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Trends in the military research and development strategy of the UK from 1997 to 2010

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Abstract

The aim of this paper is to provide a comprehensive overview of issues, trends and changes in British military research and development, with an emphasis on the time of the last Labour government (1997 to 2010). The analysis is focussed on doctrinal documents issued by government institutions. Tensions in British defence matters are highlighted by documenting responses to these documents from parliamentary bodies and a wider public.

Keywords:

Defence, R&D, R&T, Acquisition, Defence Technology Strategy, DERA, TLCM, UK

1 Introduction

1.1 Motivation and approach

The objective of all military acquisition is to attain necessary capabilities in a given time. This can be achieved, either by buying military equipment that has already been developed ("military off-the-shelf", MOTS) or by supporting the development of custom made materiel. If cutting edge technology is part of a nation's military ambition, successful research and development (R&D) is crucial.

Several developments in the last decades have led to significant changes in defence acquisition and thus in defence related R&D. One is the acceleration of technological advance, especially in information and communication technology (ICT). This is closely related to the progressing globalisation of the economy, making "national" processes less common and efficient. Stronger public pressure to employ defence resources effectively and transparently and the "revolution in military affairs" with its changed threats and less clearly defined opponents after the end of the Cold War have influenced national approaches to defence R&D.

The Fraunhofer-Institute for Technological Trend Analysis (Fraunhofer INT) has a long track record of supporting German processes of military R&D planning. Over the last few years, the scientific monitoring of European integration processes, e.g. within the "Letter of Intent"-Partnership (LoI 6) or the European Defence Agency (EDA), has become an additional focus of our work. The monitoring of trends in foreign military R&D strategies, mainly through analysis of doctrinal papers published by governments or other official bodies, is part of this endeavour.

The United Kingdom of Great Britain and Northern Ireland (UK) is especially well suited for such an analysis. On the one hand, the last British governments communicated military issues in a very open manner, allowing easy access for analysis; on the other hand, British armed forces have been involved in several armed conflicts over the last decades, so theoretical considerations had to prove their practical value within a short time frame. Again, the experience gained in those conflicts found its way into doctrinal papers rapidly, leading to a realistic and hard-headed approach.

In this paper trends in the military R&D strategy of the UK are analysed on the basis of official doctrinal documents. These documents do not necessarily describe a certain historical condition accurately, but represent a view on how things should be in the eyes of the corresponding authors. At several instances, official responses like parliamentary committee reports and statements of stakeholders are cited to obtain a more comprehensive and realistic picture. Further public statements by other individuals or institutions are considered if additional points of view are expressed. The review of positions is by no means meant to be exhaustive.

1.2 Historical background

As British history of military acquisition after World War II has been characterised by several cases of severe budget overruns, a number of reforms of defence

procurement have been carried through. One of the most notable was the *Rayner Reform*: Derek Rayner, an efficiency specialist from retail industry, was asked to analyse government procurement processes in the late 1960s. His report, coined the *Rayner Papers* (not to be confounded with the *Rayner Review*, published in 1981 by the same person), was published in October 1970 as the white book *The Reorganisation of Central Government*. A core demand was to centralise procurement in the Ministry of Defence (MOD), as poor coordination between the various agencies of different military branches was found to be a major weakness of the traditional process. When the Procurement Executive was founded on 2nd of August 1971, Derek Rayner became its first director. After Rayner returned to his original employer Marks & Spencer in 1973, the rivalry between the different military branches flared up again, now within one single agency (Smith, 1991).

Up to the early 1980s, a central principle of military acquisition was to “buy British”. This, together with cost-plus pricing, led to a relationship between the MOD and the defence industrial base (DIB) that was sometimes described as “cosy”, since competition played a marginal role only (Hartley, 2002). This changed under the government of Margaret Thatcher (1979 - 1990). Her views on liberalisation and privatisation led to a shift towards more competitive acquisition principles (“best value for money”). A central figure of that time was Peter Levene, the Chief of Defence Procurement from 1985 to 1991. The changes introduced in his time are known as *Levene Reforms* (DC705, paragraph 81). A central element of these reforms was a stronger focus on competition, involving foreign as well as UK contractors, for almost all defence equipment contracts. An industrial “prime contractor” was now appointed to integrate and manage each complex equipment project. Fixed-price contracts with stage payments, firmly linked to achievement of explicit milestones, which transferred some financial risk to industry, put additional pressure on these prime contractors (DC897, paragraphs 309 -312).

These changes led to a dramatic restructuring of the British defence sector. Corporate mergers led to the formation of large industrial groups like BAE Systems, which receives approximately 50% of the total acquisition expenses of the MOD today (Hartley, 2002). On the other hand, a risk of totally losing the national capability to build and maintain certain products emerged as fabrication was moved offshore.

Although Labour Government (since 1997) officially continued the competitive path in its early years (*Strategic Defence Review* (1998)), the MOD had already changed towards a less hostile relationship with the remaining prime contractors since the mid-1990s (*Smart Procurement*). The official course change was announced in the *Defence Industrial Policy* (2002) and codified in the *Defence Industrial Strategy* (2005): Apart from competition, long-term aspects, like the sustainment of a national defence base, would be considered in acquisition and procurement.

1.3 Finances and governmental responsibilities in defence related R&D

Since the end of World War II the UK has had the ambition to be a major military actor, while in reality it evolved into a classical middle-sized power. The more ambitious goals are still reflected in high defence spending and R&D expenditures (including research and technology (R&T) expenditures) that in the European Union (EU) are only matched by France (table 1).

Table 1: Data of the three EU nations with highest military spending (as of 2008, currency is EUR, EDA, 2009)

	UK	**France**	**Germany**
Total defence spending	42.0 bn	45.4 bn	31.8 bn
Percent of gross domestic product (GDP)	2.32%	2.32%	1.27%
Military R&D expenditures	3.21 bn	3.28 bn	1.18 bn
Military R&T expenditures	0.65 bn	0.84 bn	0.47 bn
Military R&T expenditures per GDP*	0,036%	0,043%	0,019%

*: own calculations based on data by Eurostat

In the UK the means for military R&D are predominantly organized in two budgets: The Top Level Budget (TLB) “Science, Innovation & Technology” (0.54 bn Great British Pounds (GBP)), which is supervised by the Chief Scientific Adviser (CSA), and the TLB “Defence Equipment & Support” (16.5 billion GBP), from which a large portion is used for the development of new defence material (MOD-Annual Report 2007-08, p. 290). According to official figures, the MOD spent 974 m GBP on “research” and 1.86 bn GBP on the so called Equipment Programme, which can be considered “development including demonstrators” in the fiscal year 2007-08 (MOD-Annual Report 2007-08, p. 316, alignment as in EAC, p. 41).

