Creating a European Defence Industrial Base

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The European Union (EU) is committed to creating a European Defence Technological and Industrial Base (EDTIB) aimed at removing some of the inefficiencies in EU defence markets. The plan is for an EDTIB which will be capable, competent and competitive (the three Cs). Data are a starting point, addressing the issues of what is known and not known about Europe's defence industries. The major firms in the air, land, sea and defence electronics sectors are described. Typically, EU defence industries are characterised by excess capacity with too many small firms compared with their US rivals. The paper concludes by identifying some of the challenges in creating and maintaining an EDTIB.

European defence industrial policy has three components. First, its traditional focus on collaborative defence equipment programmes (e.g. multinational Eurofighter Typhoon and Airbus A400M airlifter programmes). Second, its 2005 initiative to create a Single European defence equipment market known as the European Defence Equipment Market (EDEM). Third, the 2007 initiative to maintain a strong European Defence Technological and Industrial Base (EDTIB) which is the focus of this article.

Policy towards the EDTIB is explained and critically evaluated. The EDTIB has to address the inefficiencies in EU defence markets. Compared with the US defence industry, European inefficiencies result from small national markets, duplication of costly R&D and short production runs with European firms failing to exploit economies of scale and learning. The EDTIB has to recognise the industrial implications of historical cost trends leading to rising unit costs. A sector analysis is presented with data on the major firms in the EDTIB. The article concludes by identifying some of the challenges in maintaining an EDTIB.

The Model of the EDTIB

Three agencies are involved in implementing European defence industrial policy. The Organisation for Joint Armaments Cooperation (OCCAR) is responsible for managing European collaborative equipment programmes. The European Commission is responsible for achieving the EDEM and the European Defence Agency (EDA) is responsible for the EDTIB.

The case for the EDTIB starts from the proposition that "a fully adequate DTIB is no longer sustainable on a national basis" and that a truly European DTIB is something more than the sum of its national parts:

> We cannot continue routinely to determine our national equipment requirements on separate national bases, develop them through separate national R&D efforts, and realise them through separate national

> procurements. This approach is no longer economically sustainable—and in a world of multinational operations it is operationally unacceptable…[1]

The EDA has outlined its model of the EDTIB. It will be characterised by the 'three Cs', namely it will be *capability-driven* (i.e. capable of meeting the operational requirements of the Armed Forces whilst sustaining European and national operational sovereignty); *competent* (i.e. able to exploit the best technologies); and *competitive* both within and outside Europe. Such an EDTIB will need to be "more integrated, less duplicative and more interdependent—increased specialisation at all levels of the supply chain must take over from all (or at least too many) trying to do everything".[2] Centres of excellence will be part of the EDTIB although such centres will be determined by a combination of market forces moderated by policy considerations and a requirement for an 'appropriate regional distribution'. This EDTIB will be more closely integrated with the wider, non-defence European technological and industrial base with less European dependence on non-European sources for key defence technologies. However, the EDA model does not envisage a 'fortress Europe' but recognises the problem of accessing the US defence market and the need to establish 'balanced' technology exchange across the Atlantic.[3]

The EDA regards a 'strong' EDTIB providing the basis for the European Security and Defence Policy. It provides political, military and economic benefits. These comprise independence and security of supply for Europe's Armed Forces and economic benefits in the form of employment, exports and technological advance.[4] Data are a starting point in assessing the EDTIB: what is known about the Industry and its major firms?

Data Problems

Industrial economists analyse the European defence industry using the structure-conduct-performance paradigm. However, such an approach presents a broad aggregate analysis of the whole EU defence industrial base. This article focuses on the sectors which comprise the EDTIB, namely, air, land and sea systems and defence electronics. Ideally, each sector needs to identify the major prime contractors and their defence industry supply chains. Evidence is needed on the size of each sector as measured by sales and employment together with such performance indicators as productivity, exports and profitability. Further, each sector needs to be assessed in terms of the Three Cs components of the EDTIB: capabilities; competencies; and competitiveness.

Policy towards developing the EDTIB requires a comprehensive and reliable data set. There are, however, major data limitations: gaps in the data mean that it is not possible to obtain the statistics needed for an adequate

[1] European Defence Agency, *A Strategy for the European Defence Technological and Industrial Base* (Brussels: European Defence Agency, May 2007), p. 1.
[2] Ibid., p. 2.
[3] Ibid.
[4] Ibid., p. 1.

economic evaluation of the individual sectors of the EDTIB. The available but extremely limited data will be presented and reviewed. We need to ask: what do we know; what do we not know; and what do we need to know for sensible policy debates about these sectors? Typically, we know very little; much is not known; and we need to know much more!

