DEFENCE INDUSTRY IN THE TWENTY-FIRST CENTURY: IMPLICATIONS FOR SMALLER COUNTRIES

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Abstract: The global defence industry landscape has changed substantially over the last fifteen years. Rising costs and budget constraints have progressively forced the consolidation of defence industries in both the United States and Western Europe while, at the same time, a military technology gap has emerged between the United States and the rest of the world. These and other factors are making it increasing difficult for smaller countries to maintain independent defence industry capabilities in all but low-tech areas. It appears that these trends are likely to continue into the future, creating many challenges for smaller nations. To meet these challenges, smaller countries will need to improve their force planning, strategically prioritise their investment in domestic industry capabilities and make the best use they can of their international relationships to secure the equipment and the equipment support they need.

Acknowledgement: This paper is based on work done for, and funded, by the Australian Industry Group (Ai Group) Defence Council. Any views expressed are the sole responsibility of the author and should not be attributed or ascribed to either the Australian Strategic Policy Institute (ASPI) or the Ai Group Defence Council.
Section 1. Introduction

With a couple of exceptions, most modern high-tech military equipment is designed, developed and manufactured in the United States, Russia or Western Europe. As a result, nearly all other countries are reliant to some extent on those sources for military hardware. This dependence, however, is rarely total because even small countries tend to maintain some sort of indigenous defence industry capabilities within their own borders.

There are many reasons for countries to have their own defence industrial base despite the availability of equipment from established larger suppliers. Traditionally, the opportunity to generate domestic employment and spur economic activity has figured prominently in decisions to build local rather than purchase from offshore. National pride has often also played a role, particularly among younger nations that see a degree of defence industrial self-reliance as a sign of coming of age.

In the modern globalised world, the argument for maintaining a domestic defence industry should – in principle at least – be harder nosed. Namely, it’s either cheaper to procure and support equipment in-country, or it’s necessary to do so because foreign sources are unavailable, inadequate or strategically imprudent to rely upon. From this standpoint, the development and maintenance of a local defence industrial base should be predicated on gaining a strategic military advantage by doing so.

Unfortunately, several developments are making it increasingly difficult for all but the largest powers to maintain independent and technologically capable defence industries. This has important implications for countries other than the United States, Russia and those outside of the de facto industrial confederation of Western Europe.

The aim of this paper is two-fold. Firstly to examine the strategic imperatives for smaller countries to have some sort of domestic defence industry and, secondly, to understand the challenge of maintaining such industries in the twenty-first century. To ensure that the discussion remains concrete, the author has used his own country (Australia) as a case study in several instances. Moreover, the analysis has an unashamedly western focus with only limited attention paid to the Russian Federation as a supplier of equipment.

The paper is structured as follows. Section 2 explores, in general terms, the strategic military advantages of local defence production for smaller countries beyond the US and outside of Western Europe and Russia. Section 3 details the economic, strategic and technological factors shaping defence industry internationally. Section 4 explores how the US and Europe are responding to these pressures – both as a guide to how smaller countries might respond, and also to see where the international defence industry market is headed. Finally, Section 5 draws broad conclusions about how smaller countries might deal with the challenges ahead.
Section 2. Defence industry as a strategic capability

Nearly every country’s defence force depends on a mixture of local and offshore industry for equipment and support. For example, Australian policy takes the following carefully circumscribed view of what it expects from local defence industry; ‘Australia needs support in-country for repair, maintenance, modification and provisioning – especially in wartime when the ADF would need urgent and assured supply.’ Noteworthy by its absence is any suggestion of the need to design or build military equipment in-country.

To understand the strategic rationale behind different generic industry capabilities (repair, maintain, design etc.), the potential strategic military advantages of each are explored below.

**Repair and Maintain**
The most direct advantage of employing local industry arises in the routine repair and maintenance of equipment. For all but a handful of geographically fortunate countries, it would simply be impractical to transfer major weapons systems offshore for maintenance and repair. A ship, for example, would take weeks to transit to the US or Europe from Asia, and an aircraft would similarly burn up valuable flying hours in transit (assuming in both cases that they were not in need of repair and unable to steam/fly). In wartime the situation would become much more acute, given the need to return assets to operations quickly and the potential vulnerability of country’s external lines of communication.

This does not mean that all repair and maintenance has to be done within a country’s borders – far from it. There are many specialist systems and sub-systems for which it is impractical to maintain a domestic repair capability. These include everything from helicopter gear-boxes through to high-tech avionic components. It makes more sense to hold surplus quantities of such systems and rotate them overseas for repair and maintenance. In practice, the decision to repair in-country or hold surplus stock has to be made on an individual basis.

**Provision**
Just as with repair and maintenance, the practicality of provisioning forces with consumables inevitably involves local industry. For routine items like clothing, fuel and rations, this is easily achieved by linking commercial civil suppliers into the military logistics supply system (which is increasing provided as a service by industry). However, for uniquely military items like munitions and spare parts, a choice has to be made; does a nation stockpile foreign produced items, or retain a production capacity in country? Once again there is no single answer. Generally speaking, for most small to medium countries, precision guided munitions and high-tech spare parts are usually managed through a mixture of stockpiling and (hopefully) assured access to foreign supplies in an emergency, while other low-tech items like non-guided munitions are more likely to be produced locally.
The advantage of local manufacture of consumables (particularly munitions), is that it provides an assured supply of known quality, that’s independent of competing demands for offshore supply/production in a crisis. However, this can be difficult to achieve. For example, Australia has only achieved production self-reliance in the case of relatively low-tech munitions, and even then it’s often contingent on foreign sourced precursors.

**Modify**
To gain and retain a capability edge over potential adversaries, a country needs to be able to optimize the performance of military equipment to different operating environments and against changing threats. Sometimes this can be done simply, for example by updating electronic warfare threat libraries or through software changes. More generally, it can mean adapting and even re-engineering equipment as part of the cycle of measure and countermeasure that underpins the development of military technology – sometimes on relatively short timeframes, thereby often precluding the practicality of offshore sources. Of course, for smaller countries with a high dependence on foreign systems and components, there are practical limits to what can be achieved without substantial investment and, even more so, offshore assistance and IP.

