research and development costs, and still result in a low price per unit, makes such technology both available and affordable to anyone. Both hardware and software can be obtained over the Internet, just like a vast amount of descriptions of how to build various kinds of equipment. Some of these are quite harmless, while others can be used for actions that traditionally were available only to military or police organizations, or to very well organized criminal groups.

But there is another factor that needs to be taken into account related to any technology that is adopted for military use, and then built into weapons or platform systems, where there is minimal tolerance for malfunction, and where the environmental conditions require extreme robustness and ruggedness. This will drive the cost of military systems containing such technologies to much higher levels than for civil products with similar technologies. Cars and consumer electronics are not getting more expensive, adjusted for inflation, while the cost of military equipment increases at a much faster rate.

Some examples of military resources, where present technology development has changed, and will continue to change the pre-requisites, are as follows:

Airborne systems

The most modern combat aircraft are extremely complex platforms, with enormous fighting power, stealth capacity and advanced multifunctional radar and electronic warfare systems. They are needed to establish air superiority and to hit targets through various kinds of weaponry with precision guidance capability. Traditional dog-fights are increasingly less likely to occur, but to avoid an incoming missile you still need high-G turning ratio capacity.

When talking about airborne platforms that don't have a human operator inside the platform, there is a number of acronyms. What started out as UAVs (unmanned air vehicles) was replaced by UASs (unmanned air systems) to stress the fact that the air vehicle itself is just one component in a much more complex system, with land-based parts such as antennas, human operators and a landing strip. Recently, these systems are denoted as RPASs (remotely piloted air systems), to underline the fact that they are not fully autonomous, and that the human operator, through remote data link control, may prevent the system from making decisions with potentially catastrophic consequences.

One major issue is when an unmanned combat aerial vehicle can perform the tasks of a manned fighter aircraft equally well or better. Unmanned systems (or, as they should be referred to, remotely piloted systems) are presently used for air-to-ground attacks, and as reconnaissance and sensor platforms, but the full fighter capability is still not operationally implemented.

However, medium and high altitude long endurance unmanned vehicles will become increasingly important for a nation with "no loss of life" as a guiding principle. They are technologically complex and very costly, and that is not likely to change in the near future. Anchored balloons can play an important rôle for surveillance, and they will probably get less costly when their number and production methods change, but they will not work as offensive weapons.

But unmanned systems are here to stay, and in some respects size is less important. The early R&D for military purposes has been followed by unmanned aerial systems for civil use (reconnaissance and inspection). Sizes are shrinking, and today you can buy a rotor-driven remotely piloted vehicle in hobby shops, and even in toy stores. These small platforms are able to carry a payload like a camera or a small explosive. This opens up new areas for both surveillance and strikes (although very limited in coverage) through systems piloted by terrorists, and they are very hard to detect in advance. The technologies involved are a combination of advanced lightweight materials, miniaturized circuits, advanced communications hardware and software, including cryptos, high energetic explosives, …., most of which were developed through previous military research.

Land systems

For land warfare, the three-block war metaphor has now been with us for several years, showing that traditional battle is not the main challenge when fighting an adversary during overseas missions.

The need to protect your troops from hits by Improvised Explosive Devices is similar for big and small nations, and the problem to locate and destroy such devices before they explode is the same. Here, we see growing cooperation between nations, and in coalitions the most capable force is likely to support the others. For a small or medium sized nation, cost is not the main obstacle, rather it's the irrational behaviour of the adversary.

For soldiers, the trend is towards the concept known as "Future Warrior", with a soldier dressed up in smart fabrics, fuel cells for power generation, integrated communications and positioning systems with flexible screens attached to the body, laser guided weapons and night vision devices, all carried by the individual soldier. Technology development will solve the present issue of the combined weight of all these systems. Today, the cost is high, but many of these technologies will prove to be useful also in civil society, and when volume goes up prices will come down. Then maybe the difference in warfighting capability between a soldier from the most advanced military forces and any nation will not be that significant.

Armored vehicles have become much more advanced and well protected (using active armor and new materials) but also much more expensive than before. It is very hard for “the poor man” to find similar cheap solutions, but what has been seen for the past 20 years is that a change in tactics, e.g. confronting your adversary in crowded areas, such as city centres, removes some of the advantages associated with heavily armored platforms.

Naval systems

Offshore, there is hardly any way for a “minor actor” to challenge a medium or large naval surface ship. Long range cruise missiles are a potential threat, but such weapons systems are not a poor man’s first choice. Instead, trying to get close to the coast, the littoral waters, in fast speed-boats is a way to change the power balance.

The most obvious power projector is probably the submarine. These are advanced platforms that can stay submerged for many days, carrying high-tech and very powerful torpedoes and missiles, and at the same time work as extremely versatile intelligence gatherers. Submarines will remain extremely valuable assets, but available only to the rich and advanced nations.

Large surface ships and submarines constitute a necessary basis for any nation claiming global power and presence.