There are several political leaders that influence the course of action in military R&D. The Secretary of State of Defence is the most prominent among them, though not necessarily the most influential one, as R&D is only one of his many duties. The MOD has a long tradition of Chief Scientific Advisers that manage the small TLB “Science, Innovation & Technology”, which is primarily spent in academia and research organisations. This post is usually staffed with persons of outstanding scientific repute. All expenses connected with industrial development are managed by the head of Defence Equipment and Support (de&s), an agency formed by the merger of the Defence Procurement Agency (formed itself from the Defence Executive in 1999) and the Defence Logistics Organisation in April 2007 (figure 2). While these three positions have been fairly stable over the last 35 years, the positions of Minister of State of Defence Procurement and of Under Secretary of State of Defence Procurement have appeared and vanished in a somewhat erratic manner since 1971, when Ian Gilmore was installed as the first Minister of State of Defence Procurement in the course of the Rayner reform (figure 1). Among the

responsibilities of the last Under Secretary of State and Minister for Defence Equipment and Support of the labour government, Quentin Davies, were the "Defence Industrial Strategy" (as a process) and "Defence Science and Technology", including the Defence Technology Strategy (DTS), the Defence Science and Technology Laboratory (Dstl), and the public-private-partnership QinetiQ (MOD-Annual Report 2007-08, p. 6).

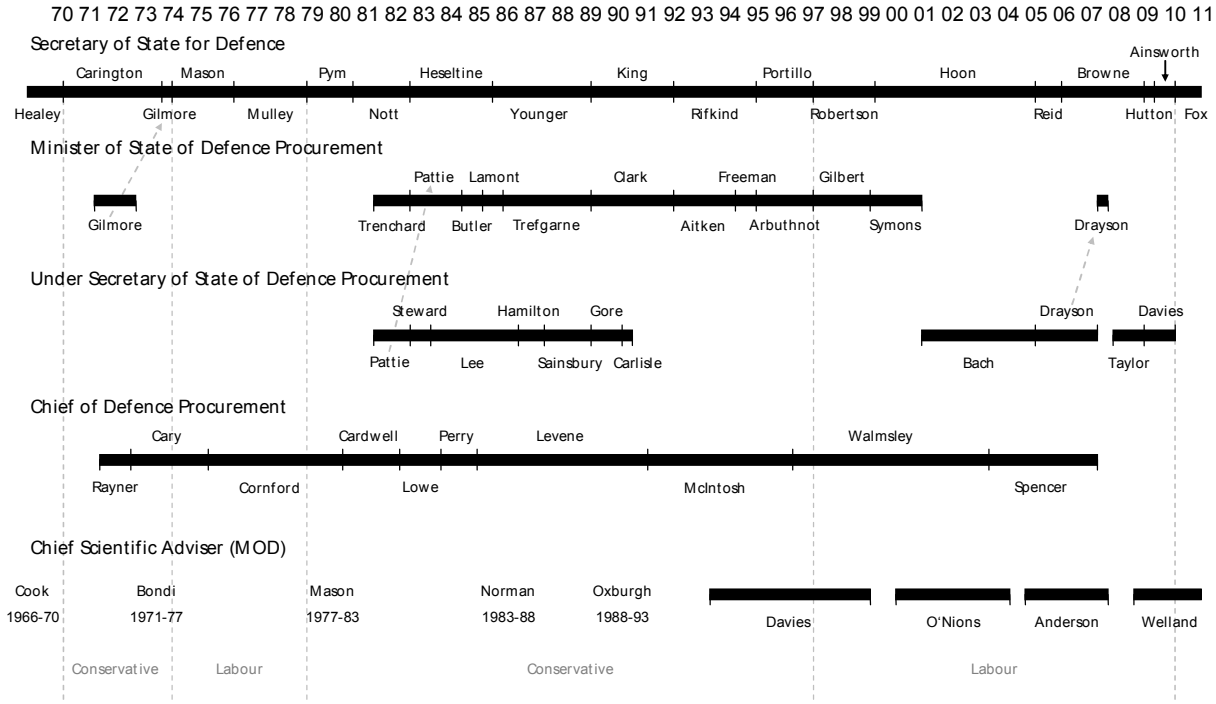

Figure 1: MOD stakeholders in defence related R&D

1.4 Military acquisition in the UK since 1997: Problems and approaches to their solution

Due to high acquisition costs, large military platforms (like ships, airplanes, and tanks) are typically in service for more than a decade, which leads to several problems. A problem of tactical nature is the fact that technical features are often outdated, which is especially visible in information and communication technology (ICT), where, due to long development processes, equipment tends to be already obsolete when put in service. The facts that technical knowledge of the exact interaction between the subsystems of a complex system is often lost, making upgrades impossible, and procedural knowledge cannot be transferred from one generation of stakeholders to the next, as procurement is such a seldom event, pose strategic problems of their own. Another problem is of political nature: As high proportions of total system costs accrue after procurement (60% of total lifetime costs for ships and submarines, 80% for helicopters, EAC, p. 35), rational choices are hard to be made under existent budget constraints, especially as this fact is often underestimated in the acquisition process.

1.4.1 Smart Procurement – Smart Acquisition

The authors of the *Strategic Defence Review* (1998) identified insufficient sensibility for risk in early project stages and a lack of flexibility in the procurement process as the most important causes for continuous delays and cost overruns. Even before the publication of these findings, the consulting firm McKinsey was tasked to develop a strategy to counter these negative effects (Tusa, September 2004). The results of their analysis were first presented to the Defence Committee by the Secretary of State, Georg Robertson, in July 1997 under the term “Smart Procurement” (DC897, paragraph 333). Approximately two years later the principles were renamed “Smart Acquisition”.

Central aspects of Smart Procurement / Acquisition are (SDR, chapter 8):

- More comprehensive early planning to allow faster development and production
- A through-life approach covering both acquisition and in-service management (later implemented as Through Life Capability Management (TLCM))
- More of a partnership between MOD and industry; this was implemented through Integrated Project Teams (IPT), which were considered to be the major novelty in Smart Procurement (DC897, Q1955)
- Separate procurement approaches for major projects, minor projects, and for commodity and other low risk items
- More personal responsibility for project leaders and greater flexibility in personnel matters

Keith Hartley, a defence economist at the University of York, has summed up the major shortfalls of this approach in a discussion paper in October 2002. He highlighted that perfect, problem-free high-tech projects do not exist and some changes in cost and delivery dates might even be desirable. He further pointed out that Smart Acquisition aimed to apply private sector management principles to the procurement process but lacks the private sector incentives (e.g. profit and competition). A further point he made was that the results of Smart Acquisition were modest at best (200 m GBP of savings each year, which corresponds to 2% of the equipment budget).

In hindsight, Smart Procurement / Acquisition introduced novel and useful ideas, but was not successful “in its aim of procuring equipment faster, cheaper, better.” It seems that the ideas were not bad in themselves, but they just had not been implemented extensively and consistently enough (DC603, p. 9ff).

1.4.2 Through Life Capability Management

Although Through Life Costing (TLC) had already been introduced in the 1980's, a broader concept was consecutively developed. It was first referred to as Through Life Capability Management (TLCM) in the *Defence Industrial Strategy* (2005).