**Upgrade**
To improve the performance of weapons systems and avoid obsolescence, it’s often necessary to upgrade major components like engines, radars, sonars, avionics, weapons and electronic combat systems. While the distinction between ‘modifying’ and ‘upgrading’ weapons systems is increasingly blurred, the latter is distinguished by the replacement of major sub-systems with more modern versions rather than trying to modify an existing sub-system. In recent years, Australia has upgraded most of its older platforms including P-3C, F-111, F/A-18 aircraft and both the FFG frigates and Collins class submarines. Because upgrades tend to be deliberate pre-planned activities that take a platform out of service for an extended period of time, the practical imperative to upgrade in-country is less than that for modifications that might need to be done within an operational time frame. And even when an upgrade is performed in-country, few major upgrades are possible without the import of critical components, IP and, sometimes, skilled personnel from overseas.

**Design & Manufacture**
Assuming that industrial mobilisation to turn ‘plough-shears into swords’ is an antiquated concept in today’s era of short decisive conflicts, the imperative to design and manufacture military equipment is difficult to justify for smaller nations. Nonetheless, it’s often argued that the ability to design and manufacture (or at least to manufacture to a foreign design) can deliver a strategic military advantage. Such circumstances include where:

- Local manufacture is a necessary pre-condition for effective through-life support.
- Local design and/or manufacture are the only ways to meet a country’s unique specifications at an acceptable level of risk.
Local manufacture of one project is a necessary commercial precondition for maintaining the industrial capacity to meet unique specifications at an acceptable level of risk in other projects, or to provide through-life support more generally.

The extent to which such circumstances arise is a matter of judgment if not debate, the details of which vary from country to country and from industrial capability to industrial capability.

**Sovereign independence**

So far, the discussion has been on the military strategic advantages of work being performed onshore as opposed to offshore. This focus on where work is undertaken, as opposed to who does the work, ignores the question of ownership and sovereign control. Herein lays a subtle point. Choosing to have industrial work done onshore for purely practical reasons (like the prohibitive transit times incurred with foreign maintenance) is quite different from maintaining an independent capability that is immune from withdrawal of foreign cooperation.

For example, while a small to medium power might well perform ambitious upgrades of its military platforms; this will not usually be possible without foreign components and expertise. For example, most of the in-country firms supporting key Australian military capabilities are either foreign owned, subsidiaries of foreign firms or are closely partnered with foreign technology providers offshore. Consequently, over anything more than short time periods, Australia’s self-reliance is dependent on the continued cooperation of foreign governments and Original Equipment Manufacturers (OEM).

However, there will always be a couple of areas where a country feels it needs to retain an independent sovereign capability through some combination of local defence industry and government owned in-house capability. For example, and for obvious reasons, many countries maintain the ability to independently and securely manage their own cryptographic systems. More interesting, however, are the following two capabilities in ascending order of difficulty:

- The ability to independently test and benchmark the performance of key assets including sensors, guided munitions and integrated systems.

- The independent capability to modify key assets to improve their performance in line with operational priorities (in case foreign cooperation is unavailable or inadequate).

Underlying such aspirations is the fear that foreign equipment will fail to meet critical performance requirements. This is not simply a matter of a country might have ‘unique’ requirements that cannot be met off-the-shelf but also that they might end up with sub-optimized ‘export versions’ of equipment. Even a close US ally like Australia is prone to such dangers. That’s why, in several areas and to varying extents, Australia has traditionally maintained exactly these sorts of independent capabilities in-country often at considerable cost. Unfortunately, the reticence of many foreign countries and OEM to
release the necessary intellectual property (and especially source code) often makes these capabilities difficult to maintain. Indeed, it’s no secret that the extent of IP release is very often a contentious point in negotiations – witness the recent, very public brawl between the US and the UK (and to a lesser extent Australia) over the F-35 JSF.

**Indirect advantage**

A strong defence industrial base can give a country strategic and diplomatic leverage quite independent of the direct military advantage conferred. For example, manufacturers of high-tech weapons systems like the US, UK, Europe and Russia routinely use the export (or non-export) of military equipment to reward (or punish) other nations quite independent of commercial interests.

However, such influence is almost exclusively the purview of larger powers. Even for middle powers, the opportunity to garner strategic or diplomatic leverage from defence export tends to be very limited. Like it or not, apart from the major powers, most countries lack the economic scale and technological know-how to design and manufacture advanced weapons systems (with the arsenal state of Sweden the obvious exception).

**Conclusion**

Aside from some areas of uncertainty – like the extent to which manufacture is, or isn’t, a precondition for ongoing support – the forgoing examination of the strategic imperatives for maintaining a defence industrial base tends to imply relatively modest goals for smaller nations.

Nevertheless, many countries have defence industry sectors that comfortably exceeds the limited goals implied above. Australia, for example goes well beyond its limited goal of ‘repair, maintain, modify and provision’ in a number of areas, especially once the ability to leverage off-shore intellectual property and expertise is taken into account. This is displayed graphically in Table 1 which lists the activities undertaken by Australian defence industry over the last decade, or planned for the next decade. There are two factors contributing to this:

- Past procurement decisions often sought to create employment and regional economic growth as a byproduct of defence procurement. At one time this was explicitly reflected in a tolerance for paying a cost premium for domestic production, more recently it’s been pursued through the Australian Industry Involvement program that gave preference to local production and work-share with minimal attention to the strategic military advantage gained.

- In some cases it’s a simple consequence of the judgment – sometimes made as an act of faith – that acquisition and/or whole-of-life costs will be less through local procurement than through offshore suppliers.

In the final analysis the following must be stressed; although local defence industries provide a wide range of goods and services in many small to middle sized countries, it is
usually only because of very extensive support from overseas. In practice, the strategic imperatives underpinning the defence industrial base in small to medium sized countries are driven more by the practical and logistical aspects of self-reliance than any serious attempt at sovereign independence.
**Table 1: Recent Australian Defence Industry Activities**

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<thead>
<tr>
<th>Capability</th>
<th>Provision</th>
<th>Maintain/Repair</th>
<th>Modify/Upgrade</th>
<th>Manufacture</th>
<th>Design</th>
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<td>Rotary Wing Aircraft</td>
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<td>Transport Aircraft</td>
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<td>COTS based C4I Systems</td>
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<td>Mil-Spec C4I Systems</td>
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Activity undertaken in Australia accepting that repair, maintain, modify, upgrade and manufacture are largely contingent on foreign components and intellectual property.