Table 1: Size of the EDTIB, 2009

	Sales (Euros billions)	Direct Employment
Total Aerospace and Defence	154.7	696,000
Aerospace:	105.9	500,000
Of which military aerospace (est)	41.5	178,678
Land and Naval	45.5	195,900
Land	26.8	113,000
Naval	18.8	82,900
Total EU Defence Industry (est)	87.0	374,578

Notes: 1) Total comprises aerospace and land and naval sales and employment. This total includes both military and civil aerospace business and is not an accurate reflection of defence only sales and employment. Defence electronics is not included. 2) Numbers are rounded. 3) (est) is author estimate based on military aeronautics and military space sales with employment based on labour productivity for land and naval sectors applied to estimated military aerospace sales. Military aerospace sales estimated at 41 percent of total aeronautics sales plus military space sales at Euros 5.46 billion. 4) Employment is direct numbers only and does not include supplier companies (i.e. indirect).

Source: ASD, *Facts and Figures 2009* (Brussels: Aerospace and Defence Industries Association of Europe, 2009).

Annual data are published for the European Aerospace and Defence Industries.[5] They provide a starting point in estimating the size of the EDTIB reflected in sales and employment as shown in Table 1. However, these data are limited in that they include Aerospace which comprises both military and civil sales and employment; they exclude supplier companies; defence electronics are not included in the data; there is only a limited time-series; and there are major discrepancies with the official published data for countries such as the United Kingdom.[6] Further serious gaps exist in the knowledge and understanding of defence industry supply chains within the EU (including the role of small and medium enterprises in such supply chains): supply chains are complex and differ between each of the air, land and sea sectors.[7]

[5] AeroSpace and Defence (ASD), *Facts and Figures 2009* (Brussels: AeroSpace and Defence Industries Association of Europe, 2009).

[6] For example in 2008, the ASD data showed total direct employment for the UK Aerospace and Defence Industry at 140,200 compared with the official figure for UK defence industry employment of 300,000 personnel. The UK figures included both direct and indirect employment and were for defence activities only; they are also well-founded on consistent definitions and economic methodology. Defence Analytical Services and Advice, *UK Defence Statistics 2009* (London: Ministry of Defence/Defence Analytical Services and Advice, The Stationery Office, 2009).

[7] K. Hartley et al., *AFV Supply Chain Analysis*, *A study of Warrior and Piranha* (London: DTI, 1997); K. Hartley, *FASM Industrial Base Study* (London: Ministry of Defence, 1999).

Data for the EDTIB are also available at the company level, based on the Stockholm International Peace Research Institute (SIPRI) Top 100 arms companies. These data will be used to analyse each sector. Some company and industry performance data are available which can be used to analyse labour productivity, research and development (R&D), profitability and exports.[8]

A limitation of the sector approach has to be addressed. A sector focus might fail to identify industrial re-structuring opportunities between sectors. Firms seeking cost-minimising opportunities, including opportunities for achieving economies of scale and scope and minimising transaction costs will not be constrained by a traditional sector focus. They will seek profitable opportunities across defence sectors and between defence and civil markets.[9]

The EU Defence Industry: Budget and Cost Pressures

Reduced defence spending following the end of the Cold War resulted in major capacity and employment reductions in the European defence industry. Re-structuring reflecting mergers and acquisitions resulted in new names emerging in the top European arms firms, namely, BAE Systems, EADS and Thales. Most European mergers were at the national level although there were a few notable cross-border mergers and acquisitions, namely, EADS and Thales. Elsewhere, some arms firms either dropped out of the top group or exited the industry. Compared with the top US arms firms, there remain further opportunities for re-structuring to create larger European arms firms capable of competing with the top US companies. These general industry trends will be reflected in similar developments in each of the aerospace, land, sea and defence electronics sectors of the EU defence industrial base.

The end of the Cold War resulted in lower defence budgets (the peace dividend) with further reductions likely following the global economic and financial crisis of 2007/10. Falling defence budgets are also subject to rising input costs, especially for defence equipment. For example, military aviation has shown an historical trend towards higher unit costs. Norman Augustine famously predicted that by 2054, the US defence budget would buy just one aircraft and that the UK would reach this position two years earlier.[10] Table 2 shows examples of unit production cost trends for a sample of UK combat aircraft. The examples reflect technical progress with the Typhoon achieving greater speeds and capabilities compared with the Spitfire. Higher unit costs mean smaller numbers purchased and hence shorter production runs for defence firms (with a limiting case of one unit of production).

[8] K. Hartley, 'BAE Systems plc: Company Survey Series 1', *Defence and Peace Economics*, forthcoming.
[9] See A. James, K. Hartley et al., 'A Study on How to Measure the Strengths and Weaknesses of the DTIB in Europe', Report for the European Defence Agency, Brussels (2008).
[10] N. Augustine, *Augustine's Laws* (London: Penguin Books, 1987).

Table 2: Unit cost trends for combat aircraft

Aircraft type	Unit production costs (£s, 2010 prices)
Spitfire (1940)	154,850
Meteor (1946)	187,500
Hunter (1955)	338,500
Lightning (1959)	1,300,800
Typhoon (2011)	73,200,000

Notes: 1) Data adjusted to 2010 prices using RPI deflator. 2) Figures are rounded. 3) Data in brackets show date of price estimate and when the aircraft was in service.