In *Enabling Acquisition Change* (EAC, 2006) the following definition is given: „TLCM is an approach to the acquisition and in-service management of military capability in which every aspect of new and existing military capability is planned and managed coherently across all Defence Lines of Development (DLOD) from cradle to grave." (EAC:2.2)

1.4.3 Defence Acquisition Change Programme

The report *Enabling Acquisition Change*, aka McKane report, was published in June 2006. It set out to study in how far the MOD was able to practice TLCM, and which changes had to be made to better adapt it to that task. The Defence Acquisition Change Programme (DACP) was set up to implement these changes. It can be seen as a follow-up of Smart Acquisition since central ideas are identical, but more attention is given to TLCM.

A central recommendation of the McKane report (EAC:1.13) was the merging of the Defence Procurement Agency (DPA), responsible for procurement, and the Defence Logistic Organisation (DLO), responsible for maintenance of defence equipment. The merger was effected in April 2007. In the new Defence Equipment and Support (de&s) responsibilities for procurement and maintenance are united under one roof and, maybe more important, one budget (figure 2). This effectively revoked the splitting of the budgets implemented in the 1980's, then implemented to "improve management".

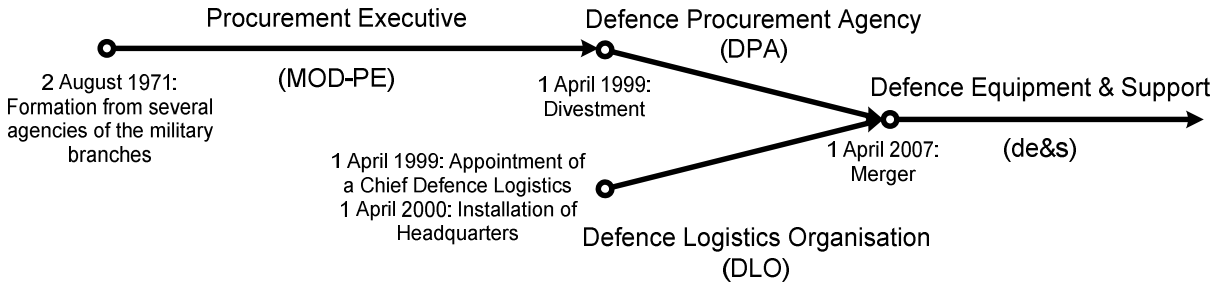

Figure 2: Organisational history of de&s

At this point in time it is impossible to determine the effects of the DACP on the quality of defence procurement. The deteriorated procurement parameters published in the Annual Report and Accounts of the MOD 2007-2008 hint that Smart Procurement/Smart Acquisition/DACP might join in the line-up of scarcely effective reforms in British defence procurement. This concern is already voiced in the McKane report when it remarks that "the [Defence] Department has a record of being sound on analysis but less strong on sustaining implementation." (EAC:1.17)

2 Analysis of doctrinal documents

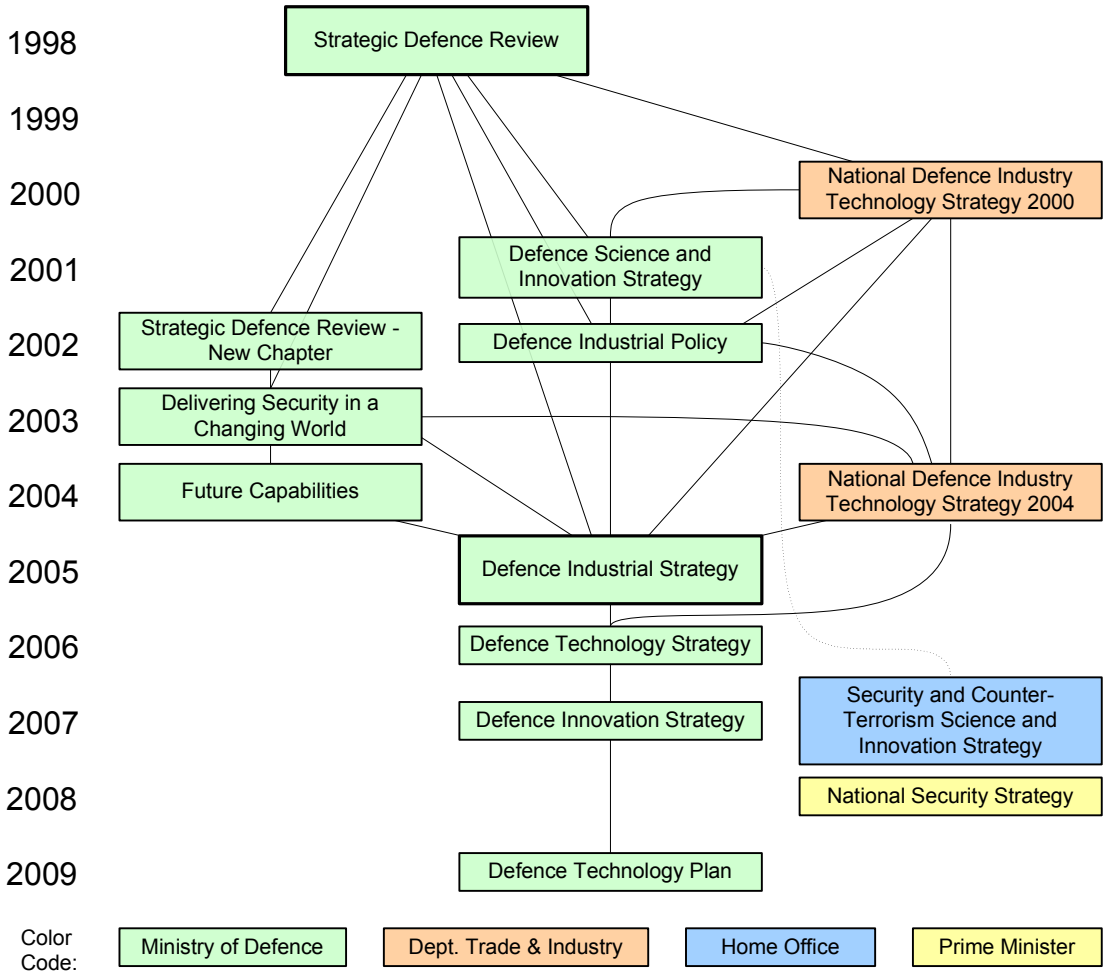

Figure 3: Relation of British doctrinal publications since 1998

2.1 Strategic Defence Review (1998)

Approximately one year after coming into office, the Labour government under Tony Blair issued a comprehensive white paper, the *Strategic Defence Review*, about its future military strategy. Concerning R&D, the introduction of Smart Procurement in chapter 8 is most notable. In this context the transformation of the Procurement Executive (MOD-PE), part of the MOD, into an independent Defence Procurement Agency (DPA) and the formation of a unified logistics organisation (which would become the Defence Logistics Organisation (DLO) in April 2000) are also announced (SDR, chapter 8, paragraphs 160 and 178; figure 2).