Activity undertaken with significant level of foreign support for upgrade and/or design.

Activity largely not undertaken in Australia.
Section 3. The factors shaping international defence industry

The international defence industry landscape began to change rapidly following the end of the Cold War. While it’s tempting to view this as a simple commercial response to falling defence budgets, there were actually several factors at play which the end of the Cold War accelerated and amplified.

To understand where the global arms market might go next requires an appreciation of these factors which are explored below. In the process, the focus will be on the US and Western Europe because they are the traditional suppliers of equipment and technology to western allies.

The rising cost of military capability

The largest single factor influencing the evolution of defence industry is the long-term rise in the unit cost of military equipment. Although this was not analysed in detail by defence economists until the 1970s, the unit cost of successive generations of military equipment has been growing exponentially since the middle of the nineteenth century.

A recent analysis of rising unit costs was undertaken by Australia’s Defence Materiel Organisation in 2005 using international data. It found that the real (above inflation) unit cost of frigates and destroyers had grown by 3% per annum, combat aircraft by 3.5% and conventional submarines by 3.75%. These figures do not include the much higher rates of growth that often accompany the adoption of new technology – such as the transition from piston to jet aircraft and the move from warships armed with guns to those armed with missiles, both of which were accompanied by double-figure growth.

The seemingly inextricable rise in the unit cost of military equipment contrasts markedly with the trend in the cost of many non-military manufactured items where productivity has reduced unit costs over time. The difference is that military equipment has to decisively outperform that employed by potential adversaries and, as a result, new technologies tend to be channeled into increasing performance rather than reducing costs. What’s more, as potential adversaries respond with improvements of their own, a competitive cycle of measure and countermeasure is established.

Over time, the relentless compounding of growth has a profound effect. For example, a 1940 Spitfire aircraft cost less than $1 million compared with close to $200 million for an F-22 Raptor today (both measured in 2006 dollars). One analysis from the late 1980s showed that if the US defense budget and unit aircraft costs continue to grow in line with long-term historical trends, the latter would exceed the former in about 2060. Clearly, this is not sustainable. So it’s no surprise that defence procurement patterns were changing long before the end of the Cold War as a result of rising costs. The adaptation is reflected in the following trends:

- Smaller production runs leading to a higher proportion of fixed costs in projects including research and development and production set-up. For example, between
1985 and 2003 the proportion of US military modernization spending devoted to research and development grew from 22% to over 40%.

- Falling fleet sizes. For example, in 1955 Australia had around 550 fast-jet aircraft but by 2005 the fleet had fallen to around 100. Over the same period the US tactical air fleet fell from around 9000 to about 2200. In both cases the bulk of the fall pre-dates the end of the Cold War.

- Less frequent replacement of equipment and more frequent upgrades.

- A trend towards multi-role rather than mission specific platforms. Australia’s planned consolidation of the strike and air-intercept role onto the JSF is an example.


- Greater use of commercial services, often through private-public partnerships, to deliver transport and logistic capabilities. This reflects not just the changing roles of government and the private sector but also a desire to reestablish economies of scale.

- Weapons producing nations are more actively pursuing commercial exports to share the fixed costs of production with others.

- Weapon purchasing nations are more actively seeking competition from diverse suppliers in order to drive down prices.

**Changing defence spending**

The end of the Cold War saw countries move quickly to harvest the long-awaited peace dividend. According to official NATO figures, between 1990 and 1999 total European NATO spending fell by 13.8% in real terms (including a 27.4% cut in the United Kingdom) while US spending fell by 28.6%. This trend was reflected world-wide with a 33% cut to global defence spending across the 1990s.

The downturn in defence spending among the traditional overseas suppliers of defence equipment amplified the pressure of rising unit costs on government and business. Indeed, because the importance of unit cost is only relative to the size of the defence budget from which a purchase is made, the roughly 30% fall in overall defence spending post-Cold War was equivalent to an extra decade of unit cost growth at 3% per annum. Trapped between falling budgets and rising unit costs – both running at around 3% per annum – governments and industry had to adapt at twice the normal pace during the 1990s. The result was an acceleration of the trends already canvassed along with a substantial consolidation and internationalisation of the defence industry sector – the details of which are explored later.
Of course, the new security environment that emerged following the events of 9/11 spurred growth in defence spending in many countries. Between 2000 and 2005, US defence spending grew in real terms by more than 36% contributing in large measure to the 18% growth in global defence spending in recent years. In the UK, the post-cold war decline has been reversed with spending up by 5% over the past five years. In Australia spending has also grown – 23% in real terms since 2000.

So far, the recent increase in defence spending has not reversed any of the trends due to rising unit costs of equipment. And one should not count on it doing so. Not only has a lot of the recent additional funding been directed to operations rather than procurement, but the rise in costs continues apace. At best, the recent boosts to spending in the US, UK and elsewhere gives us a little more breathing room to plan how to adapt to past and ongoing changes.

Within the overall waxing and waning of global defence spending since 1990, one trend has remained constant; the predominance of the US. In 2002 the US spent as much on defence as the next thirteen ranked countries. More importantly, it spends a large share of its budget on equipment. According to NATO data, in 2005 the US spent close to 2.4 times more on equipment than all of Europe (including the Russian Federation) put together, and that’s before the disproportionately large US research, development, test and evaluation budget is taken into account. This has important consequences as we’ll see below.

**International strategic context**

From a defence industry perspective, a key question is how the global strategic environment is likely to shape the demand for military equipment qualitatively and quantitatively. While the possibility of a strategic shock cannot be discounted, there is little to be gained by speculating on unforeseen crises; therefore we’ll focus on the strategic trends that can be discerned today beginning, as is appropriate in a uni-polar world, with the United States.