Sources: Ministry of Defence/DSTL, *Aircraft Contract Book Data: Historical Cost Data of RAF Aircraft 1935-1965* (London: Ministry of Defence using DSTL version, 2010); National Audit Office, *Major Projects Report: Ministry of Defence* (London: National Audit Office, The Stationery Office, 2010).

Defence R&D affects each of the three Cs components of the EDTIB: capability; competence; and competitiveness. In 2009, the major defence R&D spenders in the EU were the United Kingdom, France, Germany, Italy, Spain and Sweden. However, the total EU defence R&D spend was a mere 15 percent of the corresponding US expenditure in 2009. The differences are even greater when it is recognised that the EU total comprises all spending by each Member State and is not a genuine aggregate figure. More realistic comparisons are between each EU nation state and the United States. On this basis, the United Kingdom and France each spent 5-6 percent of US total defence R&D in 2009.[11] Such R&D data confirm the scale differences between Europe and the US defence industry with implications for international competitiveness. There are opportunities for creating a genuine EU collective defence R&D effort (i.e. creating a single EU defence R&D market as part of the EDTIB).

The impact of defence R&D on industry competitiveness is even more striking. A UK study found a positive relationship between a nation's defence R&D and its equipment quality (or time advantage) although the relationship was subject to substantial diminishing returns. In 2001, the United States was at the top of the curve with a time advantage over the United Kingdom and France of some 5-6 years and a time advantage over Germany and Sweden of 7+ and 11+ years.[12] On this basis, only the United Kingdom and France have any reasonable prospect of competing in major systems with the US defence industry. Again, there are no published data on the distribution of European defence R&D between each of the sectors. However, it is reasonable to assume that the military aerospace sector is the most research-intensive group and that this will be reflected in this sector's export performance (the involvement of European states in the US JSF/F-35 project weakens the EU defence R&D effort).

[11] European Defence Agency, *Defence Data* (Brussels: European Defence Agency, 2011).
[12] DIS, *Defence Industrial Strategy* (London: Ministry of Defence, The Stationery Office, December 2005), p. 39.

In assessing the EDTIB, there are some criteria which can be used to identify both a 'strong' and a 'weak' EDTIB. A strong EDTIB will be characterised by privately-owned firms; by free entry and exit; by sufficient numbers of firms for genuine rivalry (e.g. five or more similar-sized firms); by fixed price contracts which provide hard budget constraints; and by firms earning average or normal profits over the long-run. In contrast, a weak EDTIB will be dominated by state-owned firms; entry and exit barriers (e.g. support for national champions); inefficiencies which lead to losses and hence subsidies resulting in soft budget constraints; by cost-plus contracts which promote inefficiency; and by an absence of capital market pressures where there are no take-overs or bankruptcy.[13] These criteria can be applied to each of the air, land, sea and defence electronics sectors.

THE AEROSPACE SECTOR OF THE EDTIB

Industry data are presented in Table 1. More detailed data are available at the company level. For the company analysis, the military aerospace sector is defined to embrace aircraft, aero-engines, helicopters, missiles and space systems. Tables 3 and 4 shows the top European and US aerospace firms in 2009. Aerospace firms accounted for 80 percent of the world's top ten defence firms. US firms provide the criteria for assessing the competitiveness of the EU firms. There are substantial differences in the average size of EU and US aerospace companies. Typically, the EU is characterised by too many relatively small firms. In 2009, the average size of EU aerospace firm in terms of arms sales was $6191 million compared with average arms sales of $11,664 million for their US aerospace rivals.[14] Typically, US aerospace firms were almost twice the size of their EU counterparts. Within the EU, only the privately-owned BAE Systems was of a similar size to the top US military aerospace companies (which were also privately-owned). Thus, there are considerable opportunities for creating more, larger EU aerospace firms. For example, consider the EU aero-engine sector where both Rolls-Royce and SAFRAN are of similar size in terms of arms sales to their US rivals; but the German and Italian engine companies are 'too small' (MTU and Avio). Of course, this analysis is confined to European aero-engine companies which neglects opportunities for re-structuring across the defence sectors (i.e. with land, sea or electronics firms) or with other civil groups either in Europe or elsewhere in the world (assuming that private capital markets can determine re-structuring). Also, there are further opportunities for re-structuring amongst suppliers. But the published data provide little information on supply chains and the opportunities for mergers amongst suppliers to create larger groups able to undertake more R&D and exploit economies of both scale and scope.

The European and US aerospace firms were each involved in an average of almost three arms products suggesting that the US firms were exploiting

[13] K. Hartley, 'Collaboration and European Defence Industrial Policy', *Defence and Peace Economics*, vol. 19, no. 4 (2008), pp. 303-15.
[14] The EU was defined to exclude non-Member States and subsidiaries were excluded from the estimates of firm size, all based on Table 3.

greater economies of scale and learning. Interestingly, BAE Systems was unique in being the most multi-product arms firm in both the EU and the United States, with seven arms product groups embracing air, land, sea and electronics sectors.[15] BAE has also acquired substantial businesses in the US defence market. The EU aerospace firms were also more dependent on defence sales with a median share of 45 percent compared with a median of 34 percent for the US aerospace firms (all based on EU firms and excluding subsidiaries). The EU position of too many relatively small firms is reinforced and further illustrated by the position of the two aerospace firms in Switzerland and Norway, each of which are amongst the smallest in the top 100 group. Tables 3 and 4 show that the major EU and US aerospace firms were involved in defence electronics, so providing data on the defence electronics sectors.

