COLD WAR AIR SYSTEMS PROCUREMENT

ROYAL AIR FORCE HISTORICAL SOCIETY

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CONTENTS

SELECTED GLOSSARY

A&AEE	Aeroplane and Armament Experimental Establishment
A&SD	Administrative and Special Duties
ACAS(OR)	Assistant Chief of the Air Staff (Operational Requirements)
ACDS OR(Air)	Assistant Chief of Defence Staff (Operational Requirements) (Air Systems)
ADV	Air Defence Variant (of Tornado)
AFB	(US) Air Force Base
AFB	Air Force Board
AFD	Air Force Department
AHB	Air Historical Branch (of the MoD)
AMRAAM	Advanced Medium Range Air-to-Air Missile
AMSO	Air Member for Supply and Organisation
AOG	Aircraft On the Ground
asq	Aerosystems Course qualified
ASRAAM	Advanced Short Range Air-to-Air Missile
COEIA	Combined Operational Effectiveness and Investment Appraisal
CSDE	Central Servicing Development Establishment
CTP	Chief Test Pilot
DOD	(US) Department of Defense
DOR	Director of Operational Requirements
EA	Engineering Authority
EASAMS	EA Space and Advanced Military Systems (the EA stood for Elliott Automation, but it was never spelled out)
ECM	Electronic Counter Measures
EFA	European Fighter Aircraft
ETPS	Empire Test Pilots School
FAA	Fleet Air Arm
FAST	Farnborough Air Sciences Trust
FIMA	Future International Military Airlifter
FLA	Future Large Aircraft
FLAEG	Future Large Aircraft Exploratory Group
INAS	Inertial Navigation & Attack System

MBB	Messerschmitt-Bölkow-Blohm
MDG	Multi-Disciplinary Group
MoA	Ministry of Aviation
MRCA	Multi-Role Combat Aircraft
MSOW	Modular Stand Off Weapon
NAMMA	NATO MRCA Management Agency
OCCAR	*Organisation Conjointe de Coopération en matière d'Armement*
OR	Operational Requirements
PE	Procurement Executive
PFA	Popular Flying Association
PSO	Personal Staff Officer
RAE	Royal Aircraft Establishment
RAeS	Royal Aeronautical Society
RCDS	Royal College of Defence Studies
RMA	Royal Military Academy
RSRE	Royal Signals and Radar Establishment
RUSI	Royal United Services Institute
SAM	Surface-to-Air Missile
SAR	Search And Rescue
SDSR	Strategic Defence and Security Review
SEPECAT	*Société Européenne de Production de l'Avion ECAT (Ecole de Combat et Appui Tactique)*
SNECMA	*Société Nationale d'Etudes et de Construction de Moteurs d'Aviation*
SNEB	*Societé Nouvelle des Etablissements Brandt*
TDP	Technology Development Programme
TGWU	Transport and General Workers Union
TNA	The National Archives
UAV	Unmanned air/aerial vehicle
UOR	Urgent Operational Requirement

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BAWA, HENDON, 18 October 2016

WELCOME ADDRESS BY THE SOCIETY'S CHAIRMAN

Air Vice-Marshal Nigel Baldwin CB CBE

Ladies & Gentlemen - good morning.

It is a pleasure for our Society to be back at the BAWA – the Bristol Aerospace Welfare Association – at Filton with its excellent facilities. It is the seventh time we have been welcomed here so let me say straightaway how much we appreciate the support we have always had from the BAWA Chairman, Mr Jim Bishop, and his ever-helpful colleagues.

Our Chairman today is Air Marshal Sir Peter Norriss. Sir Peter's early RAF career was spent as a flying instructor and operational pilot, mostly on the Hunter, Buccaneer and Tornado. As a wing commander, he commanded No 16 Squadron and then, as a group captain, the Tornado base at RAF Marham.

Very relevant for us today, he served two tours in the MoD's Operational Requirements Division before joining the Procurement Executive where his last tour in the Service was as Deputy Chief of Defence Procurement (Operations) and Controller Aircraft in the Ministry of Defence, where he was directly involved with the planning and procurement of defence equipment.

When he left the RAF, as a consultant he carried out major programme reviews for the Office of Government Commerce, and served as a non-executive director of Chemring and Turbomeca UK. He was President of the Royal Aeronautical Society in 2003-04. So he is well placed to guide us today.

Sir Peter – you have control.

CHAIRMAN'S OPENING REMARKS

Air Marshal Sir Peter Norriss KBE CB AFC MA FRAeS

Ladies and gentlemen, thank you for the introduction.

I am pleased to have been asked to chair this meeting of the RAF Historical Society but, apart from my short speaking part this afternoon, I can take no credit for the agenda or the speakers, all of which were determined by Nigel and Jock.

Inevitably to try to cover the whole gamut of procurement in a one-day seminar would simply not be possible, and so this event has a very limited focus, namely the procurement of RAF air systems in the Cold War and the effect on the Service's capability, though some of us will deviate a bit from a strict interpretation of this.

Having spent some thirteen years in Operational Requirement and Procurement appointments during my time in the RAF and then had a further twelve or so years directly connected with a number of the interfaces connecting the MoD, the Services, industry and the Treasury, I have developed a number of personal views about the ways that procurement in the round has affected the Services in general and the RAF in particular. As most of these thoughts were not being covered by other speakers, and I felt strongly about them, I persuaded the organisers to let me have a few minutes to air my thoughts this afternoon. But as a preamble, I thought I'd briefly mention some aspects of procurement management by way of introduction to the subject.

Management of Procurement

Plans staffs worked hard to meet each CAS's priorities, and as the budget was always under pressure, they tended to operate with, what I would call, a 'big hand and small map' approach, and were always looking for cheaper options and for savings measures to meet their budget objectives. This often led to the procurers being asked, at very short notice, to cost new savings measures which often lacked detail. This meant that the costings often lacked accuracy and had significant caveats attached to them; such caveats were generally ignored or glossed over by the Centre. So, if these measures made it into the core programme, which they often did, they were then comprehensively costed for the following year's budget and invariably showed major

cost increases, which led in turn to further, often damaging, savings being required.

Associated with this was the now well-known ‘conspiracy of optimism’, whereby the RAF wanted new toys, industry wanted to make them, the programme staffs wanted to include them in the budget, and the procurement staffs wanted to manage the sexy new project. As a result, technologically challenging equipment projects often found their way into the budget with cost-estimates well below reality, with the result that other important capabilities often suffered to make way for them, once the real costs became known.

Each year the National Audit Office conducted an audit of MoD’s major programmes, and procurement usually took a bashing. The Parliamentary Accounts Committee often weighed-in. But invariably the details were glossed over in their public utterances in favour of political grandstanding, with the procurement staffs taking the hit, even though many of the causes of delays and cost over-runs lay elsewhere: slippage imposed by programmers for budgetary reasons; requirement changes; industry’s problems with technology development or their supply chain and as a result of inflation.

While political involvement in defence procurement is inevitable, there is little doubt in my mind that the Anglicisation of new aircraft for political reasons has generally been a disbenefit. Re-engining the Phantom with the Spey for example. The Harrier GR5 is another case in point. Ministers insisted that a Ferranti platform, the FIN1064, should be installed in lieu of the Litton one that had served the US Marine Corps well from its inception. But the Ferranti platform was not fit for purpose and kept toppling; but we had to soldier on with it for years before the issue was resolved. Similarly, the MoD had decided to privatise the Royal Ordnance Factories (ROF) but, anxious to get a good price for it, they needed to fatten it up. So they decided to replace the US-made Harrier gun, which functioned perfectly well, with a 25mm Aden cannon that did not exist, and they arranged for the design-and-build order to be placed with the ROF, as they had designed the 30mm Aden for the Hunter many years earlier. It was a raging disaster, as the factory was moved but the designers were not, and the result was a gun which had precisely the same faults as the very first Aden gun, because there had been no learning from experience, and modifications would be required to the Harrier

airframe to match those made to the Hunter decades earlier. Moreover, BAe seemed unable to overcome some vibration issues with the pylon carrying the gun, and so eventually the project was cancelled and, even though it was a close air support aircraft, the Harrier II never got a gun.

The Treasury often sought to stop or slow down projects. The long-standing requirement for an anti-armour weapon to SR(A)1238 is a notorious case in point. In 1989 the plan for a Technology Development Programme (TDP) competition between two competing solutions was approved by MoD, but with the cracks appearing in the USSR's hold over East Germany, the Treasury looked to slow it down by adopting what we saw as a scatter-gun approach before finally declaring in early 1990 that, following the fall of the Berlin Wall British forces would never again have to operate against armour. Less than nine months later Saddam Hussein invaded Kuwait, but it was many years before what is now Brimstone entered service.

Now a word or two about training. Apart from Controllers Aircraft it was extremely rare for a procurement posting to feature in Air Force Board members' CVs. And, despite the claim to be a technical service, there was no uniformed engineering officer on the board until the 1990s. Although officers going into flying appointments received pre-employment training, those going into OR and PE had none, and it was not unusual for there to be gaps between appointments. Many OR desk officers arrived straight from the front line and were itching to get back there. So, not only did they take some months to understand how the MoD worked, unless they had a knowledgeable boss who directed them about how to go about business, they often failed to consult with those who could help, such as the scientific or Resources and Plans (RP) staff, and were sometimes easily outmanoeuvred by others whose interests were not always well-intentioned towards the RAF. It was also easy to be caught out. I remember examining whether all the necessary studies had been undertaken before we launched the requirement for a Hercules replacement in 1989, and I was astonished to be told that one study, still not started, was the option of using the Channel Tunnel, which had not then been built, on the basis that transport aircraft existed only to take weapons and troops to the front-line in Europe. Out-of-area tasks could not be specially provided for, and so the Tunnel could be a credible option.

The *asq* annotation was awarded to officers who had successfully attended the intensive ten-month Aero-Systems Course, and there were a handful of *asq*-annotated posts in OR but, surprisingly, none in the PE. Despite the alleged importance of the *asq*, I found myself with one *asq*-post having three successive incumbents in the space of about 18 months because the Air Secretary's Department needed to fill what they saw as 'important' RAF posts, such as an OC Ops Wing somewhere. There is no doubt that this hampered effective delivery of the OR task.

I was personally surprised to be sent as a Director-General to the PE in 1991, as I had no PE experience and no engineering or scientific background. Once again there was no pre-employment training, and I had to seek out courses to help me do the job. At that time there was a Civil Service-run Advanced Management Course for 2-stars and above, with a few joining it from industry, but the RAF was allocated only one slot every three years, and we had apparently just had ours. But, as it happened, I was given a temporary job between appointments and so would not have had time for any training anyway! However, I am sure that had I had relevant training I would have been more confident and so more effective faster and might have prevented, or at least moderated, some of the issues that befell us later. So the bottom line for me is that, despite the importance of equipment, the RAF did not attach sufficient importance to procurement appointments, and so procurement projects often suffered.

During the course of the next few hours we will hear of some programmes that went well and some that did not.

BRITISH DEFENCE POLICY IN THE COLD WAR ERA, 1945-91

Dr Alastair Noble

Having graduated with a BA and MA in History, Alastair was a postgraduate tutor at the University of Leeds where he gained his doctorate in 1999. After two years with TNA, he spent 2002-09 as an historian at the Foreign and Commonwealth Office, followed by four years as a Speechwriter and Senior Policy Officer with the Scotland Office in London and a stint with the RMA, Sandhurst before joining the staff of the AHB in 2015. He is the author of two books and numerous scholarly articles.

> 'Britain's influence in the world depends first and foremost on the health of her internal economy and the success of her export trade. Without these, military power cannot in the long run be supported.' – HM Government, *Defence: Outline of Future Policy*, April 1957.[1]

> 'The fundamental problem that afflicts British defence policy, namely that resources and commitments do not match up, simply will not go away.' – Alan Clark MP, 1982.[2]

> 'There has always been an imbalance between the resources Britain has been prepared to devote to defence and the overseas commitments she has entered into.' – Professor Michael Dockrill, 1988.[3]

The story of post-war British defence policy is a frustrating one. All too often it is a tale of commitments running ahead of capabilities, despite the valiant efforts of the Armed Forces. A global role costs money. Unfortunately, Britain since 1945 has tended to posture at power rather than being willing to pay the price. Through it all, a range of military interventions, both domestically in Northern Ireland and overseas, varying in nature and in scale, have been conducted with differing levels of success.

This paper is a scene-setter. It seeks to provide a narrative, chronological overview of major Defence developments between 1945

and 1991. It is concise rather than comprehensive. The wide potential scope and accompanying requirement for brevity necessitates a broad-brush approach. In this context, the objectives of governments will be discussed, considering their political, economic and foreign policy priorities and the challenges they faced in these areas. These challenges tended to drive Defence policy and the level of Service expenditure. Politics, personalities and finance are central to the story. Thus, what follows often derives from political pressures and rivalries or from economic shortcomings.

Defence Reviews during the period discussed, and in most instances since, have been based on what politicians and the Treasury believed Britain could afford. As other areas of Government spending have gained stronger advocacy and earned greater popular legitimacy, the Defence slice of the spending cake has been steadily reduced in percentage terms.[4] Regrettably, rather than being a *tour de force*, this paper is more concerned with lack of forces.

Central to British Defence policy was the post-1945 geo-political situation. A clear ideological enemy was present – the Soviet Union. Moreover, for all the façade of the Big Three, by 1945 a Big Two and a Half was more appropriate – two superpowers and a faded global power. Great powers had been eclipsed or had collapsed in the crucible of total war. A new bipolar world traversed the international order.[5]

The strength of Britain's armed forces in 1945 obscured the country's 'truly frightening economic prospects'.[6] Victory over the Third Reich and Imperial Japan had involved a 'strategical juggling act'.[7] The proud memory of standing alone in 1940 could sustain hearts and minds but would not pay the bills. The economist John Maynard Keynes gloomily told the Cabinet in 1945 that Britain faced a 'financial Dunkirk' and greater austerity than at any stage of the war.[8] Friends were less accommodating. The United States adopted a tough line in 1945, scrapping Lend-Lease and abruptly withdrawing wartime atomic cooperation arrangements. Britain's independent atomic programme was subsequently driven by Labour Prime Minister Clement Attlee and his pugnacious Foreign Secretary, Ernest Bevin, to Churchill's pleasant surprise when he returned to Downing Street in 1951.[9] A loan from Washington was eventually secured later in 1945 and Marshall Plan aid helped drive British post-war growth and

exports. Still the economy remained fragile, particularly as the Government was pledged to numerous domestic and overseas commitments.

Foreign policy choices had to be made in 1945. The Labour Government, despite reservations about American conduct, was only heading in one direction.[10] Soviet expansionism was deemed by Attlee and Bevin to present the greatest threat to Britain's interests.[11] As Great Power polarisation crystallised, there would be no British 'middle way', nor any 'socialist foreign policy'.[12] Alongside building the New Jerusalem at home, the Government considered Britain a top table player. Even after Indian independence in 1947 it sought to maintain an extensive overseas Empire.[13] Criticism of the foreign policy of Attlee's Government has also emanated from the Right. Correlli Barnett maintained that Britain squandered the chance to modernise the economy and industry by excessive spending on overseas commitments, armed forces across the globe and new welfare provision.[14]

Set against this post-war backdrop, the fortunes of Defence and, more particularly, the RAF fluctuated. The RAF in 1945 was a truly formidable force. In January 1945, it comprised over 500 squadrons with nearly 9,000 aircraft in first-line service, over 27,000 aircraft in total and a manpower contingent in excess of 1·1 million officers and men. Technological advances and improvements to operational techniques had transformed the force. Jet aircraft, better guns, rocket projectiles, larger bombs and improved radar aids were factors in this development. However, de-mobilisation led to a rapid shrinkage of Britain's vast wartime forces. The RAF was allowed to decline too fast and too far – to 1,124 operational aircraft by 1948 and to around one quarter of the manpower of its wartime peak, with numbers in the regular element being a particular concern.[15] The dangerous trend of RAF contraction was only halted by the challenge posed to the West by the Berlin blockade and the Korean War. The Attlee government lengthened conscription and launched a massive re-armament drive in late 1950.[16]

The Berlin blockade was the catalyst for the creation of a transatlantic Defence community. NATO was formed in April 1949. Over the coming decades Defence policy would be anchored on Britain's prominent participation in the Alliance and the promotion of

collective security. Nevertheless, British rearmament could not be maintained at the tempo first envisaged by Attlee's Government. The level of Defence expenditure peaked at 9·8% of GDP in 1952-53 as manpower across the Services neared 900,000. The RAF strength of 277,125 officers and men included 90,000 National Servicemen.[17]

In the 1950s any lingering notion that Britain remained an independent great power was ruthlessly exposed. It was more than Suez, where indeed the RAF performed credibly – successfully neutralising the Egyptian Air Force, delivering the airborne forces and providing close support. Significantly, military success was undone by economic fragility, exacerbated by American political and financial pressures.

From the mid-1950s there was clear political will to lighten the Defence burden.[18] Politicians seized the nettle of Defence costs in 1955-56, prior to Suez.[19] The task was eventually entrusted to Duncan Sandys, Secretary of State for Defence, variously described as a 'kind of political commando, specially equipped for tasks of extreme peril'[20] or as a man whose White Paper of April 1957[21] 'did more to inflict radical damage on the British aircraft industry than anything Hermann Goering's *Luftwaffe* had done over nearly six years of war.'[22] Indeed, new Prime Minister Harold Macmillan, thought Sandys so disagreeable that 'he must have German blood.'[23] Sandys was the first Defence Secretary 'who was able to dominate the defence establishment'.[24] The Chiefs of Staff disliked Sandys immediately. However, Sandys would match them, including the First Sea Lord Louis Mountbatten. Ultimately, with Mountbatten, he laid the foundations for an integrated Ministry of Defence, subsuming the Service ministries, established in 1964.

The Sandys Review was undertaken on solely financial grounds, with the post-Suez recession being the final factor.[25] Dubbed 'the biggest change in military policy ever made in normal times' it marked a shift towards vastly reduced manpower – including the ending of National Service, fewer aircraft and more missiles.[26] Sandys wanted 'a comprehensive re-shaping of policy' – for Britain to embrace the missile and nuclear age. Prevention, based on the strength of likely retaliation, rather than preparation for war, was emphasised. Another assumption was the acceptance that in a war, some enemy bombers with nuclear weapons would penetrate the country's defences

with devastating results. Heavy cuts followed in Fighter Command and RAF Germany.[27] Sandys presented the RAF with a challenge to its very existence[28] and as a result earned an enduring notoriety in air circles similar to that of Dr Beeching among the rail fraternity.

Moreover, the Defence burden on the civil economy was seen by the Government as retarding vital economic growth.[29] Scarce, skilled manpower and precious materials for export trades were devoted to Defence to the detriment of productive industry. This argument would be repeatedly cited in Whitehall over the following decades. Furthermore, the heavy investment in Defence seemed to offer meagre returns.

Though the Canberra and the V-bombers had come on stream from the early and mid-1950s respectively, too many cutting-edge British programmes ran into difficulties in the 1950s and 1960s with resultant cost and credibility issues. To continue to attempt to play a global role on a limited budget Britain could no longer afford to go it alone. It was becoming prohibitively expensive to maintain substantial levels of Defence research and development funding across such a wide field of activities. To encourage greater competitiveness and efficiency Government also pushed famous old aircraft firms into mergers.[30] Procuring American equipment or collaborative ventures with other allies were increasingly attractive options as Britain downsized Defence.[31]

Post-Suez Defence efforts were more dependent on American goodwill. This cooperation stretched to nuclear weapons. The cancellation of the Blue Streak underground-launched missile in April 1960 effectively marked the end of Britain's independent nuclear deterrent. The US Skybolt air-launched missile was then cancelled in December 1962. The Thor missile came and went. In the interim, the V-bomber force was primed to deliver the deterrent, which would have involved low-level delivery of both free-fall weapons and the Blue Steel stand-off bomb.

The Service entrusted with delivering the deterrent ultimately changed with the Royal Navy's fleet of British-built nuclear submarines armed with US Polaris missiles taking over from the V-bombers in 1969. The 1960s was a difficult decade for the RAF. Not only did it lose responsibility for the deterrent but air defences were run down, Commands were closed or rationalised and the P1154 and

TSR-2 aircraft were cancelled.[32]

Defence came under renewed scrutiny following the election of Harold Wilson's Labour Government in October 1964. The new Defence Secretary, at the helm of an overarching ministry, Denis Healey, aimed to cut spending and address what he viewed as overstretch.[33] In a series of reviews, flagship Royal Navy[34] and RAF programmes were culled to secure savings, notably the aforementioned TSR-2 in 1965; as well as the cancellation of the order for its replacement, the American F-111.

The Wilson government's decision in 1968 to withdraw from east of Suez was driven by a severe economic crisis which trumped domestic and overseas pressures, including lobbying from Washington urging Britain to retain a presence.[35] This decision was not substantively altered by Edward Heath's Conservative administration in 1970. By then Britain had shrunk from a global power to a regional power with a 'eurocentric' defence policy.[36] A substantial RAF presence in the Middle East and Far East was consigned to history. During the early 1970s, economy exercises and recruitment caps saw RAF numbers fall by 10% from around 112,000 in 1970 to under 101,000 by November 1973.[37] Manpower cuts were essential to fund ever more expensive new technologies. In an attempt to make the purchase of equipment more efficient the Procurement Executive was created in 1972. However, as inflation rose and global fuel prices rocketed following the Yom Kippur War of October 1973, Heath's Government imposed spending cuts on Defence and quietly initiated the process for a Defence Review.[38]

This depressing trend of retrenchment continued under the Wilson and Callaghan governments of the mid to late 1970s. Defence faced a particularly challenging political and economic environment. The Labour Left sought deep cuts to the Defence budget.[39] Both Labour General Election manifestos in 1974[40] pledged to reduce Defence spending in percentage terms to a rate equating to Britain's major European neighbours.

Roy Mason's Defence Review of 1974-75 was underpinned by Field Marshal Sir Michael Carver's championing of the concept of the 'critical level'.[41] The Chief of the Defence Staff argued that significant British cuts below it would undermine key capabilities and the very cohesiveness of NATO. Ministers were told that the security of the

UK rested on the continued credibility of NATO strategy.[42] The Defence Review, which reinforced the overwhelming emphasis on NATO commitments, hit the RAF hardest. An 18,000 or 18% cut in manpower, the halving of the transport fleet, the reduction of the Nimrod maritime patrol force by a quarter and station closures were dispiriting outcomes. The continued development of the Multi-Role Combat Aircraft (MRCA) with West Germany and Italy and the Maritime Harrier offered some hope in the continued importance of air power for the future.[43] Mason's review restated the four areas where Britain made the greatest contribution towards its own security and that of NATO. These were:

- The Central Front of Allied Command Europe
- The Eastern Atlantic and Channel Areas
- The security of the United Kingdom and its immediate approaches
- The NATO nuclear deterrent[44]

These four priorities remained central to British Defence Policy until the end of the Cold War. However, Mason's comprehensive Review did not end *ad hoc* cuts to Defence. Chancellor Healey always viewed his old department as a prime candidate for savings. By 1977, uneasy NATO allies believed that Britain after 14 separate reductions in Defence spending in four years 'had lost its way and its will'.[45] The cumulative impact of a series of reductions in the 1973-76 period meant that Defence spending in 1978-79 was projected to be nearly 8% below Carver's critical level baseline for that year in the Defence Review.[46] Sir Andrew Humphrey, Chief of the Air Staff, publicly questioned the state of his Service in 1975 and 1976. He had the quality but not the quantity – barely 13% of the aircraft numbers of 1957 – to confront a growing Warsaw Pact threat.[47] The state of Britain's air defences remained a concern. At the end of 1979, barely 100 fighters were available for the air defence of the UK and 356 of the RAF's effective aircraft were over 20 years old, 189 of these over 25 years old.[48]

Morale was also a worry. Poor pay deals and high inflation had eroded Service salaries leading to an exodus of trained professionals into better paid civil employment. By April 1978 armed forces' pay had fallen 32% behind that of comparable civilian jobs.[49] The Services

felt taken for granted and exploited as emergency cover in bitter industrial disputes.[50] As the economy grew from 1977, the Callaghan Government took a mildly expansionist line on Defence. US President Jimmy Carter had called for 3% real increases in Defence spending by NATO member states for a decade at the NATO summit in London in May 1977. The Government committed to this for two years from 1979-80. Belatedly, there were also moves to enhance the UK's air defences on a number of levels and the first concrete steps were taken in April 1978 on the process to restore Service pay parity by 1980.[51]

In Foreign Policy and Defence, the lower key approach of Callaghan contrasted with the strident anti-Soviet stance of Margaret Thatcher's Conservative Government elected in May 1979. Many in Defence hoped for a new dawn under the Iron Lady. Sir Frank Cooper, Permanent Under-Secretary of State at the MoD recalled that, 'defence was at a very low ebb in 1977-78 in particular and in 1979 there was a very high expectation that defence would do a great deal better because of statements made by the incoming Tory Government.'[52] They were soon disappointed. The ramifications of familiar economic failings were again encountered. The Thatcher government accelerated Service pay parity and Defence spending increased in real terms by over 8% in the three years to June 1981.[53] This could not continue. As an unforgiving monetarist macroeconomic policy was adopted, a downturn in economic activity and fall in GDP in 1980 and 1981 meant that Defence could not sail against the tide.[54]

Surprisingly Mrs Thatcher was in two minds.[55] Defence was a cherished commitment but she was determined to reduce public spending. During 1980 as other orders dried up, businesses placed a premium on Defence contracts and a surge of equipment deliveries soon overwhelmed the MoD's cash limit levels.[56] Moreover, the Government committed Britain to the American Trident nuclear deterrent. As other departments scurried around making savings, the Defence budget seemed to be steaming ahead, to the concern of the Treasury.[57] Mrs Thatcher adopted a compromise approach – savings were sought from Defence but not to the level demanded by the Treasury. A self-imposed three-month moratorium was initiated by the MoD on new equipment orders to rein in spending but Francis Pym's unwillingness to accept cuts to his budget, and his threats to resign,[58] led to his removal as Secretary of State in January 1981. His

replacement, the more monetarist John Nott, faced the same problems. Within three weeks of his appointment he was having to announce £200 million of reductions for 1981-82.[59] Though an advocate of cash limits, Nott also found it increasingly difficult to keep spending under control. A Defence Review was inevitable, despite Nott's initial public reservations and it duly took place during the spring and early summer of 1981.[60]

Conventional wisdom dictates that the Royal Navy was the big loser in this exercise but many of the planned reductions were then annulled after the Falklands conflict of 1982.[61] This is only true to a point. The Royal Navy accounted for 57% of the reductions announced by Nott but some ships were reprieved before the conflict began. Though the RAF did not face cuts of mid-1970s levels, it did not escape completely unscathed.[62] However, Nott's programme was much less painful than the even more stringent Defence savings that Chancellor of the Exchequer Sir Geoffrey Howe proposed to the Cabinet.[63]

Nevertheless, familiar problems remained. Equipment costs continued to surge. The rate of increase in the real cost of equipment outstripped GDP growth. The statistics were startling. In real terms, more was being spent on Defence equipment than ever before – it constituted a 30% share of the Defence budget in 1950 but 46% by 1982. Real costs escalated because of technological developments. Government spent more but got far fewer ships, aircraft and tanks. In real terms the Harrier was four times more expensive than the Hunter of the 1950s.[64]

Post-Falklands there were calls for a new course with a maritime emphasis. The naval lobby renewed their fight against Nott's review. The Navy's versatility was highlighted. Supporters of the 'senior service' pointed to Soviet threats outside Europe and the resultant risks they posed to Britain's wider interests. Similarly, they implied that by adhering to the concept of Forward Defence in Germany, the BAOR and RAF Germany were trapped in a static Maginot Line mentality.[65]

Admiral of the Fleet Sir Terence Lewin, Chief of the Defence Staff, publicly spoke out against any portrayal of disunited Services as, 'the Falklands operation was demonstrably a tri-Service action' with 'all participants…worthy of praise'.[66] Moreover, the role of the

RAF and air power against Soviet threats on land and at sea was articulated by former Chiefs of the Air Staff.[67] They observed that the Falklands had illustrated the vulnerability of surface ships without the presence of a sufficiently strong air umbrella. Nott himself publicly argued that it was unwise to go 'overboard on Navy spending'.[68] For the remainder of the decade, despite more resources heading to the South Atlantic, the focus of Defence Policy remained solidly on the NATO commitment and the European theatre.[69] Domestically, the Ministry of Defence was subjected to Michael Heseltine's centralised management techniques (MINIS – Management Information System for Ministers) and slimmed down considerably – divesting itself of manpower-heavy Royal Ordnance factories and Royal Dockyards.[70]

The rapidly changing security environment of the late 1980s posed fresh challenges for Defence, though London remained more cautious than Washington about developments in Moscow. Nevertheless, by 1989 international relations were entering a new era and Defence planning began to reflect this. Talks on the reduction of Conventional Forces in Europe (CFE) between NATO and the Warsaw Pact began in March 1989. Future Defence requirements were discussed at a seminar on CFE convened by Mrs Thatcher at Chequers on 30 September 1989.[71] The starter's gun had been fired in the Defence Review process. Tom King, the Defence Secretary, kept his cards close to his chest.[72] Ostensibly the review was based on strategic considerations, although the Treasury wanted to secure the savings from a 'peace dividend' in Europe. It was more about savings than options. Meanwhile, the Service Chiefs, sidelined by King, remained guarded and underlined the value of their forces, particularly if matters soured in eastern Europe.[73] The situation did indeed sour, though initially further afield.