**The United States – near-term threats**

In the near term, the ‘Long War’ (as the US now calls the conflation of combating Islamist terrorists and stabilizing Iraq) will continue for at least several more years, in one form or another. This will maintain current demand for military equipment in the US, especially in relevant land warfare technologies. The resulting demand, however, will not be a driver of innovation except in niche areas (like IED countermeasures). In contrast, the emerging challenge of a nuclear armed ‘rouge’ will not only maintain support for overall defence spending and investment in the US, but also drive innovation in several high-tech areas like ballistic missile defence systems.

**The United States – long-term strategy**

Given the overwhelming predominance of US defence spending, the US has the ability to maintain a technological edge across the board over any other nation, or group of nations, for the foreseeable future. What’s more, it has resolved to do so.
If there was any thought that the US would respond to the new asymmetric security environment with more ‘boots on the ground’ than high-tech platforms, the 2006 Quadrennial Defense Review set the record straight. In the context of ‘shaping the choices of countries at the strategic crossroads’ it says that:

“The United States will develop capabilities that would present any adversary with complex and multidimensional challenges and complicate its offensive planning efforts. These include the pursuit of investments that capitalise on enduring U.S. advantages in key strategic and operational areas...”

And

“Sustaining America’s scientific and technological advantages over any potential competitor contributes to the nation’s ability to dissuade future forms of military competition.”

This continues a theme from the 2002 National Security Strategy that talked about the US having forces strong enough to “dissuade potential adversaries from pursuing a military build-up in hopes of surpassing, or equaling, the power of the United States”. There can be little doubt that the message is intended for China, and to a lesser extent perhaps Russia.

This declared intent is reflected in the allocation of resources. According to official US defence budget papers, between 2000 and 2006 approval for research and development grew by 63% compared with 19% for personnel, 27% for procurement and 16% for operations and maintenance (all in real terms). At the same time, US ‘black’ procurement programs have reached their highest level in real spending terms since 1988. The 2006 US budget request included classified projects valued at $28 billion amounting to 19% of total acquisition funding. This represents a doubling in real terms of spending on ‘black’ projects compared with the post-Cold War nadir of 1995.

If the US adheres to this strategy – and there’s no reason to think they won’t – there are two possibilities; they spend a lot of money and their strategy dissuades potential adversaries, or their strategy fails and they spend even more money. Either way, the US will continue to move ahead of the rest of the world in military technology. What’s more, they will be as cautious as ever to protect this capability edge by guarding sensitive IP, especially when dealing with third-party countries (including some in Europe) that might be willing to sell arms to China.

Europe

Peace broke out in Western Europe long ago, and reconciliation with Eastern Europe (i.e. Russia) is holding for the moment. Moreover, aside for the UK, the Europeans are cautious about getting involved in so-called ‘global’ responsibilities as shown by their very limited involvement in Afghanistan and their late and very cautious approach to the Balkans. Consequently, the quantitative demand for equipment in Europe is unlikely to go beyond the scale of current programs to replace ageing platforms. Nor, more importantly, does there appear to be any driving imperative to develop future ‘next
generation’ military capabilities in Europe. (As will be seen, even if this was not the case, the fragmentation of European industry would hamper an effective response.)

In the final analysis, the fact that the major powers of continental Europe devote a relatively small share of their gross domestic product to defence spending (including Spain 2.6%, France 2.1%, Italy 1.3% and Germany 1.2%) compared with the US (4.4%) and UK (3.2%), says it all; this is a continent firmly at peace. The only foreseeable development that could change this would be the re-emergence of a hostile Russia. Indeed, the current European posture is arguably a hedge against just such a development.

In strategic affairs, the UK is the odd man out in Europe having signed up to the ‘coalition of the willing’ at a level well beyond any other country other than the US itself. However, with UK defence spending at around only one-tenth that of the US, it is in no position to independently (or even with its continental colleagues) seek parity in military technological with the US.

Indeed, a recent UK Ministry of Defence study found that by 2001 the UK had already fallen five years behind the US in capability due to low R&D spending. The same study put Germany, Sweden and China respectively seven, eleven and sixteen years behind the US. The situation is unlikely to change any time soon with US R&D spending more than twelve times higher than the UK and six times higher than the EU.

**Russian Federation**

For the moment at least, the Russian Federation continues to field and export capable military equipment. How long this will continue remains unclear because of two countervailing factors. Firstly, the absence of Cold War-style competition with the West diminishes the imperative to update and develop new systems (although, as already discussed, technological developments in the US continue unabated). Secondly, the Russian Federation lacks an effective tax base to provide the capital needed for future product development.

The failure of Russian industry to field a fifth generation fighter aircraft is a clear sign that they are already slipping behind the US in technology. On current trends, the gap will continue to widen and the Russian Federation will become a supplier of second-tier quality to those countries that cannot access, or afford, superior equipment from the US or Western Europe. But this might not necessarily be the case; one intriguing possibility is that Chinese capital will eventually fund the development of next generation weapons systems leveraging Russian expertise.

**Australia**

In its largest military build-up since the mid-1960s, Australia is expanding its expeditionary land capability and bolstering its traditional priority area of air and maritime control. In the process, it is also moving to a significantly higher level of preparedness than at any time in the last thirty years. None of this is of the scale...
necessary to make a more industrially self-reliant defence posture economically feasible or strategically necessary.

The key strategic development from an industry perspective in Australia is the growing priority for interoperability with the US. This has resulted in several sole-source decisions in recent years including the new air combat capability, submarine upgrade, heavy-weight torpedo and air warfare destroyer combat system. Over the same period, the US has reemphasised the importance of working with allies in pursuit of its goals, and in the 2006 QDR went as far as saying that the United States ‘places great value on its unique relationships with the United Kingdom and Australia’. It remains to be seen whether this translates into either a higher priority for interoperability or greater access to sensitive US military technology, or both.

Rest of the world

Assuming that globalization continues to deliver wealth to the developing world in the coming decades, it can be expected that the market for military equipment will grow correspondingly. As a general rule, all other things being equal, countries tend to spend more on defence as their wealth grows. This will provide growing markets for US, European and Russian arms that will assist in maintaining economies of scale in the respective defence industrial bases. However, given that the US is likely to receive a healthy share of these exports, it’s unlikely to erode the predominant industrial position of the US. Indeed, given that the US is already selling its weapons systems into Europe (including to ex-Soviet block countries like Poland and Western European leaders like the UK) it’s probable that the international export market will only reinforce the position of the US – ditto for the traditional US customers in North Asia like Japan, South Korea and Taiwan.