In *Supporting Essay Three: The Impact of Technology*, part of the *Strategic Defence Review* package, some ideas are voiced that would be elaborated in greater detail in future doctrinal documents. In order to obtain "battle-winning forces […] a decisive technological edge over any potential opponent" is considered necessary. This can be achieved by procurement of "equipment on high but proven technology" (SDR,

Supporting Essay 3, paragraph 2). Furthermore, „hard choices will be required to cope with the wide range of possibilities within a limited budget.“ Communication and information systems, improved explosives, better sensors and improved simulation were identified as “areas where we can really make a difference” (SDR, Supporting Essay 3, paragraph 5). Market scanning for novel civil technologies that could have an impact on military capabilities should be carried out in a systematic way (SDR, Supporting Essay 3, paragraphs 6 and 7). As a reaction to the high pace of technological advance, especially in information and computer technology (ICT), “the balance of investment will shift from platforms in favour of the progressive update of in-service equipment.” (SDR, Supporting Essay 3, paragraph 8) This suggestion already pointed to the concept of Through Life Capability Management (TLCM), although without using this term. Ultimately, the necessity for international collaboration was stressed as a reaction to the cost of high technology defence research (SDR, chapter 8, paragraph 165). As the technological development would “inevitably be led by the US”, close collaboration with the USA was seen as essential, as incompatibilities “could lead to political as well as military problems.” (SDR, Supporting Essay 3, paragraph 10)

The *Strategic Defence Review* was intensively discussed in the Defence Committee. In its 1998 report, several concerns were voiced that would haunt the discussion about Smart Procurement for years:

- “How will the government decide if it wishes to use competition or a partnership with a preferred supplier for a particular acquisition or phase of an acquisition?” (“Memorandum submitted by Professor Trevor Taylor“, DC897)
- How do Smart Procurement and international collaboration fit? (ibid.)
- How do “value for money” and “wider economic, social and political factors” (both should be considered according to the SDR) fit? („Memorandum submitted by Professor Keith Hartley“, DC897)
- How can life-cycle costs be calculated, if it is not known whether equipment will be kept in store or deployed in active service? („Memorandum submitted by Mr Nick Hooper“, DC897)
- How do Smart Procurement and saving money go together? (Keith Hartley, DC897, Q1456f)

2.2 Defence Science and Innovation Strategy (2001)

The *Defence Science and Innovation Strategy* (DSIS) was published in December 2001 under the auspices of Keith O’Nions, the then Chief Scientific Adviser (CSA). Apart from summing up the ideas of the *Strategic Defence Review* concerning science and technology, it allows insight into the planning process of military R&D.

Towers of Excellence (ToE) are introduced as a novel concept in defence research: Acknowledging the fact that not one nation will be able to cover all relevant scientific areas at world-class level, some areas should be identified that deserve special attention. In these areas research clusters would be set up with as many contributors

as possible, explicitly including academia. These clusters are financed jointly by the MOD and contributing industry, although the financial endowment is small, as the ToE have the character of networks of experts and not of research programs. Currently six Towers of Excellence have been installed (table 3). While the ToE focus on whole systems, and thus on applied research, the Defence Technology Centres (DTC), announced in the 2002 *Defence Industrial Policy*, were formed as basic science counterparts.

Table 3: Towers of Excellence (ToE) and Defence Technology Centres (DTC) (Sources for starting dates: golith.ecnext.com, www.theregister.co.uk, www.se-towers.org.uk, difdtc.gdstorm.uk, www.hfidtc.com, www.seasdtc.com, www.emrsdtc.com)

Starting Date	*Name*
July 2002	Guided Weapons ToE
December 2002	Radar ToE
April 2003	Data and Information Fusion DTC
April 2003	Electro Magnetic Remote Sensing DTC
April 2003	Human Factors Integration DTC
June 2003	Underwater Sensors ToE
Mid-2004	Synthetic Environments ToE
November 2004	Electronic Warfare ToE
March 2005	Systems Engineering for Autonomous Systems DTC
2008 (?)	Electro Optic Sensors ToE

Another central issue of the DSIS concerns the partial privatisation of the Defence Evaluation and Research Agency (DERA), which was effected in July 2001. DERA had been formed by amalgamation of four previously independent research bodies in April 1995 and was the main provider of scientific expertise for the MOD at that time. It was split into the private company QinetiQ and a residual public Defence Science and Technology Laboratory (Dstl). The shares of the new company, comprising approximately 75% of the assets and personnel of former DERA, were sold in two tranches, with British government keeping a “golden share” to prevent QinetiQ acting against British strategic interests (DSIS, paragraph 23). Dstl’s missions are to “provide a high level overview of defence science and technology, act as an in-house source of impartial advice [to the MOD] and manage international research collaboration.” (DSIS, paragraph 22) Furthermore, it conducts research in highly sensitive fields, e.g. CBRN protection.

It is interesting to note that there has hardly been any support for this privatisation outside government and high level management of DERA. Neither defence industry („Memorandum submitted to the MoD by the Defence Manufacturers Association on the Public Private Partnership proposals for DERA”, DC998, Ev 88), nor trade unions („Memorandum submitted by IPMS on Research Expenditure“, DC998, Ev 90), nor the Defence Committee (DC998, paragraphs 91 to 121) thought the proposed mode of privatisation satisfactory and called for reconsideration. These protests were

ignored and privatisation was carried out in two stages: the sale of a minority stake to the financial investor Carlyle in 2002 and the flotation of the business on the London Stock Exchange in 2006.

Seven years after the publication of the DSIS, the Committee of Public Accounts dealt with these proceedings (24th Report of Session 2007-08). The conclusions drawn included that the timing of the sale of shares to the financial investor was less than perfect, as in 2002-03 market conditions were poor and a significant long term contract with QinetiQ had not been agreed upon (conclusion 3) and that the early elimination of bidders (including Serco Group plc, the only trade bidder (paragraph 10)) weakened competition (conclusion 5). Through an internal incentive system, the top management of DERA was able to achieve approximately 107 m GBP with an investment of 0.54 m GBP (factor 200), while other shareholders (MOD, Carlyle, other employees of DERA) were only able to receive benefits with a factor of nine (paragraph 19 and conclusion 7). In the end, a total of 576 m GBP were obtained for the treasury, with MOD still holding 19.3% of the shares of QinetiQ (paragraph 26), but “the Department could have received 90 m GBP more than it did from privatisation” through several simple measures (paragraph 26 and conclusion 11).

Apart from these financial considerations, the partial privatisation of DERA affected the relationship between the MOD and defence industry. When DERA was an official agency, industry freely shared sensitive information with it, as DERA was not seen as a competitor. When QinetiQ was founded as a commercial enterprise, industry became concerned about the fate of their Intellectual Property (IP). They found the process by which they could reclaim their IP from the new competitor to be less than satisfactory. This shook the mutual trust between industry and the official side. Molas-Gallart and Tang (2006) even argued “that the privatization process has hampered the attempts to introduce substantial innovations in the defence procurement process (the so-called ‘Smart Procurement Initiative’)” as “the major UK defence manufacturers have become wary of sharing technical information with Ministry of Defence departments and agencies.”