Tom King stood up in the House of Commons on 25 August 1990 to outline the Options for Change proposals, which involved a 14,000 cut to RAF manpower, the closure of stations in Britain and Germany, the disbanding of Phantom squadrons and the mothballing of Tornado squadrons.[74] Eight days later Iraq invaded Kuwait and a fresh challenge suddenly had to be faced. The end of the Cold War coincided with the largest deployment of British forces since 1945. The first chapter of post-Cold War operations for the RAF was about to begin.[75] It is where this paper ends.

Notes:

[1] HM Government, *Defence: Outline of Future Policy* Cmnd 124 (HMSO, London, April 1957), p1.

[2] Clark, Alan; 'The special respect Nato owes Britain', *The Times*, 10 July 1982.

[3] Dockrill, Michael; *British Defence since 1945* (Basil Blackwell Ltd, Oxford, 1988), p11.

[4] Lewis MP, Dr Julian; 'Defence Spending', *The Times*, 21 September 2016. Dr Lewis, Chairman of the House of Commons Defence Select Committee, succinctly summarised the shift in spending, comparing Defence expenditure with other high-spending departments: 'In the mid-1960s, defence was overtaken by welfare spending, which is now six times its size. In the 1980s broadly similar sums were invested in defence, education and health. We now spend 2·5 times on education and nearly four times on health what we spend on defence.'

[5] Kennedy, Paul; *The Rise and Fall of the Great Powers: Economic Change and Military Conflict from 1500 to 2000* (Unwin Hyman, London, 1988 reprint), p357.

[6] Kennedy, Paul; *The Realities Behind Diplomacy: Background Influences on British External Policy 1865-1980* (Fontana Press, London, 1989 edition), p361.

[7] Kennedy; *Rise and Fall of the Great Powers*, p347.

[8] Hennessy, Peter; *Never Again: Britain 1945-51* (Penguin Books edition, London, 2006), p361.

[9] Gilbert, Martin; *Churchill: A Life* (Minerva, London, 1991), p901; Kennedy; *The Rise and Fall of the Great Powers*, p370. Outstripped economically and in terms of military machinery and manpower by the superpowers, the British Government viewed the possession of atomic weapons as a 'relatively cheap' way of retaining independent Great Power influence.

[10] Wrigley, Chris; *Oxford Dictionary of National Biography*, entry for Ernest Bevin. Attlee and Bevin's admiration of the wartime achievements of the Soviet people was clouded by a marked distrust of their leaders.

[11] Tusa, Ann and John; *The Berlin Blockade* (Hodder & Stoughton, London, 1988), p36; Self, Robert; *British Foreign and Defence Policy since 1945: challenges and dilemmas in a changing world* (Palgrave Macmillan, Basingstoke, 2010), p35. Bevin's insistence that he was 'not going to have Britain barged about', led the brutal Soviet Foreign Minister Vyacheslav Molotov to complain, 'Eden is a gentleman, Bevin is not'.

[12] Walden, George; 'Capability Bevin', *London Review of Books*, Vol 6, No 2, 2 February 1984; Whitaker, Reginald; 'Letters', *London Review of Books*, Vol 6, No 6, 5 April 1984. Truman found Bevin to be abrasive at Potsdam and later told aides: 'Stalin and Molotov may be rough men but they know the common courtesies; Bevin was entirely lacking in all of them, a boor.'

[13] FCO Historians; *The FCO: Policy, People and Places 1782-1995* (1999) https://issuu.com/fcohistorians/docs/history_notes_cover_hphn_2 accessed 3/11/2016. Sir Orme Sargent, Permanent Under-Secretary of State at the Foreign Office from February 1946, highlighted the altered situation in Europe and the Soviet threat in his famous memorandum 'Stocktaking after VE-Day' produced for the then Foreign Secretary, Anthony Eden, in July 1945. Sargent argued that the only way 'to compel

our two big partners to treat us as an equal' was for Britain to take over the leadership of western Europe, in addition to the Empire or Commonwealth. These ideas chimed in well with Bevin's vision of Britain's continued world role.

[14] Barnett, Correlli; *The Lost Victory: British Dreams, British Realities, 1945-1950* (Macmillan, London, 1995); Edgerton, David; 'Declinism', *London Review of Books*, Vol 18, No 5, 7 March 1996; Self; *British Foreign and Defence Policy*, p36. Barnett believed Bevin to be 'an altogether disastrous Foreign Secretary', blinded by a fatal delusion of Britain's continued global role. Barnett; 'Letters', *London Review of Books*, Vol 18, No 6, 21 March 1996 criticised 'Britain's nostalgic attempt to going on playing the world and Commonwealth power, with expensive armed forces spread all the way through the Middle East and Far East […] the combined demands of the "world-power" role and "New Jerusalem" squeezed back much-needed investment in modernising Britain's industries and infrastructure.'

[15] HM Government, *Air Estimates 1948-49* (HMSO, London, February 1948); 'The Outlook', *Flight*, No 2045, Volume LIII, 4 March 1948; http://hansard.millbanksystems.com/written_answers/1968/jul/02/raf-manned-strength accessed 9/11/2016, House of Commons – Hansard Written Answers, 2 July 1968, columns 211-212; Thetford, Owen; *Aircraft of the Royal Air Force since 1918* (Putnam Aeronautical Books, London, 9th edition, 1995), pp11-12; Delve, Ken, *The Source Book of the RAF* (Airlife, Shrewsbury, 1994), p272. Various figures of RAF strength in 1948 are suggested, dependent on criteria covered and the time of the year, further complicated by demobilisation and National Service. In Vote A of the *Air Estimates* the maximum number of officers, airmen and airwomen to be maintained for Air Force service was set at 325,000. The 1968 Parliamentary Question answer cited RAF strength of 256,827, while Air Historical Branch (RAF) suggests a figure of 237,681. What is clear, and was stressed in the *Flight* article, was the significance of the trained and experienced regular element, which was said to number around 100,000. Though the Government was pledged to build up the regular element, there were major concerns arising from the continued release and discharge of personnel during 1948.

[16] Dockrill; *British Defence since 1945*, pp36, 43-44. A rearmament programme of £3·7bn over three years was approved in 1950 and this was increased to £4·7bn in January 1951. However, as economic pressures mounted, the spending programme was spread over a longer period by the Attlee Government and later reduced under Churchill.

[17] House of Commons – Hansard Written Answers, 2 July 1968, columns 211-212; Thetford; *Aircraft of the Royal Air Force since 1918*, p13. These were the manpower figures on 1 April 1953. Total RAF aircraft strength reached a post-war peak of 6,070 in 1952.

[18] Eden, Sir Anthony; *Full Circle* (Cassell, London, 1960), pp. 367-380. Eden believed the economy could not be expected to withstand the 'mounting strain' of increasing defence spending and concluded by July 1955, 'We had to call a halt in defence expenditure and hold it over a period of years.'

[19] The National Archives, Kew (TNA), AIR 41/86, James, T C G; *The RAF in the Postwar Years: Defence Policy and the Royal Air Force 1956-1963* (Air Historical Branch (RAF), 1987), pp3-4. Harold Macmillan, Chancellor of the Exchequer in

Eden's administration, sought to reduce public expenditure particularly on Defence. Eden was 'determined to pursue it by orderly process rather than by an imposed solution based on arbitrary judgements of the resources to be allotted to defence'. In early 1956, Sir Norman Brook, the Cabinet Secretary, gathered together a small Whitehall-wide group of officials to produce a paper on the 'essential objects of British policy today – political, military and economic'. The group worked outside the normal Whitehall machinery. There was no consultation with the Chiefs of Staff who only learned about this development in mid-May 1956 and were not pleased. This led to the formation in June 1956 of a small committee of senior ministers chaired by Eden – The Policy Review Committee (PRC) – to which other ministers and the Chiefs of Staff were only invited to attend when committee business required it. The PRC met frequently in June and July 1956. It did not meet again until 18 December because of Suez. By this time Eden was unwell and weeks from resignation and Macmillan was demanding even deeper Defence savings.

[20] 'Obituary Lord Duncan-Sandys', *The Times*, 27 November 1987.

[21] HM Government; *Defence: Outline of Future Policy*.

[22] Hamilton-Paterson, James; *Empire of the Clouds: When Britain's Aircraft Ruled the World* (Faber and Faber, London, 2010), p238.

[23] Horne, Alistair; *Macmillan: Volume II of the Official Biography* (Macmillan, London, 1989), pp8, 45-51. Macmillan admired Sandys' drive and ability to get things done and thought him to be 'a very tough man', though recognised he was 'disagreeable and *cassant* in relations with other ministers or officials'.

[24] Horne; *Macmillan: Volume II*, pp8, 45-51; Dockrill; *British Defence since 1945*, pp5-6.

[25] Dockrill; *British Defence since 1945*, pp8-9.

[26] HM Government; *Defence: Outline of Future Policy*, p7; Defence Correspondent; 'Defence Forces to be Nearly Halved', *The Times*, 5 April 1957. The combined strength of the three Services was to be reduced from 690,000 in 1957 to 375,000 by 1962. RAF personnel was predicted to fall from 230,000 to 140,000 during this period.

[27] HM Government; *Defence: Outline of Future Policy*, pp3-4, 9. The White Paper said: 'A manned fighter force, smaller than at present but adequate for this limited purpose [defending bomber airfields essential for the delivery of the nuclear deterrent], will be maintained and will progressively be equipped with air-to-air guided missiles. Fighter aircraft will in due course be replaced by a ground-to-air guided missile system.' In addition, the aircraft of the Second Tactical Air Force in West Germany were to be halved in number by March 1958 though it was said this would be offset by giving some squadrons atomic bombs. A similar reduction was to be made to the light bomber force in Britain which was assigned to NATO. See also 'The Move to the Sandys White Paper of 1957', July 1988, Institute of Contemporary British History, 2002, http://www.icbh.ac.uk/icbh/witness/sandys accessed 3/11/2016.

[28] Probert, Air Commodore Henry; *High Commanders of the Royal Air Force* (HMSO, London, 1991), p54. On 5 April 1957 in a BBC interview, Sandys was asked how long he thought manned aircraft would retain their usefulness and replied: 'I am afraid I cannot give you a definite answer in dates. I would say of course that there are

some roles, for example in minor wars and anti-submarine work, where manned aircraft will, I am sure, continue to be needed as far ahead as one can see', '"Manned aircraft will be needed" Mr Sandys on special uses', *The Times*, 6 April 1957.

[29] HM Government; *Defence: Outline of Future Policy*, pp2, 8, 10. This was critical of the Defence burden on civil industry – including the scale of employment of scientists, technicians and engineers and use of resources such as metals deemed important to increase exports.

[30] Hamilton-Paterson; *Empire of the Clouds,* pp240-241.

[31] Fitzpatrick, David; 'Choose Your Weapon: Combined Operational Effectiveness and Investment Appraisal (COEIA) and its Role in UK Defence Procurement', *RUSI Whitehall Papers Series (No 36)*, 1996, p57. The decline in the birth rate of new aircraft entering RAF service is striking. In the 1950s, 27 new aircraft entered service. Subsequently in the 1960s it was 14, in the 1970s, it was nine, in the 1980s it was five (including the two Tornado variants) and in the 1990s a mere two.

[32] Bennell, Anthony S; *Defence Policy and the Royal Air Force 1964-1970* (Air Historical Branch (RAF), London, 1994), chapters 1,2, 17; Stanhope, Henry; 'How the RAF could be strangled by its own purse-strings', *The Times*, 19 September 1974.

[33] Healey, Denis; *The Time of My Life* (Penguin Books edition, London, 1990), chapters 13 and 14.

[34] Hampshire, Edward; *From East of Suez to the Eastern Atlantic: British Naval Policy 1964-70* (Ashgate, Farnham, 2013).

[35] Ritchie, Sebastian; *The RAF, Small Wars and Insurgencies: Later Colonial Operations, 1945-1975* (Air Historical Branch (RAF), Northolt, 2011) highlights the 'brushfire' wars of the 1950s and 1960s which accompanied the retreat from Empire and RAF support for the Army in supply, transportation and evacuation operations.

[36] Dockrill; *British Defence since 1945*, p11; Bennell, *Defence Policy and the Royal Air Force 1964-1970*, p17-14.

[37] Stanhope, Henry; 'Manpower worries for Britain', *The Times*, 19 February 1974. On 30 November 1973 the strength of the three Services was 355,632 men and women - 80,646 (Royal Navy and Royal Marines), 174,177 (Army) and 100,809 (RAF). Service personnel numbers fell by 20,000 during the period 1970-74, around 11,000 in the RAF. There were restrictions on RAF intakes in 1971-72 and 1972-73. See HC Deb 21 March 1974 vol 870, cc154-5W, http://hansard.millbanksystems.com/written_answers/1974/mar/21/recruitment accessed 3/11/2016.

[38] Editorial; 'Are They The Right Cuts?', *The Times*, 4 December 1974; Editorial; 'There Is More Safety In Realism', *The Times*, 2 August 1976. Further Defence cuts would have inevitably followed had the Conservatives won the February 1974 General Election.

[39] Mason, Roy; *Paying the Price* (Robert Hale, London, 1999), p123. Mason, the new Defence Secretary, recalled: 'In Labour circles, Defence was by far the least popular department in Whitehall. Many party members, not to mention an influential minority of our MPs, thought it was a waste of money to maintain our military strength at such a high level of preparedness.'

[40] Labour Party Manifesto for February 1974 General Election, *Let us work together – Labour's Way out of the Crisis*, http://www.politicsresources.net/

area/uk/man/lab74feb.htm accessed 5/5/2016; Labour Party Manifesto for October 1974 General Election, *Britain Will Win With Labour* http://www.politicsresources.net/area/uk/man/lab74oct.htm accessed 5/5/2016.

[41] Dyson, Philip; 'The Limits of Influence: The Treasury, The Ministry of Defence and the 1975 Defence Review' (MA dissertation, King's College London, 2012).

[42] TNA CAB 130/732, MISC 16(74)3, Defence Review Steering Committee, Defence Studies Working Party – Final Draft Report, 18 June 1974, p42. Arthur Hockaday, Chairman of the Defence Studies Working Group, advised: 'We then thought it useful to identify the minimum critical level of military capability below which, in the opinion of the Ministry of Defence, our contribution to the essential land/air and maritime/air elements of NATO's strategy in the Central Region of Allied Command Europe and in the Atlantic and Channel Maritime Commands (linked in each case with the defence of the United Kingdom itself and its surrounding air space and waters), would so have deteriorated that the strategy itself could no longer be sustained.'

[43] HM Government, *Statement on the Defence Estimates 1975* Cmnd 5976 (HMSO, London, March 1975), pp18-21.

[44] *Ibid*, pp9-10.

[45] TNA DEFE 4/283, COS 4th Meeting/77, 8 February 1977. General Sir David Fraser, UK Military Representative to the NATO Military Committee, told the Chiefs of Staff: 'It must be realised that the over-riding sentiment in NATO was a feeling, however unjustified, that the United Kingdom had lost its way and its will, and the level of priority which was apparently accorded to defence was considered prime evidence for this judgement.' See also DEFE 4/283, COS 8th Meeting, Appendix 1, Valedictory Address to the United Kingdom Chiefs of Staff by Admiral of the Fleet Sir Peter Hill-Norton, Chairman of the NATO Military Committee, 17 March 1977. He recorded his 'serious concern at the military trends, largely imposed by economic constraints and the almost inevitable political consequences if these adverse trends are not addressed.' Hill-Norton added that having announced fourteen separate reductions in Defence spending in four years this had 'an effect which I need not describe' on the standing of the UK in NATO headquarters and in other Alliance capitals.

[46] TNA CAB 129/194, CP(77) 24, 'Public Expenditure Priorities in the Next Survey', Memorandum by the Central Policy Review Staff, 9 March 1977. The Chiefs of Staff were also insistent that the Critical Level should be considered an evolving and not a static concept. See TNA, DEFE 4/285, COS 10th Meeting, 9 May 1978.

[47] Thetford; *Aircraft of the Royal Air Force since 1918*, p13; Reed, Arthur; 'RAF chief gives warning against big cash cuts', *The Times*, 18 December 1975; Humphrey, Air Chief Marshal Sir Andrew; 'The Threat – CAS (now CDS) addresses the RAFA', *The Royal Air Forces Quarterly*, Volume 16, Number 3, Autumn 1976, pp203-207. The total first-line strength of the RAF was about 750 aircraft in 1975.

[48] New Soviet weaponry in the late 1970s, including the supersonic Backfire bomber and the SS-20 mobile missile, caused increasing anxiety in the RAF. Parliamentary Staff; 'Old RAF aircraft', *The Times*, 1 December 1979. Parliamentary Staff; 'Still relying on the few', *The Times*, 21 December 1979. The Government advised that 104 RAF fighters would be available for the defence of the UK by the summer of 1980

and another 12 (an additional Lightning squadron) would be available by 1982.

[49] TNA CAB 129/200, CP (78) 45, 'Pay Anomalies and Forward Commitments', Memorandum by the Chancellor of the Exchequer, 18 April 1978.

[50] Chalfont, Lord; 'How long will the troops put up with this?' *The Times*, 28 November 1977.

[51] TNA DEFE 4/283, Confidential Annex to COS 8th Meeting/77, 17 March 1977, The Growth of Soviet Military Power. Prime Minister James Callaghan was concerned about the Soviet capability to attack UK targets. When the Chiefs of Staff met him in December 1976 to record their concerns at further Defence cuts, Callaghan accepted their view that public awareness of the growth of Soviet military power should be increased and invited them to submit a paper on this. Similarly, Callaghan was also concerned about the ability of the UK and NATO to defend targets in the UK identified by the Joint Intelligence Committee as being threatened by the Soviets. See TNA, DEFE 4/284, COS 33rd Meeting/77, 20 December 1977.

[52] Boren, David K.; 'Britain's 1981 defence review' (Ph.D dissertation, King's College London, 1992), p110.

[53] HM Government, *The United Kingdom Defence Programme: The Way Forward* Cmnd 8288 (HMSO, London, June 1981), p2.

[54] TNA, CAB 129/220 C(86)5 Annex I, 11 February 1986. UK GDP fell by 2½% in 1980 and by 1½% in 1981. It had risen by 2½% in 1979; Kennedy; *The Rise and Fall of the Great Powers*, p. 425. Britain was the world's sixth largest economy in the early 1980s.

[55] Hampshire, Edward; 'Margaret Thatcher's First U-Turn: Francis Pym and the Control of Defence Spending, 1979-81', *Contemporary British History*, Vol 29, No 3, 2015, pp359-379.

[56] Kavanagh, Denis; 'Lord Barnett obituary', *The Guardian*, 3 November 2014. Joel Barnett, Chief Secretary Treasury, and Sir Leo Pliatzky, Second Permanent Secretary at the Treasury, combined to introduce a system of cash limits on public spending in the mid-1970s and considered this an important tool to encourage spending restraint during a period of high inflation.

[57] Howe, Geoffrey; *Conflict of Loyalty* (Macmillan, London, 1994), p144. Howe added that, 'She [Mrs Thatcher] retained this ambivalent attitude towards defence spending for some years to come.'

[58] Hennessy, Peter; 'How the defence lobby defends its budget', *The Times*, 21 May 1981.

[59] Editorial; 'In the context of NATO', *The Times*, 22 January 1981. Defence policy was 'once more caught up in a cycle of stop-go-stop' and 'The euphoria with which the Services welcomed Mrs Thatcher's election triumph eighteen months ago is already starting to evaporate.' The cuts left the Royal Navy and Royal Marines most disappointed, followed closely by the RAF. The RAF's planned extra squadron of Lightnings to help bolster Britain's air defences, which the Government had said were in a 'parlous state' whilst in Opposition was cancelled. The rundown of the Vulcan force and Shackleton early warning aircraft was accelerated and the RAF suffered heavy cuts to fuel allocations.

[60] HM Government, *Statement on the Defence Estimates 1981*, Volume 1 Cmnd

8212-1 (London: HMSO, April 1981), Introduction; Hennessy, Peter; 'Mr Nott lays basis for spending review', *The Times*, 16 April 1981. The Government disliked the term 'Defence Review', believing it had negative connotations with the previous Labour Government. Nott insisted he was conducting an examination of the roles of the Armed Forces in a realistic way. Nott explained his vision in the introduction to the 1981 Defence Estimates: 'Change is overdue and new programmes are needed to exploit new technology and tactical concepts […] We must re-establish in the long-term programme the right balance between inevitable resource constraints and our necessary defence requirements.'

[61] HM Government, *The United Kingdom Defence Programme: The Way Forward* Cmnd 8288 (HMSO, London, June 1981); Boren, 'Britain's 1981 defence review'; 'The Nott Review', 20 June 2001, Institute of Contemporary British History, 2002, http://www.icbh.ac.uk/witness/nott/ accessed 3/11/2016; Dorman, Andrew; 'John Nott and the Royal Navy: The 1981 Defence Review Revisited', *Contemporary British History*, Vol 15, No 2, Summer 2001, pp98-120; Dorman; 'The Nott Review: Dispelling the Myths?' *Defence Studies*, Vol 1, No 3, Autumn 2001, pp113-121; Hampshire, Edward; 'Strategic and budgetary necessity, or decision-making "along the grain"? The Royal Navy and the 1981 Defence Review', *Journal of Strategic Studies* (forthcoming).

[62] Taylor, Claire; *A Brief Guide to Previous British Defence Reviews* (House of Commons Library Note SN/1A/5714), 19 October 2010, p8. Some 57% of planned cuts fell on the Royal Navy. The cuts to the Navy were twice as large as those to the Army and seven times greater than those to the RAF. More than one-third of the Army and 10% of the RAF remained in West Germany, with costly foreign exchange repercussions. Thatcher, Margaret; *The Downing Street Years* (Harper Collins Publishers, London, 1993), p250; Mrs Thatcher later noted: 'There was no room for savings on the RAF: on the contrary, additional expenditure would probably be required.'

[63] TNA, CAB 129/213, C(81) 31, 'The Defence Programme', Memorandum by the Secretary of State for Defence, 15 June 1981; C(81) 33, 'The Defence Programme', Memorandum by the Chancellor of the Exchequer, 16 June 1981; CAB 128/71, CC(81) 24th Conclusions, 18 June 1981.

[64] HM Government, *Statement on the Defence Estimates 1982* Part I Cmnd 8529-I (HMSO, London, June 1982), p27. The White Paper noted: 'The evidence is clear. As each generation of equipment is improved in the light of experience and knowledge to achieve greater effectiveness against the threat, so do real costs increase.'

[65] Editorial; 'Too Much on the Rhine', *The Times*, 1 July 1982; Clark, Alan; 'The special respect Nato owes Britain', *The Times*, 10 July 1982; Speed, Keith; 'Why Nott is wrong about the Navy', *The Times*, 31 July 1982; Stanhope, Henry; 'Whitehall plays down attack by First Sea Lord', *The Times*, 4 September 1982; Editorial; 'Slide Rules all at Sea', *The Times*, 18 September 1982.

[66] Lewin, Admiral of the Fleet Sir Terence, 'Tri-service action in Falklands', *The Times*, 25 September 1982.

[67] Spotswood, Marshal of the Royal Air Force Sir Denis; 'Lessons from the Falklands conflict', *The Times*, 1 July 1982; Cameron, Marshal of the Royal Air Force

Sir Neil; 'Keeping the balance in defence forces', *The Times*, 8 July 1982.

[68] Nott, John; 'After the Falklands, let's not go overboard on Navy spending', *The Times*, 27 July 1982; HM Government, *The Falklands Campaign: The Lessons* Cmnd 8758 (London: HMSO, December 1982), noted the Soviet threat was paramount.

[69] Cowton, Rodney; '£1,000m to be spent on making good Falklands losses', *The Times*, 15 December 1982. When the Government published its White Paper on the lessons of the Falklands conflict on 14 December 1982, Nott underlined to the Commons: 'In many respects the Falklands conflict was unique. We must be cautious therefore in deciding which lessons of the campaign are relevant to the United Kingdom's four main roles within Nato. Those roles remain our priority, and the modernization of our forces devoted to them must still have the first call on our resources.'

[70] The number of UK-based civilians in the Ministry of Defence fell from 248,000 in 1979 to 141,000 by 1989. See also 'Military mandarins', *The Economist*, 30 September 1988.

[71] Clark, Alan; *Diaries: In Power, 1983-1992* (Phoenix Paperback edition, London, 2001), pp257-260, 30 September 1989; Trewin, Ion; *Alan Clark: The Biography* (Phoenix, London, 2009), pp320-329.

[72] Clark; *Diaries: In Power*, pp263-266; Evans, Michael; 'How Alan Clark's vision for Forces became a reality', *The Times*, 2 August 2005. King's caution bred dissent. Alan Clark, Minister of State (Defence Procurement), prepared his own clandestine and radical 3,500-word 'Options for Defence' and passed it to No 10 for Mrs Thatcher's Christmas 1989 recess reading.

[73] Urban, Mark; 'A Farewell to Arms', *The Spectator*, 16 June 1990.

[74] http://hansard.millbanksystems.com/commons/1990/jul/25/defence-options-for-change#S6CV0177P0_19900725_HOC_225 accessed 4/11/2016. Options for Change cut RAF personnel from 89,000 to 75,000. In Germany two out of four stations were earmarked for closure and the number of squadrons reduced from fifteen to nine. Four Tornado squadrons were withdrawn from Germany and two Phantom squadrons disbanded. In the UK Tornado squadrons were increased from six to seven and two Phantom squadrons were disbanded. Three Tornado squadrons, two from Germany and one from the UK, were placed in storage.

[75] See *Air Power Review* First Gulf War 25th Anniversary – Special Edition, Summer 2016. Wilkins, Group Captain Paul; 'Foreword', pp5-8 highlights the scale of the British contribution – 53,462 UK Armed Forces personnel, including over 7,000 RAF personnel and 157 aircraft. Ritchie, Sebastian; 'The Royal Air Force and the first Gulf War, 1990-91: A Case Study in the Identification and Implementation of Air Power Lessons', pp188-205 considers the RAF's role, experiences and lessons.

AIR SYSTEMS PROCUREMENT THROUGH THE AGES

Sir Donald Spiers

After graduating from Cambridge, Sir Donald spent some time with de Havilland Engines before joining the Air Ministry in 1961 which took him to Aden and Singapore. Having become Assistant Chief Scientist to the RAF, he moved to the Procurement Executive in 1978 where he was director for the Hawk, Jaguar, Tornado and Eurofighter projects. During the 1980s he was, in turn, responsible, within NATO, for the overall policy control of the Tornado programme, then Controller of Establishments, Research and Nuclear Programmes in the MoD, and finally Controller Aircraft. Since the 1990s he has been a director of several aerospace companies and President of the RAeS and the PFA. He is currently Chairman of the Farnborough Aerospace Consortium and a trustee of Vulcan to the Sky and of the FAST Museum.

A formal system of Air Systems Procurement only really began in 1940 with the creation of the Ministry of Aircraft Production. Before that time the Air Ministry let it be known what they were after and industry submitted proposals which either found favour or didn't. In this way both the Hurricane and Spitfire designs found favour and moved ahead to development by Hawker and Supermarine respectively. There were no procurement staffs because project management was not recognised as a separate skill and there was no Engineer Branch in the RAF.

Although Prime Minister Chamberlain seemed intent on appeasing Hitler in 1938, preparations for war were going ahead in industry and the Air Ministry asked Morris Motors to investigate how quickly their Cowley plant could be turned to aircraft production. Then in July 1938 the Air Ministry bought a site next to Castle Bromwich airfield to build a shadow factory for Supermarine in order to supplement their factory at Southampton.