Collaborative programmes are a distinctive feature of the European aerospace sector. These programmes involve the sharing of total R&D costs and the pooling of production orders between the partner nations. Aerospace has been involved in collaborative programmes for military and civil aircraft, helicopters, missiles and space systems. Some have led to the formation of European companies, namely, Airbus, MBDA, Eurocopter and ESA. Collaborations have ranged from the minimum two nation collaboration (e.g. Anglo-French Jaguar and the helicopter programmes) to three to four nations collaborations on advanced combat aircraft (e.g. Tornado; Typhoon) and the seven European nation collaboration on the A400M airlifter. Collaboration is one of the distinctive features of European defence industrial policy; but it has been mostly confined to the aerospace sector. This reflects the high and rising costs of modern aerospace projects, especially for development.[16] In principle, collaboration enables European aerospace firms to compete with their US rivals.

Opportunities remain for improving the efficiency of European collaboration on military projects. Typically, work-sharing arrangements and the bureaucracy associated with these projects leads to extra costs and delays.[17] Also, there remain opportunities for creating European companies rather than relying on *ad hoc* loose federations of project-specific arrangements for managing such programmes. Airbus in the civil aircraft market shows that international collaboration can be successful.

[15] Product groups refer to the number of arms sectors in which companies were listed in the SIPRI data base for the Top 100 companies. For example, BAE was listed as involved in seven arms product groups, namely, aircraft, missiles, electronics, artillery, ammunition, vehicles and warships. An arms firm's involvement in other civil markets is indicated by its percentage share of arms in total sales—e.g. a 10 percent arms share means a 90 percent share of total sales in civil markets.

[16] Hartley, 'Collaboration and European Defence Industrial Policy', pp. 303-15.

[17] K. Hartley, 'Defence Industrial Policy in a Military Alliance', *Journal of Peace Research*, vol. 43, no. 4 (2006), pp. 473-89.

Table 3: Top European Aerospace Firms, 2009

Company	Country	Sector	Arms sales (US$ millions)	Arms employment	Arms sales as share of total sales (%)
BAE Systems	UK	Ac, El, Mi, A, MV, SA/A, Sh	33,250	93,100	95
EADS	W. Eur	Ac, El, Mi, Sp	15,930	32,268	27
Finmeccanica	Italy	Ac, El, Mi, A, MV, SA/A	13,280	38,722	53
Thales	France	Mi, El, A, MV, SA/A, Sh	10,200	36,645	57
SAFRAN	France	Eng, El	4,740	18,107	33
Rolls-Royce	UK	Eng	4,140	10,036	26
MBDA (BAE; EADS; Finmeccanica)	W. Eur	Mi	3,610	9,750	100
Eurocopter (EADS)	France	Ac	3,050	6,128	48
CASA (EADS)	Spain	Ac	2,900	5,842	92
AgustaWestland (Finmeccanica)	Italy	Ac	2,800	5,997	58
Saab	Sweden	Ac, El, Mi	2,640	10,790	82
EADS Astrium (EADS)	W. Eur	Sp	2,400	5,400	36
Cobham	UK	Comp (Ac, El)	2,260	8,886	77
Alenia Aeronautica (Finmeccanica)	Italy	Ac	1,810	5,280	67
Dassault Aviation	France	Ac	1,360	7,805	67
Thales Air Defence (UK)	France	Mi	1,210	4,348	100
GKN	UK	Comp (Ac)	1,110	6,494	17
Kongsberg Gruppen	Norway	Mi, El, SA/A	1,090	2,710	50
Diehl	Germany	Mi, SA/A	1,070	4,274	35
Meggitt	UK	Comp(Ac)	810	3,240	45
MTU Aero-Engines	Germany	Eng	740	1,534	20
RUAG	Switzerland	Ac, Eng A, SA/A	730	3,540	47
Avio	Italy	Eng	670	1,464	28
Patria	Finland	Ac, MV, SA/A	660	3,000	88

Table 4: Top US Aerospace Firms, 2009

Company	Sector	Arms sales (US$ millions)	Arms employment	Arms sales as share of total sales (%)
Lockheed Martin	Ac, El, Mi, Sp	33,430	103,600	74
Boeing	Ac, El, Mi, Sp	32,300	78,550	50
Northrop Grumman	Ac, El, Mi, Sp, Serv, Sh	27,000	96,560	80
Raytheon	Mi, El	23,080	69,750	93
United Technologies	Ac,Eng, El	11,110	43,407	21
General Electric	Eng, El	4,700	9,000	3
Sikorsky (United Technologies)	Ac	3,980	13,875	63
Pratt and Whitney (United Technologies)	Eng	3,940	11,160	31
Textron	Ac, Eng, El, MV	3,570	10,880	34
Goodrich Corp	Comp (Ac)	2,010	7,200	30
Precision Castparts Corporation	Comp (Ac)	880	2,896	16
Vought Aircraft Industries	Ac	640	2,655	34
Esterline Technologies	Comp (Ac, A, SA/A, Sh)	640	4,005	45
AAR Corporation	Comp (Ac), Serv	610	4,685	79