Six years after the publication of the *Defence Science and Innovation Strategy* the *Security & Counter-Terrorism Science & Innovation Strategy* (2007) was published as its civilian counterpart. It was conceived by a number of government agencies under the guidance of the Office for Security & Counter-Terrorism at the Home Office. The establishment of a process for the identification and priorisation of research issues is a central topic of the strategy. CRBRN, explosives and “prevent” aspects of social sciences have been identified as “pathfinder” areas to test the new approach (SCTSIS, paragraph 12, page 8).

2.3 Further policy papers of 2002 and 2003

2.3.1 Strategic Defence Review – New Chapter (2002)

As a consequence of the changed threat perception after the attacks of 9/11, a supplement to the *Strategic Defence Review* (1998) was issued. This New Chapter of 2002 is mainly focussed on new geopolitical trends and conflicts the British armed forces were involved at that time. Concerning R&D it stressed the importance of "Network-Centric Capability" (p. 15) and identified unmanned aerial vehicles as "increasingly valuable battlefield tools" (p. 17).

2.3.2 Defence Industrial Policy (2002)

The *Defence Industrial Policy* was launched in October 2002, after 18 months of discussion between the MOD, the Department of Trade and Industry (DTI) and bodies of defence industry. In this document, aka *Defence Policy Paper no 5*, the MOD described how it intended to develop its relationship with the national industrial base. Two aspects of acquisition decisions are discussed in greater detail: "long-term value for money" and "wider factors", mainly concerning the sustainment of the defence industrial base (DIP, tables 1 and 2). Tensions between these two classes of aspects are acknowledged (DIP, paragraph 2).

"Project performance – ensuring that reliable and supportable equipment is developed and delivered within time and price constraints" is identified as the basis for the MOD's relationship with industry (DIP, paragraph 15). One policy to achieve this aim is to spend a higher proportion of the defence equipment budget at early project phases to reduce technical risks and before the main investment decision is made (DIP, paragraph 54). This approach, also an integral part of *Smart Procurement*, is not new: The *Downey Study*, commissioned by the MOD in 1968, already recommended "that sufficient technical work should be done in the early Feasibility Study and Project Definition phases (ideally absorbing about 15% of the total development cost)" to ensure that the given requirements could be met (DC897, paragraph 307). It is telling that this recommendation was never fully implemented, and that there "continued to be over-optimism in the Services, research establishments and contractors about costs and timescales." (DC897, paragraph 308)

The DIP can be seen a prelude to the much more comprehensive *Defence Industrial Strategy* that was issued three years after (see section 2.5).

2.3.3 Delivering Security in a Changing World – Defence White Paper (2003)

Building upon the *Strategic Defence Review* (1998) and its *New Chapter* (2002), *Delivering Security in a Changing World* (DSCW, 2003) laid out the direction of future

strategic defence decisions. International terrorism, the proliferation of weapons of mass destruction, and failing states were perceived as the main security challenges. Further risks were identified in demographic problems (over-population), religious and ethnic tensions, and ecologic crises (DSCW, chapter 2). While future requirements for defence and the military capabilities necessary to meet them were described (DSCW, chapters 3 and 4), very little was actually said about R&D. On the other hand, this white paper represents the backdrop of the fundamental *Defence Industrial Strategy* (2005).

2.4 Intermezzo: The era of Paul Drayson

Following the 2005 elections, Paul Drayson (Baron Drayson of Kensington in the Royal Borough of Kensington and Chelsea) replaced William Bach as "Under Secretary of State and Minister for Defence Procurement" (title as given in the MOD Annual Report and Accounts 2005-06). He was singular in several aspects: This was his first government office as he had never held any political office before and in fact never stood for an election. Drayson had made a fortune in bio-pharmaceutical industry and did not ask for any remuneration for his office. He did not visibly aspire to any higher office in industry or government and in fact left office to follow his passion for car racing (BBC News, 2007; Ripley, 2007).

Drayson, who holds an engineering degree and a PhD in robotics (Page, 2007), brought a solid understanding of science and technology into his office. On the other hand, he had been a very successful businessman who made millions in vaccines. He had experience in dealing with government, and although there were allegations that his performance was associated with less than ethical behaviour (Leigh and Evans, 2004; Choueka, 2005), two inquiries cleared ministers and Drayson's company of any wrongdoing (Randerson, 2008).

During the thirty months of his office (he was appointed "Minister of State for Defence Equipment and Support" in April 2007 (title as given in the MOD Annual Report and Accounts 2006-07)) three doctrinal documents and two acquisition studies were drafted by the MOD. Both the *Defence Industrial Strategy* (2005) and the *Defence Technology Strategy* (2006) are outstanding in their comprehensiveness and detail (see below), and can be considered milestones in the development of the defence procurement doctrine of the UK.

Drayson left office on 7 November 2007, officially to compete in the American Le Mans series of car racing, which "cannot be combined with the challenge of full-time government office." (Page, 2007) Former shadow defence secretary Bernard Jenkins claimed that other issues stood behind this resignation: "He's walking away from a terrible mess because the spending review leaves the MOD's Equipment Plan short of around one billion GBP over the next three years," (BBC News, 2007) which threw de&s into "complete turmoil" (Ripley, 2007) and would endanger the processes laid out in the *Defence Industrial Strategy* (2005). Furthermore, it was reported that

Drayson had become increasingly frustrated at the Brown government's lack of interest in defence issues (Ripley, 2007; Howarth, 2007).

The magnitude of Drayson's driving power concerning the doctrinal process became evident after he left office: The only doctrinal document issued by his successor, the former chief whip Baroness Ann Taylor, was the *Defence Innovation Strategy* (December 2007) which clearly bore Drayson's handwriting. The update of the *Defence Industrial Strategy*, originally announced for December 2007, has meanwhile been renamed "DIS 2.0". Its publication has been claimed several times to happen "soon", but up to this time (February 2011) nothing has come forth.

2.5 Defence Industrial Strategy (2005)

The *Defence Industrial Strategy* (DIS) of 2005 was jointly issued by the MOD, the Ministry of Trade and Industry and the Treasury. It "is the most comprehensive statement of defence industrial policy ever published by an UK Government." (Hartley, 2006)

The DIS is divided into three sections: Section A gives a strategic overview, including military, economic and technological aspects. In Section B both industrial sectors and "cross-cutting capabilities" are analysed in great detail. Finally, Section C describes which steps will be taken to implement the findings and requirements formulated in the previous sections.