Before that, in November 1935 the Hurricane made its first flight at Brooklands and then the Hawker Board of Directors voted to tool-up for, and build, a production line at Kingston for 1,000 Hurricanes at Company expense, without receiving any contract from the Air

The main source of Spitfires, and later Lancasters, the Castle Bromwich Aeroplane Factory, was the largest wartime aircraft production plant in the UK. (Chris Taylor)

Ministry. Not something you can imagine happening today! That was one of the reasons that, in 1940, there were twice as many Hurricanes as Spitfires. The other reason being that the Hurricane had a simpler construction and only took 10,000 man-hours to build compared with 15,000 for the Spitfire.

When Winston Churchill became Prime Minister in May 1940 one of his first actions was to create a Ministry of Aircraft Production (MAP) and appoint Lord Beaverbrook as the Minister in charge. This was an interesting appointment since Beaverbrook had used his newspapers to support Chamberlain and promote appeasement in the 1930s! He was of course a newspaper mogul who had been created as the first Baron by Lloyd George in the First World War. Incidentally, his grandson, Max Aitken, the third Baron, is currently the Commandant General of the Royal Auxiliary Air Force with the honorary rank of air vice-marshal.

Beaverbrook set to work with gusto, initially operating from his own home before permanent offices were established in Whitehall. He took over control of both the Cowley and the Castle Bromwich sites and, as well as addressing aircraft production, he also took control of

the RAF storage units and of the repair of damaged aircraft. Altogether he raised the fighter production rate to more than double that being achieved by Germany. Monthly output of new fighters rose to over 1,000, while the number of aircraft available for operations rose to more than 700 by August 1940.

As an aside, he raised an appeal for housewives to give up their aluminium pots and pans to make Spitfires. This was an excellent public relations exercise, which inspired the general public, although the pans were of little or no use for aircraft production.

Beaverbrook did not in fact remain very long in the MAP before Churchill moved him on to other ministerial responsibilities in 1941 (first to Supply, then to War Production, then as Lord Privy Seal). He was subsequently replaced as Minister for Aircraft Production by Stafford Cripps, who had previously been the Ambassador to the Soviet Union.

The Ministry of Aircraft Production itself did not long survive the end of WW II and it was merged into the Ministry of Supply in 1946, which was also responsible for the production of tanks and equipment for the War Office.

At this time the Ministry of Supply also controlled the Defence Research Establishments, including RAE Farnborough, RSRE Malvern and A&AEE Boscombe Down. During this period the Ministers of Supply included Duncan Sandys, Selwyn Lloyd and Reginald Maudling.

In 1959 the Ministry of Supply was itself wound up and a Ministry of Aviation was created with responsibility for the regulation of Civil Aviation and for the supply of military aircraft. Duncan Sandys again became the responsible Minister.

Subsequently, following his victory in the 1964 general election, Harold Wilson created a Ministry of Technology, which in 1967 took on the supply of military aircraft while the regulatory responsibilities were given to the Board of Trade.

Interestingly, Wilson appointed Frank Cousins, the General Secretary of the TGWU to be Secretary of State at MinTech, but his performance was described as ‘disappointing’ and he resigned in 1966 to be replaced by Tony Benn.

However, following Edward Heath’s success at the 1970 general election, the new Prime Minister decided to merge Wilson’s MinTech

with the Board of Trade to create a new Department of Trade and Industry. At the same time Heath also created a Ministry of Aviation Supply to undertake the procurement of military aircraft.

Thus from the start of WW II onwards there were no project management staff within the Air Ministry or within the unified Ministry of Defence when it was created in 1964.

The only scientific staffs under direct RAF control were the Operational Research staff in the department of the Scientific Adviser to the Air Ministry and then of the Chief Scientist (RAF), who were located in the MoD HQ and in the RAF Commands.

It became increasingly clear that this was not a sensible arrangement for managing aircraft procurement and in 1971 the government asked Derek Rayner, the Chief Executive of Marks and Spencer, to advise on relations with the aircraft industry.

One of Rayner's principal recommendations was that the procurement of military aviation should be undertaken by a separate organisation within the MoD, which would also assume the responsibility for all other military procurement.

Thus was born the Procurement Executive of the Ministry of Defence, which came into being on 1 April 1971, exactly 53 years after the formation of the RAF. Having carried out the original study, it was perhaps inevitable that Derek Rayner was appointed as the first Chief of Defence Procurement (CDP) to run the new Procurement Executive. In this position he also became a member of the Defence Council of the Ministry of Defence.

The PE continued in existence for the next 28 years. For most of that time the staff were accommodated in various London buildings, but in 1995-96 all staff were moved and co-located at a new greenfield site at Abbey Wood near Bristol.

In 1999, following the McKinsey study which was part of the 1997/98 Defence Review, the PE became the Defence Procurement Agency, which was wholly owned by the MoD and subsequently in 2007 it was merged with the Defence Logistics Organisation to become Defence Equipment and Support, still a wholly owned Government Agency.

So much for the Ministerial and Departmental history of responsibility for aircraft procurement. We now need to look at how the Air Systems procurement staffs were organised within those

ministries and how they operated over the years.

As soon as he became Minister of Aircraft Production, Beaverbrook appointed Eric Fraser from ICI, initially as Director General of Equipment Production and then as Director General of Aircraft Production, which post he held until the end of the war. There was a large staff that was mainly concerned with planning rather than project management, which was left largely to the manufacturing sector.

When the Ministry of Supply was set up in 1946, the position of Controller of Supplies (Air) was established, reporting directly to the Minister. Under the Controller, a Director General Air Supplies supervised the various aircraft production Directors.

The post of Controller Aircraft was then created in 1953 within the Ministry of Supply and filled for the first three years by Air Chf Mshl Sir John Baker, whose previous post had been VCAS. He and all his procurement staff were established in the Ministry of Supply.

When the Ministry of Aviation was set up in 1959, the Controller Aircraft post remained in the new Ministry and was filled at first by civilians: George Gardner in 1959, followed by Morien Morgan in 1963. Similarly, all the procurement staff were established within the Ministry of Aviation.

Then, when the Ministry of Technology was created in 1964, the post of Controller Aircraft moved to the new Ministry but reverted to being filled by the RAF in the person of Air Mshl Sir Christopher Hartley, who became a member of the Air Force Board of the Ministry of Defence. There were other Controllers within the MinTech organisation, including particularly a separate Controller of Guided Weapons and Electronics (CGWL). None of this changed when the separate Ministry of Aviation Supply was formed in 1970 and the majority of the staff remained in St Giles Court where they had been accommodated for many years.

Then, finally, in 1971 with the creation of the PE, everyone concerned with Air Systems procurement was finally established in the MoD and were ultimately responsible to the Secretary of State for Defence.

So far as the air force was concerned, procurement matters were under the leadership of the Controller Aircraft. Initially he had four Deputy Controllers at 3-star level, but these were gradually reduced to

one and then abolished.

Under the Controller Aircraft the project management duties were led by several Director Generals at 2-star level: one for aircraft production; one for engines; one for navigation and radio; and one for air armaments. The individual project managers and their staffs worked under these DGs.

This arrangement had a serious shortcoming in that an aircraft project manager was not responsible for the engines or the radars that his aircraft depended on. Thus there was no one below the Controller Aircraft himself with total responsibility for any aircraft procurement project.

In 1984 Michael Heseltine, as Secretary of State, asked Peter Levene, who was then the Chairman and Chief Executive of United Scientific Holdings, to examine the organisation of Defence Procurement and make recommendations.

As a result of his study, Levene proposed that the Director Generals reporting to the Controller Aircraft should be re-organised so that each had complete responsibility for their assigned aircraft projects, including the engines and all installed equipment. There was, however, a separate DG for Air Weapons.

The individual project management teams were to be composed of multi-disciplinary staff covering the technical, financial and contractual elements. Where necessary, managers could also call for technical advice from the Defence Research Establishments such as RAE Farnborough and RSRE Malvern.

In 1985 Levene was then appointed to the position of Chief of Defence Procurement to implement his recommendations.

Moving on to the present day, following the move to Abbey Wood and the subsequent formation of Defence Equipment and Support, the organisation under the Chief Executive has again changed to include a 3-star Chief of Materiel (Air) and under him a Director Air Support and a Director Combat Air both at 2-star level.

I now turn to the management of collaborative projects, such as Jaguar, Tornado and Typhoon, which naturally involve multi-national management. It is inevitable that the total cost of a collaborative project will be more than the cost of a single nation doing it alone. In particular, it is often said that the development costs rise in proportion to the square root of the number of participants. But, of course,

because the development costs are shared and because production runs are larger, the cost to each nation will be less than doing it alone. However, the real advantage of collaborative projects is that they are very difficult to cancel. And after the trauma of the 1960s that is a very valuable advantage.

In the case of Jaguar this was a simple arrangement with the French managing the airframe aspects, while the UK managed the engine aspects. A joint company, SEPECAT, was set up by Breguet and BAC to produce the aircraft. Regular meetings were held between the British and French government project offices, usually at 1-star level, and very few management problems arose. Meetings were conducted in both French and English.

In the case of Tornado, or the Multi Role Combat Aircraft (MRCA) as it was initially called, a NATO project office, the NATO MRCA Management Agency (NAMMA) was set up in Munich and co-located with Panavia, the company set up by MBB, Aeritalia and BAe to build the aircraft. It was agreed that the post of General Manager of NAMMA would be filled by Germany, while Italy and the UK would fill the two Deputy General Manager positions.

Each nation provided staff to fill the various procurement positions, covering the technical, financial and contractual aspects of the project. It was agreed at the outset that the project language would be English and that the Chairman of the Board of Directors, which met every month to monitor the project, would always be British. In practice, the Chairman was always the 2-star Director General of the MRCA project in the Air Systems Controllerate. Having a joint project management agency meant that only a relatively small staff was required in the Air Systems Controllerate.

As the Air Defence Variant of the Tornado was only ordered by the UK, this side of the programme was managed entirely in the UK and there was a separate contract directly between MoD and British Aerospace to cover these aeroplanes. These aircraft were delivered on time and 3% over the agreed cost, which was a good performance by BAe.

When the Eurofighter Typhoon programme started, a new agency, the NATO Eurofighter Management Agency (NEFMA) was again set up in Munich to manage the project and to be the single point of contact with the manufacturer, Eurofighter Jagdflugzeug.

Subsequently these two agencies were combined and renamed as the NATO Eurofighter and Tornado Management Agency (NETMA). This acronym does not, as is sometimes said, also mean 'Nobody Ever Tells Me Anything'!

Finally, I want to talk about the type of contracts used over the years. During WW II contractors delivered aeroplanes, submitted invoices and were paid without problems. This was very different from the aftermath of WW I, when in 1919 the Treasury sued Tommy Sopwith for making excess profits on the production of Pups and Camels, driving his company into bankruptcy. Sopwith immediately founded a new company, which he named after his chief test pilot; an Australian called Harry Hawker!

For many years nearly all procurement contracts were let on a Cost/Plus basis where both sides agreed actual costs as the project proceeded and then an agreed percentage was added for profit. This was a very bad system from the customer's point of view because there was little incentive for the contractor to keep to time and contain costs.

Other types of contract used were Cost Plus Fixed Fee, which effectively fixed the profit paid regardless of any cost overrun; and Cost Plus Incentive Fee, where a target price was agreed and the profit paid varied with the contractor's performance regarding time and cost overruns.

Of course, the best type of contract is a Fixed Price Contract, where time and cost are contractually binding. However, this type of contract is only possible when the product can be precisely defined and agreed between customer and contractor, preferably following a competition. Obviously, therefore, it cannot be used for a programme that involves a lot of cutting edge development work. Also once a Fixed Price Contract has been let, any changes to the specification by the customer are an excuse for the contractor to increase the cost and extend the timescale for the project.

Where competition is not possible, a policy of NAPNOC (No Acceptable Price, No Contract) can sometimes also be considered to drive down the price put forward by a contractor.

As a part of the NAPNOC policy, Peter Levene also introduced the concept of Spares Price Labelling. The idea behind this was that a technician replacing some small component on an aircraft could report

any obviously inflated price up through the chain. This did not work particularly well but one interesting result was finding that the ballcock float in the VC10 toilet cistern was a Dunlop White Spot squash ball!

Returning finally to the concept of Fixed Price Contracts, one programme where this type of contract worked really well was for the Hawk jet trainer. You may remember that there was a competition between Hawker and BAC, who each submitted their design to MoD. Hawker won the competition and a contract was let for 175 aircraft for a price of £100M. Later in the programme the RAF wanted to change the Heading Reference System because the gyro toppled during aerobatics. Because it was a fixed price contract, I refused to do this and amazingly, since I was only operating at group captain-level at that time, nobody overruled me. We later ran a separate competition to replace the Heading Reference System with a Twin Gyro Platform.

The fixed price of £100M comprised £60M for the airframe, £30M for the engine and £10M for contingencies and the resolution of disputes.

After the final delivery, which was made on time, I met with Colin Chandler, who was then the Managing Director of the Kingston/Brough division of British Aerospace, to finalise the payment due. There were twelve points of dispute between us and, after discussing the matter all morning in his office at Kingston, I said, ‘You have those six and I will have these six and now you can take me to lunch.’ And so it was!

AIRCRAFT PROCUREMENT UNDER LABOUR 1964-70: SOME MYTHS

Richard Moore

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This paper considers aircraft procurement for the RAF under the Labour governments of Harold Wilson between 1964 and 1970, a period usually described as one of decline and disaster. It offers perspectives on some well-known and controversial stories, but it also tries to go beyond some of the myths, putting forward a, possibly unpopular, view that by no means all aircraft procurement in these years was a disaster.

Why should I try the patience of readers in this way when there is already an extensive literature on the subject? A lot has been written about these years – or rather, a lot has been written about one particular aircraft, the TSR2, and a lot of it has the wistful air of what is 'lost' and 'might have been.'[1] But these years were not *all* about TSR2 and its cancellation. And, unfortunately, much of the writing on TSR2 – with some honourable exceptions, including this society's special journal issue on the subject in 1998[2] – is fundamentally derived from the partisan accounts of Stephen Hastings and Roland Beamont.[3] Hastings had a colourful career: Eton, Sandhurst, the Guards, the SOE and the Italian partisans. In 1960, he became a Conservative MP although his keenest interests were in hunting, communist subversion and, especially, Rhodesia, which meant he stayed a backbencher. He was also a director of Handley Page, the aircraft company most resolutely opposed to the Labour government's industrial policies. It's no surprise therefore that his book shows, to say the least, no academic detachment. Similarly, Beamont, a brilliant

The, still controversial, TSR2.

pilot and a most reliable source on the TSR2 flight programme, is honestly less interesting and useful on politics.

So let me depart from the script that says TSR2 was a world-beating aircraft which performed like a dream but was 'murdered', almost as a deliberate party-political act of vandalism, by a socialist government listening to slanted advice from a coalition of journalists, the Royal Navy and a zoologist; and that civil servants with their bloated committees would have done better to leave the people who knew what they were doing, *viz* aircraft designers and test pilots, alone to pursue their expensive passions. Let me take, instead, a slightly more rounded approach.

Labour came to power in October 1964 having fought an election in which defence was a real issue and having expressed strong views on aircraft: 'public money has been lavished on wasteful military projects', said the 1964 manifesto, and 'many thousands of millions have been spent on the aircraft industry [...] we shall submit the whole area of weapons supply to a searching re-examination.' Labour promised 'a deliberate and massive effort to modernise the economy; to change its structure and to develop with all possible speed the advanced technology and the new science-based industries with which our future lies' and to 'stimulate new advance by using, in the field of civil production, the research and development contracts which have hitherto been largely confined to military projects.'[4] An important part of the policy on which Labour had been elected therefore was to divert money, effort and technology from defence and use them to mobilise the civilian export economy.

Prime Minister Harold Wilson, and Secretary of State for Defence

Denis Healey, embarked on a long series of defence reviews with three main objectives. The first was to cap the annual defence budget at £2bn/year by 1969/70, down from the projected £2·4bn. The second was to reduce commitments overseas. Some writers persist in claiming that governments only ever reduce budgets, never commitments; but Healey was very clear in government papers, again and again and again, that commitments had to go to unlock savings. The third was to reform Britain's aircraft industry, which was tying up £250m/year (about £4·25bn in today's money) in research and development.[5]

One of the first things Healey did on taking office was call for studies into replacing the three biggest military aircraft development projects then underway – the P.1154 supersonic vertical-take-off fighter, the HS681 transport and the TSR2 – with American alternatives.

Wedgie Benn, as he then still was, and officials in his new department, MinTech, which merged with the Ministry of Aviation in 1967, soon discovered there was a weak correlation between national R&D investment and economic growth, and came to believe that Britain lacked, not technology and ideas and research, but organisation, planning, enterprise and an interest in pull-through of technology to production. The government continued to advocate technology – this was the age of the 'white heat' – but in line with its manifesto commitment it did cut expenditure on big military aircraft and also on civil nuclear R&D.[6] Benn got on very badly with aircraft industry bosses.[7]

It may be useful to focus on two key documents which throw more detailed light on Labour's policy. The first is the internal report of March 1965, originally Secret, of a Defence Equipment Working Group of the Ministry of Defence under Sir William Cook, the Deputy Chief Scientific Adviser for Projects. Cook was an Admiralty scientist who later very successfully managed the British H-bomb programme as Deputy Director at Aldermaston before taking up a senior role under Sir Solly Zuckerman in the MoD. Cook's group was asked to examine 'the implications for the defence programme of a substantial reduction, not later than the end of the decade, in the currently planned military development effort; and of switching to a largely 'buy foreign' policy' (there was a parallel report, still classified, specifically on nuclear weapons).[8]

Meanwhile Lord Plowden, a key Treasury official under Stafford Cripps after the war and later Chairman of the Atomic Energy Authority, was asked to lead a wide-ranging inquiry into 'the future place and organisation of the aircraft industry in relation to the general economy of the country.' This culminated in a published White Paper, ie a statement of government policy, in December 1965.[9]

Neither of these reports was really an input into ministerial decision-making. By the time Cook and Plowden wrote, momentous decisions on aircraft procurement had already been made. But they did take considerable trouble to think through and set down the implications of Labour's policies.

Cook concluded that 'a balanced approach of independent development, increased cooperative [international] development and 'buying foreign' will both retain a technical competence in the UK and will achieve a substantial reduction in development expenditure by the end of the decade.' Keeping that technical competence was a key concern. Cook saw clearly that the UK needed to remain, as we might say today, an intelligent customer: without continued UK development work in airframes, aero-engines and electronics 'within a few years there will be no industrial capacity in the UK to carry out defence work in the aircraft field and it will become difficult even to formulate requirements and assess the worth of foreign equipment.' And Cook wanted balance because he saw, again with foresight, that a buy-American approach 'would put vital areas of our defence policy at the mercy of balance-of-payments crises.' He also personally contributed thoughts on the commercial and project management excellence likely to be required in future.

Plowden, having digested a vast amount of evidence, offered sensible if cautious recommendations on such matters as subsidy and the social and economic importance of the aircraft industry. 'The traditions of the industry,' said Plowden, 'especially its role in the last war; the penetration of scientific frontiers that it involves; the intangible way in which it spreads the nation's name across the world; and, quite simply, the inherent glamour of aeroplanes: all these combine to make the industry a symbol of Britain's aspirations. In a period when she has lost many such symbols, this fact cannot be dismissed out of hand. [But] to fulfil this role, the industry must be successful.' Plowden described the record of the aircraft industry,

unsentimentally, as ‘disappointing.’ He observed that the eight fixed-wing military aircraft designs introduced since 1955 had between them generated precisely 16 exports (these were the Buccaneers sold – controversially – to South Africa). He thought a smaller amount of government support was needed ‘to help the industry ultimately reach a position where it can thrive’ and, like Cook, he recommended a balance in future aircraft procurement: European collaboration where the export potential justified the development costs, and buy-American for more complex aircraft.

I have spent some time on these two reports partly to counter any view that Labour casually dismissed or disregarded the aircraft industry – on the contrary, a lot of thought went into its future, and destroying the industry was absolutely not on the agenda. However, against that background, Labour ministers did take a dim view of the British Aircraft Corporation’s TSR2. TSR2 was already at the eye of a storm. It was finally in the air – 4½ years after the development contract was let and a fortnight before the election. But government and industry were divided against themselves. Air Staff papers bemoaned that ‘virtually no attempt has been made to keep down costs [...] this can only complete our loss of faith not only in BAC’s word but in that of the [Ministry of Aviation], who are supposed to see that we get value for money ... The fact is that the MoA have no interest in getting production costs down.’[10] Plowden’s report noted that ‘in evidence before the committee, the most serious criticism of the Ministry [of Aviation] came from the [MoD] Air Force Department witnesses.’[11] Industry also complained bitterly at the MoA’s interference. And the rivalries under the surface between the Vickers and English Electric teams, forced by the creation of BAC to work together on TSR2, are well known.

A sober and thoughtful study of TSR2 was produced for RUSI by a team under Dr Geoffrey Williams of Southampton University in 1969 – when it was already, as the authors put it, ‘difficult to separate the true history of the aircraft from the surrounding political mythology and parliamentary rhetoric.’ Cost, they concluded, was the biggest factor in cancellation but ‘the government’s view on the future size of the aircraft industry and its place in their economic strategy for the country’ was part of the background. They also highlighted numerous weaknesses in management and contracting: the limited powers of

BAC, as prime, over the engine and avionics sub-contractors, for example, who were still working under R&D contracts to the MoA; the all-or-nothing attitude of the Air Staff to the requirement; the contradictions inherent in that requirement and the poor logic in particular behind the stated need for short-take-off performance; the fact that the choice of Vickers and EE had more to do with industrial strategy than any technical considerations, still less any commercial competition; the absence of value engineering and programme management tools before about 1963; the all-or-nothing approach of the MoA, requiring a development batch of aircraft meeting the full requirement, rather than an early basic prototype or interim type suitable for further development later; *et cetera*. We don't know how well TSR2 development would have gone beyond 1965, but serious problems were certainly outstanding with the engine and avionics and Williams and his co-authors speculated that either the Conservatives would have cancelled TSR2 themselves, if they had won the 1964 election, or that development work on avionics would still not have been complete in 1969 when they were writing.[12]

I believe that it is now time to recognise that TSR2 wasn't the wonder of its age, but a very troubled programme whose cancellation seemed eminently sensible. The elected government wanted something different from British industry: it didn't want big prestige aircraft projects, it wanted a new balance between defence and the civil economy, R&D money and people saved for reinvestment elsewhere. At one press conference, they pointedly stated that there were 25,000 skilled engineering vacancies in the UK, and 20,000 people working on TSR2.[13]

Some of those workers marched through London in protest on 14 January 1965: 'let us arm Britain ourselves', said their banners. But the very same day, the Chief of the Air Staff, Sam Elworthy, at a meeting of ministers and officials, spoke in favour of replacing TSR2 with a version of the American F-111, and this is what Healey recommended to colleagues the following day.[14] Elworthy's surviving papers show that he agonised over expressing any opposition to the British aircraft, but that, in the end, his own and the Air Staff's preference was for the F-111. After considering various pros and cons, all he would admit to in writing was that he favoured the F-111 'on grounds of cost' – the unit price was an estimated £2·1m, against

As CAS 1963-67, Air Chf Mshl Sir Sam Elworthy was a key player in the TSR2 v F-111 debate but he was eventually obliged to put his weight behind the American option.

£5·8m for the TSR2.[15]

One doesn't have to look very far in the surviving documents and memoirs to find that similar sentiments had been expressed previously. Elworthy and his minister, Hugh Fraser, had both shared their misgivings about TSR2 with Healey's Conservative predecessor, Peter Thorneycroft.[16] The Cabinet finally decided to cancel TSR2 on 1 April 1965.

In its place the RAF found itself with an option initially – later converted by Healey into firm orders – for the American F-111.[17] The F-111 was conceptually similar to the TSR2, and the Air Staff had been monitoring its progress since 1960, shortly before the USAF's requirement was formally issued. The requirements of the two air forces, for a conventional and nuclear strike aircraft with 1,000nm combat radius, supersonic performance at low level and M2+ at altitude, were broadly equivalent, although there were also important differences. Most obviously, the F-111 had swing wings, a technology considered in the very earliest days of TSR2 but rejected in the UK as too ambitious. Notoriously, Defense Secretary Bob McNamara forced the US Air Force and Navy to work together on the F-111 for commonality and cost effectiveness, so there was a US Navy fighter version, the F-111B. Also notoriously, McNamara chose General Dynamics (GD) as lead contractor against the strong recommendations of both services for the rival Boeing design. Allegations of impropriety over the contract award meant he found himself having to testify personally in front of the Senate Permanent Subcommittee on Investigations in 1963.

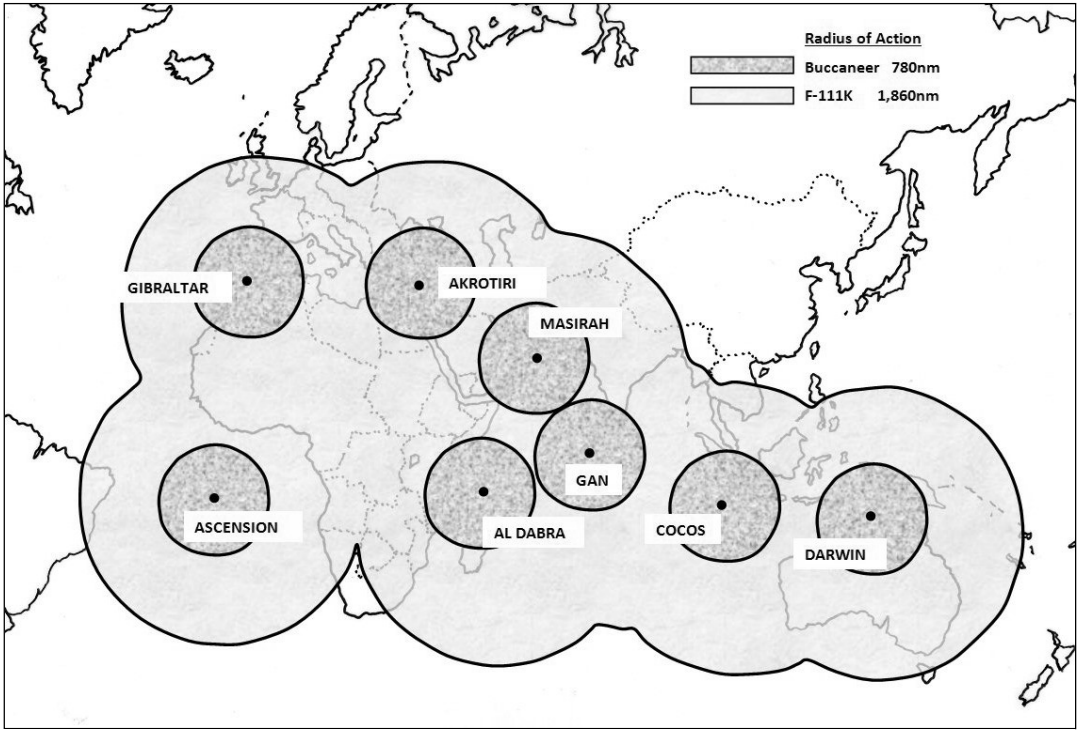
The US Air Force's F-111A version first flew less than two years after the development contract was signed with General Dynamics,

but the plane's political troubles were matched with technical problems, especially with the engines and later structurally around the wing pivots and the carry-through box connecting the wings to the fuselage. Its avionics were also less advanced than TSR2's, a disadvantage in terms of accuracy and blind bombing which the UK Air Staff expected to see solved in a later version.

The Air Staff's Operational Requirement for TSR2 was redrafted around the F-111 – the UK version was later designated F-111K – and reissued in October 1965.[18] British reconnaissance, communications and flight-refuelling equipment was to be incorporated, and wiring for British nuclear weapons.[19]

Technical problems and UK modifications affected the cost of the F-111K, which crept up over time to nearly £3m per aircraft, but Healey still had a good deal from McNamara and used this fact as leverage with his ministerial colleagues. In the context of what was essentially an endless defence review between 1964 and 1968, the temptation was strong to put off any and every decision until more was known, but Healey fought hard. By 1967 he had placed firm orders for 50 F-111Ks and a ceiling price and long-term credit terms were in the bag; also offset sales – for example the US promised to buy head-up display equipment and air data computers from Elliotts of Rochester, Jetstream passenger aircraft from Handley Page and even $1·3m of barbed wire from Tinsley Wire of Sheffield.