Notes: 1) Ac=aircraft; Eng=engines; Mi=missiles; Sp=space; A=artillery; El=electronics; MV=motor vehicles; SA/A=small arms/ammunition; Serv=services; Sh=ships; Comp=components. 2) Companies reported are all those in the SIPRI Top 100 with any aerospace products, defined as aircraft, engines, missiles and space plus aircraft component suppliers. Other non-aerospace products are also shown. Further mergers since 2009 can result in changes to names and rankings. 3) Arms employment estimates are derived by applying the arms share of sales to total employment: hence, the figures are broad approximations only. In some cases, arms employment was estimated by applying the average company productivity to the sales figures. Where the firm is 100 percent defence-dependent, the arms employment figures are accurate. 4) Arms employment estimates are for all arms activities of the firm. For example, BAE arms employment are for its employment in air, land and sea systems and defence electronics. 5) Company names: where brackets are shown with the company name, this shows that it is a subsidiary of the group named in brackets. Subsidiaries of subsidiaries are not listed. 6) Sales in $US millions at current prices and exchange rates.

Source: *SIPRI Yearbook 2011* (Stockholm: Stockholm Peace and Research Institute, 2011).

Applying the US 'model' shows some of the opportunities for re-structuring the EU military aerospace sector. The United States has three major combat aircraft firms compared with six European firms in this market. Re-structuring also means reductions in excess capacity in the sector. The possible end of future manned combat aircraft and their replacement with UAVs will mean capacity reductions in the military aircraft production sector. For example, the United Kingdom expects that the future number of military aircraft plants will fall from four to two.[18] However, so long as manned

[18] DIS, *Defence Industrial Strategy*.

combat aircraft remain in service they will require support and up-grading over their life-cycle: hence, this capability will need to be retained.

THE LAND SECTOR

In 2009, turnover in the EU Land Sector was Euros 26.8 billion with total direct employment of 113,000 personnel.[19] Compared with the military aerospace sector, land systems are not R&D-intensive and lack established and successful European collaborative programmes. Like aerospace, the sector has experienced substantial industrial re-structuring. For example, since 1995, the UK land sector has been reduced from some five prime contractors (Alvis; GKN Defence; Vickers Defence Systems; RO Defence; Marconi Defence Systems) to one prime, namely, BAE Land Systems (with headquarters in the United States). The factors leading to this industrial consolidation included low profit margins, gaps in work load, a lack of competitive products; a decline in the world export market following the end of the Cold War; and a change in national defence requirements (e.g. reduced demand for tanks).

Little is known about defence industry supply chains, but one major study provided insights into the complexity of the supply chain for the UK Warrior AFV (Armoured Fighting Vehicle). On Warrior, there were over 200 first tier suppliers (selling directly to what was then GKN: now BAE Land Systems), but there was substantial concentration within the supply chain. A total of ten suppliers accounted for over 70 percent of the value of GKNs Warrior purchases and the top forty-two suppliers accounted for 85-90 percent of total GKN purchases. Then, the 207 first level suppliers on Warrior used an average of eighteen suppliers (second tier) whilst these second tier firms had an average of seven suppliers (third tier).[20]

For munitions, there is further information on major suppliers. The UK Ministry of Defence purchases 80 percent of its munitions from BAE Land Systems. In 2005, much of the remaining munitions spending was with twelve suppliers: Chemring Countermeasures; Bofors Defence; PW Defence (UK); NAMNO; Wallop Defence; Austin Hayes; Rheinmettal Waffe Munitions; Troon Investments; General Dynamics; QinetiQ; Nobel Enterprises; and Denis Ferranti Meters Ltd.[21]

Table 5 shows the major land systems firms in 2009. Typically, the average size of US land systems firms was some twice the average for EU land systems firms suggesting opportunities for further re-structuring within the European land sector. There are too many relatively small firms in this sector: with US scales of output, the same level of EU output could be achieved with half the number of European firms. Also, the EU firms produced an average of three arms products compared with the US average of two arms products. As a result, the US firms were achieving greater

[19] ASD, *Facts and Figures 2009*.
[20] Hartley et al., *AFV Supply Chain Analysis*.
[21] DIS, *Defence Industrial Strategy*, p. 98.

economies of scale (larger output over fewer products). On average, both sets of firms had similar degrees of defence-dependence.