The space domain

Until a few years ago, the space domain was reserved for the super-powers or very rich nations. But research and development, resulting in miniaturized equipment, lightweight materials, new and less hazardous fuels, and, coupled to an increasing demand for space-based services, have made possible microand nano-satellites. New ways of getting these into orbit can lower the cost significantly, and orbiting such satellites are now changing the playing field. With possibilities to have advanced on-board surveillance equipment, although small in size, new nations may get access to first-hand information not previously available.

The cyber domain

A fairly recent way to wage war is through computer attacks, known as cyber warfare. The characteristics include the difficulty of attribution and the possibility of massively parallel attacks at a very low cost, once the competence and appropriate infrastructure has been acquired. To prepare a society to withstand cyber attacks requires a new way of thinking, compared to legacy preparatory actions for conventional wars and nuclear threats. The boundary between military activity and criminal activity is hard to define when it comes to cyber-related “warfare”, and remains a judicial challenge.

The low cost implies that cyber warfare can be conducted by small and medium sized nations with scarce defence funding, as long as you have competence and access to reasonably advanced (but still cheap) IT equipment

Information and computer technology development has for the past 50 years consistently outperformed any other technology area, with exponential growth in performance (twice the performance every 18 months), and this at approximately fixed cost. This trend is likely to continue, through ever-smaller circuit designs and by going to three-dimensional structures, until fundamental quantum mechanical limitations become significant.

So with the seemingly never-ending pace of rapid technology development, why don’t we just buy military equipment that is reliant on the presently available state-of-the-art technology? Let me address the issue through a number of slides.

An example of a potential technology game changer: The 3D printer

One technology that can fundamentally change both the access to dangerous equipment but also to spare parts and other necessities out in the field, is the three-dimensional (3D) printer. It can manufacture 3D parts from a software drawing (printing instructions that could be accessed over Internet), if you have the right basic materials available. Those plastics and other fabrics can be transported in small crates to the site, making it hard to control and stop them on their way, but it will also be hard to determine what the intended use is. The use of 3D printing is presently growing at an extraordinary rate, and the ideas for how this technology can be used seem limitless, where the benign use in medicine is dominant. But the market for not so benign purposes is also growing, and the instructions and drawings for how to print a working handgun (only a few specific metal parts are needed) are apparently available at some Internet sites.

So with the seemingly never-ending pace of rapid technology development, why don't we just buy military equipment that is reliant on the presently available state-of-the-art technology? The answer to this is a lack of funding to handle the associated costs, some of which are spiraling out of control.

Some fundamental acquisition issues

According to Charette (2008), there is a number of reasons that significantly complicate defence technology acquisition:

- The strongly political nature of what's fundamentally a technical/technological process
- Shortage of skilled engineers, program managers, and contract oversight staff
- Reliance on unproven, exotic technologies
- Enormous complexity and interconnectedness of new military systems
- Unrealistic cost projections that allow too many programs to be approved

An example of ever-rising platform costs: Fighter aircraft

In (Arena et al., 2008) the average unit procurement cost for American fighter aircraft in the time span 1974 to 2005 is analyzed. The trend towards (sometimes dramatically) increased per unit cost is clearly visible (Arena et al. 2008, 13). The production of the F-22 aircraft was halted prematurely, mainly for cost reasons. The F-35, also known as the Joint Strike Fighter, has recently seen dramatic cost increases compared to what's shown in (Arena et al. 2008, 13), and production numbers have been reduced, particularly for the less-rich partner nations, (Richmond 2014). The Swedish Gripen fighter aircraft, in its present version, would, from a cost perspective, be located in the same range as the F-16 aircraft. It remains to be seen whether the future upgraded version of the Gripen (which is presently being negotiated by Brazil) will, as is claimed, be cheaper than its predecessor.

The persistent per unit cost increases inevitably lead to significant reductions in the number of aircraft ordered, e.g. as seen in (Arena et al. 2008, 3)

Some remarks on the Swedish defence budget

Declining defence budgets is obviously no remedy for ever-rising development and procurement costs. (Cornucopia, 2013) contains a number of time series for the period 1996-2012, provided by the Swedish International Peace Research Institute, and by the Statistics Sweden bureau.

What's shown in (Cornucopia, 2013) is how the nominal Gross Domestic Product (GDP), officers' salaries, and the Consumer Price Index (CPI) have evolved during the time period: +100% for the GDP, +50% for officers' salaries and +25% for the CPI. Also shown in (Cornucopia, 2013) is the defence budget being fairly constant at approximately 40 billion Swedish crowns, or 3.8 billion Euros, throughout the entire time period. This obviously implies an erosion of purchasing power of at least 30% during the 16-year interval analyzed. Partly due to the crisis in the Ukraine, there is a recent debate, and apparent political consensus, on raising the defence budget, but the numbers mentioned are far from restoring the budget to anywhere near its past values in the 1980s.

Defence budgets of EU member states

There is much recent evidence showing that international defence equipment collaboration is most likely to succeed between a small number of like-minded, culturally similar nations of comparable size, capabilities and funding.