Fifty wasn't many F-111s: the Air Staff originally planned 110, and at one point Elworthy asked for a further 20 as a bonus to replace the Fleet Air Arm. But Healey was faced, by at least October 1965, with a reaction against the dollar cost and industrial implications of buying so many American aircraft. Industry and the MoA were exceptionally keen to preserve British expertise especially in vertical take-off, variable geometry and supersonics, and these arguments were more important to ministers than the myth-makers would have you believe. So, for example, the international standing of Rolls-Royce was the key argument used in favour of Spey engines; and when ordering the first F-111s Healey was forced to concede that 'I doubt whether my [ministerial] colleagues would agree to take up the initial option [...] unless I could assure them that we were prepared to meet a substantial part of the total requirement with British-built aircraft.'[20]



F-111K versus Buccaneer potential target coverage being claimed by the Air Staff in early 1966: Hi-Lo-Hi profile (200 nm Lo inbound and outbound); max overload fuel and 2,000lb warload (nuclear or conventional).

Healey therefore asked the Air Staff to look at different mixes of strike aircraft. Maps proliferated showing their ranges and capabilities as comparisons were made. For example in one paper for the ministerial Defence and Oversea Policy Committee in February 1966, the world from Brazil to the Solomon Islands was coloured in air-force blue to symbolise its vulnerability to attack by long-range F-111Ks. The inferiority of the subsonic, short-range naval Buccaneer – a plane the Air Staff was *determined* not to have – was emphasised by smaller concentric circles.[21] These maps were actually rather misleading – there were no plans to attack all these places, and actually one place where there were nuclear targets, southern China, wasn't covered – but more careful studies of real operational scenarios did tend to support the view that the F-111 could be supplemented by a cheaper, less capable aircraft.

One leading possibility was the AFVG, the Anglo-French Variable Geometry aircraft or *avion à géométrie variable*.[22] This was a two-seat twin-engined aircraft, roughly the size and shape of the later Tornado although without the uncompromising squareness of the latter. It had the rounded engine inlets with half-conic shock diffusers of the Mirage series, showing the influence of Dassault, which designed the airframe in collaboration with BAC. The engines were a SNECMA/Bristol-Siddeley joint project. Top speed was M2·5 at altitude and combat radius was between 400-1,000nm for strike missions of various profiles. Weight was limited to around 37,000lb by the need to operate from the French Navy's carriers and although the AFVG was intended as a multi-role aircraft this weight limit meant design compromises: for example it would be hard to fit the advanced nav/attack system needed for a really accurate conventional strike role. The AFVG was however designed to carry French, British or American nuclear weapons semi-recessed externally and/or other stores including two air-to-ground Martel or three air-to-air missiles.[23]

The aircraft was certainly not originally conceived as a part-replacement or rival to the TSR2 or F-111, nor was Anglo-French cooperation a new idea of the Labour government. The earliest hint of the AFVG that I have found is in late 1963 in documents from an Anglo-French R&D Steering Group set up in 1957 by Duncan Sandys.[24] In mid-1964 there were talks on cooperation between Conservative ministers Julian Amery and Peter Thorneycroft and the

Denis Healey and Pierre Messmer signed an Anglo-French MoU in 1965.

French armed forces minister Pierre Messmer, and a possible large variable-geometry interceptor was mentioned in briefing material as a replacement for the British Lightning and Sea Vixen and the French Mirage III.[25] Healey continued these talks with Messmer, who appears to have been genuinely enthusiastic about cooperation. By March 1965, talks focused on two ideas: the trainer/light strike requirement which was to lead to the Jaguar, and the larger interceptor, which was morphing into the multi-role AFVG.

During the spring of 1965 British officials talked about these aircraft in very traditional terms of industrial policy, ie which firms had capacity and needed the work. Once again this was hardly the Labour government looking to dismantle the aircraft and aero-engine industries. Similarly, in France the government wanted Dassault and SNECMA to work with British firms to strengthen and save them from the 'clutches' of the Americans – Pratt and Whitney had recently taken a stake in SNECMA and GD were interested in a similar relationship with Dassault.[26] A Memorandum of Understanding was signed by Healey and Messmer in April 1965.[27]

Ministers having agreed to develop a variable-geometry aircraft, the respective naval and air staffs set to work on a detailed operational requirement, numbered OR 388 in the Air Staff series. By September, this requirement existed but was described as 'a summation of the needs of four services with little attempt to compromise.'[28] The Royal Navy wanted a heavy, high-performance multi-role aircraft to replace its Phantoms and Buccaneers in the late 1970s. The Air Staff, which also now had Phantoms on order, was starting to think as a result that a Lightning interceptor replacement was less urgent and important than a strike/reconnaissance aircraft of sub-F-111 performance, closer

to the French requirement to replace air force Mirage IIIs and naval Etendards. After February 1966, there was no need to worry about Fleet Air Arm requirements because Healey managed to cancel the Navy's new carriers. Other tensions emerged however: for example, the Air Staff was now interested in using the new Rolls-Royce RB153 engine which might be cheaper and more suitable for a strike aircraft, whereas French politics dictated that SNECMA must have the lead.[29] There were also political misgivings in the Foreign Office over the AFVG's nuclear role: to cooperate on a nuclear-capable aircraft with France appeared to undermine Britain's counter-proliferation policy. There is some evidence that efforts were made, as a result, to remove the word nuclear, though not the aircraft's actual nuclear capability, from the written requirement.[30]

The views of Marcel Dassault were also an important problem. He had little of Messmer's interest in collaboration; he was more or less secretly pursuing his own independent variable-geometry research; and he absolutely refused to play second fiddle to BAC.[31] Dassault's nephew, René Bloch, was also Messmer's lead negotiator for a time and a difficult man to deal with, making a great deal of fuss about Britain's commitment to the F-111 even though, as British ministers believed, it was only the fact we were buying the F-111 off the shelf that made it possible for us to devote development money and effort to the AFVG. When Healey converted his option into a first firm order for the F-111K in 1966, Bloch wrote that 'such a decision by the British government could only be a cause of the greatest anxiety and mistrust on the part of the French government.' Wilson had to intervene personally with de Gaulle to unravel the problem.[32]

And if the TSR2 and F-111 were controversial domestically, this was as nothing compared to the problems with civil/military relations in France. The military had helped bring de Gaulle to power, but a military putsch had been mounted against him in Algiers in 1961 and two of the ringleaders, Maurice Challe and Edmond Jouhaud, were air force generals who, incidentally, also disagreed with aspects of de Gaulle's nuclear policy.[33] Jouhaud, French Chief of the Air Staff between 1958 and 1960, had wanted to prioritise NATO over the independent *force de frappe*. After the failure of the putsch, he joined the terrorist OAS and for this he spent seven months on death row in 1962. (Happily, British Chiefs of the Air Staff enjoyed rather more

harmonious relations with their elected leaders; also, Labour effectively abolished the death penalty in this country in 1965).

By 1966, ideas of an interceptor role for the AFVG had been shelved by the Air Staff in London, who wanted 'an adequate strike aircraft for the RAF to replace the V-force in complementing the F-111K [...] in the shortest possible timescale and at the least possible cost in development and production.'[34] As such the AFVG featured prominently in the 1966 British Defence White Paper: 'By the mid-1970s, we intend that the Anglo-French variable-geometry aircraft should begin to take over [the reconnaissance/strike] and other roles. Both operationally and industrially, this aircraft is the core of our long-term aircraft programme.'[35] Between 175 and 200 AFVGs were now envisaged for the RAF, to equip ten or more squadrons.

There were ominous signs, however, that French support was wavering. The French Air Staff still wanted a high-performance strike aircraft but de Gaulle's announcement in March 1966 of withdrawal from the NATO command structure tended to shift emphasis onto the aircraft's role in the air defence of France. Thus, paradoxically, whilst the British had started by emphasising the interceptor role of the AFVG and become more interested over time in a strike aircraft, the French did exactly the reverse. De Gaulle, like Dassault, was more interested in relatively small, short-range military aircraft for home defence and export. In early 1967 Messmer lost his seat in elections to the National Assembly. Though continuing as minister, he lost some political influence and in the end, in June 1967, the French withdrew from the AFVG project, citing cost grounds.[36]

A definitive history of the AFVG is impossible without access to French archives, but it seems clear that this was another ill-starred project. The practical difficulties of cooperation may be illustrated by an MoA internal memo of September 1965: 'The French have suggested informally that the [Jaguar] and Variable Geometry joint projects should be done in metric from the start.'[37] The two governments, air forces and four companies involved understood each other poorly and the aircraft, which was at the mock-up stage at BAC at Warton when cancelled, was an uneasy compromise between roles. It was also however, it should be said, a step on the road to the Tornado.

Although they seem to have been annoyed by the French, it is not

When the intention to cancel the UK's order for fifty F-111Ks was announced in January 1968, the first two airframes, XV884 and XV885, were already under construction.

at all clear that the Air Staff viewed the end of the AFVG as a disaster.[38] Partly at least, this was because their 'spearhead' F-111K was now almost literally taking shape at Fort Worth. In November 1967, however, sterling was devalued, and this led to a chain of events ending in the dramatic cancellation, in turn, of Britain's order for the F-111. Wilson famously declared that devaluation didn't affect 'the pound in your pocket', but it did affect the pound in Denis Healey's pocket, because overnight the F-111 became 14% more expensive.

Devaluation also brought Roy Jenkins to the Treasury as Chancellor. Jenkins had been Minister of Aviation when TSR2 was cancelled, and he was no friend of the F-111, which soon found itself on a hit list of deep new spending reductions. Between 4 and 15 January 1968, eight gruelling Cabinet meetings were held on the cuts. Healey spoke 'interminably', as Tony Benn put it, in favour of the F-111.[39] Foreign Secretary George Brown described his talks in Washington on the subject as 'bloody unpleasant ... the most awful experience of his life.'[40] On a close vote, however, ministers accepted this and other cuts. Healey was 'no match for Roy', said Dick

Crossman: 'we tottered out of Cabinet.'[41]

The RAF's reaction to cancellation was much more strident than it had been over the TSR2 or AFVG: John Grandy, now the Chief of the Air Staff, wrote that he 'deplored' the Cabinet's decision and that 'there is no need for me to emphasise the effect of the void left in our defence policy by the loss of the advanced strike reconnaissance capability [...] a void which reduces the effectiveness of our remaining land, sea and air forces to an extent out of all proportion to its size.'[42]

With TSR2 gone, AFVG gone and now the F-111 gone, and with more than a whiff of I-told-you-so, Roly Beamont wrote that Labour's policy, of balancing home-grown, collaborative and US military aircraft procurement, 'was in shreds.'[43] Let us consider, however, the rather numerous successful aircraft procurements of the Labour years.

The McDonnell-Douglas Phantom was chosen over the P.1154 for the Navy in 1964 and the RAF in February 1965, and brought significant work to the UK: around 40% of the aircraft by value including Rolls-Royce Spey engines, rear fuselage redesigned and built by BAC, and radar licence-produced by Ferranti. First flight of a UK Phantom prototype was in 1966 and the aircraft was in RAF squadron service at Coningsby and Leuchars in 1969. The Phantom was one of the most successful military aircraft of the late 20th century although, to be fair, the Spey-engined version, chosen by the government mostly to protect British industry, was widely criticised.[44]

The home-grown Nimrod was chosen in February 1965 ahead of US and French alternatives to meet revised RAF maritime patrol requirement OR 381 for a Shackleton replacement. First flight was in March 1967 and this aircraft too entered service with the RAF in 1969.

The Jaguar was a remarkably harmonious collaboration between BAC, Breguet, Rolls-Royce and Turbomeca, chosen in 1965 to meet Air Staff jet trainer/light strike aircraft requirement OR 362 as part of the same deal as the AFVG.[45] First flight was in 1968 and service entry in 1974; it was also successfully exported.

The Lockheed Hercules, another of the most successful aircraft of its time, was chosen over the HS681 in February 1965 and became the quickest of all these procurements; first flight of the UK version was in 1966 and service entry in 1967.[46]

If space permitted, I could also cover the Harrier and indeed the

Buccaneer, which the Air Staff had devoted years of time and energy to avoiding but found, in the end, to be a perfectly good aircraft. We don't read as much about any of these projects, perhaps because good news is less interesting and dramatic than bad, but clearly domestic, collaborative and US procurement all *could* work quickly and affordably, especially if the amount of leading-edge R&D could be controlled. Talk of cost-effectiveness and value engineering, and the consideration of a wider range of procurement options than from-scratch development in the UK, gradually made MinTech a different procurement organisation than the old MoA, and in 1971 Derek Rayner, planning the next big round of changes, paused to give credit for several aspects of procurement including the introduction of more project management systems and professional training.[47]

Beamont's assessment, looking back in 1968, was that there had been an 'emasculation of the aircraft industry' and a 'drastic reduction in the effectiveness of the Royal Air Force. 'Those concerned,' he said, 'bear immense responsibility in this deliberate policy [...] down to a point which must result inevitably in a level of relative military weakness in the 1970s unprecedented in this country's history for many hundreds of years.'[48] I don't think this is right at all. Histories of Britain in the 1970s are all about strikes, turmoil and crisis: rubbish clothes, rubbish music and rubbish piling up in the streets. But the armed forces, which are barely mentioned in these histories, meanwhile prepared for a war, which thankfully never came, in the NATO area, where the RAF became quietly much stronger and more effective. A high-performance strike aircraft, the Tornado, was also finally developed.

With the Phantom, Nimrod, Hercules, Harrier and Buccaneer entering service before Labour left power in 1970, there seems to me to be a good case for saying Labour's aircraft procurement policy had been an outstanding success – if our measures of success are time, cost and quality of procurement projects and whether Denis Healey left the RAF stronger than he found it, and better prepared for the challenges of the 1970s.

Notes:

[1] For example, Hastings, Stephen; *The murder of TSR-2* (London, Macdonald, 1966). Beamont, Roland; *Phoenix into ashes* (London, William Kimber, 1968).

Gardner, Charles; *British Aircraft Corporation* (London, Batsford, 1981), ch 14-16. Wood, Derek; *Project Cancelled: the disaster of Britain's abandoned aircraft projects* (revised edition, London, Jane's, 1986), ch 9-10. Barnett-Jones, Frank; *TSR-2: phoenix or folly?* (Peterborough, GMS Enterprises, 1994). Lucas, Paul; *BAC TSR2: lost tomorrows of an eagle* (Bedford, SAM, 2009). Burke, Damien; *TSR2: Britain's lost bomber* (Marlborough, Crowood Press, 2010).

2 *RAF Historical Society Journal 17B*: *TSR2 with hindsight* (1998).

3 Hastings, *op cit*; Beamont, *op cit*.

4 'The new Britain', Labour Party election manifesto 1964: http://labourmanifesto.com/1964/1964-labour-manifesto.shtml (accessed 15 Dec 2016).

5 See, eg Wilson, Harold; *The Labour government 1964-70: a personal record* (London, Weidenfeld and Nicolson, 1971), pp39-44. Bartlett, C J; *The long retreat: a short history of British defence policy 1945-70* (London, Macmillan, 1972), pp197-9. Bennell, Anthony; *Defence Policy and the Royal Air Force 1964-70*, pp2,.4-5 (I am grateful to Sebastian Cox for arranging access to this MoD Air Historical Branch narrative).

6 Edgerton, David; *Warfare state: Britain 1920-70* (Cambridge UP, 2006), ch 6. Sir Richard (Otto) Clarke, 'Mintech in retrospect – II' in *Omega International Journal of Management Science* 1/2 (1973), pp137-63.

7 Benn, Tony; *Out of the wilderness: diaries 1963-7* (London, Arrow, 1988), p467; *Office without power: diaries 1968-72* (London, Arrow 1989), p102.

8 The National Archives, Kew (TNA), DRE(65)15, 4 March 1965, in AVIA 65/1768 (Cook's parallel nuclear report remains classified in closed TNA file AB 48/299).

9 Cmnd 2853, *Report of the committee of inquiry into the aircraft industry appointed by the Minister of Aviation under the chairmanship of Lord Plowden* (London, HMSO, December 1965).

10 TNA, DOR3 note, 17 June 1964 in AIR 2/17210.

11 Cmnd 2853 (note 9), p87.

12 Geoffrey Williams, Frank Gregory and John Simpson, *Crisis in Procurement: a case study of the TSR2* (London, RUSI, 1969).

13 'The questions begin', *Flight International*, 15 April 1965, p551.

14 Bennell, *op cit*, pp2.4-5.

15 TNA, AIR 8/2413, Quinlan to CAS, 24 March 1965 with Elworthy's manuscript notes; AIR 8/2414, ACAS(OR) to PS/CAS, redrafted note for CAS signature, and Healey's reply to CAS, all 31 March 1964. Bennell seems to have had access to a further 30 March 1964 draft of CAS's note (*Defence Policy*, pp2.13-14).

16 Cooper, Sir Frank ;'TSR2 and Whitehall', *RAF Historical Society Journal 17B*, pp43-64; TNA, DEFE 25/50, Fraser to Thorneycroft, 29 January 1964.

17 For more details of the RAF's F-111 story see Moore, Richard; 'F-111K: Britain's *Lost* Lost Bomber' in *RAF Air Power Review* 18/3 (Autumn/Winter 2015), pp10-28.

18 TNA, AIR 2/13709, OR 343 Issue 3, drafts of 10 and 30 June and 6 July 1965, and AIR 2/13710, draft of 25 August 1965, and AIR 2/17312, formal issue of 26 Oct 1965.

[19] Specifically, UK-based F-111Ks would carry one or two high-yield WE177B bombs, or the same number of low-yield WE177A bombs east of Suez. There was no plan for the F-111K to carry US nuclear weapons under 'dual-key' arrangements.
[20] TNA, AIR 8/2452, DC/P(65)20 of 5 October 1965 and DEFE 13/745,Healey to CAS, CSA and PUS of 8 October 1965.
[21] TNA, CAB 148/27, Appendix 3 to Annex A, OPD(66)30 of 8 February 1966.
[22] Gardner, *op cit*, ch 19; Wood, *op cit*, ch 12; James, Andrew D and Judkins, Phil; 'Chute libre avant le décollage: le programme GFVA d'avion à géométrie variable franco-anglais 1965-7' in *Histoire: économie et société* 2010/4, pp51-73.
[23] Various sources give slightly different details for the AFVG, whose performance was still being debated at the time of cancellation. The figures here are from the agreed Anglo-French Joint Staff Requirement (JSR) issued to the firms by the MoA and its French equivalent organisation the Service Technique Aéronautique (STAe). Air Staff Requirement (ASR) 388 was a UK Air Staff document which clarified and elaborated the RAF's requirement in places. The JSR was on its ninth draft and the ASR on its fifth when the project was cancelled; both were circulated on 15 February 1967 and are preserved in, for example, TNA, AIR 2/17968 and AIR 2/17973. The operational scenarios driving the UK Air Staff's range requirement, mostly east of Suez, are explained in greater detail in, for example, a 1 April 1966 brief with tables in AIR 2/17962, and an undated (February 1966) brief in AIR 2/17966. The nuclear weapons to be carried were given in the UK ASR as two WE177A or B, or alternatively two US Mk 57 or Mk 61 under 'dual key' (see also papers in AIR 2/17967). The French version would have been able to carry one rather heavier 2,500lb 'special weapon'.
[24] TNA, DEFE 7/2139, note of meeting 13 December 1964, mentioning a possible variable-geometry interceptor.
[25] TNA, AVIA 65/1680 and DEFE 7/2244, brief for Amery/Messmer meeting on 16 June 1964.
[26] TNA, AVIA 65/1799, ACAS(OR) to CAS, 26 March 1965, note of Controller Aircraft's meeting on 9 April 1966, George Edwards (BAC) to Richard Way (MoA), 12 January 1966, and other papers.
[27] There are copies of the MoU in, for example, TNA, AIR 2/17631 and AVIA 65/1680.
[28] TNA, AVIA 65/1799, draft Weapons Development Committee paper of 22 September 1965.
[29] TNA, AIR 2/17631, US/Air B note of 13 January 1966 and, AVIA 65/1799, summary of progress, 15 April 1966.
[30] TNA, correspondence in AVIA 65/1799. The sixth draft of the JSR of February 1966 (see TNA, AIR 2/17966) was much more explicit about nuclear weapons than the ninth draft (see note 23 above) which coyly referred to 'all kinds of weapons.'
[31] Gardner, *op cit*, p137. James and Judkins, *op cit*, p60, say (my translation): 'Dassault made clear from the start of the project that he didn't expect to give up leadership of the AFVG studies to anyone [...] "this was an unnatural idea!"'
[32] TNA, AVIA 65/1799, translation of note handed over by Bloch, 3 December 1965 and other paper.

[33] Facon, Patrick, *Histoire de l'armée de l'air* (Paris, La Documentation française, 2009), pp401-2, 429-35.
[34] TNA, AVIA 65/1799, undated (March 1966) note of DCAS policy line.
[35] Cmnd 2901, *Statement on the Defence Estimates 1966 Pt 1: the Defence Review* (London, HMSO, February 1966), p11.
[36] James and Judkins, *op cit*, pp66-8. Papers around cancellation, eg in TNA AVIA 65/1799 – which do not, incidentally, suggest that the British embassy in Paris was particularly well informed on the politics of the AFVG project in France.
[37] TNA, AVIA 65/1799, AS/Air B3 note, 9 June 1965. I should be fascinated to know what became of this suggestion.
[38] Several of the Air Staff's files, now in the TNA, continued without a break and with hardly a comment as the AFVG was replaced initially by a further UK Variable Geometry (UKVG) study project under BAC. This had been one of the alternatives to the AFVG under consideration for some months.
[39] Benn, *Office without power*, p12,
[40] *Ibid* and TNA, PREM 13/1999; Brown used the same phrase 'bloody unpleasant' in a telegram to Wilson from New York on 11 January 1968,
[41] Crossman, Richard; *The diaries of a cabinet minister, vol 2* (London, Hamilton and Cap 1976), p635.
[42] TNA, AIR 20/11920, undated (but circa 15 January 1968) note from Grandy to Healey (possibly unsent); AIR 2/18054, Grandy to Healey, 22 January 1968.
[43] Beamont, *op cit*, p182.
[44] Bill Gunston said that, in the Spey version, 'we had the biggest, most powerful, most expensive and slowest Phantoms in the world' (quoted in Tony Buttler, *British secret projects: jet fighters since 1950* (Earl Shilton, Midland, 2000), p121. The 40% figure is from a 1968 MinTech brief in TNA, T 225/3012.
[45] Gardner, *op cit*, ch 20.
[46] Jackson, Robert; 'RAF aircraft procurement 1950-65: the American involvement' in Roger G Miller, ed, *Seeing off the bear: Anglo-American air power cooperation during the cold war* (Washington DC, USAF, 1995), pp91-99.
[47] Cmnd 4641, *Government organisation for defence procurement and civil aerospace* (London, HMSO, April 1971).
[48] Beamont, *op cit*, p184.

PROCUREMENT

Air Mshl Sir Roger Austin

Sir Roger joined the RAF in 1957 and, after an initial stint as a QFI, flew Hunters with Nos 20 and 54 Sqns and Harriers with No 4 Sqn and as OC 233 OCU. He commanded Chivenor and Stanley, was AO i/c CTTO and Commandant Cranwell and spent his last five years at the MoD, first as DCDS (Systems) and finally as Controller Aircraft/Deputy Chief of Defence Procurement (Operations). Following retirement in 1994 he flew with No 6 AEF and was National President of the Royal British Legion, 1997-2000.

The majority of military procurement programmes address the replacement of existing equipment which no longer does the job or is getting very expensive to maintain but, before drafting formal requirements, the MoD staff officer will talk to the policy staffs to double-check that no change is on the horizon which would put a question mark over the programme.

Sometimes, however, Defence policy does change significantly and *new* equipment, rather than merely a replacement, is needed. This tends to be more of a challenge. When old equipment is replaced after 15-20 years, there is plenty of time to anticipate the programme and monitor the market, commission research, conduct war-gaming exercises, etc. But policy change can occur with little warning and the pressure is on to get rapid results whilst still obeying all the sensible rules of procurement. We will look at a couple of instances where policy changed significantly and equipment change resulted and, while doing so, we will look at one or two of the more notable procurement programmes.

We start with the mother of all programmes, the like of which we are unlikely to see again because it was not just belt and braces – it was two belts and two pairs of braces – the programme which produced the V-bombers.

It began during the Second World War, when a number of British scientists were sent to Los Alamos where they made what we believed

to be a significant contribution to the Manhattan Project which was to lead to the atomic weapons dropped on Hiroshima and Nagasaki. I would imagine that a number of people on this side of the Atlantic were a bit miffed when, in August 1946, the US passed the Atomic Energy Act, more commonly known as the McMahon Act after its proposer. Henceforth, the US would not indulge in nuclear cooperation with any other nation.

Prime Minister Clement Attlee wrote a strong letter to President Truman with little success, as he lacked the close personal relationship that Churchill had enjoyed with President Roosevelt. But there were other reasons too; some in Washington were uneasy about working with a British government which they saw as socialist and it did not help that the nuclear scientist, Alan Nunn May, who had worked on the Manhattan Project, had just been arrested and charged with passing UK and US secrets to the Russians. He got 10 years with hard labour.

Attlee had already formed the GEN 75 Committee as a sub-committee of the British Cabinet. It was secret, so secret that if you were not on it you would not even know it existed. Alongside Mr Atlee were Herbert Morrison (Lord President of the Council), Ernest Bevin (Foreign Secretary), Hugh Dalton (Chancellor of the Exchequer) and A V Alexander (Defence Minister) and the Committee's task was to establish the British government's nuclear policy. This led to the GEN 163 Committee which dealt with the technical details. The outcome was that there would be a British bomb which could be delivered by a jet bomber and the V-bombers resulted. For interest, the Controller of Production, Atomic Energy, was Viscount Portal, the recent CAS.

To appreciate the emphasis placed on this programme, one has to remember the international situation of the day. The world was still a turbulent and potentially dangerous place. We had just ended the second major war in 30 years and Russia was being difficult. Construction of what Churchill described as the Iron Curtain began soon after the war ended. The Russians blockaded Berlin in 1948. In 1949 NATO was established in April; the Soviets detonated their first atomic weapon in August and the Chinese Communists took power from the Nationalists in October – and in 1950, the Korean War broke out. Believe it or not, the UK defence budget for 1950 was over 10%

of GDP.

Back in November 1946, the Air Staff had issued a draft requirement for a new bomber to deliver the weapon. It had to fly twice as fast and twice as high as current bombers and the range had to be greater too. The creation and deployment of the V-Force was the single most important and costly procurement activity between 1945 and 1969.

The V-bombers:

It was assumed that the BLUE DANUBE atomic bomb would weigh 10,000 lb and would need a weapon bay 10 feet in diameter and 30 feet long.

OR 229 required an aircraft to carry such a weapon over a range of 3,350 nm and be over the target at 500 kt and 50,000 ft. This was a pretty demanding specification at a time when the RAF was replacing the Lancaster with the Lincoln. Such an aircraft would have to be radically new in terms of configuration and capability.

Six companies responded to the invitation to tender based on Specification B.36/45: Avro, Armstrong Whitworth, English Electric, Handley Page, Short brothers and Vickers.

After much careful deliberation the Air Staff selected two designs which were very similar in capability: the Avro 698, which would eventually become the Vulcan, and the Handley Page HP 80, which was to be the Victor. Vickers' offering, the Type 660, a more conventional aircraft, was put to one side as it did not meet the specification, primarily in range.

The Avro 698 was a tailless delta, something which had not been built before, and the swept-wing Handley Page design featured compound sweep and that had not been tried either. This was a project which could not be allowed to fail so, recognising the risks inherent in these advanced designs, the Air Staff issued Specification B.14/46 to Short Brothers for a more conventional aircraft using existing technology, which meant a reduced speed and altitude performance, as a back-up. The Short SA4 Sperrin (named after a range of mountains in Northern Ireland) flew on 10 August 1951.

Was this an over-cautious step? No, I don't think so. There would have been many in the Air Staff who could remember a number of WW II aircraft which had failed to perform as expected and saw little

All three V-bombers in the short-lived 'high speed silver' finish that soon gave way to anti-flash white.

or no operational service: the Avro Manchester, the Blackburn Botha, the Armstrong Whitworth Albemarle, the Westland Whirlwind and the Saunders Roe Lerwick for example. And there were others which suffered from unexpected delays as the manufacturers worked to cure development problems. Often it was the engines which caused difficulties and all the likely engines for the V-bombers were at a relatively early stage. There was probably satisfaction that the 698 would use the Bristol Olympus, the HP 80 would use Armstrong Siddeley's Sapphire and the Vickers 660 would employ the Rolls-Royce Avon. One of them might hit problems but hopefully not all.