Table 5: EU and US Major Land Systems Firms, 2009

Company	Country	Sector	Arms sales (US$ millions)	Arms employment	Arms share of total sales (%)
Europe					
Finmeccanica	Italy	A, MV, SA/A, Ac, El, Mi	13,280	38,722	53
Thales	France	A, MV, SA/A, El,Mi, Sh	10,200	36,645	57
Rheinmetall	Germany	A,MV,SA/A El	2,640	10,874	55
Krauss-Maffei Wegmann	Germany	MV	1,630	2,993	95
Nexter (ex-GIAT)	France	A, MV, SA/A	1,230	2,690	100
Kongsberg Gruppen	Norway	SA/A, El, Mi	1,090	2,710	50
Diehl	Germany	SA/A, Mi	1,070	4,274	35
Chemring Group	UK	SA/A	750	3,216	96
RUAG	Switzerland	A,SA/A, Ac, Eng	730	3,540	47
Patria	Finland	MV, SA/A, Ac	660	3,000	88
Iveco (Fiat)	Italy	MV	650	1,744	7
United States					
General Dynamics		A, MV, SA/A El, Sh	25,590	73,360	80
BAE Systems	Land/armaments HQ in United States	A, MV, SA/A, El	19,280	48,020	100
SAIC		Comp (MV), Serv	8,030	34,188	74
AM General		MV	3,720	Na	Na
Textron		MV, El, Eng, Ac	3,570	10,880	34
Alliant Techsystems		SA/A	2,810	10,620	59
Navistar		MV	2,800	4,296	24
Oshkosh Corporation		MV	2,770	7,956	52
Force Protection		MV	980	1,170	100

Notes: 1) See Notes to Table 3 and 4. 2) Some firms are involved in land and other defence business so that the data reflect their total arms sales and employment and not only land systems. 3) Land systems are defined as artillery (A); motor vehicles (MV); and small arms and ammunition (SA/A). 4) BAE Systems is UK-owned but with major businesses in the United States (Land and Armaments and Electronics, Intelligence and Support) each with HQs in the United States. In addition to plants in the United States, the Land and Armaments division also has plants in the UK and Sweden. 5) Na= not available.

Source: *SIPRI Yearbook 2011* (Stockholm: Stockholm Peace and Research Institute, 2011).

THE NAVAL SECTOR

In 2009, the European Naval sector had sales of Euros 18.8 billions and employed directly 82,900 personnel.[22] It is more research-intensive than the European land sector. Within Europe, the major shipyards are DCNS (France); TKMS (Germany); Fincantieri (Italy); Navantia (Spain); BAE and Babcock International Group (United Kingdom).

The names of shipbuilders in Table 6 conceal substantial re-organisation and cross-ownership. TKMS (ThyssenKrupp Marine) comprises Blohm & Voss (frigates) and HDW (submarines). Further, HDW owns Hellenic Shipyards (Greece) and Kockums (Sweden). In 2009, TKMS and Abu Dhabi MAR Group formed a joint venture for the construction of naval surface ships. Part of the joint venture involved the sale of B&V shipyards in Hamburg to the Abu Dhabi MAR Group.[23]

DCN of France became DCNS after DCN acquired all of Thales French naval business whilst Thales acquired a 25 percent stake in DCN with the newly-merged company known as DCNS. Navantia of Spain was formerly Bazan or Izar and has the capability to build aircraft carriers. Similarly, Fincantieri of Italy has an aircraft carrier capability. There are other warship builders in Denmark (Danyard Aalborg/part of Danyard Group); Netherlands (Damen Shipyards: Royal Schelde); and Portugal (ENVC).

US shipbuilders are on average twice the size of their major European rivals. If European firms were of the US average size, then Europe's shipbuilding output could be produced by some four firms, representing a halving of the European industry's number of shipbuilding firms. The European industry also contains a larger number of specialist shipbuilders which specialise in shipbuilding as their only arms product suggesting scope for adding more arms products so allowing firms to exploit economies of scope (including adding electronics to shipbuilding).

The naval sector has only limited experience with European collaboration of the type so prevalent in aerospace (Horizon frigate). One explanation is that nations value their national warship industry and are willing to pay the price of independence (i.e. the pressures of costly and rising R&D and unit production costs are not sufficiently great to lead to European collaboration, as with the EU land sector). However, there have been recent changes with more national re-structuring and internal rationalisation removing some excess capacity. Future competitive threats to EU warship builders are likely to come from Asian firms such as Hyundai, Daewoo, Samsung and STX and from the US firms of Northrop Grumman and General Dynamics Marine Systems.

[22] ASD, *Facts and Figures 2009*.
[23] Ibid.