Several guiding principles were specified in the DIS:

- Appropriate Sovereignty (A1.21): "This is not 'procurement independence', or total reliance on national supply of all elements," but to "maintain the appropriate degree of sovereignty over industrial skills, capacities, capabilities and technology to ensure operational independences against a range of operations that we wish to be able to conduct."
- Through-Life Capability Management (A1.23)
- Maintenance of key industrial capabilities and skills (A1.24): The definition of these key capabilities and skills forms a major part of the DIS
- Systems Engineering (A1.25)
- Recognition of the benefits of a "healthy, competitive and dynamic national industry" (A1.26)
- Openness for change on both industrial and official side (A1.27)

While the DIS goes a long way in defining key industrial capabilities (e.g. construction of submarines and battle ships, manufacturing of small arms munitions and cryptographic equipment, capability to maintain mayor platforms), it leaves the definition of key technologies to the *Defence Technology Strategy* (2006).

Since the DIS was originally intended as a continuous process, a second version was planned for December 2007 (DC308, p. 72, paragraph 198). The government's lack of ambition to support, and in fact to fund, this process has been put forward as one of the reasons for Lord Drayson to leave office in November 2007. Since then several deadlines have slipped: "The MoD claimed that the original deadline was missed because of the need to finalise Planning Round 2008. More recently, the MOD has claimed the delay has been caused by the need to complete the short examination of the defence equipment programme. The short examination has been completed and both the MOD's Permanent Secretary and the Chief of Defence Materiel have told us they were confident that the updated version of the DIS would be published in 2009." (DC308, page 75, paragraph 207) The Defence Committee found it "astonishing that the new Minister for Defence Equipment and Support [Quentin Davies] was 'open-minded' as to whether it made sense to have an updated version of the DIS." The members of the committee "condemn the failure to date [February 2009] to publish an updated version of the DIS and consider that its continuing absence increases the risk that the UK Defence Industrial Base will not be able to meet the future requirements of our Armed Forces." (DC308, p. 75f, paragraph 208)

2.6 Defence Technology Strategy (2006)

In October 2006 the *Defence Technology Strategy for the Demands of the 21st Century* (DTS) was issued in order to describe the MOD's technological vision in greater detail, as announced in the *Defence Industrial Strategy*. It was the "first time MOD openly publishes its priorities for R&D, funding, skills, improved processes, opportunities and areas for international research collaboration" (DTS, page 6, paragraph 3), and it did so in a very comprehensive way (192 pages in total). More remarkably than just stating technological interests, it also states fields the MOD decided to pay less attention to in the future.

The DTS is divided into three sections: In section A ("Introduction") the foundations and the context of military R&D are discussed. Section B ("Sector Analysis") is the largest section by far. It contains detailed analyses of current trends, future themes, and the standing of British technology in eleven defence sectors, segmented in a similar way as in the DIS. Section C is titled "Taking Forward the Defence Technology Strategy" and relates to issues concerning the strategic planning implications of the DTS.

Like the DIS, the DTS carries the handwriting of Paul Drayson: His intimate knowledge of commercial thinking makes him open for the needs of industry, but he is also a demanding agent for public interests. So while he acknowledges that the MOD will remain the main funding source of defence R&D, he also demands that

"once the science has been established, and ideas turn towards more applied research and on to development and demonstration, industry will need to make an increasing contribution." (DTS, page 8) This especially applies to technologies beyond the stage of demonstrators (*Technology Readiness Levels* 6 and higher, DTS:A9.2), as from that stage on, there is a major potential for the generation of revenues.

In order to establish R&D priorities four criteria were applied (DTS:B1.6):

- Strategic assurance: "Capabilities that are to be retained in the UK as they provide those technologies necessary to safeguard the state," e.g. nuclear capabilities and high-grade cryptography.

- Defence capability: Technology "that is necessary for assurance of continued and consistent equipment performance or to support more general military capability."

- Strategic influence: Capabilities that provide "important strategic influence, in military, diplomatic or industrial terms. Collaborative or complementary programmes may often be relevant here."

- Technology benefits: Investments that strengthen the UK industrial base as a whole (defence technology spin-out).

Complementary to these guidelines, the DTS acknowledged that "technology development is primarily driven by the civil sector and MOD needs to work effectively with industry and academia in order to identify new technologies of defence interest, react to capability developments of potential adversaries and exploit new capabilities that are generated by the combination of existing technologies." (defence technology spin-in, DTS:B12.1) This is especially the case in rapidly developing areas like information and communication technologies (DTS:B12.11 to 17), ergonomics (DTS:B12.18 to 23), and generic technologies (like biomimetics (DTS:B12.29), nano-materials (DTS:B12.30), advanced electronics (DTS:B12.31) and smart/interactive textiles (DTS:B12.32)).

In order to speed up R&D exploitation, a process to develop technology roadmaps was announced (DTS:C3.1). The results of this process were presented in February 2009 as part of the *Defence Technology Plan*.

Although the DTS includes a comprehensive review of a multitude of technologies, nine are pointed out to be of exceptional importance (DTS, page 7): Man-portable biological detection systems, radar, modular open systems, as a key enabler for TLCM and technology insertion, modelling and simulation, propulsion (TLCM and

novel systems), generic medical countermeasures, satellites for information collection and analysis, gallium nitride circuit technology, and materials and structures for protection and through life support.

Reactions to the DTS were less pronounced than to the DIS, probably because the DTS was just a continuation and amplification of the DIS concerning R&D. The main points of criticism brought forward dealt with funding. On the one hand, industry was "a little frightened by the suggestion that they might invest more in R&D." (DC806, Ev 14 (Professor Roy Anderson), see also DC606, Ev 23 (SBAC)) On the other hand, the MOD failed to give numbers on how much it was going to spend on defence R&D. Both the *Defence Manufacturers Association* (DMA) (DC606, Ev 25) and QinetiQ (DC606, Ev 26f) expressed concerns that "without a real increase in MOD research investment, many of [the] aspirations [of the DTS] will remain unfulfilled." These concerns regarding finances are shared by the RUSI Acquisition Focus: "However, [the DTS] is a disappointing document in that, while it states the need for more investment from both industry and MoD, it does not say how this extra investment is to be produced. Without it, little improvement will be possible." (Weston et al., 2008)

In October 2006 a study labelled *Maximising Benefit from Defence Research* (aka *Capability and Alignment Study*) was published. It evaluated a representative portion of MOD financed R&D. The results gained from this pilot study were seen as so important that a more comprehensive review was commissioned. The results of that investigation were published in October 2007 under the title *Maximising Defence Capability Through R&D*. As the latter study is supported by a larger base of evidence, while not contradicting the earlier one, findings of *Maximising Defence Capability* are cited here, only.

The review team judged "that the technical quality of the vast majority of R&D activities meets MOD's needs." (paragraph 5, page 4) A major point of criticism was, however, the fact that "MOD's R&D is not presently considered or managed as a coherent whole; as a consequence there is no unifying vision or clear strategic direction." (paragraph 3.1, page 14) It is noteworthy that "the Review Team found very little evidence of effective Data Capture from MOD's R&D spend through databases or other means" (paragraph 3.45, page 23), although the report announces that this requirement "will be met by the Science and Technology Research Information Management System (STRIMS) database" that was to be developed (footnote 23, page 24).