In the longer-term, the critical issue is how China (and Russia as a source of technology) responds. Unless the US policy of dissuading potential peer competitors works, direct competition may develop between China and the US and/or between China and the US through the intermediary of Japan or Taiwan. In either case, the result will be renewed resolve and an investment in scale and technology by the US and, in some cases, its allies.

Trends in military technology

Notwithstanding Word War I, where evenly matched adversaries fought a bloody war of attrition, the ability to prevail on the battlefield has often depended crucially on the advantage that better technology confers. From the long bow at Agincourt to the use of radar in the Battle of Britain; better arms have repeatedly delivered decisive victory against numerically superior foes. If anything, this is becoming increasing truer today as the move to networked warfare magnifies the advantage already inherent in advanced targeting sensors and precision weapons. For a country like Australia with a small armed force that relies on a decisive capability edge, having access to the best military equipment will only get more important.
(Aside: Of course, as Iraq shows, technology is far from a guarantee of success. A commitment to a high-tech force at the expense of raw scale must be accompanied a strategy of avoiding battlefield where asymmetric tactics can nullify the advantage conferred by technology. New military technologies can be worthless without the right tactics and strategy.)

Growing importance of COTS technology
For much of the 20th century, military research and development was an important driver of basic technological innovation; radar, digital computation, cryptography, nuclear energy, rocketry and satellite technology all owe their genesis to military applications. Today the commercial sector is at the forefront of innovation with the military largely relegated to being an exploiter, rather than a developer, of underlying technologies.

One consequence is that a wider range of providers, and a greater number of skilled individuals, are available from the broader economy to deliver and support C4ISR capabilities and the electronic ‘smarts’ of new systems. Arcane mil-spec programming languages are rapidly being replaced by an open architecture approach using commercial standards.

As a result, acquisition and support costs may fall as commercial economies of scale increasingly underpin equipment production and maintenance, especially in the areas of electronics and computation – both traditional cost drivers of military equipment. However, a similar expectation has arisen with each successive generation of new technology in the past – an expectation rarely fulfilled. Perhaps reality will match expectation this time around.

Several factors however, are working against it. First, the renewal cycle for modern IT systems is around eighteen months – ten times more frequent than for traditional weapons systems. What is saved in acquisition costs may be lost, in part at least, through more frequent upgrades. More broadly, the demand to maintain a decisive capability edge (driven somewhat by a reduced tolerance of casualties) may drive costs up faster than technology delivers cost reductions. In any event, key elements of weapons systems like sensors will still require a high degree of specialist engineering.

The move to COTS technology will also drive an unavoidable increase in the dependence on non-allied foreign suppliers for the ‘raw materials’ of the 21st century; individual electronic components. Although the large volumes and ready availability of, for example computer chips, makes it hard to see how this could become a critical problem, it’s an issue worthy of note.

Along with the adoption of COTS technology, there have emerged new equipment support concepts that exploit modern technology and adapt the best ideas from civil practice. Self-diagnostic systems, rapid switch-out of subsystems, just-in-time logistics and incremental product improvement are increasingly being employed. At the same time, supply chains for purpose built sub-systems are becoming increasingly diverse and globalised – as with the JSF program which will see the US drawing on the innovation
and greater competition available from a multinational subcontractor base (albeit largely for non-critical components).

While the sources of sub-systems might become more numerous and variable, the core intellectual property of many advanced weapons systems is still closely held – especially by the US. The critical question is the extent to which new open-system architectures will allow countries to modify and adapt advanced weapons systems for their purposes. In principle, modern technology should make this easier to do than in the past while still maintaining the integrity of the core IP.

In any case, the trend with advanced weapons systems will be towards incremental upgrades that demand a combination of strong links with the OEM, local systems integration expertise and a comprehensive appreciation of system performance.
Section 4. The future of international defence industry

Three characteristics describe the transformation of the defense industry landscape in the western hemisphere since the end of the cold-war. In order of descending importance they are:

- Consolidation of firms in an attempt to regain economies of scale lost due to falling defence budgets and rising unit costs.

- Privatization of national arsenals in many countries as part of the general transfer of activity from the public to private sector begun during the Thatcher-Regan era of the 1980s.

- Increased commercialization of the arms industry as the geopolitical constraints of the Cold War have been removed – in effect, heralding a partial return to the practices of the first half of the last century.

The consolidation of defence industry has been most dramatic in the US. The process there began in earnest in 1993 when the DoD effectively directed firms to rationalise with the proviso that viable competition be left at the prime contractor level. To support the process, tax concessions were even provided to subsidise the cost of mergers and acquisitions. However, while the government was instrumental in initiating the process, they largely let market forces decide the details. That is, until the late 1990s when they stepped in to call a halt, having judged that further consolidation would imperil competition.

The result was the concentration of US defence prime contractors into a handful of very large firms. This came about in two ways. Firstly, many firms chose to leave the defence sector; of the 100 top defence contractors in the late 1980s, twenty-four abandoned defence work during the 1990s. Secondly, and more importantly, the remaining firms largely consolidated into five big leviathans that together represent the aggregation of fifty-two independent companies from the 1980s.

The rationalisation in Europe has been less dramatic, and in a sense less explicit, than in the US. The thirty largest European firms operating in 1990 have consolidated into around fourteen larger firms. However, this statistic beguiles a complex web of joint ventures between firms that constitutes a de facto consolidation that generates economies of scale but tolerates inefficient multiple overheads and fragmented management.