(Guzelyté 2013, 19) shows 2011 and 2012 defence research and development expenditure for the 26 member nations in the EDA (26 out of the present 28 EU members, since Denmark is not in the EDA and Croatia had then not yet joined the EU). The funding imbalance is obvious, with France, the UK and partly Germany being hugely dominant.

The initial euphoria after the creation of the EDA in 2004, when the guiding principle seemed to be "the more the merrier", has given way to a number of bi- and trilateral agreements between similar nations, realizing that having too many dissimilar participants simply doesn't work.

Some examples of such agreements are the "Lancaster House" treaty in 2010 between the UK and France (involving, at least initially, missiles, aircraft carriers and even nuclear weapons), the Nordic Defence Collaboration Memorandum of Understanding in 2009 between Sweden, Norway, Finland, Denmark and Iceland, and the Visegrád group formed in 1993 by the Czech Republic, Hungary, Poland, and Slovakia.

Some remarks on particular difficulties with international collaboration

In addition to what's claimed by Charette (2008), there is a number of particular difficulties associated with cross-border collaboration:

- Nations have different budget cycles
- Nations have different parliamentary processes
- There is sometimes an unwillingness to compromise on requirements
- The principle of "Juste retour": Industrial participation is expected to be proportional to the financial contribution to the program

- Intellectual Property Rights (a.k.a. IPR): Who will own them?
- How to treat foreground knowledge (what's created in the program) and background knowledge (what's brought into the program based on previous experiences and activities).
- Differences in terms of culture, language, management style, …

So what's a small country, like Sweden, to do? Technology rushes ahead, and domestic funding is insufficient. Cooperation with other nations is necessary, and unavoidable, but difficult.

Ways to proceed

The following proposes a few ways ahead, and also some caveats. The observations refer to Sweden, but should also be applicable to similar-type nations.

We must accept our status as a second-rate nation in Europe with respect to future defense equipment programs. The Swedish self-image as a major European player in defence equipment matters is simply not relevant anymore.

We must furthermore accept the declining US interest in collaborating with Sweden. Even with the recent unrest in the Ukraine, factors such as the US pivot to South-East Asia, the NATO membership of several eastern European nations, and an awareness of Sweden's limited defence spending have all contributed to this reduced US interest.

We should establish/continue some advanced R&D programs in order to be an attractive partner nation. As only a buyer of what's available on the market, you're of much less interest to others as a potential development partner.

We have to prioritize among collaborative opportunities. Presently, the money is spread too thinly across a large number of simultaneous activities.

We should look for joint programs with a small number of like-minded participating nations. Having too many dissimilar participants simply doesn't work. Last week's bilateral talks between Sweden and Finland on future defence collaboration are certainly a step in the right direction.

And, finally, we must not expect significant progress from EU/EDA or NATO. EDA's Pooling and Sharing initiative, and NATO's similar Smart Defence proposal, make a seemingly logical claim that nations in Europe should increasingly develop, procure and even jointly operate defence equipment. This make sense for completely novel capabilities, such as NATO's jointly owned and operated C-17 strategic transport aircraft, based in Hungary, but it immediately runs into problems when dealing with existing capabilities: with more than 15 nations in Europe producing armored vehicles, which nation's industry will remain after consolidation, and will the other nations get delivery in times of crises or war?

Final remarks

So, to conclude, commercially driven technology development that can be mass-produced is definitely changing the operational capabilities that can be produced by small and "poor" nations, capabilities that were previously available only to super-powers or very rich nations.

The Internet, together with the free flow of goods, have created a situation where small groups of people can get access to powerful tools to inflict harm and chaos. Conventional countermeasures tend not to be as powerful anymore, and new ideas are needed.

So is the high-tech approach coming to an end? No, it will continue unabated along somewhat predictable tracks, but it may also sometimes take a path that we never envisioned, being disruptive to the extent that a paradigm shift is created in how to fight an adversary. No amount of planning will ever shield us from such unpredictable events.

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References

Arena, M. V., Younossi, O., Brancato, K., Blickstein, I., and Grammich, C. A. 2008. *Why Has the Cost of Fixed-Wing Aircraft Risen? : A Macroscopic Examination of the Trends in U.S. Military Aircraft Costs over the Past Several Decades*. RAND Corporation Report 2008026145

Augustine, Norman. 1986. *Augustine's Laws*. United Press International.

Charette, Robert N. 2008. *What's Wrong with Weapons Acquisitions*? IEEE Spectrum

Cornucopia. 2013. http://www.cornucopia.cornubot.se/2013/04/sa-hur-gick-forsvarets-ekonomi-at-skogen.html. In Swedish. (retrieved June 13, 2014)

Guzelyté, Silvija. 2013. http://www.eda.europa.eu/docs/default-source/finance-documents/national-defence-data-2012.pdf (retrieved June 13, 2014)

Richmond, Ben. 2014. http://www.motherboard.vice.com/read/more-allies-are-cutting-orders-for-the-pentagons-costly-new-fighter-jet (retrieved June 13, 2014)