While "the overall quality of MOD's R&D is mainly good and the most appropriate contractors are being used," (paragraph 3.23, page 19) it was found that the MOD had problems handling intellectual property in the hands of industry as "intellectual property owned by industry with MOD user rights is not catalogued centrally." (paragraph 3.30, page 20) "The team [even] found reports incorrectly marked 'company proprietary' or 'company copyright' when they should have been 'Crown Copyright'." (paragraph 3.32, page 20) These findings confirm the existence of a significant problem within the MOD concerning the management of intellectual

property rights (IPR), as they take the same line as Molas-Gallart and Tang (2006) when they describe the problems relating to the privatisation of DERA (see above).

Like the DIS, the DTS was planned as the beginning of a series of documents. Originally, updates were announced every two years "to be flexible and responsive as the threat and technology changes." (DTS, page 7, paragraph 6) No further reference to such an update has since been made.

Although the *Defence Innovation Strategy* of December 2007 was officially issued by Ann Taylor, it can be seen as the last document of the Drayson era. This rather brief document (14 pages) was meant to be a link between DIS, DTS and the *Defence Technology Plan* (DTP), which was then announced to be released by the end of 2008. Apart from this annunciation, the *Defence Innovation Strategy* mainly reiterates ideas of former documents and the Defence Acquisition Change Programme (DACP). In contrast to the DIS, which mainly aimed at prime contractors, this document lays out how small and medium sized enterprises (SME) can be involved more directly in defence acquisition (paragraphs 24 and 28 to 31, p. 8f). The MOD expects that the strict application of open system architectures and Through Life Capability Management (TLCM) will open opportunities for SME, especially concerning upgrades (paragraphs 17 to 22, p. 6f).

As the *Defence Innovation Strategy* did not contain revolutionary new concepts, there was hardly any public response to it (Page, December 2007).

2.7 Defence Technology Plan (2009)

In the *Defence Technology Strategy* (2006) the MOD stated that it was essential to ensure that "suppliers are aware of defence requirements so that they can play a major role in generating solutions." (DTS:C3.6) It announced that a process to generate technology roadmaps would be established by September 2007 (DTS:C3.1). In its annual report for 2007-08 the MOD assured that a *Defence Technology Plan* (DTP) would be published by late 2008. It would be made available in a "dynamic online format, allowing regular updates when necessary." (MOD-Annual Report 2007-08, p. 107)

On February 26, 2009 the *Defence Technology Plan* (DTP) was published online (http://www.science.mod.uk/strategy/dtplan/default.aspx). The website is divided into three areas: systems, emerging technologies, and capability visions.

The area "systems" is subdivided into seven groups of military capability: ships and submarines; land equipment; air and helicopters; C4ISTAR and CBRN; weapons; cross cutting; and joint supply chain. For each of these groups a set of "research and development objectives" is given. For each of these objectives a "desired outcome", a balanced cost sheet (with cost given in bands), and a graphical roadmap are

provided. Each of the research themes that appear on the roadmap is further described, including a statement on project duration.

"Emerging technologies" are characterised as "immature technologies in the early proof-of-principle stages" or "more mature technologies but where a novel defence application has been identified." The aim of this section of the DTP is to "establish a framework for wide engagement with the UK academic and industrial community, including those who may not have worked with defence before." The MOD states that "this is not unique to defence and there are a range of Horizon Scanning and Technology Watch activities across government that MOD works with," stressing that "these areas of interest will not necessarily receive direct MOD funding." (http://www.science.mod.uk/strategy/dtplan/technologies_Default.aspx, retrieved on 3 March 2009) Fifteen emerging technologies are laid out as graphical roadmaps without further comments or explanations.

Concerning "Capability Visions" the aim is to "identify innovative options to address long-term defence challenges." These could be "to promote a longer term perspective, to stimulate new activity in the wider R&D community and to act as a guide for industry-funded research and for suppliers to seek new applications for existing technologies." (http://www.science.mod.uk/strategy/dtplan/capabilityVisions_Default.aspx, retrieved on 3 March 2009)

Five concepts are detailed:

- "electronics defeat" (to provide a detailed understanding of how sophisticated electronic systems and information technology can be attacked, and the protective measures which can be adopted)

- "future protected vehicle" (to achieve the effectiveness and survivability of a heavyweight land force with the logistic footprint and agility associated with a lightweight force)

- "novel air concept" (to provide a more cost-effective means of achieving the effects currently provided by manned aircraft and cruise missiles by using new concepts in unmanned (combat) air vehicles)

- "reducing operational dependency on fossil fuels" (mainly by exploiting civilian technology)

- "reducing the burden on the dismounted soldier"

The DTP is definitely a milestone regarding public communication of military research planning. It will be interesting to observe in how far it will reach its goal of engaging a broader scientific base for defence related research.

3 Conclusions

The last Labour government has managed to further develop the British acquisition doctrine as documented by the series of doctrinal documents described in this paper. Institutional changes, like the formation of de&s, demonstrate the impact of this process.

Regarding R&T priorities, the broad bandwidth of issues catches one's eye. Besides overarching themes like TLCM, systems engineering, and modularisation that have received much attention since the *Defence Industrial Strategy* was published in 2005, information and communication technology (ICT) has always been in the centre of attention (although under different labels, e.g. "Network-Centric Capability", "Network Enabled Capability " (NEC), and C4ISTAR). Another recurring theme is sensors, both for CBRN and the electromagnetic spectrum, with radar playing a prominent role (e.g. DTS:B2.6f). Further core interests, like nuclear technologies and cryptography, are less visible as they are not discussed in publicly available documents (DTS:A1.5).

Through relatively high military R&T spending, the UK has secured an advantageous position compared to other European nations. In certain fields its technological level is comparable to the USA, which is remarkable, as the USA spends eleven times more for military R&T (USA: 7.3 bn EUR, UK: 0.65 bn EUR, as of 2008; European Defence Agency, http://www.eda.europa.eu/defencefacts/).

British military R&T has a comparably broad base, both in industry and the public sector. It is so well established in academia that some observers even fear an over-militarisation of British universities (Pallister, 2007; Street and Beale, 2007). On the other hand, the privatisation of DERA in 2001 has led to a significant loss of state owned technological expertise. QinetiQ, the company formed from a large portion of DERA, sees itself as a global actor and generates increasingly larger shares of its revenues overseas (see Figure 4). The fact that these overseas activities have been more profitable in the critical fiscal year ending March 2010 (operating profit of 5.3 m GBP for QinetiQ North America, operating loss of 17.8 m GBP for all other regions, including the UK) will probably cause further erosion of the British military R&T base as QinetiQ might move more of its activities to where the highest operating margin can be obtained.