Vicker's Type 660, initially rejected as it did not meet the range

requirement, was the subject of an energetic campaign by George Edwards, the Chief Designer, who managed to persuade the Ministry of Supply that his design relied on proven aerodynamics rather than theory, was a low-risk, lower-cost project and would thus be a very suitable interim solution. One suspects that he claimed it would have higher performance than the Short SA4, which it did, and a contract for two prototypes was issued in February 1949. As a result of commendably rapid work at Vickers, it first flew on 18 May 1951 – from Wisley, which was then a grass airfield This was 3 months before the SA4 took to the air and, at Farnborough that year, Jock Bryce demonstrated it rather more energetically than Tom Brooke-Smith was able to do in the very new Sperrin.

The Sperrin was side-lined and it is possible that the second prototype was only completed in order to provide work in Belfast, but both aircraft did good work and paid for themselves. One flew for ten years, and the other for five until it had to give up components to the first machine. Among their research tasks were dropping representative facsimiles of BLUE DANUBE and the innovative over-and-under engine installation meant that it was a relatively simple task to install a different engine and one of them acted as an airborne test-bed for the DH Gyron.

Originally thought of as a fall back, the Valiant entered service as an interim solution in January 1955 at Gaydon and dropped the first British atomic bomb at Maralinga on 11 October 1956 followed by the first H-bomb at Christmas Island on 15 May 1957. It was to be the only V-bomber ever to drop a nuclear weapon. The Valiant also took part in the Suez operation in 1956 and, until the BLACK BUCK raids, was the only V-bomber to drop conventional bombs in anger. The three prototypes were followed by 104 production aircraft and, when superseded as a front-line bomber by the other two V-bombers, the Valiant gave good service as a tanker and in the strategic reconnaissance role.

In July 1952, before either had flown, the Ministry ordered 25 Avro 698s and 25 HP 80s. The Treasury had pressed for 50 of one type but the Air Staff insisted of 25 of each for full squadron trials in view of the vital importance of the V-Force in the nuclear age. It is interesting to note that the Air Staff view prevailed over that of the Treasury.

In 1956 the first 707A was shipped to Australia where the Aircraft Research and Development Unit (ARDU), carried out a series of aerodynamic trials. Retired in 1963, it is currently on display, still with its 'cranked' Phase 2 wing, in the RAAF Museum at Point Cook.

To reduce the risk with such advanced designs, small piloted test vehicles were built – today we would call them Technology Demonstrator Projects – TDPs. The Avro 707 was a simple, inexpensive aircraft: the canopy came from a Meteor and the main undercarriage from an Athena. It flew on 4 September 1949 and completed some test sorties before crashing near Blackbushe on 30 September; the probable cause was the airbrakes sticking in the out position. There was no ejection seat and the pilot, Eric Esler, was killed. The 707B flew a year later on 6 September 1950. It was intended for low speed testing and featured the same dorsal intake as the 707. The 707A was intended for high-speed work and featured intakes similar to the Vulcan; it flew 10 months after the 707B in July 1951. A second 707A flew 19 months later and a fifth aircraft, the 707C, featuring a side-by side two-seat cockpit flew in July 1953. The disappointing fact is that they were all too late to influence the basic design of the 698 which flew before the 707A or 707C. Nevertheless, the first 707A was instrumental in developing the Phase 2 wing, with its kinked leading edge, that was fitted to the Vulcan Mk 1s in order to

overcome a potentially serious buffet problem.

The results from Handley Page were similar. The HP 88 was also simple: it was built by Blackburns at Brough and used the fuselage of a Supermarine Attacker, hence the tailwheel layout. It first took to the air on 21 June 1951, six months after construction of the two Victor prototypes had already begun. Two months later, 'Duggie' Broomfield took off from Stansted for airspeed calibration runs down the runway at 300 feet. On the first run, the aircraft broke up. Broomfield ejected but too late and was killed. The HP 88 had contributed virtually nothing to the Victor programme.

The Avro 698 first flew on 30 August 1952. The first two aircraft, now named Vulcan, were delivered to No 230 OCU at Waddington in January 1957, two years behind the Valiant.

The HP 80 prototype first flew on 24 December 1952. No 232 OCU at Gaydon received its first Victors on 28 November 1957**,** two and a half years behind the Valiant.

It was not unusual for two solutions to a requirement to be pursued in those days, eg the Blackburn YB1 and the Fairey 17 (the Gannet), the Hunter and Swift, and the DH 110 and the Javelin, and for two prototypes of each to be built and evaluated, but it is hugely expensive for both to be taken forward into production. With the V-bombers, *four* different designs were built and three were taken into service. This obviously trebled the cost of development, conversion units, technical schools for groundcrew, simulators, spares holdings, Air Publications, etc, etc. So why was it done and how did the Air Staff prevail over a Treasury which wanted just one solution?

The international situation was tense and the Government had committed to the production of a national nuclear weapon. The Royal Air Force was responsible for delivering it and failure was not an option. Whilst two of the original four aircraft were relatively low-risk, the two most promising were not and few people were totally confident that there would not be unforeseen difficulties and delays. The CAS, Air Chf Mshl Sir John Slessor, believed that, had the air force been obliged to choose just one of the three heavy bombers under development in the late 1930s – the Manchester, the Stirling and the Halifax – it would have chosen the wrong one. And most of the WW II aircraft which failed to make the grade, did so because the selected engines did not produce the required power – and the

Olympus, the Sapphire and the Avon were all new. So they went for a twin belt and braces solution.

The cost of the, already expensive, V-bomber programme was driven up by associated, but essential, infrastructure projects, notably major reconstruction of ten airfields to prepare them as main bases and, to provide dispersal options in times of tension, over two dozen others had additional concrete laid.

Looking back, it is difficult to see exactly when the decision was made to bring both the Vulcan and Victor into service rather than just one of them – as both Avro and Handley Page, and others, had expected. As far as I can see, there was never a decision to do it: it was the lack of a decision *not* to do it. With both the Vulcan and Victor showing considerable promise, no one (other than the Treasury) wanted to do away with all the work which had gone into both, so both remained.

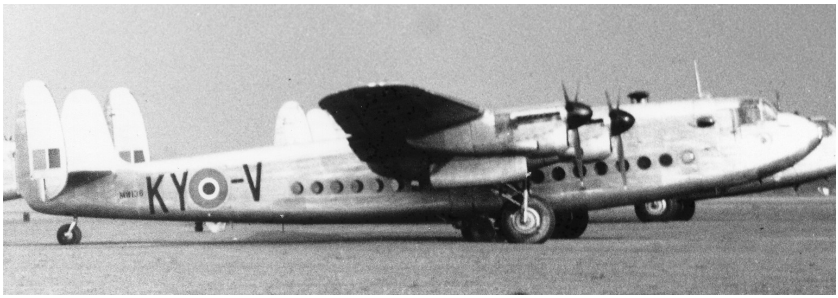
Other factors were a Government wish to provide work for a number of companies in the aviation industry as they struggled to readjust from wartime conditions to those of peace – and to keep up with the USA technologically. It also provided more jobs.

Although it was a very expensive programme, it worked and V-bombers would remain in service, as bombers, until 1982 when the last few Vulcans were converted into tankers as a short-term stopgap; but the Victor continued to give sterling service as a tanker until as late as 1993.

The 1957 Defence Review

Now we move to the second example of a policy change. The Defence Review of 1957 is probably best remembered for Duncan Sandys' pronouncement that the days of the manned fighter and bomber were numbered, but there were many other significant innovations, mostly resulting from shortage of money. The Air Branch of the RNVR was cut and that spelt the end for the Short Seamew which had been destined for the RNVR. Also disbanded was the RAuxAF and, in industry, the smaller aviation companies were told to join one of the larger groups because the Government would only award contracts to one of the big two – the British Aircraft Corporation and Hawker Siddeley.

But probably the most far-reaching innovation was the ending of



A York, MW126, of No 242 Sqn in 1947.

National Service, which meant that the strength of all the Armed Forces would be considerably reduced. This was one of the factors which contributed to the Government's decision that Britain should pull out of many overseas garrisons over the next ten years whilst giving assurances of a capability to reinforce rapidly any emerging trouble-spot. The Near East Air Force, centred on the Mediterranean, the Middle East Air Force centred in Aden and the Far East Air Force based on Singapore were all to go, although FEAF hung on longer than the others due to the Indonesian Confrontation of Malaysia.

For Transport Command, this meant a need for strategic transports which could move men and equipment over large distances, and a much-reduced need for short and medium range transports designed to operate within these overseas theatres.

The chart at Figure 1 covers the period 1950-80. Each line represents a squadron and the style indicates the theatre of deployment. It illustrates the way in which, during the 1960s, the core function of the RAF's air transport force changed from the provision of a primarily, short-ranged, tactical capability, much of it based overseas, to providing UK-based, long-range, high capacity, strategic airlift.

During WW II, we had concentrated our industrial resources on building offensive and defensive aircraft plus basic trainers and we relied on the US to supply the transports – about 1,900 C-47 Dakotas. At the end of the war, we bought 600 of them and leased a further 650. To those were added 208 Avro Yorks, which had been a private venture by Avro using the engines, undercarriage and flying surfaces of the Lancaster matched to a fuselage more suited to passenger and

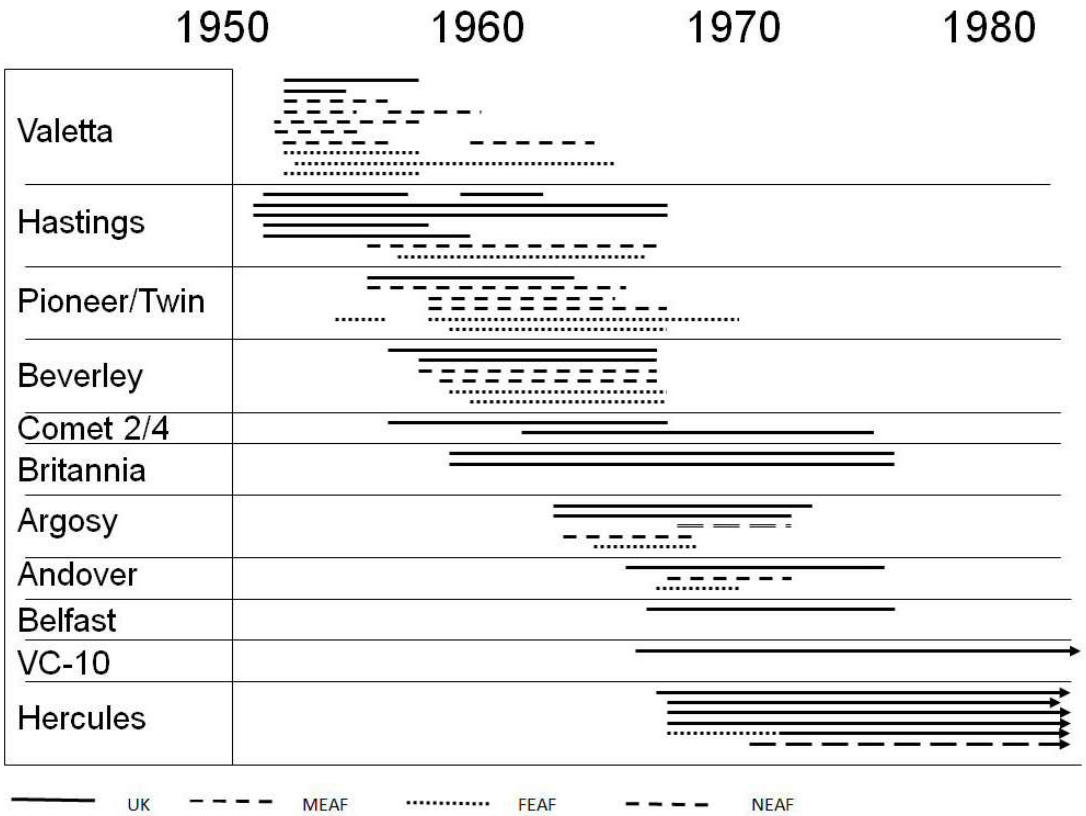


Fig 1. Periods of service of RAF transport aircraft 1950-1980.

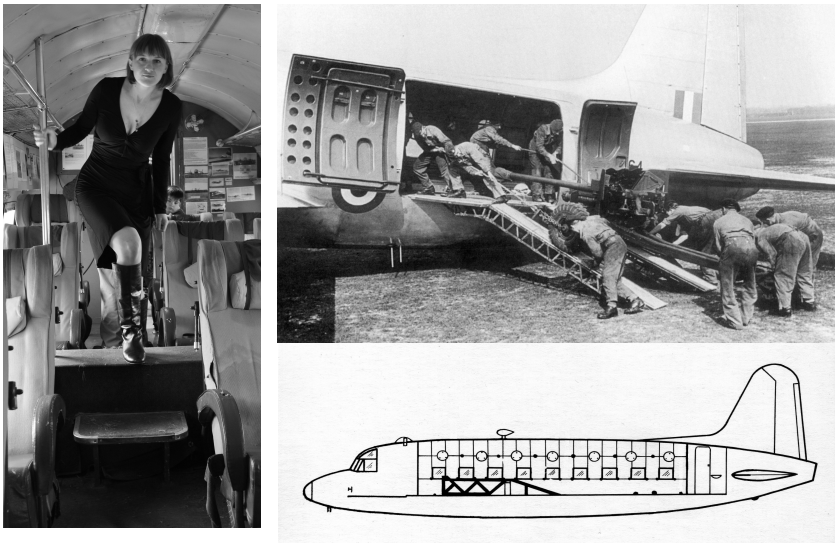
freight operations; a third fin was added to improve directional stability. Production had been a trickle during the war because the Lancaster had priority but it accelerated when the war finished. The York had only modest success with the airlines because it was far from comfortable for the passengers. Sitting a third of the way back in the unpressurised cabin, abeam the propellers, passengers had a view of six Merlin exhausts on either side and, much as we all like the sound of a Merlin, having the exhausts six feet away for several hours with only a thin sheet of aluminium alloy as insulation tended to induce temporary deafness.

The British aviation industry was desperate to get back into the business of making airliners, because that appeared to be where much of their future income was going to come from, but they were going to have to work very hard to catch up with the Americans. Douglas had made over 10,000 DC-3s or C-47s and, whilst they made only a few more post-war, thousands remained in service, civilian and military, and their continuing support must have provided a good source of income. But Douglas had also built the four-engined DC-4 prototype before the war and it became the wartime C-54 for the USAAF. Post war, with little modification, C-54s were converted into commercial DC-4s, which had already been certificated, and the basic design was subsequently pressurised and stretched to become the DC-6, the DC-7 and ultimately the DC-7C.

Lockheed had its pressurised wartime C-69 Constellation which would be extrapolated into the post-war Super Constellation and Starliner. Boeing had already produced the C-97 Stratofreighter for the USAAF and it was a simple task to turn it into the Stratocruiser.

We had the unpressurised, noisy York, which had practically no development potential. The British armed forces and the nationalised airlines were expected to help industry by using British products, most of which had some form of launch aid from the Government. Furthermore, the Treasury was very loath to approve dollar expenditure, so purchases from the US would be problematical.

The Dakotas were replaced by the Valetta, a military version of the Viking; both owed much to the Wellington bomber and this was a significant handicap. Ideally, a bomber needs a mid- or high wing in order to provide an unrestricted bomb bay and the aircraft's centre of gravity (CofG) must be located at the middle of the bomb load. If it is



Left, negotiating the Viking/Valetta main spar was a considerable inconvenience, especially in a tight skirt; top right, manhandling awkward freight, like an artillery piece, could be a manpower intensive business and, bottom tight, the portable ramp required to manoeuvre freight over the spar and into the forward cabin.

not, a sudden reduction in an unbalanced weight of up to 20 tons could move the CofG to such an extent that the aircraft could become uncontrollable. The Wellington had a mid-wing, but a transport aircraft needs either a low wing or a high wing, so that the main spar passes through the fuselage either above the ceiling or below the floor. Vickers had to decide whether to completely re-design the centre section of the Wellington and move the wing down – or up. They decided that speed of production was critical and they stayed with a mid-wing so, on the Viking and Valetta, the main spar passed through the middle of the cabin.

The upshot was that the air hostesses had to clamber over the spar, not easy when carrying a tray of refreshments. It was a nuisance and, at the very least, an embarrassment – especially when pencil skirts became fashionable.

For the Valetta, in its freighter configuration, the spar was far more than a nuisance because heavy loads must be located on or astride the

CofG, which presented a challenge – as did loading bulky items through the side door on to a sloping floor. The Valetta was able to carry two jeeps, but, in order to accommodate one of them ahead of the CofG, that involved the installation of a ramp and platform to overcome the real problem represented by that really inconvenient spar bisecting the cabin floor.

Nevertheless, two squadrons of Valettas were UK-based, there were seven in the Middle East (at various times) and three in the Far East. They had a fairly short life before being replaced by the Beverley.

If you measure the success of an aircraft by the number sold to organisations which were not obliged to buy it, 163 Vikings were built of which 98 were bought by either a state-owned airline or the RAF. With the Valetta, 252 were built and all went to the Royal Air Force, as did all but one of the 163 Varsitys.

General Aircraft had been thinking of a military freighter with additional civilian applications in WW II and they were influenced by their Hamilcar glider. When Air Ministry Specification C.3/46 was issued, they were ahead of the game. They merged with Blackburn in 1949 and the Blackburn and General Aircraft Universal Freighter first flew in June 1950. It was a simple design with a fixed undercarriage, no pneumatics, no pressurisation and with very large single mainwheels which, despite its being much bigger and heavier, gave the aeroplane a footprint load similar to a Dakota. The freight hold was 36 feet long, 10 feet wide and 15 foot 6 inches high and the large slotted flaps, plus reversible pitch propellers, gave it an impressively short take-off and landing capability.

The second prototype introduced four-wheel main bogies, removable clamshell rear doors to the freight bay, a re-shaped tail boom which could accommodate 42 passengers and Centaurus engines replaced the prototype's Hercules. Forty-seven were ordered. Two squadrons were UK-based, two operated in the Middle East and Africa and there was one squadron in the Far East. They entered service in 1956 and did very useful work, both between the UK and Germany, and within the overseas theatres but by 1967 they had all gone, replaced by the Hercules.

Working alongside both the Valetta and the Beverley was the Hastings, which had been conceived during WW II as both a tactical

Compared to the Valetta and Hastings with their side doors and sloping floors, loading freight into the Beverley's cavernous hold was relatively straightforward, especially for wheeled vehicles, which could be driven in under their own steam.

and a strategic transport which would replace late-model Halifaxes in the transport role. A pressurised version, the Hermes, was aimed at BOAC's requirements. The Hastings prototype first flew on 7 May 1946 and, after many problems with longitudinal stability, the first squadron (No 47) formed at Dishforth in October 1948, just in time to go to Germany to take part in the Berlin Airlift. The 146 Hastings that were built served with eight squadrons, six in the UK and one in each of MEAF and FEAF and they remained in service for about 20 years until the C-130 Hercules arrived.

At the light end of the spectrum came the Pioneer and Twin-Pioneer, grouped together in Figure 1, because squadrons often operated both types. Specification A.4/45 ('A' for Army Cooperation) called for a robust communications aircraft which could operate from rough strips of short length. A Gypsy Queen 31 of 240 hp was specified. Scottish Aviation had considerable aircraft engineering experience, but they had never built an aircraft from scratch before. Nevertheless, they produced the Pioneer, which looked not unlike the Fieseler Storch, in 1947. It had full-span leading edge slats and large

Fowler flaps on the trailing edge but the aircraft's performance did not meet with approval at Boscombe Down and the prototype was returned to Prestwick. Scottish Aviation replaced the Gypsy Queen with a much bigger 520 hp Alvis Leonides with which it performed far better and A.4/45 Issue 2 required an initial four aircraft for the Malayan campaign. Four passenger seats were specified plus the ability to take a stretcher and a medical attendant. A total of 40 was eventually supplied between 1953 and 1957.

The Twin Pioneer flew in 1955 and was aimed primarily at the civil market. It used the wings of the Pioneer mated to a new centre section which accommodated two Leonides of 540 hp. The boxy fuselage seated sixteen passengers. The RAF ordered 39 which were delivered between 1958 and 1961. Most Pioneers and 'Twin Pins' served in the Middle or Far East until the UK withdrew from those theatres.

Strategic transports were needed if we were to be able to deploy reinforcements rapidly and the first acquisition, the Comet 2, was an example of opportunity procurement. The prototype Comet first flew in July 1949 with Ghost centrifugal engines and square windows. In this company, I do not need to go over the tragedy of the Comet 1. When the problems were identified, BOAC's requirement had moved on to something with more seats and more range and so the Comet 2 was born: 3 feet longer with more fuel and Avon axial flow engines and round windows. An order for 12 was placed for BOAC. It first flew in August 1953 and, soon after, John Cunningham flew it the 3,064 miles to Khartoum in 6½ hours – but BOAC now wanted something even larger and with even more range.

What to do with the now unwanted Comet 2s? Answer: dump them on the RAF. But the RAF was reasonably happy to be dumped on. Jet transport was the shape of things to come but it might have been difficult to make a case for such aircraft. The Comet 2s were gladly accepted and 10 C2s went to 216 Squadron at Lyneham while three unmodified C2(RC)s, lacking the thicker skin and retaining the original square windows, went to 51 Squadron who operated them at a reduced pressure differential which involved using oxygen masks at cruising altitude. No 216 Sqn later received four Comet C4s which could be quickly modified for casevac duties and the Comet fleet gave good service on a range of tasks including VIP work.

The strategic airlift capability was further improved when 23 Britannias were purchased. The RAF had hoped for the Vickers 1000, a low-wing transport development of the Valiant bomber but a number of factors were against it. It needed a developed Rolls-Royce Conway of unproven power; the Air Ministry was facing financial difficulties and the Government wanted the RAF to take the Britannia, due in part to the work that would go to Shorts in Belfast – and so the V.1000 was cancelled and the Britannia was ordered. In the short term, that was a blessing, as the Britannia was already in airline service and most of its problems had been resolved. It entered service and served with Nos 99 and 511 Sqns for seventeen years.

In the late 1950s, Air Ministry Specification C.203 had called for a strategic freighter. Short Bros of Belfast had built thirty Britannias and they had earlier proposed the Britannic freighter, in effect a high-wing Britannia. But C.203 called for a greater payload and range so, for their SC5, Shorts replaced the Proteus engines with Tynes and the wing span was increased by 16 feet. This proposal beat offerings from Blackburn, Handley Page and Vickers and ten were ordered to go, eventually, to No 53 Sqn. Development was protracted by higher than expected drag from the upswept rear fuselage. This was solved by large fences either side of the rear door, which increased cruising speed by 40 mph. The Belfasts gave good service until defence cuts ended their service careers somewhat prematurely in 1976. Some were bought by civilian operators and they were occasionally leased by the RAF for outsize loads.

Next up was the Argosy, which nearly died as a result of the 1957 Defence Review. It was targeted at an OR of 1955 which sought a medium range freighter. Unusually, the specification laid emphasis on the need for the aircraft to meet civil requirements. But it was a classic military freighter design, using the Shackleton's wing while the Dart engine pods came from the Viscount. The initial prospect of a military order evaporated, so Armstrong Whitworth went for a civil aircraft as a private venture, adding a hinged nose-door. The Argosy prototype flew on 8 January 1959 and the first customer was Riddle Airlines of Miami, but military interest returned and, eventually, 56 aircraft were ordered, the first flying in March 1961. For a few years, there were two squadrons in the UK, one in MEAF and another in FEAF and when the latter were withdrawn some of their aircraft were transferred

The Andover had a kneeling undercarriage in order to reduce the gradient of the access ramp.

to Cyprus.

The Andover was a good example of political pressure on industry producing an aircraft which was less than ideal. An Air Staff Requirement for a Valetta replacement produced two contenders from the old rivals, Handley Page and Avro. Handley Page offered a Herald with an upswept tail and rear loading – the classic military freighter configuration. Avro came up with the Andover, an extrapolation of the commercial 748. As a low-wing design with a high freight floor, the Andover had to resort to a partially-retracting, or 'kneeling', undercarriage to permit wheeled vehicles to be driven in. This meant a freight floor on the slope, not the best when loading pallets on a roller floor. The Air Staff preferred the Handley Page design but Ministers would not award an order to Handley Page unless Sir Frederick agreed to merge with BAC or Hawker Siddeley. He refused, as he believed

the offer for his company undervalued it and the order went to Avro. Sadly, Sir Frederick died in 1962 and Handley Page went into voluntary liquidation in 1970.

The penultimate RAF transport aircraft of the Cold War era was another aimed at rapid reinforcement of trouble spots – the VC10 – but acquisition was slow. It had already established itself in airline service and little work was necessary to make it meet the RAF's requirement: a large freight door on the left-hand side, a strengthened floor, additional fuel in the fin (already available in the Super VC10), a flight refuelling probe and an auxiliary power unit (APU). Five were ordered in 1961, six in 1962 and the final three in 1964. Eleven years later in 1974, No 10 Sqn lost four of its thirteen aircraft – although they returned later as tankers.

Finally, the C-130 Hercules, a remarkable aircraft which first flew in 1954, 62 years ago. A tactical transport and, eventually, a tanker too. Procurement was fairly straightforward as it was already in service with the USAF and the first of 66 arrived in 1966 and soon there were six squadrons of them. Some were stretched and others became tankers. When replacement was needed, 25 of the new J-Model were ordered to arrive in the 1990s and the Hercules went on to break records for being in production for over 60 years.

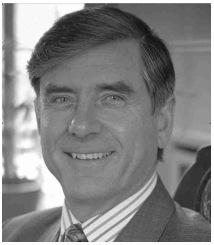
To sum up, a few procurement points illustrated by Figure 1:

1. The switch from a primarily short-ranged, overseas tactical capability to a UK-based strategic airlift force took place during the late 1960s.
2. After the Dakota, all the aircraft were British – until the C-130.
3. There are few export successes.
4. Political direction caused the RAF to operate some aircraft which could have been better (Valetta and Andover).

But, regardless of the limitations of any given design, the Royal Air Force crews could always be relied on to squeeze the best performance out of the fleet.

SOME PERSONAL VIEWS

Air Mshl Sir Peter Norriss



Sir Peter's early RAF career was spent flying within the Hunter, Buccaneer and Tornado communities, eventually commanding No 16 Sqn and RAF Marham. Senior appointments culminated in the combined post of Deputy Chief of Defence Procurement (Operations) and Controller Aircraft. Following retirement from the Service in 2000, he undertook several reviews for the Office of Government Commerce, served on the boards of Chemring and Turbomeca UK and has been involved in a number of service and academic charities and societies.

I plan to cover three topics quickly:

- Technology Demonstration
- Collaborative Projects
- Urgent Operational Requirements

Technology Demonstration

A project to support technology development for EFA – the European Fighter Aircraft – was launched in 1983. The Experimental Aircraft Programme (EAP) was designed to research technologies to be used for a future European combat aircraft. Jointly funded by UK MoD and industry at a total cost £180M, it included innovative structures, a variety of advanced avionic systems, and co-bonded carbon fibre composite assembly systems to prove new tooling and manufacturing techniques. It had its first flight in 1986, with further design work continuing over the subsequent five years. It is generally recognised that, without the technology development from the EAP, the Eurofighter programme could not have been achieved in anything like the same timeframe or cost.

Technology, or rather the lack of it, has been the *key* factor behind the expensive overruns of cost and timescale that have affected many significant aircraft programmes over the last 50 years. I will use aero-engines to illustrate this.

In the late 1960s and early '70s the problems with the reheated by-

The BAe's EAP technology demonstrator, now at the RAF Museum's Cosford site. (BAE Systems)

pass system on the Spey engine, which led directly to the reduced availability of Phantom and Buccaneer aircraft, stemmed from want of available technology. The RB199 on Tornado, and the Gem engine on the Lynx, were other engines that suffered from the failure to invest in the necessary technology ahead of the start of their respective development programmes. In the case of the RB199, despite the hundreds of modifications introduced before the Tornado entered service, that engine required much further development before it achieved anything like its design performance levels.

It need not have been like that. Following its collapse in 1971, Rolls-Royce submitted a paper arguing for a new category of work 'Technology Development' to bridge the gap between research and full-scale development, with a fully costed and integrated programme embracing all aero-engine types. It was a well-argued case with considerable evidence drawn from past development programmes. Despite considerable support for the proposal by the then Controller Aircraft and his colleague, the Chief Scientific Adviser, the proposal did not get into the MoD budget.