Table 6: Major European and US Naval Firms, 2009

Company	Country	Sector	Arms sales ($US millions)	Arms employment	Arms share of total sales (%)
Europe					
BAE Systems	UK	Sh, Ac, El, Mi, A, MV, SA/A	33,250	93,100	95
Thales	France	Sh, A, El, MV,SA/A	10,200	36,645	57
DCNS	France	Sh	3,340	12,200	100
Babcock International Group	UK	Sh, Serv,Other	2,010	11,315	68
Navantia	Spain	Sh	1,980	4,968	90
Thyssen Krupp	Germany	Sh	1,550	5,625	3
VT Group	UK	Sh, Serv	1,240	7,050	64
Navantia	Spain	Sh	1,110	4,390	79
Fincantieri	Italy	Sh	860	2,000	19
United States					
Northrop Grumman		Sh, Ac, El, Mi, Sp, Serv	27,000	96,560	80
General Dynamics		Sh, El, MV, A, SA/A	25,590	73,360	80
Curtis-Wright Corporation		Comp(Sh, Ac)	760	3,192	42
Esterline Technologies		Comp(Sh, A, Ac, SA/A)	640	4,005	45

Notes: 1) Naval sector defined as those firms involved in shipbuilding (Sh). 4) VT Group arms employment estimate based on labour productivity for Devonport Management. VTs warship business was acquired by BAE Systems to form BAE Systems Surface Ships (2009). Later, the remaining business of VT was acquired by Babcock International Group (which also owns Devonport Management). These ownership changes are not shown in Table 6.

Source: *SIPRI Yearbook 2011* (Stockholm: Stockholm Peace and Research Institute, 2011).

THE DEFENCE ELECTRONICS SECTOR

The European Aerospace and Defence Industries Association recognises that little is known about the EU defence electronics sector and its data do not separately identify this sector. Yet, defence electronics is one of the key enablers embracing the air, land and sea sectors. Electronics now plays a crucial role in weapons systems. For example, on the British Lightning combat aircraft in the 1960s, avionics represented about 25 percent of flyaway costs; on the Eurofighter Typhoon in 2004, the avionics share was some 35 to 40 percent of unit flyaway costs; and for the future, with unmanned combat air vehicles there are forecast that electronics systems will account for about 50 percent of unit costs.[24]

[24] P. Dowdall et al., 'The UK Defence Electronics Industry', *Defence and Peace Economics*, vol. 15, no. 6 (2004), pp. 565-86.

Table 7: The Defence Electronics Sector, 2009

Company	Country	Arms sales ($US millions)	Arms employment	Arms share of total sales (%)
Europe				
Indra	Spain	940	7069	27
Thales	Netherlands	880	Na	100
Ultra	UK	810	3328	80
Selex Galileo (Finmeccanica)	Italy	770	2410	87
United States				
Honeywell		5380	20,740	17
ITT Corporation		4730	17,286	43
URS Corporation		2770	13,500	30
Rockwell Collins		2580	11,194	58
Harris		1900	5852	38
SRA International		760	3490	50
Teledyne Technologies		730	3321	41
Others				
Elbit	Israel	2700	10,678	95
NEC	Japan	770	2847	2
CAE	Canada	710	3010	53
Aselsan	Turkey	640	3581	96

Note: 1) L-3 Communications was not included since it had both Electronics and Services sectors. 2) Thales Netherlands is a subsidiary of Thales and Selex Galileo is a subsidiary of Finmeccanica. These subsidiaries were included in the analysis since they were specialist defence electronics firms. 3) Na=Not available.

Source: *SIPRI Yearbook 2011* (Stockholm: Stockholm Peace and Research Institute, 2011).

The major EU and US defence electronics firms are shown in Table 7 together with some of their rivals in the rest of the world. The focus is on firms specialising in defence electronics only (i.e. single arms product defence electronics firms in the SIPRI Top 100). Other arms firms with defence electronics sectors as part of a multi-product business are shown in Tables 3 to 5 (i.e. firms in the aerospace and land sectors). There are four features of Table 7. First, there were larger numbers of specialist US defence electronics firms in the SIPRI Top 100 compared with the number of EU rivals. Second, there were significant size differences between the US and EU firms. On average, the specialist US defence electronics firms were some three times larger than the average size of their EU rivals. Third, the EU specialist defence electronics firms were more defence-dependent with a median defence share of 84 percent compared with a US defence-dependency share of 41 percent. Fourth, there are major rivals in the rest of the world, including Canada, Israel, Japan and Turkey as well as newly-emerging firms in China, India, Singapore, South Africa and South Korea.[25]

[25] Ibid.

Challenges for the EDTIB

At the EU level, the Member States have a range of defence industries which have varying degrees of capability, competence and competitiveness (the Three Cs) which provide the basis for an EDTIB. Much of the Three Cs features are concentrated in the major national defence industries, especially in France, Germany and the United Kingdom. These industries also have varying degrees of international competitiveness. Broadly, France and Germany are competitive in land and sea systems whilst the United Kingdom is competitive in the aerospace sector. Other EU Member States have varying elements of the Three Cs in their national defence industries (e.g. Italy; Spain; Sweden). But the creation of a Three Cs EDTIB needs to address three issues:

1. The lack of an EU collective defence R&D effort capable of competing with the scale of US defence R&D spending.

2. The massive duplication and excess capacity in the national EU defence industries, reflecting each nation's continued commitment to supporting some form of national defence industry, leading to small-scale production for national markets.