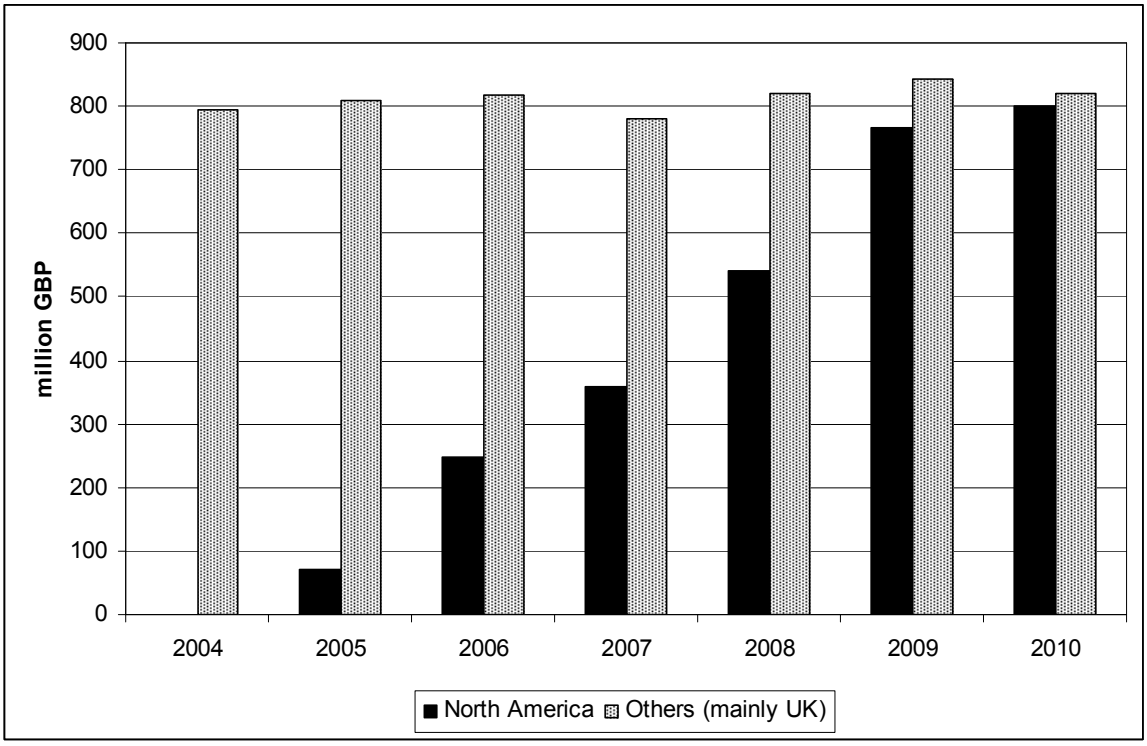

Figure 4: Revenue of QinetiQ by origin (Source: QinetiQ Annual Reports and Accounts)

The new coalition government that came into power in May 2010 laid out its defence doctrine in "The Strategic Defence and Security Review" published in October of the same year. This document is mainly concerned with closing the gap between the ambitious programmes initiated by previous governments and the lack of funding available. Public discussion on whether this can be achieved by the measures of this strategy is still going on (e.g. Giegerich and Jonas, 2011). Concerning the strategic options in international cooperation, the "special relationship" with the USA will be supplemented by further strategic partnerships, especially with France. The reserved attitude towards multilateral organisations like the European Defence Agency (EDA) has not changed.

Up to now, the new coalition government has not detailed its plans for military R&D, although a technology strategy has been announced for spring 2011. At this point in time, it is thus not possible to predict, in how far the new doctrines, spelled out in the *Defence Acquisition Change Programme*, will be maintained and in how far they will influence decisions concerning new projects. While the historic experience inspires little hope, careful optimism seems appropriate as long as the enthusiasm of the Drayson era and the new drive for realism of the current government still linger on.

Abbreviations

Documents:

DC308	Defence Committee, Third Report of Session 2008–09
DC603	Defence Committee, Sixth Report of Session 2003–04
DC606	Defence Committee, Sixth Report of Session 2006–07
DC705	Defence Committee, Seventh Report of Session 2005–06
DC806	Defence Committee, Eighth Report of Session 2006–07
DC897	Defence Committee, Eighth Report of Session 1997–98
DC998	Defence Committee, Ninth Report of Session 1998–99
DIP	Defence Industrial Policy (2002)
DIS	Defence Industrial Strategy (2005)
DSCW	Delivering Security in a Changing World - Defence White Paper (2003)
DSIS	Defence Science and Innovation Strategy (2001)
DTP	Defence Technology Plan (2009)
DTS	Defence Technology Strategy (2006)
EAC	Enabling Acquisition Change (2006), aka „McKane report“
NDITS	National Defence Industry Strategy (2004)
SDR	Strategic Defence Review (1998)
SCTSIS	Security & Counter-Terrorism Science & Innovation Strategy (2007)

Further abbreviations:

aka	also known as
bn	billion
C4ISTAR	Command, control, communication, computers, intelligence, surveillance, target acquisition and reconnaissance
CBRN	Chemical, biological, radiological and nuclear threats
CSA	Chief Scientific Adviser
COTS	Commercial off the shelf
de&s	Defence Equipment and Support
DACP	Defence Acquisition Change Programme
DERA	Defence Evaluation and Research Agency (was split up into Dstl and QinetiQ in July 2001)
DIB	Defence Industrial Base
DLO	Defence Logistics Organisation (formed from several precursor agencies in April 2000; merged with the Defence Procurement Agency to form de&s in April 2007)
DLOD	Defence Lines of Development (training, equipment, personnel, information, concepts and doctrine, organisation, infrastructure, logistics)
DMA	Defence Manufacturers Association
DPA	Defence Procurement Agency (formed by divestment of the Procurement Executive in April 1999; merged with the Defence Logistics Organisation to form de&s in April 2007)
Dstl	Defence Science and Technology Laboratory
DTC	Defence Technology Centre

DTI	Department of Trade and Industry
EDA	European Defence Agency
EU	European Union
EUR	Euro (European currency)
GBP	Great British Pound
ICT	Information and communication technology
IP	Intellectual property
IPR	Intellectual property rights
IPT	Integrated Project Team (central aspect of Smart Acquisition)
LOI 6	Group of six European nations that signed a Letter Of Intent for closer cooperation in the armaments sector in July 1998
m	million
MOD	Ministry of Defence (UK)
MOTS	Military off the shelf
NDIC	National Defence Industry Council (membership includes representatives of the MOD, the Department of Trade and Industry, the Treasury, the DIB, and trade unions)
NEC	Network Enabled Capability
p.	page
R&D	Research and development (EDA definition: All efforts up to the point where expenditure for production of equipment starts to be incurred.)
R&T	Research and technology (EDA definition: Expenditure for basic research, applied research and technology demonstration for defence purposes (a subset of R&D))
RUSI	Royal United Services Institute for Defence and Security Studies (military, London-based think tank, founded 1831)
SBAC	orginally: Society of British Aircraft Constructors, today: Society of British Aerospace Companies (trade association representing over 2600 British companies supplying civil air transport, defence, homeland security and space)
SME	Small and medium sized enterprises
TLB	Top Level Budget
TLCM	Through Life Capability Management
ToE	Tower of Excellence
UK	United Kingdom of Great Britain and Northern Ireland
USA	United States of America

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