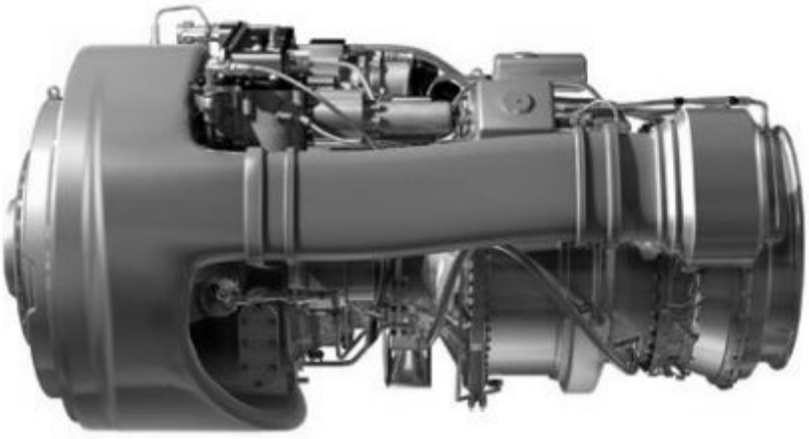
Fast forward to 1980/81 when the requirement for what would become the European Fighter Aircraft, was being developed with other European nations. The received wisdom was that, given the cost and timescale overruns of the RB199, the new fighter would have to make do with the same engine. Those in the know about engines and technology knew that this was bonkers, and that unless something was

done quickly to prepare for the launch of a new engine, MoD would be on course for a repetition of the hugely expensive shortcomings of the RB199 programme. They also knew that, for similar reasons, a new helicopter engine would also be required.

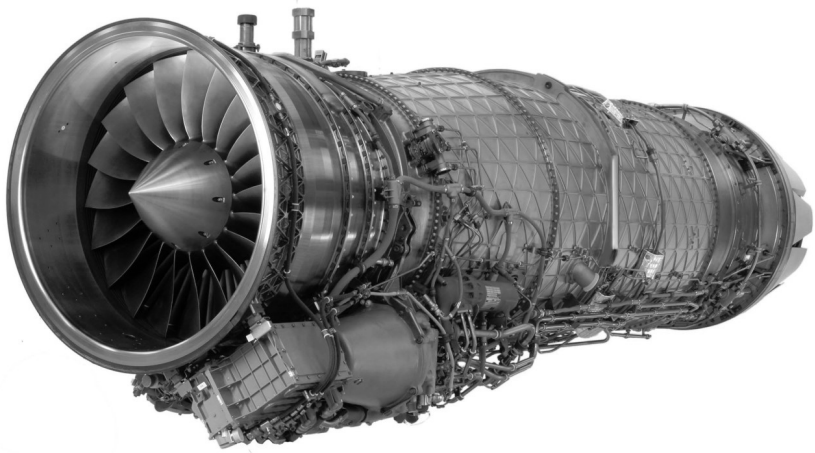
The then Director General Engines put together an integrated rolling programme of engine TDPs for combat aircraft, helicopters, large aircraft and associated control technologies that would address such future needs and, despite massive opposition from programmers, budgeteers and others, managed to get it into budget, with the added bonus of having the funding allocated directly to himself to manage. This greatly reduced the lengthy approval bureaucracy and facilitated a big reduction in the time between industry submission and contract, without diminishing the scrutiny process.

But that, surprisingly, was not the end of the matter. The notion of such long-term planning was an alien concept to many, and both he, his successors and subsequently I, had to battle every year with those who wanted to chop it, despite the clear evidence that kept emerging of the value of such TDPs. The programme delivered spin-out technologies such as single-crystal blades to other engine programmes. One calculation in the 1990s put its value in the order of 5:1 benefit for every £ spent. However, taking the programme overall, there can be little doubt that it yielded a much greater advantage. And the outstanding performance and reliability of the EJ200 on Typhoon and the RTM322 on many helicopter types bear witness to the cost-effectiveness of that programme.

It is therefore regrettable that the cost-cutters, thwarted in their attempts to crush the whole programme, managed to have the engine TDP for the Large Transport Aircraft chopped. The chickens came home to roost, when what is now, the A400M Atlas was being developed. Prominent among the problems were the difficulties with the newly designed engine, the Europrop TP400. In particular, delays arose from problems with the electronic engine control system. It was like a flash-back to the bad old days of expensive cost and timescale overruns because of technology shortfalls – exactly what the architects of the engine TDP programme had wanted to avoid. So, ironically, the cost-cutters' action in chopping the funding vividly demonstrated the overwhelming case for pursuing such TDPs. I only wish that they had learnt from that.



Examples of successful engines, above, the RTM322 for helicopters (Rolls-Royce) *and, below, the Typhoon's EJ2000* (Eurojet Turbo)



Urgent Operational Requirements (UOR)

During Operation GRANBY in 1990/91 my co-director in OR and I were responsible for managing the process of UORs on all UK air systems, ie for all three Services. Notable among these was the installation in all aircraft of secure HAVE QUICK radios compatible with US forces, many EW detection and countermeasure systems, introducing GPS onto Tornado GR1s, significant upgrading of helicopter engine protection to cope with the hostile sand environment,

Representative UORs implemented during Op GRANBY, above, HAVE QUICK secure UHF radio and measures to minimise problems to do with sand and helicopter engines, below, the TIALD pod and, bottom, the ALARM missile.

and the bringing forward of deployment on Tornado of two mission-critical systems: the Thermal Imaging Airborne Laser Designating pod (TIALD) and the Air-Launched Anti-Radiation Missile (ALARM), both of which worked extremely well during the war.

Whenever routine procurement projects run into difficulties, there are many who say that it would be so much cheaper and better to do all procurements the way that they were managed as Urgent Operational Requirements, not least as industry would not have time to spend all that money! While, superficially, that has some attractions, there are a number of disadvantages. Firstly, UOR equipments are funded for *only* the operation concerned, and for *only* the number of platforms to be employed on that operation; so the support required for post-war use is not funded, and squadrons end up with fleets within fleets which cause enormous problems for both operators and engineers. Secondly, the equipment might be suitable only for that one sort of operation. Thirdly, for use in war the installation of the UOR equipment might not meet all peacetime engineering requirements; the refuelling hose passing through the cockpit of the Nimrod in Operation CORPORATE is a case in point, and after Opertion GRANBY, for example, this led to Tornados being grounded on return to the UK so that some of the UOR equipment could be removed, much to the chagrin of the aircrew who had grown to enjoy having the extra capability provided and wanted to keep it.

Collaborative Projects

As previous speakers have indicated, collaborative projects have mixed blessings. Unquestionably, it is more difficult for one nation to pull out once a collaborative project is launched, and so they bring greater certainty to air forces. They also assist with operational interoperability. The types of programme that lend themselves to collaboration are those where the development bills are so large that sharing the costs outweighs the inefficiencies of the collaborative approach, or where the economies of scale are such that the savings outweigh the extra costs.

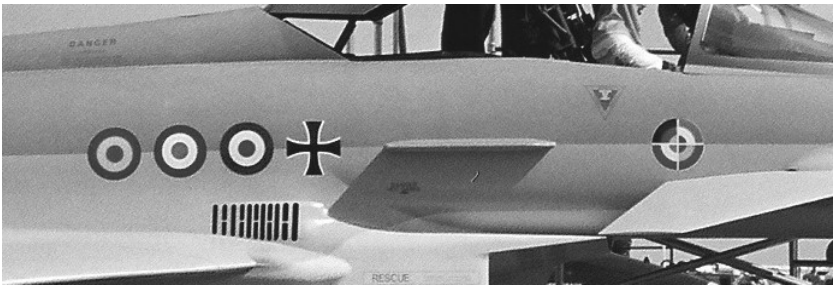
However, they do take longer, often involve unwelcome compromise, and are more expensive in development than single-nation projects. The rule of thumb that Sir Donald mentioned is, I think, probably right here: the square root of the number of

participants defines the eventual price. Generally speaking, collaboration does not pay where the production costs are substantially larger than the development costs. Thus it pays for aircraft development programmes, such as Tornado or Eurofighter, or for guided weapon programmes, but it is less valuable for armoured vehicle programmes, with relatively low development costs and with learning curves that run out after 1,000 or so vehicles, or for ships where the national variants create extra costs that outweigh the development savings, and where the multiple yards involved in building them make production savings elusive.

It is important that, as far as possible, the policy aims of the parties align in collaborative programmes. The problem is that nations are often not completely honest with their potential partners when they start out. It was, for example, apparent on Eurofighter that Spain, and to a lesser extent Italy, were more focused on technology acquisition and workshare than on developing a combat aircraft for operational use.

It also often takes a huge amount of time before agreement is reached between nations, and quite often those exploratory discussions come to nothing. For example, much time and effort was expended with France in early discussions about EFA, before they withdrew because their need for a smaller aircraft to operate off their carrier was eventually deemed to be incompatible with the requirements of the other nations. And the UK spent many months trying to get Germany to join us on the mid-life update of Tornado GR1 in the mid-1980s, but that came to nought. Indeed, when it comes to upgrade programmes, getting timely agreement for a particular upgrade is often difficult, as the other partners will have their priorities which will invariably be different. The UK's wish to use Typhoon in ground-attack roles and to carry different weapons was eventually achieved years later than desired.

The difficulties of getting agreement on EFA were compounded by the contractual arrangements, which saw workshare on the development programme based on the intended production off-take. The UK and Germany stated a requirement for 250 aircraft each, with Italy and Spain having 265 between them. So the development work was contracted on that basis, but when the Germans wanted to reduce their off-take to 140 to help fund the reunification of Germany in the wake



The need to satisfy the different, fluctuating and sometimes conflicting, demands of four nations complicated, and inevitably delayed, the Eurofighter programme.

of the fall of the Berlin Wall, there was a huge battle over how the consequential workshare in *production* would be restructured, as Germany was not prepared to see their workshare fall below 30%, even though it should have been only 24%. Eventually a compromise was reached, with Germany agreeing to 180 aircraft and 29%, even though they should have had less. This was also made more difficult by the original agreement that it was not just the overall workshare in development that had to be met, but that the same split had to be applied to sub-components such as engines, airframe and systems, even though Spain and Italy did not have credible suppliers in some areas. This necessitated much shuffling of the sub-contract cards to ensure credible suppliers and still achieve the agreed workshare.

Add to that the politics of four nations, which were operating to different electoral timetables, and so progress on decision-making for the next step often had to move at the pace of the slowest. And, of course, four different currencies were also involved, with exchange rates changing, often significantly, and this materially affected what were very large contractual sums; so this in turn tended to slow down agreements to proceed with the next phase.

This was further affected by the fact that large parts of the EFA development programme were essentially fixed price. On Tornado, the cost-plus arrangements meant that all parties were interested in doing extra work to solve problems, whereas on Eurofighter the work required to solve problems had to come out of someone's contingency or margin, which led to a lot of time passing the parcel and identifying who was responsible for the problem. On guided weapons, the

The two-nation Jaguar programme generated some overseas sales for the UK aerospace industry, notably to India which eventually acquired more than 150 aircraft, many of them built under licence; this one is a locally developed model optimised for maritime strike.

different cultures between BAe Dynamics, working on fixed prices, compared to Matra, working on more of a cost-plus approach, was marked. BAe would try and choose one solution to a problem in an effort to contain costs. Matra would identify two or three solutions and work them in parallel, seeing which produced the fastest fix. This cost more and so earned them more revenue, but was perhaps a better way to maintain the development schedule.

Jaguar and the helicopters were interesting examples of collaboration in the export market. Despite the joint work on Jaguar, the French pitched the Mirage F1 against Jaguar in the export markets, although they were supportive in implementing the sales won by BAC with the Jaguar. Within the helicopter field the collaborative arrangements gave the French the lead on the Gazelle and the Puma, and the Brits the lead on the Lynx. Not surprisingly France decided to procure the Gazelle and the Puma but not the Lynx, whereas the UK procured all three.

Collaboration with the US is entirely different. The history of multilateral collaborative projects involving the US suggests that this is something to be avoided, as more often than not the Pentagon initiates in parallel a project in the black world and, once that appears to be a satisfactory way forward, they withdraw from the multilateral

The sale of the AV-8A Harrier to the USMC was doubly fortuitous in that it led to the collaborative development of the far more sophisticated and capable Harrier II.

programme, usually causing it to collapse. There are a number of examples of this, notably in my time the MSOW-B project.

Bilateral collaboration with the US can often work, though, as hopefully the F-35 will demonstrate, provided the US is the dominant partner, and a leader/follower arrangement is put in place. However one danger is that the partner will be locked into the follow-on US upgrade programme *or* be left picking up the pieces, which can be difficult, as the DOD is very unwilling to release source codes to others. Those who hung their hat on the prospects of the AMRAAM/ASRAAM deal leading to the USAF buying ASRAAM should have looked at history; there was no way that the USAF would ever purchase such a key combat weapon from an overseas country, though the UK's slow development of ASRAAM did help the US argument here. It was remarkable that the US Marine Corps went for the Harrier, but they have always been a bit of a maverick, innovative force doing their own thing.

THE IMPACT OF AIR DEFENCE PROCUREMENT DECISIONS ON OUR UK AEROSPACE INDUSTRIAL CAPABILITY 1965–95

Professor Iain Gray

Having initially read Engineering Science at Aberdeen University, Iain subsequently gained an MPhil at Southampton and he has received Honorary Doctorates from Bath, Bristol, Aberdeen, Aston, Cardiff and Exeter Universities. He has 27 years' industry experience in the aerospace sector including appointments with British Aerospace and BAE Systems before taking on the roles of Director of Engineering and then Managing Director at Airbus UK. He became the first Chief Executive of Innovate UK (formerly known as the Technology Strategy Board) on its establishment in 2007, his work there being recognised by a CBE. Since 2015 he has been Director of Aerospace at Cranfield University.

Good morning ladies and gentleman. It is an honour to be asked to speak at this RAF Historical Society event exploring the impact of air defence procurement decisions from the past, and particularly during the Cold War period of 1965 to 1995. My perspective is that of an industrialist, as distinct from an operator or a procurer, and the views I express are personal. Although this seminar is primarily concerned with procurement during the Cold War, I have extended the scope of my own reflections to include the development and acquisition of the FLA/A400M military transport aircraft. I consider this to be relevant, as it illustrates the long-term impact of procurement decisions on our industrial strategy and demonstrates links between the cancellation of the HS681 and our current industrial position as the manufacturer of composite wings for Airbus. I draw on my own experience from working on the A400M project although, once again, I should stress that the views expressed are purely personal.

There is little doubt that defence procurement is a complicated business and the decisions that it involves inevitably affect the security of the nation. The aim, of course, is to provide our troops with the best possible equipment but, at the same time, it is necessary to

ensure that the tax payer gets good value for his money. Furthermore, procurement decisions have a long-term, and significant, societal and economic impact. In short, the problem is to obtain the degree of capability necessary in order to permit the government to implement its defence policy while providing a long-term benefit to the national economy. Unfortunately, there is no easy right answer, and I would argue that a number of the decisions taken during the Cold War, and since, have had an adverse effect on the position of our aerospace industry today. We need to understand that major industrial decisions have an impact that lasts for many years and it is essential that we take account of this when making such decisions in the future.

In this presentation, I consider the industrial impact of the Cold War procurement decisions, notably those taken in 1965, and, more recently, the links between the A400M programme (formerly the FLA project) and our current aerospace manufacturing capability.

I intend to cover a number of topics linked to the industrial impact of our procurement decisions, starting in the early 1960s when the UK arguably led the field in aerospace technology. I will cover the cancellation of several high profile British projects in 1965, which led to substantial orders being placed for US aircraft to take their place, and consider the long-term impact that I believe this had on our aerospace industry.

I will also examine the FLA decisions of the early 1990s and ask whether this was the 1960s happening all over again. The acquisition of the RAF's future transport fleet is now a done deal, but the decisions that this involved will be with us for a generation or more. I wonder, however, whether the recently instituted Defence Growth Partnership has fully recognised the lessons that have been taught in the past?

From the earliest days of flight, the UK had developed a strong aeronautics and aerospace industry. During both World Wars it had been at the forefront of technological development and had produced aircraft that were world beaters. Sir Frank Whittle had given the UK a strong lead in the field of gas turbine engines and, in commercial aerospace, we had led the way with the Comet jet airliner. In the early 1960s the UK was still leading the way with the development of a supersonic commercial aircraft – the Concorde. On the defence side, BAC was doing the same with the TSR2. In the summer months of

1964, therefore, there was good reason to believe in the future of the British aircraft industry. Three major defence projects were in play, the TSR2 and, from Hawker Siddeley, the HS681 transport aircraft and the supersonic vertical take-off P1154.

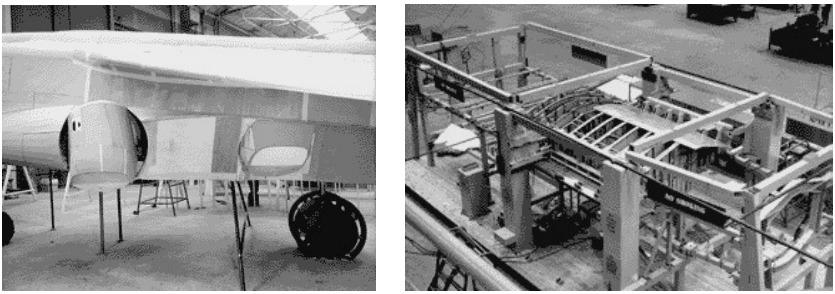
There was a bad feeling in the wind, however, with a change of government increasing the likelihood of defence cuts. It was also recognised that there was a need for further rationalisation within the aerospace industry but a growing suspicion that the US was playing serious politics with the UK to the advantage of the American aerospace industry.

We can only speculate on what might have been had these three very advanced projects been allowed to progress, but it was not to be. The HS681 and P1154 were cancelled in February 1965.[1] TSR2 had a brief stay of execution, albeit at a cost of £4M per month (about £70M at 2016 prices) but in April its cancellation was also announced.[2]

In the course of a Parliamentary debate on the cancellation of the three projects held on 13 April, Dennis Healey, Defence Minister in Harold Wilson's Cabinet, explained that the critical factor had been cost and he went on to say:[3]

> 'The fact is that for too many years we have been spending far too much money on too few aircraft. This has not been in the interest of the Services, the aviation industry or the nation. The day of national self-sufficiency in aviation is past. We must co-operate with other countries to share research and development costs and to provide a sufficiently large market for production. The British aviation industry cannot hope to prosper, as right hon. Gentlemen opposite seem to think, by producing smaller and smaller batches of military aircraft for this country alone at higher and higher costs. It just is not on. Man for man, our aviation industry is the equal of any in the world. The basic cause of its difficulties is that until now the Government have consistently chosen the wrong sort of military projects for the size of the potential market.'

There are some illuminating aspects to this statement, notably that 'the day of national self-sufficiency is past', but did that justify a decision to cancel the UK's current programmes outright and to order American aircraft in their place, without due regard to the long term



Left, the P1154 mock-up in 1964 and, right. the prototype under construction when the project was cancelled in February 1965. (BAE Systems)

implications for the British aerospace industry?

The loss of the TSR2, HS681 and P1154 projects, caused anger throughout the industry, protest marches in London and elsewhere, and provoked considerable debate at Westminster. The most immediate impact was on the morale of people in the industry. Job losses were inevitable, immediate and plain for all to see.

The UK initially considered filling the vacuum left by TSR2 with 110 F-111s. Fifty were eventually ordered but they were cancelled early in 1968. While the loss of TSR2 was deeply felt, I would argue that cancellation of the P1154 was actually an even bigger blow. It is often said that the Harrier was Britain's greatest post-war aircraft programme. Imagine, what might have been achieved if the P1154 had gone ahead, permitting the UK to provide the world's first supersonic V/STOL fighter.[4] What impact might that have had in the context of our participation in the development of the F-35?

As to the HS681, it had been given the go-ahead in 1962 with a project study leading to an anticipated first flight in 1966. Instead, it was cancelled and the Government announced that it would buy the Hercules in its place. We are currently celebrating the 50-year career of what has undoubtedly been a great American aeroplane but, had we persevered with the HS681, we just might have been celebrating 50 years of a British transport aircraft. While it attracted the least publicity at the time, of the three programmes cancelled in 1965, it was, I suggest, the loss of the HS681 that actually had the greatest long term industrial impact.

The aftershocks of the triple cancellation rumbled on for a time, the focus tending to be on TSR2, but the adverse implications for the entire aerospace industry were widely recognised. For instance, in that same 13 April 1965 Commons debate, Julian Amery MP, whose Preston constituency had been deeply affected by the loss of TSR2, said:[5]

> 'If the industry is dismantled, we shall have to spend an increasing proportion of the money abroad and lose valuable exports which we are getting at the present time. What is more, the quality of our design work will fall. You cannot maintain the highest standards of aircraft and aero-engine design unless your designers are swimming in a big pool, unless there is a wide range of activities from which they can gain experience and which will give them the necessary scope. I think it necessary to look at the Government's decision in the context of the programme which we were pursuing. We had a full programme to meet nearly all our civil and military ends.'

In the same debate, Christopher Soames MP said:[6]

> 'The cancellation of its three big military projects has pulled the carpet from under the industry's feet. It was having a hard enough struggle anyway to sell the BAC-111 and the VC10 in the face of American competition, but things will be much harder for it now. It is natural that its American competitors should now be saying that, with the loss of these three military projects, the British industry is on its way out and anyone who buys British aircraft needs his head examined. It is like buying a motor car, so the argument runs, from a firm which is going out of business. It is no wonder that we read in the Press that people in Washington are cock-a-hoop.'

As Soames suggested, the cancellation of the three advanced military projects was going to have a considerable knock-on effect on the UK's ability to sell its commercial aeroplanes. Indeed, the cancellation of the HS681 in favour of the Hercules may well have killed the UK's prospects as a supplier of airliners – the eventual outcome being its present role as a component supplier, albeit a significant one, to, for instance, Airbus and Bombardier.

The TSR2 programme, and its cancellation, is the best-documented, having been the subject of many papers and books, including a notable contribution by this society.[7] There is still some debate about that aeroplane's real military capability, the maturity of its technology and just how much it might have cost, but there can be little doubt that its loss set back our military aviation capability by at least a decade. In fact it was 20 years, 1986, before the UK was next able to demonstrate its expertise with the EAP (Experimental Aircraft Programme) technology demonstrator which led, eventually, to the Typhoon. Similarly, it could be argued that the ground lost as a result of the cancellation of the P1154 ultimately led to the UK having little more than a 'supply chain' function within the F-35 programme.

To put the TSR2 into perspective, its genesis lay in GOR339 which was submitted to industry in 1957. At that time, when the Britannia had just entered service with BOAC and the first production Boeing 707 had just made its first flight, GOR339 envisaged a supersonic, all-weather, long range aircraft able to operate at high level at Mach 2+, or low level at Mach 1·2 – with a STOL capability into the bargain. That was an exceptionally ambitious target for the technology of the day. It was that technology stretch that rationalised the UK supply chain which could, or at least should, have given the UK an unrivalled capability. Unfortunately, the programme was dogged by political and organisational issues – Vickers and English Electric were chosen as joint main contractors with the political objective of driving further industry consolidation. That led eventually to the formation of BAC which meant that TSR2 was now competing for resources against the demands of the VC10, BAC-111 and Concorde.

Nevertheless, the project made progress and XR219 flew for the first time on 27 September 1964. A second aircraft was close to flying when the programme was cancelled, by which time the prototype had completed 24 sorties. Cancellation was implemented with indecent haste. Further flying was prohibited which prevented further assessment of the airframe and engine and hindered development of the advanced systems. It was the loss of the ability to validate these technologies that cost the UK a couple of decades. Needless to say, the cancellation led to the loss of thousands of jobs spread across the aviation industry and arguably leading to the closure of Weybridge. In the Venn diagram represented by military capability, economics and

While it attracted the least publicity, of the three major projects cancelled in 1965, the loss of the HS681 may have had the greatest long-term adverse implications for the British aerospace industry.

politics it was the latter that contributed most to this loss of industrial capacity.

Personally, I consider the cancellation of the HS681 to have been an even more damaging, if less talked about, decision.[8] The requirement, OR351, had been for a medium-range freighter to replace the Hasting and Beverley. Armstrong Whitworth's design featured a shoulder-mounted swept wing, a tailplane mounted on top of the fin and a fuselage reflecting what had become the classic layout for an aeroplane for this role. It had a tricycle undercarriage to provide a level freight bay with access via full-width loading doors and a ramp built-in to an upswept tail section. Power was to be provided by four pylon-mounted Rolls-Royce Medways but, in order to achieve the desired short-field performance, some very innovative technology was involved, including vectored thrust nozzles, boundary layer control

and blown flaps and ailerons. This was leading edge stuff and its complexity, and expense, may well have contributed to the downfall of the project.

It had been anticipated that 50 aircraft would be ordered and, had the project gone ahead, this just might have established the UK as a player in the large transport aircraft market. But it was not to be and in February 1965 the government announced that it would be buying C-130Ks from Lockheed instead.

The Armstrong Whitworth factory in Coventry was closed, with a loss of 5,000 jobs. However, I believe much more significantly, this is the point where we lost the ability to build complete aircraft, conceding our place within the global market to the USA, and even leadership within Europe to the French-dominated Airbus consortium. The decision to cancel the HS681 was taken in the absence of a clear industrial strategy and without understanding the longer term consequences on our industry.

In terms of lost jobs, the impact of the HS681 cancellation was mitigated, at least at Shorts in Northern Ireland, by production of the Belfast strategic freighter. An extrapolation of the Britannia, the Belfast had been ordered for the RAF in 1959. It first flew in January 1964 but, following the UK's withdrawal from east of Suez, it was withdrawn from service in 1976. That said, the Belfast had been a sound enough freighter – capable of carrying up to 150 troops, ten Land Rovers with trailers, three Saladin armoured cars, a pair of Wessex helicopters or, notionally at least, even a Chieftain tank. But with a production run of only ten aeroplanes, the Belfast had made no contribution to a coherent long-term industrial strategy.

Starting in the mid-1960s and continuing throughout the '70s the UK forfeited its stake in the large military transport market – and that had a significant impact on our ability to compete with respect to commercial airliners and, indeed, aerospace generally.

A generation of product development was lost to the USA and, specifically, to the C-130 – an aeroplane that air forces around the world, including the RAF, grew to love as a capable and reliable workhorse. The UK gained some spin-off industrial benefit from the Hercules through companies like Marshalls who, having been designated a 'Sister Design Authority' can do pretty much anything to or with a C-130. This is an impressive capability, of course, but it is

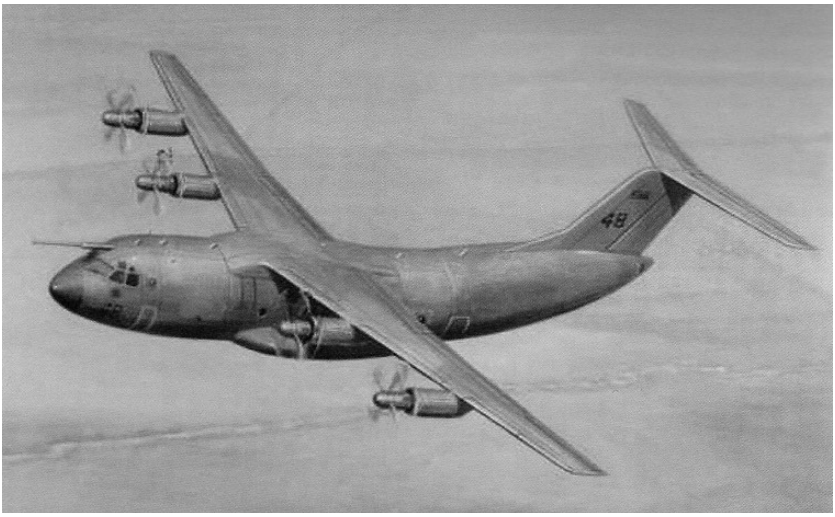
essentially a service industry which falls well short of the independent production programme led by a British company that the HS681 might have been.

We now need to fast-forward to the early 1980s. The RAF and other European air forces were beginning to search for a replacement for the C-130 and the Transall C-160. This exercise provides a classic illustration of just how difficult it is to replace an incumbent aircraft supplier. The UK's long-term support arrangements for the C-130 were in place and the RAF had become used to the aircraft. This reinforces the point that procurement decisions do not just impact the short term. They have long term implications because they shape future industrial capability and subsequent product decisions a generation or more ahead of the next requirement.