Europe’s internal borders are to blame for the lesser degree of consolidation compared with the US. Despite the progress of the European Union, and the fact that more than twenty-seven government-owned European defence firms were privatised in the 1990s, national sentiments remain strong – particularly in the area of defence industry where notions of sovereign independence remain. Nevertheless, some large cross-border
consolidations have occurred, including the predominately French-German amalgamation that resulted in the formation of EADS

Consistent with its lead in defence spending, US firms make up the lion’s shares of the global market. Of the top ten international defence firms in 2004, four of the top five defence companies were US based; Lockheed Martin, Boeing, Northrop Grumman, and Raytheon. The fifth, BAe Systems, is a UK based firm increasingly active in the US market. Of the next five, the US firm, General Dynamics, comes next followed by three European firms; Thales, EADS and Finmeccanica. In tenth places comes the US firm United Technologies.

The scale and concentration of US corporate dominance is best appreciated by looking at aggregate turn-over rather than just rank order. For example, the top five international defence firms in 2004 (all of which but one are US based) had a turnover more than twice the size of the bottom five. Moreover, the top ten US defense firms that year had a turnover 2.4 times larger than the top ten European firms (or 3.7 times larger if one counts the increasingly transatlantic BAe on the US side of the ledger).

The picture does not change if one includes firms below the top tier. A 2002 RAND report said that of the top 100 defence firms world-wide, fifty were from the US commanding 63% of global market share, ten were UK companies with a share of 14%, seven were French with an 8.6% and three were German with a 1.4% share.

To remain viable, the smaller and more fragmented European defence industry sector has been forced to commercialise in two directions. Firstly, it has actively sought defence exports. Secondly, it has diversified into the global civilian market. On both fronts there has been success, as the Airbus program clearly demonstrates. However, aside from the UK, Europe has had only very limited success in penetrating the lucrative US defence market.

Without further consolidation within Europe or across the Atlantic, or at least a revival of trans-Atlantic joint programs, it’s unlikely that Europe will be able to prevent a growing capability gap with the US; currently, for example, the US spends more on missile R&D than the entire EU military R&D budget.

**What’s next?**
Recent developments give little clue to the critical question – will the US and Europe establish a more collaborative approach to defence production or not? On the surface the argument to do so is strong since both would benefit from greater economies of scale, increased competition and a wider intellectual base for innovation. What’s more, in the 1980s, trans-Atlantic programs were relatively common in the joint effort to match the Soviet threat, and following the end of the Cold War commercial investment in non-military areas has flowed strongly both ways between the US and Europe. Yet there are big hurdles in the way.
On the US side is a reticence to share sensitive technology. Even with its closest ally the UK, the US draws a firm line on the release of the intellectual property underpinning its military capabilities (as we’ve seen with the recent stand-off over the JSF). And although the latest attempt to protect US defence manufacturing jobs through the ‘Buy American’ bill was defeated, there remains a strong protectionist sentiment in the US. A sentiment tainted at the political level with resentment over the stance parts of Europe took over the invasion of Iraq. Consistent with this, it’s noteworthy that the European firm that’s made most headway into the US market is the UK owned BAe Systems.

The US DoD, however, tends to take a more pragmatic approach to foreign production than US politicians – at least when sensitive technologies are not involved. The recent decision to choose a European helicopter to replace the ‘Marine One’ fleet is an example, as is the willingness to at least consider the Airbus solution for the USAF tanker fleet. Nonetheless, the US currently spends less than 2% of its procurement budget on imports and only 7% with foreign (mainly UK) owned companies.

Europe, for its part, seems focused on freeing up the constraints on further defence industry cooperation within its borders. Recent examples include the establishment of a common defence R&D program and the late 2005 introduction of a voluntary code for cross-border defence procurement competition within members of the European Defence Agency (EDA). Whether this is a prelude to a cross-Atlantic approach, or another step towards establishing an insular ‘fortress Europe’ is difficult to say.

Once again, the UK is the odd man out in Europe. While they stay closely involved in European programs, they have been making strong inroads into the US market – in 2004 around £2 billion was spent by UK firms (including Rolls Royce and BAe Systems) on acquisitions in the US. So, whatever happens, the UK will have a foot in both camps.

Ultimately, the decision on trans-Atlantic consolidation and cooperation will be a political one. From a purely commercial perspective both sides have much to gain (Europe more so) through pooled efforts and greater competition. It’s a question of whether these benefits are perceived to outweigh parochial sentiments and security concerns.

Irrespective of whether the US and Europe decide to cooperate, the overall trend in defence industry is towards a small number of increasingly transnational defence firms that deliver a correspondingly small number of advanced programs.

The UK approach

It’s instructive to see how the UK is adapting to this new industry environment as a guide to how other countries might position themselves. Fortunately, the UK published a detailed Defence Industry Strategy (DIS) White Paper in December 2005 that makes transparent their approach.

Broadly speaking, the UK have identified a number of critical capabilities that they are willing to quarantine from foreign competition and thrown the rest open to competition.
Table 2 summarises the goals set out in the DIS for UK industry. What’s interesting is that their aspirations are only a measured step beyond the recent pattern of Australian industry activity in Table 1 – notwithstanding that they have three times Australia’s population and four times its defence budget.