3. The lack of an accurate data base on the EUs defence industries. Defence firms and industries need to be defined[26] and there is a need for reliable data on the size of the EUs defence industries (e.g. sales; employment) and their performance (e.g. defence R&D spending; productivity; defence exports by product group; profitability). Data are also needed on Europe's defence industry supply chains, especially where there are key monopoly suppliers which might be at risk of exit (i.e. suppliers needed for appropriate sovereignty and security of supply).

The sector analysis shows that Europe's defence industries continue to be characterised by too many small firms leading to excess capacity and that considerable opportunities remain for further re-structuring, especially in the land and sea systems sectors. In comparison, the US defence industry has a much smaller number of larger defence firms. The trend towards IT warfare means that there has been and will continue to be an increasing use of electronics in complex weapons systems. However, a sector analysis has its limitations since it tends to focus on re-structuring within each sector and neglects opportunities for re-structuring between sectors. Here, there are two general models of defence firms which represent alternative methods of economising on transaction costs. First, there is the aerospace and defence firm model which is represented by Boeing and EADS where each are large firms with a defence business and a substantial civil aircraft business.

[26] The definition of defence firms and industries is fraught with problems. For example, what proportion of defence sales in total sales constitutes a defence firm: is it over 50 percent; but what of firms such as shipping companies and airlines which currently might have zero defence business but which constitute surge capacity in a national emergency?

Second, there is the large specialist defence firm involved in air, land and/or sea systems as well as defence electronics. Examples are BAE, Lockheed Martin and Northrop Grumman. These are large defence firms able to achieve economies of scale, learning and scope with further potential for technology transfer from, say, aerospace to land and sea systems (e.g. application of stealth technology to tanks, AFVs and warships). Increasingly, defence firms have acquired electronics firms reflecting the greater emphasis on electronics inputs in modern defence equipment.

Initially, industrial re-structuring is most likely within *nation* states and will involve the land and sea sectors. *International re-structuring* is the next development. This might involve the creation of European-wide companies. There are also opportunities for EU collaborative programmes. There are two options. First, *government-led and dominated collaboration* of the type adopted for the EU aerospace industry. Second, *firm-led international collaborations or consortia* where firms make commercial decisions about their partnerships searching for profitable opportunities and seeking to economise on international transaction costs (e.g. naval sector examples of consortia). Where such international collaborations are dominated by private firms they will be based on market judgements, commercial criteria and entrepreneurship reflecting partners seeking to develop mutually-beneficial exchange.

There are opportunities for improving the efficiency of European collaborative programmes. Typically, the focus on work-sharing rules results in substantial inefficiencies. Future collaborations might be based around a small number of partners (e.g. two partners) with other nations joining the programme as 'associates' with no prior commitment to receiving specific technology and production work packages (c.f. the partnering arrangements for the US JSF/F-35 aircraft).

Conclusion

National governments determine their defence markets and industries. EU nations with a national defence industry are likely to adopt a defence industrial strategy which will seek to retain key defence industrial capabilities within the nation state. Such national policies will affect the future development of the EDEM and EDTIB. Retention of key national defence industrial capabilities means that such capabilities cannot be opened to the EDEM; but these capabilities might become part of the EDTIB. Capabilities which are not part of the key capabilities which a nation wishes to retain provide opportunities for developing the EDEM (with nations willing to import non-key equipment).

The 2005 and 2007 EU policy initiatives on the EDEM and EDTIB signal a new era in European defence industrial policy. Previous policy initiatives have not affected the current size, structure, performance and ownership of the EU's defence industries and the policies of national governments. This is not to say that major EU policy initiatives cannot be effective. One

obvious example is Article 346 whose abolition would create a genuinely open EU defence equipment market. Article 346 allows Member States to protect their national defence industries: its abolition would create an EDEM comparable to the Single Market for civil goods and services and for civil public procurement.

Overall, the major drivers which have affected the current size, structure and performance of the EU's defence industries have been defence budgets, rising equipment costs, national defence industrial policies and industry supply side adjustments (via mergers/acquisitions and entry into foreign markets with the example of BAEs entry into the US defence market).

The EC and EDA face some major policy challenges in relation to the EDEM and EDTIB. These include:

i) *Conflicts between the EDEM and EDTIB*. Choices are needed either to restrict competition to firms from Member States only or whether to allow other firms from the rest of the world to enter EU defence markets (e.g. US defence firms). Competition might also threaten key defence industrial capabilities and the 'appropriate regional balance of capabilities needed for the EDTIB. In the absence of competition, privately-owned monopoly defence firms will have to be treated as regulated firms with the associated problems of determining prices, efficiency and profitability.

ii) Maintaining key specialised defence industrial capabilities during troughs in development and production work. These are specialist firms with no alternative uses for their plant and human capital but which are needed in the future (e.g. capability in nuclear-powered submarines; main battle tanks; aircraft carriers). Such specialist capabilities might be prime contractors or small and medium enterprises in the defence industry supply chain. Selecting which key capabilities to retain is only the starting point. Further issues arise about how to retain such capabilities (e.g. interim orders; mothballing of plants, etc), the costs of alternative retention policies, who decides and who will pay.

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