The first evolutionary development was the establishment, in 1982, of the Future International Military Airlifter (FIMA) group comprising Aerospatiale, British Aerospace, Lockheed and Messerschmitt-Bölkow-Blohm (MBB). In May 1984 the industrial FIMA consortium was complemented by a parallel political organisation, the Future Large Aircraft Exploratory Group (FLAEG), comprising the Heads of Defence and Industry of the participating nations. The UK's, Michael Hessletine, volunteered to Chair the group's meeting. The FLAEG considered a variety of options, and by January 1985 it had settled on a configuration designated D4P. Broadly similar to today's A400M in size and shape and powered by four turboprop engines, this became the baseline solution to meet the requirement, mainly because of its superior tactical performance. This decision was not universally welcomed, however, particularly by the RAF who had wanted a turbofan aircraft, and there was recurrent debate over the relative priority to be afforded to strategic versus tactical capability.

Nevertheless, in March 1988, a major milestone was passed when the eight nations of the FLAEG signed a draft Outline European Staff Target which was then issued to the FIMA consortium, which had been joined by CASA of Spain and Italy's Alenia in 1987. The early design work was led by a team based in Rome with the British Aerospace contingent based in Woodford.

However, within FIMA significant tension was developing between Lockheed and the European companies and in June 1988 Lockheed proposed a wide body derivative of the C-130 as a cheaper



An artist's impression, by Arthur Sturgess, of the FIMA project circa 1985 in its D4P configuration.

and quicker solution to the FLA requirement. This idea was rejected but the differences within FIMA were becoming too great and in May 1989 Lockheed notified the partners that it wished to withdraw. The Europeans decided to dissolve FIMA, which permitted Lockheed, no longer a participant in the European FLA programme, to set about developing an upgraded Hercules that would eventually become the C-130J. Meanwhile the erstwhile FIMA had promptly been reconstituted as the European Future Large Aircraft Group (Euroflag) and its projected aeroplane began to be referred to as the FLA.

I am indebted to Roger Taplin, BAe Chief Engineer for the FLA/A400M development programme, and to Derek Empson, former BAe Operational Requirements and Business Development Manager, for their recollections of the interplay of UK industry and Government politics in the 1980s and '90s, along with UK Operational Requirements already specified by the UK MoD in the FLA European Staff Requirement document.

However, at the September 1989 meeting of the FLAEG, little more than year after it had been formed, the UK resigned the Chairmanship and ceased to be an 'active' member. It retained a connection, but with observer status only and it declined to fund any

studies. This decision reflected a failure to recognise the importance of the FLA project to the UK and revealed, what amounted to, a complete lack of an industrial strategy. Since the government had declined to pay, responsibility for staying in the programme, and for participating in its funding, which could be regarded as paying an insurance premium to protect the long-term interests of the national aerospace industry, lay with industry itself – the same industry that had lost out on the original C-130 procurement decisions some 25 years earlier.

This was compounded in July 1991 when Alan Clark MP, the Minister for Defence Procurement, announced a major reduction in R&D funding for replacements of large military aircraft and stated that in future the UK would acquire all such aircraft from the USA. It was a replay of 1965. Once again the relationship with the US appeared to be taking priority over the UK's industrial requirements. What seemed even worse, to my mind, was that it was evident that, at the same time, the MoD was overlooking its own requirements for a new aircraft, as laid out in its Staff Requirements.

Meanwhile, in May 1990 Euroflag had been contracted by the participating nations to carry out a 6-month study of the cost benefits of the FLA. British Aerospace was left to self-fund the UK contribution to this study, keeping the UK involved in the programme – but only just!

The nations agreed the European Staff Target in May 1993 with the UK, still only an observer, merely noting it. The tempo was increasing, however, and in the same month British Aerospace's FLA Project Team relocated from Woodford to BAe's Airbus facility at Filton, anticipating a reorganisation that would eventually see the FLA programme become an Airbus project.

Concerned that the UK should not lose out to the Americans a second time, British Aerospace's Dick Evans decided to put the company's full weight behind a campaign intended to bring the UK back on board the FLA project. Under his leadership, a dedicated headquarters was established in Burwood House, London at the end of 1993. Together with Rolls-Royce and Shorts, a high-profile lobbying campaign was launched, which attracted strong support from other aerospace concerns across the UK and the publicity and posters supporting the campaign made much of the industrial significance of

'His dream is in Aerospace – are you prepared to shatter it?' (BAE Systems)

the FLA programme and included some very persuasive images. For example, one of the posters showed a young school boy holding a model of an Airbus aeroplane with the strapline 'His dream is in Aerospace – are you prepared to shatter it?' It seemed to summarise what the decision was about and brought the industrial strategy aspect of the procurement decision into focus.

As part of the FLA campaign British Aerospace decided to build a full-scale mock-up for the September 1994 Farnborough Show. It was developed under the codename of ALFREDO and took centre stage. The primary purpose of this exhibit was to demonstrate the aircraft's impressive load carrying potential – for example, the ability to accommodate a 25-ton Warrior IFV. ALFREDO attracted a lot of publicity – not all of it positive, Lockheed calling it a Farcically Large Aircraft! However, it got the message across and, combined with the lobbying road show, this persuaded the MoD to re-join the programme. Malcolm Rifkind announced on 4 December that the UK would resume full membership of the FLA Sub Group that was refining the draft European Staff Requirement.

A key feature of the BAe Airbus campaign was the Hercules Rolling Replacement Combined Operational Effectiveness and Investment Appraisal (COEIA) conducted by the MoD to determine whether to recommend UK Ministers to re-join the FLA programme as 'active' participants. An important element in this exercise was, the FLA Critical Load List of equipment already defined by the MoD, half of which could *not* be carried in a C-130J. In addition, more than 270 other UK air-portable equipment types would be transportable in the FLA/A400M but *not* in the C-130J. Also, the FLA was able to carry Land Rovers, trailers and 105 mm guns side-by-side, doubling the payload compared with the C-130J. While deployment load tables

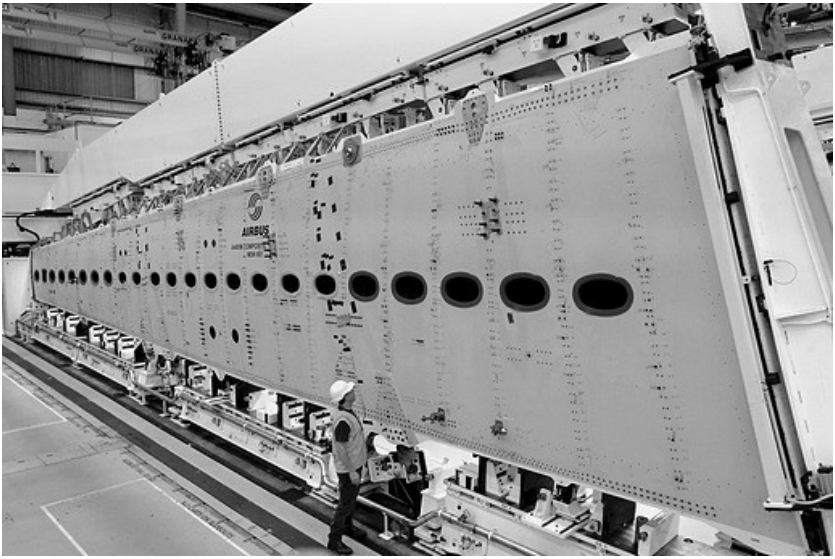
were ostensibly Joint Service, they were prepared largely by the Army, the main customer. Ensuring that the COEIA took full account of both the Critical Load List, and the actual rapid deployment inventories, became a major aim for BAe's lobbyists. If the COEIA analyses included *only* items of equipment that could be carried by a C-130, the full benefits of the FLA would not be apparent.

On 16 December 1994, in a written answer to a Parliamentary Question, Malcolm Rifkind, the Secretary of State for Defence, announced that the UK intended to begin to replace its existing Hercules fleet by ordering 25 C-130Js. He went on to say, however, that, although it was not yet available, it was anticipated that there would also be[9]

> 'a requirement for between 40 and 50 FLA. The United Kingdom will, therefore, rejoin the FLA programme at the end of the feasibility phase provided that it is managed on a commercial basis under the umbrella of the Airbus consortium. Resources will need to be available at the time and our requirements on price and performance must also be met. Commercial management should include United Kingdom firms being given the opportunity to compete in the programme fairly and on merit. A programme of work on FLA has been set in hand with our partners.'

The sting in the announcement, of course, was the order for the C-130J, a decision that, I believe, significantly underestimated the technical risks associated with the second-generation Hercules programme. A cheaper, and equally effective, interim arrangement would have been to refurbish the existing C-130K fleet. This would have protected the A400M programme and avoided the subsequent need to reduce the order.

During 1995 the configuration of the aircraft continued to evolve. There was, again, particular focus on the power plant and studies continued to explore four options – two turbofans, four turbofans, four propfans and four turboprops. In May 1995 the decision was taken to pursue the four turboprop solution on the basis that the turbofans would not provide the performance needed for a steep descent and very low speed operation for air delivery and/or reverse manoeuvring on the ground.



While the UK succeeded in securing overall leadership of the wings for the A400M, the composite surface panels would be manufactured in Germany. (BAE Systems)

It was at this stage that some serious industrial politics resurfaced, in particular concerning who was to build the wing – and what it was to be made of. Within Airbus, Germany had never made any secret of its ambition to take over the leadership of wing construction from the UK and the FLA programme provided the backdrop against which the industrial politics over the responsibility for Airbus wings were played out. Germany proposed a full carbon wing box which would permit it to develop a comprehensive national composites capability which would set it up to produce the wings for all future Airbus airliners. The UK, quite rightly, took the view that the material choice should be based on what was best for the aircraft and the customer and during 1995 British Aerospace established, and funded, a test programme which involved designing and building a full-scale carbon wing box which it tested for battle damage compared to a metal wing. Meanwhile, Spain had proposed a hybrid form of construction employing metal ribs. This became the final solution with manufacture to be undertaken in the UK, which cemented the UK's

place within the FLA programme.

Having effectively secured the future of wing manufacture, the UK was now, in effect, firmly committed to the FLA project. This was of critical importance, since all of the nations were jostling to satisfy the demands of their individual industrial strategies and the UK needed to be a full participant if it was to secure its slice of the FLA pie. Hence the lobbying campaign which had aimed to set that commitment in concrete.

It will be recalled that a condition of the UK's re-joining the programme was that it should be managed by Airbus. The intention to transfer the project to Airbus had been announced at the 1994 Farnborough show but it would be January 1999 before this actually happened, when Airbus Military (since January 2014, Airbus Defence and Space) was set up specifically to handle the maturing A400M project. In the meantime, it continued to be run by Euroflag. In 1996 the European Staff Target of 1993 was superseded by a European Staff Requirement which was approved by all participating nations but, although it had played an important role in the development of the Requirement, it was not actually signed by the UK.

Nevertheless, the A400M was now beginning to approach the hardware stage as a multi-national, four-engined turboprop, tactical airlifter with strategic capabilities to which the host nations were now committed and which was beginning to attract the attention of other air forces.

The original FLA partners – France, Germany, Italy, Spain, the UK, Turkey, Belgium and Luxembourg – decided to charge the Organisation for Joint Armament Cooperation (OCCAR) with the management of the acquisition of the aircraft. It was agreed that manufacture and development would reflect the '*juste-retour*' principle whereby workshare allocated to a nation would be related to the number of aircraft it ordered as a percentage of the total. The initial production run was expected to be for 180 aircraft, with first flight due in 2008 and first delivery planned for 2009. The current (November 2016) order book is shown at Table 1.[10] The RAF had eventually ordered only 22 aircraft – a long way short of the 40-50 that had been announced by Malcolm Rifkind in 1994.

Notwithstanding the notional commitment to '*juste-retour*', there is

Country	Order	Delivered
UK	22	12
France	50	10
Germany	53	5
Luxembourg	1	0
Belgium	7	0
Spain	27	1
Turkey	10	3
Malaysia	4	3
Totals	**174**	**34**

Table 1. A400M order and delivery status as at 30 November 2016.

little doubt in my mind that games were being played in the early days of the programme with some countries inflating their order numbers to achieve the objectives of their industrial strategies. Thus, for example, Rifkind's statement, indicating a UK order for as many as 50 aircraft, had been instrumental in securing leadership of wing construction. However, the reduction to 22 had resulted in a significant reduction in the UK's actual workshare and, although overall leadership and wing assembly remained in the UK, manufacture of the composite wing skins had been allocated to Germany. The final A400M workshare is

Country	Workshare
UK	Overall wing leadership
Belgium	Detailed machined elements of wings
France	Flight Control System and overall systems integration
Germany	Overall fuselage leadership – composite manufacture
Portugal	Fairing panels & some flight control surfaces
Spain	Final assembly; some composite component manufacture
Turkey	Major structural elements & some flight control surfaces

Table 2. A400M workshare.

shown Table 2. Incidentally, it is also interesting to note that Germany had originally ordered 60 FLAs, later reduced to 53 plus 7 options and later still it announced that it would try to resell 13, as it only actually required 40 – had the original 60 been a workshare bargaining chip?

I am not suggesting that the UK was wrong to have reduced its order numbers, but did this have an adverse impact on its long-term wing leadership position within the overall Airbus enterprise? What is certain is that wing skins for the new A350 airliner are *not* being manufactured in the UK.

The A400M was developed in a similar timeframe to the A380 airliner. This meant that the Airbus A350 XWB was the first all-new Airbus aircraft to benefit from, and be influenced by, the experience acquired via the A400M. The A350 XWB is a family of long-range twin-engined aircraft with extra wide bodies (hence XWB). The A350 series incorporates many advanced technologies but perhaps the most significant is the widespread use of composite materials – including the wing. It is the first all-composite wing to be developed by Airbus for a commercial airliner. The distribution of workshare for the A350 was based on production efficiencies and facilities, but also where expertise lay, within the Airbus system. Airbus needed to control the programme risks. The wing panels for the A350 are amongst the largest composite components ever produced and, because it lacked the experience of composite wing skin manufacture gained from the A400M, it was considered to be too big a risk for them be manufactured in the UK. As a result, while overall wing design and assembly continues to take place at Filton, the composite skins come from the Airbus facilities at Stade in Germany (where the A400M wing panels had been made) and at Illescas in Spain. That means that the UK has no role in the manufacture of wing panels for Airbus civil products and I would argue that, in the context of industrial strategy, this is a classic illustration of the way in which a short-term decision (the reduced order for the A400M in favour of the C-130J) can have long term consequences.

The A400M's first flight took place on 11 December 2009 from Seville in Spain. The development of the programme is worthy of a separate review and I am sure that, in the fullness of time, the Society will examine the lessons learned from (or at least taught by) the A400M. There were considerable delays and cost overruns and

The RAF took delivery of its first Atlas C Mk 1 at a ceremony held at Brize Norton on 17 November 2014.

between 2009 and 2010 the project faced the prospect of possible cancellation. However, the customer governments chose to maintain their support, albeit at considerable cost to both Airbus and national budgets. The A400M received its European Aviation Safety Agency (EASA) certification in March 2013 and the first aircraft was delivered to the French Air Force in the following August. The A400M entered service with RAF, as the Atlas C Mk 1, in July 2015. A great achievement and a product that I know will serve the RAF well.

Behind the development of the programme, however, there was the story of securing a long-term wing manufacturing capability for Airbus in the UK. Balancing the complicated procurement trilemma of military need, politics and economics is particularly difficult to manage and it requires a far more 'joined up' approach between Government departments.

Have we learned the lessons of the past 50 years regarding the links between procurement and industrial strategy? The answer will lie with the Defence Growth Partnership, the creation of which was first

The RAF's current state-of-the-art airlift capability comprises the Atlas, the second-generation Hercules and the Globemaster.

announced by David Cameron at Farnborough 2012. Its strategy is summed up in the following statement.

> 'Taking a fresh and ambitious approach through a joint commitment from Government and Defence Industry to work together to develop new opportunities building on our nation's strengths in air capabilities and intelligent systems and deliver growth through innovative and tailored solutions for customers around the globe.'[11]

It is a pity that we did not have that same policy in the mid-1960s. If we had, I believe that we would have had a very different British aerospace industry today.

I finish with two pictures that to my mind tell a story. The first is of the RAF's large transport aircraft, three types, each of them a great aircraft in its own right. The C-130J is a tactical aircraft from Lockheed and a direct descendant of the defence procurement decisions of 1965; McDonnell Douglas' magnificent C-17 strategic airlifter, incorporating technology that resembles much of what had been promised with the HS681; and the A400M – a bespoke aeroplane developed to meet the future needs of European air forces and an aircraft which was key to keeping Airbus wing assembly here in the UK.

The second picture is of the new Airbus A350, specifically its very sophisticated wing. It was designed, and is assembled in the UK, but with its composite wing panels made in Germany and Spain which, I would argue, is a consequence of our having failed to recognise the

The Airbus A350's hi-tech wing is assembled in the UK, but from components manufactured in Germany and Spain. (Airbus)

strategic industrial implications involved in the A400M procurement decisions.

That trilemma of achieving the right balance of military capability, politics and economics is not an easy one to resolve but I would suggest that our procurement processes have not always leveraged, or contributed to, our industrial strategy as well as they might have. I hope that we have learned our lesson and are now fully aware that account must be taken of the potential long term industrial implications of any procurement decision.

Thank you for listening.

Notes:

1 Hansard; HC Deb 2 February 1965, vol 705, cc930-32.
2 Hansard; HC Deb 06 April 1965 vol 710 cc325-26.
3 Hansard; HC Deb 13 April 1965, vol 710, cc1204-05.
4 www.harrier.org.uk/history/history_p1154.htm
5 Hansard; HC Deb 13 April 1965, vol 710, cc1216-17.
6 Hansard; HC Deb 13 April 1965, vol 710, c1185.
7 *TSR2 with Hindsight*, RAF Historical Society Journal 17B; 1998.
8 www.secretprojects.co.uk/AW681
9 Hansard, HC Deb 16 December 1994, vol 251, c823W.
10 A400M Order and Delivery Status as at 30 November 2016, see https://airbusdefenceandspace.com/wp-content/uploads/2016/12/2016-11_mrs_gen_ord-deliv-by-country.pdf
11 http://www.defencegrowthpartnership.co.uk/

SUPPORT MATTERS

Air Chf Mshl Sir Michael Alcock

Commissioned into the Technical Branch in 1959, most of Sir Michael's early career was within Bomber Command. In the later 1970s he was OC Eng Wg at Coningsby (Phantoms) before commanding No 23 MU. Following appointments at HQ Support Command, the MoD and Bracknell, he was AO Eng at High Wycombe during Gulf War I, subsequently becoming. Chief Engineer, AMSO and, ultimately, the first AOCinC Logistics Command. Since retirement in 1996 he has worked as an aerospace consultant and been involved in the management of the RAF Benevolent Fund and of Princess Marina House.

As one who never actually served in any procurement organisation you could be forgiven for questioning my contribution this afternoon. Before joining as a National Serviceman I did spend five formative years as a Student Apprentice at the Royal Aircraft Establishment, Farnborough – at the time, arguably, the leading centre of aeronautical research and a part of the Ministry of Supply (MoS). As a newly commissioned pilot officer in the Technical Branch I knew next to nothing about the RAF, but I did have an excellent grounding of things aeronautical from the heart of the procurement organisation of the day. And Sir Donald has reminded us how the MoS has evolved since then.

I shall endeavour to present my views as objectively as possible, but, inevitably, they are *subjective* as references are few beyond personal papers and a fading memory. My time scale covers my career – 1959 to 1996 – from the Cold War, to Gulf War I and its aftermath.

A few years ago, I was asked to contribute a paper to a society seminar entitled, *Supply – An Air Power Enabler*.[1] I took the view then, as I do now, that there is more to it than 'Supply'. I think that the real enabler of air power is 'Support', a word in my dictionary that combines the best of engineering *and* supply management skills – which is my theme for the next 30 minutes.

Air power is, and always has always been, a maintenance intensive

More than 300 aircraft received modifications associated with Gulf War I not least, as with these Jaguars, painting most of those actually deployed in 'desert pink'.

business.[2] Military aircraft have always been state of the art, pushing the boundaries of technology, which tends to mean that designs are ever more complex. That, in turn, means that they can often fail to live up to promised performance and sometimes require continuing development work after getting into squadron service.

Throughout this period we continually adapted operational capability to reflect changing threats, whilst at the same time repeatedly extending service lives. The net result being ample modification work to be done in-service, in addition to the routine maintenance that is essential to underwrite airworthiness.

Fielding all this technology depends on a vast, and at times bewilderingly complex, organisation, linking science and industry with the front line. It takes massive national resources to design, develop and deliver air power, and lots of trained manpower to support it in operations. It may surprise some to hear that more than 84,000 personnel were deployed to support 2nd Tactical Air Force in France and Belgium in 1944.[3] It was a similar picture the next time we were involved in a large deployed operation – the first Gulf War[4] in 1990, with far fewer aircraft involved,[5] when 46% of deployed RAF personnel were involved in direct maintenance activities.

Engineering and support policies remained largely unchanged from those put in place during the Second World War. Indeed, organisations were based on the same two 'smokestacks' – Equipment and Maintenance were the terms originally in vogue, rather than Supply and Engineering which came later. In 1937 Maintenance Command was formed to control the numerous depots[6] and by 1940

its personnel were being drawn from the Stores (later Equipment and later still Supply) Branch, which had been in existence since 1919[7] and the Technical (later Engineer) Branch which was announced in 1939 but not actually established until 1940.[8]

So much for organisation, but what about support philosophies? Until the mid-1980s the RAF was very much the leading light in delivering a philosophy of 'Supporting the Design'. We took the weapons systems from their inception within the aerospace industry and did our best to understand the technology, matching our engineering skills to that technology and then determining how best to make it all work so that the front line had effective weapon systems to use.

Our maintenance policies were based on manufacturers' initial recommendations, refined over time as we gathered in-service performance data. Spares were similarly procured and we paid for Post Design Services from the original manufacturers so that our continuing decisions were based on the best evidence.

We managed safety and configuration ourselves through the concept of Engineering Authority (EA), a self-regulating system of governance that underpinned airworthiness. In short, we did all the thinking ourselves, and we controlled and managed all the activities, buying advice, spares and repairs from industry and carrying out the work from squadrons at First Line to stations at Second Line and we ran our own, in-service, Third Line, overhaul and repair facilities, to which I shall return in a moment.

We had a formidable corporate knowledge base in the shape of the Central Servicing Development Establishment (CSDE) at Swanton Morley whose work in many areas was adopted by industry, as well as many other allied air forces. It was CSDE that: developed the concept of 'Reliability Based Maintenance'; carried out studies of Reliability, Maintainability and Testability; and did ground-breaking work on computer modelling to test the effect of different support strategies to decide how best to work within cost constraints.

It was all this work, and more besides, that led to the 'Inception Procedures' that made the first attempt to get Prime Contractors to take an interest in how their products would be supported. Prime Contractors made their money, of course, by selling us more spares, repairs or advice on which to base further modifications that we then

The advent of V/STOL added a whole new dimension to maintenance. Here a Harrier GR3 is having its engine changed in the field, in this case in Germany, but it would be the same anywhere. Sam Thompson.

had to pay for separately – they were not particularly interested in containing the life cycle cost of their products, quite the reverse. And it was the rising cost of supporting ever more complex technology that was beginning to distort the Air Force and Defence budgets alike.

Throughout the early 1980s we had begun to seriously study life cycle costs – revealing the true cost of ownership. Hunting Engineering completed some excellent stuff on the Harrier GR3[9] and the Hawk.[10] The latter was, I think, instrumental in getting the subject taken seriously within PE – I believe that there was, eventually, a modest reliability clause in the Hawk procurement contract. All this work on costs of ownership was supposed to lead to an AFB paper on the subject though I have failed to find such a reference. I do know that the National Audit Office took a close interest and issued a number of helpful reports.[11] One of these Audit Reports made it to the Public Accounts Committee in 1984, so the message was getting the attention of influential decision makers.[12] These studies, and more besides, all pointed to the fact that 'reliability' – or, to be more

precise, the *unreliablity* of equipment – was costing us millions.

Getting widespread support for the notion that we should target reliability and insist on support cost being contained was not easy, but it gained strength from a similar movement taking place in the USA under the banner of Integrated Logistic Support, a concept that was almost identical to ideas from CSDE and that took us now from 'Supporting the Design' to a philosophy of 'Designing for Support'. At last we had a methodology that was accepted throughout the industry and one on which the USAF and we were joined up.[13]

But it was how we repaired all this unreliable kit that had caught most people's attention. When you understand that repairable components make up less than 20% of our vast inventory – containing one million line items – yet they account for some 80% of the total cost, it becomes clear where big changes are needed.

Repair and overhaul is a big ticket item, but we never sought to do it all in-service. Engine repair in-service in the 1970s was pretty much non-existent. At least that remained the policy until the fateful day in January 1971 when Rolls-Royce went bust! I recall vividly, as a new PSO to the then Director General of Engineering, the call coming through from CAS to Air Mshl Sir John Hunter-Tod, who was the first 3-star Chief Engineer.[14] CAS wanted to know what impact the news would have. The answer? We would have to stop flying in about three months! That led directly to a change of policy to build up our engine repair facilities so that we could never again be put in a similar position; a policy that was aided by the industrial strife of that era. Remember 'Red Robbo', scourge of the motor industry?

We should now consider the strategic case for an in-service Third Line, which was based on two principle arguments.

First, to provide the necessary manpower reinforcements for War Establishments. Throughout the Cold War operational units were only established, and manned, for peacetime training. War Establishments provided skilled, uniformed reinforcements from Third Line so that operational units could function 24 hrs a day at intensive flying rates for 30 days – the accepted NATO commitment. Third Line units were mixed manned, normally 50:50, uniformed:civilian. Employing a proportion of uniformed technicians in Third Line also served to enhance their skills to remain current on technology in use at front line squadrons.

Joint uniformed:civilian maintenance in practice – BAE Systems and RAF technicians working on a Tornado at Marham. (BAE Systems)

Secondly, policy makers wanted an alternative to industry so as to avoid an industrial monopoly. Fear of being held to ransom by industrial action was definitely a contributory factor as well. Having our own repair facilities gave us flexibility, plus the opportunity to compare costs with industry.

Repair policy had been under almost continuous study for decades. Quite the most perceptive being a study done by the late Air Mshl R E W Harland immediately before taking command of Maintenance Command.[15] In 1973 he pointed out the inherent shortcomings, particularly if we did not have an in-service capability. He described the typically lengthy time scale of getting a component repaired; critical items often experienced repair cycle times of well over a year, which can drive up initial provisioning cost in the first place.

Every study I came across concluded that closer working between engineer and supply staffs, together with the procurement organisation, was essential to tackle the inefficiencies. Contracting for repairs, and for resupply of spares, was the responsibility of PE. Moreover, engineering staffs depended on PE to let and manage Post Design Staff (PDS) contracts that covered defect investigation, modification preparation, design office queries and so on.

As the front line reduced in size, major overhaul work was

A Tornado undergoing a major overhaul at St Athan.

rationalised into one well-equipped Third Line unit at St Athan, capable of deep airframe overhaul, engine repair and testing, and some component repair. It had a surface finishing and heat treatment plant, machine shops, a design office for structural airframe repair and a modern paint shop for refinishing fast-jet-size aircraft.

Supply Depots were another part of Maintenance Command, with numerous warehouses, a computer complex at RAF Hendon that controlled how items were issued on demand to users, together with Supply Managers located at Harrogate who managed every conceivable range of kit, including all repairable components and spare parts.

Avionic repair was concentrated at RAF Sealand, at the time the largest avionic repair facility in Europe and the envy of most avionic supply companies. Whilst it began life as an RAF repair factory it soon expanded to include avionic systems for all three Services, well before 'jointery' became fashionable. The simplicity of, what was known as, a Direct Exchange scheme was part of its success: black boxes or other electrical components that failed test on base were loaded on to a dedicated fleet of trucks that called nightly at every base, returning overnight to Sealand and delivering a replacement box the next day. These transactions were completed with minimal paperwork, merely phone calls between technicians at both ends. A fast turn round time became its hallmark.

Unfortunately, there was no similar generic approach for mechanical items, though a RN depot at Almondbank had traditionally

Marshalls have handled the deep servicing of the RAF's Hercules fleet (and those of other air forces) for many years. (ITN News, Anglia)

specialised in helicopter transmissions and was developed as the gearbox repair facility for Chinooks.

For most of this period there were no specialist repair companies within the UK's aerospace industry. Adding repair to a production line for new products rarely works efficiently. Selling *more* components and consumable parts does. Our repair model has been described as one in which we contract for failure – the more spares or repairs we buy, the better the contractors' reward.