**Table 2: United Kingdom Defence Industry Future Goals**

<table>
<thead>
<tr>
<th>Capability</th>
<th>Provision</th>
<th>Maintain &amp; Repair</th>
<th>Modify &amp; Upgrade</th>
<th>Manufacture</th>
<th>Design</th>
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<tbody>
<tr>
<td>Ballistic Munitions</td>
<td></td>
<td></td>
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<tr>
<td>Complex Weapons</td>
<td></td>
<td></td>
<td>Some level of domestic ability desired but willing to go off-shore – depends on value for money</td>
<td>Some level of domestic ability desired but willing to go off-shore – depends on value for money</td>
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<tr>
<td>Small Arms</td>
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<td>Military B Vehicles</td>
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<td>Light Armored Vehicles</td>
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<tr>
<td>Heavy Armored Vehicles</td>
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<tr>
<td>Fast Jet Combat Aircraft</td>
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<tr>
<td>Mission Specific Aircraft</td>
<td></td>
<td></td>
<td>Retain ability to design and engineer new mission systems, avionics etc</td>
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<tr>
<td>Rotary Wing Aircraft</td>
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<td></td>
<td>Retain some specific areas of expertise</td>
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<td>UAV UCAV</td>
<td></td>
<td></td>
<td>Technology demonstrator program only at this stage</td>
<td>Technology demonstrator program only at this stage</td>
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<tr>
<td>Transport Aircraft</td>
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<tr>
<td>Aircraft Mission Systems</td>
<td></td>
<td></td>
<td>Retain ability in key systems – mainly EWSP</td>
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<tr>
<td>Complex Naval Surface Vessels</td>
<td></td>
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<td>Retain minimum ability to build &amp; integrate in-country</td>
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<tr>
<td>Non-Complex Naval Vessels</td>
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<td>Nuclear Submarines</td>
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<tr>
<td>Naval Combat, Sensor &amp; Weapons Systems</td>
<td></td>
<td></td>
<td>Retain systems integration and combat systems expertise plus abilities in key maritime systems</td>
<td>Retain systems integration and combat systems expertise plus abilities in key maritime systems</td>
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<tr>
<td>CC4ISTAR</td>
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<td></td>
<td>Ability to understand, integrate, assure and modify mission critical systems, plus cryptographic capabilities.</td>
<td>Ability to understand, integrate, assure and modify mission critical systems, plus cryptographic capabilities.</td>
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<tr>
<td>CBRN Protection</td>
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<tr>
<td>Systems Engineering</td>
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<tr>
<td>Smart Buyer Test &amp; Evaluation</td>
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<td></td>
<td>Looking for international collaboration on T&amp;E.</td>
<td>Looking for international collaboration on T&amp;E.</td>
<td></td>
</tr>
</tbody>
</table>
Of course, the relatively measured goals of Table 2 are not a reflection of current defence industry activity in the UK – many of the areas designated as non-critical already have large domestic programs underway – nor does it preclude UK firms winning work in future competitions. Moreover, while it looks as though the DIS has made some hard decisions, these are largely left for others to implement when the next cycle of production commences. Even so, it provides clear guidance to defence industry so that they can decide whether to make a long-term commitment to the UK or move on the other markets – a critical question for the trans-Atlantic BAe Systems.

In the DIS, the UK has taken an impressively ‘dry’ approach to defence industry in the – much more so than their continental colleagues. The strength of the DIS is that it allows the UK to focus its efforts on critical industry areas while reaping the full benefit of competition in the US and European defence markets elsewhere. On the other hand, the DIS signals a reduced role for competition in some areas where it is necessary to retain capabilities on-shore. In some cases, it has split the difference and decided to retain an existing firm in a privileged position but with the threat of going offshore if performance is inadequate.

It’s interesting to consider what a chart like Table 2 would look like for the US. No doubt there would be an expanse of green signifying their desire to retain most, but not all, industrial capabilities in-country. Increasingly the US is willing to let the global market deliver non-critical capabilities including high speed vessels (Australia), helicopters (Europe) and aircraft (Brazil). In addition the US is active, through the JSF program at least, in engaging the innovation and competition available in partner countries.
Section 5. Implications and conclusions

Smaller armed forces
No country’s defence force is immune from the march of rising military equipment costs, especially for countries that seek to maintain a high-tech capability edge over potential adversaries. As in the past, rising costs will see the size of fleets fall until eventually entire capabilities are foregone; Australia lost its last aircraft carrier in the mid-1980s, and is set to lose its dedicated bomber force in 2010. The same pattern will be repeated in other small to middle powers in the absence of a clear and imminent threat that impels a substantial increase in defence spending.

The challenge for smaller countries is to find ways to maintain national defence with a smaller and less broadly structured armed force. This places a high premium on effective planning and optimum use of available resources.

Greater reliance on foreign sources
As the cost and technological sophistication of equipment grows, it becomes more difficult to maintain the full range of ‘design, build, upgrade, modify and maintain’ capabilities in-country. The result is that the more difficult tasks are progressively either transferred off-shore or done with more foreign assistance.

Australia provides an illustrative example. Where once Australia designed and built its own aircraft, over the last two decades it’s been progressively downgrading the work done in-country. While Australia assembled its F/A-18 in-country, they will not do so with the JSF, nor are they likely to pursue an ambitious Australian-unique upgrade of the JSF in the same way they did for the F/A-18 and F-111.

Choosing when to forego domestic work in favour of foreign supply can be critical – over-reaching on defence projects can be very costly. On the other hand, moving too early to foreign dependence can close off the opportunity to modify equipment to meet a country’s own ends. The aim of smaller countries should be to avoid going a ‘generation too far’ in military technology in terms of what is attempted in-country.

A strategic approach – along the lines adopted by the UK – is likely to give a country the best chance of marshalling its industrial resources to maximum benefit.

Less competition
The number of defence equipment suppliers in both the United States and Western Europe has fallen. This contraction in the two markets has made it increasingly difficult to sustain effective competition within either. Yet, for countries outside, it’s still possible to compete US and Western European suppliers against each other (augmented, in some cases, by Russia as a credible third option). This is fortunate because competition can reduce costs to the customer and increase the likelihood of finding a suitable product.
But it’s often not simply a matter of competing one source against another to get the best deal. Not only does interoperability with allies have to be considered, but the likelihood that the US will continue to widen the military technology gap is also important. These factors can create dilemmas for countries looking to buy military equipment.

Australia’s situation is indicative of that faced by many US allies. Not only does Australia place a high priority on US interoperability, but they remain committed to maintaining a capability edge in their region. Accordingly, Australia has developed an (unofficial) procurement strategy that’s reflected in the recent pattern of procurement. Specifically:

- For key capabilities where networked connectivity, interoperability and cutting edge performance is critical, US equipment solutions have been chosen on the basis of ‘strategic considerations’, often in the absence of competition. Examples include submarine and air warfare destroyer combat systems and the choice of the Joint Strike Fighter for new air combat capability.

- For other capabilities, especially those that are less likely to be tightly integrated into operational networks, competition has been used to extract the best value for money solution between US and European contenders. Examples include the aerial refueling tanker, troop lift helicopters and attack helicopters.

It’s likely that Australia’s future defence acquisitions will follow this pattern, with commercial competition sacrificed for interoperability and/or superior equipment. Other countries will face similar trade-offs involving their international relationships, military requirements and the potential benefits of competitive procurement.

**Supporting military capability in the age of global programs**

The rising cost of weapons systems and the accompanying consolidation of defence industry have resulted in a shrinking number of increasingly transnational firms delivering a limited number of advanced weapons programs. For the more cutting edge programs, the trend is towards cross-border support strategies that employ global supply chains for components and sub-systems while retaining core IP and software in the hands of the OEM. This can present both opportunities and challenges for countries.

The opportunities arise from being able to supply sub-systems into global programs. The JSF program, for example, allows firms from customer countries to bid to supply niche components for the entire global production run. The argument is that it is better to build several thousand subcomponents for export than fabricate a hundred complete systems for the local market. While this is good for the economy and the companies concerned, it contributes very little to the through-life support of the weapon system or the country’s military self-reliance.
The challenges of global programs for smaller countries are many. Not only can it be difficult to influence equipment specifications, but smaller countries are likely to find themselves at the back of the queue when production starts. Arguably, however, the critical issue is the same as that arising with any purchase of advanced weapon systems from offshore; that of gaining access to IP. Either a country develops the ability to make their own changes to systems (which will become increasingly difficult), or they have to establish the ability to do so as part of through-life support arrangements with the parent OEM. As the complexity and sensitivity of weapon systems grows, the latter approach is likely to become more practical and affordable.

Ultimately, success or failure in securing access to IP for advanced weapons systems will hinge on the political relationship between supplier and customer. Smaller countries will need to make best use of their international relationships to secure the equipment and support they require for their armed forces.

**Conclusion**
The rising unit cost of military equipment and the resulting consolidation of the defence equipment supply market have several implications for smaller countries:

- Armed forces will shrink in size and breadth thereby increasing the importance of prudent force planning.

- The cost to smaller nations of maintaining technologically sophisticated defence industries will grow, demanding strategic prioritisation of investment in domestic industry capabilities.

- Access to sensitive IP will underpin a country’s ability to fully exploit its military equipment placing a high premium on good relations with supplier nations.

- There will be less competition for the supply of defence equipment exacerbated by the growing technological lead of the United States.
Bibliography
(Were available, references have been hyperlinked to web source.)

1. The structure and economics of Australian defence industry

Defence and Australian Industry: Description and Economic Analysis
Allen Consulting Group, 1992

Defence Procurement
Productivity Commission Report 1994

Impact of Major Defence Projects: A case study of the ANZAC Ship Project
ACIL Tasman, 2002

Impact of Major Defence Projects: A case study of the Minehunter Coastal Project
ACIL Tasman, 2002

A profile of the Australian Defence Industry
ACIL Tasman, 2004

2. Australian Defence Industry Policy

Defence and Industry Strategic Policy Statement
Department of Defence, 1998

Defence 2000: Our Defence Force
Australian Government, 2000

Australian Industry Involvement Manual
Department of Defence, 2001

Commonwealth Procurement Guidelines
Department of Finance, 2005

Submission to the Naval Shipbuilding inquiry by the Senate FAD&T Committee
Submarine Institute of Australia Inc, 2005

3. Economics of defence equipment cost growth and its consequences

The Cost of Seapower
Philip Pugh
Conway Maritime Press, 1986

Augustine's Laws
Norman Augustine
American Institute for Aeronautics and Astronautics, 1983

Trends in the Costs of Weapons Systems and the Consequences
David L. I. Kirkpatrick
Defence and Peace Economics, Vol. 15.3 June, pp 259-273, 2005

4. Evolution of the global defence industry

Task Force on Globalization and Security
US Defense Science Board Report, 1999

Transformations in the Global Defense Markets: Implications for the Future of Warfare

The Defence Industry in the 21st Century
PriceWaterhouseCoopers report, 2005

Why Globalization Will Not Affect the Defence Industry: Political Incentives against Cross-Border Defence Restructuring
Eugene Gholz, 2002

5. US defence industry

The Defense Technology and Industrial Base: Key Component of National Power
Boezer et al (Carlisle) 1996

Arming the Future: A Defence Industry for the 21st Century
Ann R. Markusen & Sean S. Costigan, Council on Foreign Relations, 1999

Globalization of the Defence Industry
James R. Nelson (Lockheed Martin) 2001

Consolidation of the US Defence Industrial Base
Acquisition Review Quarterly – fall 2001
John Deutch, 2001

Transforming the Defense Industrial Base: A Roadmap
US Department of Defense, 2003
6. US Defense Policy

The National Security Strategy of the United States of America, 2002
The White House, 2002

The National Military Strategy of the United States of America, 2004
US Department of Defense, 2004

Classified Funding in the FY 2006 Defense Budget Request
Steven M. Kosiak (CBSA) 2005

US Department of Defense, 2006

7. Chinese defence industry

New Directions of China’s Defense Industry
Medeiros et al (RAND) 2005

8. UK defence industry

The UK Defence Industrial Base: Problems and Prospects
Keith Hartley (University of York) 2002

Defence Industrial Strategy
Defence White Paper
UK Ministry of Defence, 2005

9. Transatlantic defence industry

European and Transatlantic Defence-Industrial Strategies
Burkard Schmitt (EUISS) 2002

The Transatlantic Defence Industrial Base: Restructuring Scenarios and their Implications
Terrence R. Guay (RAND) 2005

Europe’s defence industry: a transatlantic future?
Gordon Adams et al (CER)

Transatlantic Defense Cooperation: From an Industry perspective
Ralph Crosby (EADS)

10. European defence industry

From cooperation to integration: defence and aerospace industries in Europe
Burkard Schmitt (Challiot) 2000

Trends in European Defence Industry: Fortress Europe or Atlantic Defence Industry
Debra R. Mohanty, 2001

From National Champions to European Heavyweights: The Development of European Defense Industrial Capabilities across Market Segments
Katia Vlachos-Dengler (RAND) 2002

Towards an EU Defence Equipment Policy
EU Commission Communiqué, 2003

The Rise of Europe’s Defense Industry
Seth G. Jones (Brookings) 2005

11. Skills, innovation and technology

The Knowledge Economy: Is the United States losing its Competitive Edge?
American Innovation Taskforce, 2005

12. COTS technology

Commercial Item Acquisition: Considerations And Lessons Learned
US Department of Defence, 2000