Some of the more enlightened manufacturers did have dedicated repair factories; Rolls-Royce had the best example at East Kilbride and a similar facility in Montreal. Clearly, the company understood the commercial value of a repair business to its customers. Dowty also treated repair as a separate activity to production.

Any repair facility depends on access from the Original Equipment Manufacturer (OEM) to repair processes, with piece part spares, tooling and test equipment, as well as skilled technicians. There were many British companies that cooperated with our in-service arrangements. Ferranti, for example, located the sole full bench test rig for the complete Tornado ADV radar at Sealand. Doing that saved the procurement cost of tooling and test rigs and allowed a cooperative approach to system development, paying handsome dividends for

repair over its lifetime. Not surprisingly, international collaborative projects with off shore sub-contractors, were a good deal less cooperative; by using their intellectual property we were denying them a potentially lucrative source of income for the life time of their product.

So what was getting in the way of doing things more smartly?

The way we organised our staff had something to do with it. Looking back on my experience I think the most frustrating issue was our fragmented logistic organisation – divided by parochial Branch politics between Engineers and Suppliers, with no clear, defined aims on cost control or operating efficiencies. At MoD level both Branches remained part of AMSO's organisation, as they had been in 1941. The first recorded study of engineer and supply working practices dates from 1970,[16] closely followed by a wider study looking at a support organisation for the RAF.[17]

A Controller of Engineering and Supply was created under AMSO in the late 1970s. That did kick-start many useful changes, but it took too long to come to fruition.

The practice of separate working locations and separate higher management chains did not help when what was needed was a team approach, working in close proximity so that each could understand the other's problems. At a personal level, a spell at HQ Maintenance Command as Gp Capt Plans with all disciplines sharing a large open office, working closely for a CinC who insisted on cost being part of any decision, taught me that it did not matter what your professional background was. The important thing was to look objectively and constructively at the problem.

The support 'problem' boils down to three important factors:

Availability – which clearly matters on a daily basis in order to produce the number aircraft on the line to meet the flying programme and to satisfy NATO declarations and operations.

Capability – most aircraft types had 'fleets within fleets', so not all aircraft were equally capable and poorly managed modification programmes could easily introduce big safety and support problems with differing configurations.

Sustainability – which is arguably *the* critical component of any

An impressive line-up of Coningsby's Phantoms in the 1970s – but were there enough engines to go around?

fighting force; 'how long can we sustain this tempo of operations?'

Of all the 'illities' these next two are really what drives the *costs* of engineering support.

Reliability – from which most direct maintenance costs are derived, closely allied to . . .

Maintainability – largely dictated by design considerations. How often do we have to inspect or test something and why? What is involved in an engine change, for example?

If one could design for infinite reliability the system would be maintenance free of course – an unlikely goal, but one that every engineer should recognise.

Numerous studies all pointed to massive waste. Allegedly, some 70% of spares for the Lightning were never used! And yet aircraft were regularly AOG for lack of spares. Aircraft availability suffered and was, on a few occasions, dire. Take Coningsby in the days of the Phantom, for instance – No 228 OCU and Nos 6, 41 and 54 Sqns with some 70 airframes on charge yet, when I took up my appointment as OC Eng Wing in 1972, there were only enough Rolls-Royce Spey engines for about 30 aircraft.[18] Re-engining a proven design had definitely been a very costly decision. In the 1980s, when we eventually acquired some second-hand American Phantoms with J79s,

they seemed to fit the bill just as well! Strange goings on in OR?

Industry and customer alike seemed unwilling to grasp the consequences of not designing for reliability or maintainability, issues which we *knew* were key driving factors that determined both costs of ownership and operational availability. In short, we failed to insist on these criteria featuring in design considerations and were procuring aircraft without any serious regard to the costs of ownership.[19] This is an issue that persists to this day. It affected Typhoon on entry into service; at one stage aircraft delivered to Marham straight off the production line were being immediately grounded so that they could be robbed of critical spares. I hope that that has been sorted by now.

There was a school of thought in PE, going back many years, that the answer to all this was to make procurement staffs responsible for all aircraft system support from 'cradle to grave'. There was certainly a study done by AVM Alistair Steedman in 1976 that had addressed the working interface between AFD and the Air Systems Controllerate.[20]

Removing the users from any control over support did not find favour with too many in light blue, but it was an oft repeated proposal nevertheless. As I have already mentioned, numerous initiatives and studies had made the case for varying degrees of radical change over the years to get closer alignment of working between the Engineer and Supply Branches.

My own experience, as the leader of one of these studies, left a deep impression on me, if nobody else. The original study by Air Mshl Sir Alec Morris into creating a Maintenance Executive concluded in February 1984

> 'that decision making for in-service support could be improved by collocating staffs working in EA and Support Management Branch activities with Post Design Staffs in PE and financial representation from F6(Air).'[21]

Few doubted that this change was needed, but it was shelved as other big changes were imminent and, on leaving the RCDS, I was asked, along with AVM Tony Woodford, to revisit Air Mshl Morris's conclusions on which we reported in March 1985.[22] After lengthy study of earlier work, we set out to consult widely and found lots of support for the concept of working in teams with related disciplines to

tackle underlying inefficiencies. Not surprisingly, it was difficult to prove the case for savings beyond head-count reduction, as very little financial information was available to back up our claims. Moreover, the difficulty of wholescale movement of staff to a suitable location was never going to be easy, particularly whilst other big changes were underway in the MoD. Unexpectedly strong support came from the Fleet Air Arm who had just completed a similar piece of work done by PA Management Consultants.[23]

At the time the FAA, and our SAR force, were suffering dire consequences with a shortage of gearboxes for the Sea King helicopter. The RN's operational capability was severely limited with over half of its aircraft grounded. The RN, rightly, demanded urgent action, so, with Ministerial support, supply action demanded replacement gearboxes, which were placed as new contracts with Westland. That decision exacerbated the problems the same factory were having with repairing the same gearboxes on an existing repair contract. The real reason for shortages was unreliability, combined with lengthy turn round times caused by shortages of piece part spares lower down the supply chain. The proper remedy was more piece part spares and quicker repair turn round – *slicker* repair – *not* more *new* gearboxes. Supply action had thus been precisely the wrong solution, as well as being vastly more expensive and with a longer timescale.

Whilst my own study gathered dust like its predecessor, a growing weight of evidence did help us to form Multi-Disciplinary Groups (MDGs) in 1989 to eliminate this sort of daft action.

I am conscious that I have provided no scale to what I have said so far to give you any feel for the complexity of the situation. Support is always about detail, yet getting the context right is important in order to appreciate the magnitude of the task. I have no truly comparative data but I do have a 'pocket brief' note of fleet sizes from my time as AO Eng at HQ STC in 1988-91, a period that included Gulf War I. The figures are at Figure 1.

Strike Command's combined fleet amounted to 935 aircraft and my staffs were also the Engineering Authority for several others, making the overall total 1,107 aircraft, of 28 different types and 64 separate marks. The eagle-eyed may have spotted a few wild cards, notably the stored Nimrod AEW airframes. While not intended as a proper comparison, I think that at this time British Airways had

	Fleet total	On charge to STC
Fast Jet		
Buccaneer	63	63
Canberra	46	46
Harrier	51	51
Hawk	150	85
Hunter	13	11
Jaguar	138	64
Phantom	134	110
Tornado	176	176
Total	**771**	**606**
Tanker		
Hercules	6	6
TriStar	6	6
VC10	9	9
Victor	14	14
Total	**35**	**35**
Helicopters		
Chinook	23	23
Puma	28	28
Sea King	19	19
Wessex	58	58
Total	**128**	**128**

	Fleet total	On charge to STC
MPA		
Nimrod	37	37
Total	**37**	**37**
ATF/Comms		
Andover	17	14
BAe 146	2	2
Hercules	56	56
HS125	12	12
TriStar	3	3
VC10	13	13
Gazelle	5	5
Total	**108**	**105**
Misc		
BBMF	10	10
Vulcan	1	1
Nimrod AEW	11	7
Shackleton	6	6
Total	**28**	**24**
EA/Role Office	**1107**	
STC Fleet		**935**

Fig 1. The aircraft under the overall aegis of HQSTC and those actually on charge to STC units circa 1990.

around 250 aircraft, with far fewer types to contend with.

Each of the EA offices was progressively expanded to include supply specialists working together in MDGs. We were dealing with a big management problem, though I certainly felt optimistic as I knew that, given proper empowerment, there was no lack of talented individuals ready to rise to the challenge. What we lacked was the ability to collocate all the essential functions of engineering, supply, contracts and finance and then to be held fully accountable for our

decisions.

Whilst AMSO was functionally responsible for support, financial responsibility lay elsewhere in the procurement organisation and with AFD finance staff. In pure management terms, an accountable manager must have both functional responsibility *and* financial authority in order to achieve proper accountability. Resolving this impasse proved a difficult nut to crack.

In Michael Heseltine's time as Secretary of State (in the mid-1980s) he had introduced MINIS,[24] a frustrating paper chase to many, aimed at giving him an overview of who did what and where. What it progressively led to though was nothing short of a revolution in financial control. It started a process of changing the budget structure to align with functional responsibility and, in due course, all functional commanders gained Top Level Budgets (TLB) that delegated financial authority from the MoD centre.

Scrutiny of Defence never stands still. Following Operation GRANBY every aspect of in-service support came under ever closer scrutiny. The so-called market testing initiative got back into full swing and RAF Support Command lead the way with the formation of the first Agency, the Maintenance Group Defence Agency under a 2-star Engineer,[25] with a budget in excess of £600M for which he was held directly accountable to the Secretary of State. Agency status gave its Chief Executive flexibility on how he spent his budget allowing innovative ideas to flourish.

Numerous examples soon emerged demonstrating that relatively simple investment could produce big benefits. None were going to resolve defence budgets targets, but it provided evidence that if we could scale things up we could deliver change, and the strange thing was we never heard a complaint from industry. These are a few random examples:

- Repairing Tornado cockpit canopies, rather than returning them to industry, saved £1M in its first year, while turn round time fell to 14 days instead of 7 months.
- Repairing Tornado wing nibs[26] – a item in perennially short supply; they were sent back to industry at a cost of £26,519, compared to £2,852 in-service.

- Repairing £4M worth of Tornado turbine blades that Rolls-Royce said should be scrapped.
- Improving a shaft balancing test rig that enabled full repair of all modules of the Adour engine for the Jaguar and Hawk fleets instead of sending them to industry.

Supply Depots came under close scrutiny too; many were full of obsolete aircraft spares – thirteen Canberra mainplanes, for example. Each range of spares displayed a placard recording when the last issue had taken place – in some cases 20, 30 or 40 years ago. Supply staff had done their stock taking efficiently, but few had asked the right questions. The resulting fundamental study, to define the structure, location and resourcing of all our Supply Depots, revealed that it could all fit into one, RAF Stafford. One further problem remained – how to get rid of mountains of obsolete stock. The answer was to invite industry to take it away, sell it and keep 70% of the value. It worked.

SAC (T) Kerry McStea, working on an Adour engine.

The badge of RAF Logistics Command, which was formed on 1 April 1994.

All of this innovation was a wonderful advertisement for the merits of being an 'Intelligent Customer'. It starts with corporate knowledge from the CSDE, flowed from the MDGs and from being trusted with a degree of financial control in the first Defence Agency. Happily, these and other examples, demonstrated to those *not* in the support business things that most of my ilk had suspected for a very long time.

'Options for Change' and the 'Prospect Study' led to a tri-Service agreement that each Service would move to a similar organisation and in so doing rusticate each of the Principal Administrative Officers (PAOs) – Chief of Fleet Support for the Navy,[27] Quartermaster General for the Army,[28] and AMSO for the RAF – to form three new Commander-in-Chief appointments.

Forming Logistics Command was long overdue, the first significant change to managing support since Maintenance Command was created in 1937.

As I moved from being the last AMSO[29] to taking command in 1994 as the first CinC of Logistics Command,[30] Air Member for Logistics and Chief Engineer I relished the chance to implement real change and was very fortunate to lead so many outstanding people who showed what was possible.

The figures were revealing. My Top Level Budget showed that we spent £1·2 billion per year in industry on spares and repairs, a figure that *excluded* Tornado which was still under PE project management at the time.

We had a growing spares inventory valued at some £5 billion.

Approximately 60% of our total RAF budget of about £5 billion – for running the whole Service – could be attributed to support costs of manpower and materiel. If you excluded the new procurement slice of our expenditure, the RAF would have been the eleventh largest company in the UK. Based on support costs alone, we spent more than

any other UK company on support activities.

An affordable air force depends on controlling the cost of **support** as well as the cost of **acquisition**. Achieving cost saving by continually reducing front line numbers is not the only answer.

Quite why the MoD decided, before we had barely let the paint dry, to abandon the single-service focus for a joint service Defence Logistics Organisation is for others to explain.

Support does matter**,** I hope the procurement system of the day has learned.

Notes:

[1] *RAF Historical Society Journal No 35*, 2005.

[2] Dye, P; 'Logistics of Air Power – A Failure of Doctrine?' in *RAF Air Power Review, Vol 2, No 1*, Spring 1999, pp85-86.

[3] Total uniformed strength was over a million; 1,181,813 personnel.

[4] Total uniformed strength was 89,685 personnel.

[5] Sources inevitably vary, not least because numbers fluctuated over time, but 12 Jaguars, 50 Tornado GR1/1As, 18 Tornado F3s, 12 Buccaneers, 17 Chinooks, 19 Pumas, 3 Nimrods, 7 Hercules plus Victor, VC10 and TriStar tankers being deployed in-theatre will not be far off, along with (including those based in Cyprus) some 7,000 RAF personnel.

[6] CD1131. *The Second World War 1939-1945 Royal Air Force – Maintenance*, originally issued as a CONFIDENTIAL document by the Air Ministry (AHB) in 1954 but subsequently published by the MoD in March 1966 in an UNCLASSIFIED edition as AP3397.

[7] The establishment of a Stores Branch was announced by Air Ministry Weekly Order 1158/1919 dated 21 October. Air Ministry Order 428/1930 dated 8 July changed the name to Equipment Branch although, curiously, it was December 1936 before this began to be reflected in the Air Force List. The change to Supply Branch was announced by DCI(RAF) S110 dated 1 July 1970.

[8] The creation of a Technical Branch having been approved in July 1939, it was eventually established on the authority of Air Ministry Order A.228/1940 of 22 April. In the closing months of the war the situation was reviewed and it was decided to retain the branch in the peacetime air force, this decision being announced by A.1026/1946 of 12 December. The Technical Branch was reconstituted as the Engineer Branch with effect from 1 October 1966 on the authority of DCI(RAF) S159 of 29 September.

[9] Harrier GR3 Life Cycle Engineering Costs, HE/Q5301/800 dated May 1984.

[10] Hawk T Mk 1 Life Cycle Engineering Costs, HE/Q5301/100 dated August 1984.

[11] House of Commons HC481; report by the Comptroller and Auditor General: Ministry of Defence: Maintenance of Major RAF Equipments; HMSO, June 1984.

[12] House of Commons HC39; first report from the Committee of Public Accounts. Session 1984-85: Maintenance of Major RAF Equipments. Ministry of Defence. November 1984.

[13] Exeter University's innovative Centre for Management of Industrial Reliability, Cost and Effectiveness, led by the redoubtable Dr Jezdimir Knezevic since 1988, had produced the academic study in UK of the impact of unreliability.

[14] Commissioned into the A&SD Branch in January 1940, Hunter-Tod transferred to the new Technical Branch in April where he specialised in signals. He flew operationally, was awarded the Battle of Britain clasp and, in 1941, he participated in two successful engagements while flying with OC 25 Sqn, Wg Cdr David Atcherly, and qualified for the new RO flying badge. In the early post-war years, he was one of a select band of officers involved in the development of the first British atomic bomb; he eventually retired in 1973.

[15] TNA AIR 20/12521. REWH/MRO/01 dated 30 May 1973; 'Review of management of repairs and overhaul in RAF: the Harland Report'.

[16] TNA AIR 20/12459. AF/AMSO/EEWP/3 dated 26 June 1970; 'Engineer And Equipment Branches Working Party Report'.

[17] TNA AIR 20/12416. AF/SOFT/200 dated December 1972; 'Support Organisation for RAF: Report'.

[18] HP2 turbine blade failures and incomplete development work on intake matching were the culprits.

[19] *TSR 2, With Hindsight*; ISBN 0-9519824 8 6; RAF Historical Society, 1998. See p164 (or 170 in the on-line edition) where Jim Cole (formally of Vickers Armstrong and at the time with EASAMS) noted that '. . . the real killer for TSR2 would have been the problem of MTBF [*which was*] measured in minutes [*and*] great maintenance problems would have ensued [*because*] the concept had been technologically ahead of its time.'

[20] TNA AIR 20/12680. AF/22/20/4, Vol 1; 'Formation of Controllerate of Engineering and Supply', 1 Jan 73-31 Dec 76.

[21] A Maintenance Executive for the Royal Air Force, the Morris Report, by Air Mshl Sir Alec Morris – D/MEST/31 dated February 1984.

[22] A Study of the Proposals for a Maintenance Executive for the Royal Air Force, 'The Alcock Report' by AVM R J M Alcock, D/MEST/32 dated March 1985.

[23] Recollections of DGAN, Rear Admiral Mike Simpson CBE RN in an unpublished memoir – *The View from Below*, a memoir of an Aircraft Artificer 4th Class 1949/51.

[24] Ministerial Information System.

[25] Air Vice-Marshal D R French.

[26] The Tornado's wing nibs (in effect 'gloves') are the highly swept, fixed sections of the inboard wings that house the wing pivots.

[27] Vice Admiral Toby Freer.

[28] Lt General Willy Rouse.

[29] AMSO post created 1936.

[30] Formed on 1 April 1994.

ACQUISITION EXPERIENCES FROM THE PAST – AND LESSONS LEARNED

AVM Graham Williams

Commissioned in 1957, Graham Williams flew, mainly, Hunters, Harriers and Jaguars in the UK, Middle East and Germany including command of No 3 Sqn and RAF Brüggen. An ETPS graduate in 1966, he joined the early Harrier test programme before becoming the project pilot for the Spey Phantom; he later undertook the first operational assessment of the Jaguar and in 1983 he was appointed Commandant of the A&AEE. From 1986 he was at the MoD, ultimately as ACDS OR(Air) but, after a final year as Commandant General of the RAF Regiment, he left the Service in 1991 to become a defence consultant before joining Loral, later Lockheed-Martin, with responsibility for the latter's air systems programmes in the UK until 2005.

In my time in the RAF, I had experience of a fairly large number of acquisition programmes in a number of different roles, first as a test pilot (tp), and subsequently as Commandant, at Boscombe Down, then four years in operational requirements at the MoD. These covered some interesting times from 1966 to 1970, and then 1983 to 1990.

When you went to A&AEE in the 1960s you could be lucky or unlucky when it came to new aircraft. Sometimes you could do three years there and not really see a new programme. But I was lucky. In my time we had three new programmes – the F-4K/M Phantom, the Harrier and the Jaguar. My first bad experience was with the F-4K. If I remember correctly, I think that the aircraft was primarily acquired to replace the ageing Sea Vixen when CVA-01 was in vogue. In my lowly position as a tp, I was not privy to the whys and wherefores of the programme. But I was aware that Rolls-Royce had made some pretty extravagant claims about what the Spey engine would do for the aircraft in terms of thrust and vastly improved range. Why anyone would want to go through the expense of fitting a new engine when the aircraft performed more than adequately with the J79 was beyond

The test team for the British Phantom (the aeroplane is XT595, the first YF-4K); L-R: Dennis Sharpe, the trials engineer; Lt Dick Searle, a FAA back-seater, and Flt Lt Graham Williams.

me. But RR had persuaded the politicians that it was a wise thing to do. Personally speaking, I thought that it was plain stupid.

I was despatched to Edwards AFB to do some single-engine performance testing with McDonnell Douglas – MacDac for short. In the background to the accompanying photograph of the test team is the prototype F-4K, named, by the company, as 'Wally the Whale'. Why? I discovered that on my first trip. It had one of the nastiest little Dutch rolls all the way down the approach which I initially thought was due to my incompetence but, I discovered at the debriefing with the MacDac pilots, that it had existed from its first flight and they had never been able to cure it. Fortunately, it was only on this particular aircraft and not on the subsequent F-4K/Ms.

However, that was not the major problem. Every time I lined up on the runway for take-off and engaged the afterburner, I got more flames out of the front of the engine than the back! Being a highly trained tp, I could tell that this was not right and I taxied back in. This happened on numerous occasions and, if I remember correctly, MacDac had to change engines four or five times before we got it to work properly. Meanwhile Dick Searle and I were piggies in the middle with RR on one side of the room and MacDac on the other, each blaming the other, RR saying it was an intake problem and MacDac saying it was

Having joined the A&AEE fleet in 1968, Harrier XV741, was used for the 1969 Transatlantic Air Race and, by the author, for hot weather trials and demonstration flights in the USA in 1970. Subsequently brought up to current GR1 standard, it became Wg Cdr William's personal aircraft as OC 3 Sqn.

an engine problem. Personally speaking, I tended towards MacDac as I thought it was a result of the catalyst lighting system for the afterburner which took a finite time to react, as against the hot shot system in the J79. But what did I know? And, of course, the performance of the F-4K was well down on the US variants, both in terms of top speed and fuel consumption. You only had to look at the intakes to figure out why – the F-4K's were twice the size of the intakes on a J79 variant, with the consequent effect on drag. So we spent all that money for no good reason so that the politicians could claim that they had acted in the interest of UK industry – money that we in the MoD could ill afford. Lesson number one – when you have a good airframe/engine match, don't mess about with it.

It is interesting to note that one aircraft that we did not have much trouble with, as far as I can recollect, was the Harrier, especially as it was such a new and revolutionary concept. The one aspect I do remember was testing the INAS. We had one aircraft that was set up for testing the navigation aspects and another that was used mainly for weapon aiming. When it came to rocketing with the SNEB rocket, the system was so good that we seemed hardly able to miss the target. But when it went into service it was a complete dog's dinner and the service pilots couldn't hit a barn door; so they had to resort to manual weapon aiming for quite some time before it was sorted out. I have never really understood why this happened. My theory was that,

because we had an aircraft system set up purely for weapon aiming, which was obviously specially tweaked as we tested each particular aspect, it worked well. But if you had a total system that had to be capable of all aspects, somehow all the amps and volts got all confused and it could do nothing.

Whilst I was at Boscombe all the Jaguar testing was done at Istres and our resident pilot at the time was Robin Hargreaves. My only involvement was to undertake the first so-called operational assessment. I was told on a number of occasions that it had a superb low level ride and went a long way. When I first flew it I realised that this was a euphemism for no wing, no thrust and wouldn't turn worth a damn. I know of no fighter pilot worth his salt who is not prepared to put up with a bumpy ride if it means that you have a wing, that wonder aid to manoeuvrability.

In one of my post-flight debriefs to a gathered throng of engineers, I criticised the Jaguar's fuel system saying that if I met the guy who designed it, I would cheerfully wring his neck – and a little voice from the back of the room said, 'It was me, Sir'. I did not realise quite how perceptive my comment had been because, when I was at Brüggen some years later, we had a rule which said that if you had a fuel system problem, don't try and fix it in the air; put the aircraft on the ground at the nearest airfield and *then* think about it. We had several instances of pilots getting deeper into trouble by trying to take the recommended emergency actions when something went wrong.

After four years at Boscombe, I then went off back to the real world and did not get back into the test world until 1983 when, after a short tour as CO Experimental Flying at Farnborough, I became Commandant of the A&AEE. I was, of course, more concerned with the mechanics of running the establishment than with the actual test flying. One programme that I did get involved in, albeit in only a small way, was the assessment of the three contenders for the basic training aircraft, the Tucano, the PC-9 and the Firecracker. There was no doubt which was most fun to fly and that was the Firecracker. It was very light with a pretty powerful engine and a good performance. But the engineering was appalling and it did have one or two quirks such as flicking into an inverted spin when you recovered from an upright spin. Inverted spinning is not to be recommended at the best of times and it certainly got my attention. Quite what it would have done

The NDN-1T Firecracker had certain characteristics that precluded its use as an RAF basic trainer. Nevertheless, this one (of three built) found long-term employment in the USA, latterly with the International Flight Test Institute at Mojave, CA.

to the ab initio student is beyond my imagination, and there was no doubt which was the preferred option – the PC-9.

However, the Tucano was fairly close to the PC-9 and it was a well-engineered aircraft. There was, therefore, no overriding reason why the Tucano could *not* be selected and, as I understand it, the decision to go with the Tucano was made primarily on political grounds, as it was deemed advantageous to be seen to be nice to South America after the Falklands. And then another political industrial decision was made and the production contract was given to Shorts to support Northern Ireland. The aircraft was extensively modified for RAF service and again, as I understand it, Shorts did not make too good a job of this and reliability and maintainability suffered. So politics ensured that we did not get the best solution.

My time at Boscombe came to an end and I was posted to the MoD as DOR2 to take over from Roger Austin. DOR2's responsibilities covered, in the main, what I would describe as 'bleeps and squeaks and air defence'; in fact all the items that I understood least. Not long after arriving, AVM Mike Adams, who was ACDS (OR)Air, called me in and said that Controller Aircraft (CA – Air Mshl Sir David Harcourt-Smith) wanted to see me, as he had a little job that needed

Never the RAF's favoured solution, over £1 billion was spent on the Nimrod AEW 3 project before it was abandoned. (BAE Systems)

doing. That little job was to put a team together to conduct a technical assessment of the Nimrod AEW – which was currently in deep trouble in its development programme – against the Boeing E-3A. Talk about drawing the short straw! There were two problems; first it was difficult to persuade Boeing that we were serious and they were not being used as a stalking horse for GEC and BAe; and secondly, finding radar specialists who were not part of RSRE who were, of course, one of the main protagonists of the Nimrod's AEW system.

So I returned to my old roots at the A&AEE and I recruited Tom Coldwell, who was the Superintendent of Nav & Radio at Boscombe, to lead the technical team and a number of other worthies from around the bazaars, avoiding anyone from RSRE. However, you did not need to be a rocket scientist, or even a radar specialist, to know that all was not well with the programme – and that is a slight understatement. It was during all this turmoil that the PM, Maggie Thatcher, sent me a copy of a letter, without any comment, that she had received from Lord Weinstock complaining about my behaviour and that of one of my flight lieutenants. It all came to a head one Sunday evening when CA called a meeting with the main players in MoD when, despite the best efforts of the head of RSRE, the decision was taken to recommend binning the programme and to go ahead with acquiring the E-3.

I am aware that the RAF had always preferred the E-3 solution, it being seen as a lower risk programme, already working and also in

service with NATO. But this was another programme where both politics and UK industry persuaded the system that it would be better to go for a unique UK solution. So, we wasted over £1 billion trying to reinvent the wheel before it became obvious that it was not going to work.

Not long after that event, I was promoted and found myself in the office of ACDS (OR)Air and one of the first things that happened was that I was invited to lunch with Arnold Weinstock in his eyrie at Stanhope Gate, I assumed, to make peace. He said that there was one thing he regretted doing during the Nimrod AEW affair and that was writing to the PM to complain about one of my flight lieutenants. Obviously, in his mind, I was fair game, but a junior flight lieutenants was not! In fact, I liked Arnold. He was a charming man and very good company. He must have turned over in his grave at what his successors did to GEC.

However, let me move on. Apart from getting the requirement for the E-3s through the Equipment Procurement Committee (EPC) which was one of my first major programmes, the other programme which was my main priority in my time in MoD was the Typhoon. Let me look back through history for a moment. It took two years from inception to in service for the SE5, six years for the Spitfire, eight years for the Hunter, and only ten years for the Harrier – which, I think, was pretty good, considering that not only was it a totally new aircraft, it was a totally new concept. I was never involved in any way with the Tornado and I would not claim to be an expert. However, after all the problems with the TSR2 and F-111, I could never understand why we went for that rather than develop the Buccaneer 2*. The Buccaneer was an excellent airframe/engine combination with a bomb bay; it just needed much better avionics and would have outperformed the Tornado by miles. The Buccaneer's main disadvantage, from an RAF point of view was that it was primarily a naval aircraft and also subsonic. People seem to forget that as soon as you hang stores on an airplane it becomes subsonic in any case. The Tornado was yet another collaborative programme with too many compromises on the grounds of European politics. And that brings me to the Typhoon.

Typhoon's roots go back to AST 403 and the history of the project is as follows:

Ten years from concept to this – XV741 operating from a coal yard at St Pancras for the 1969 Transatlantic Air Race.

1971 – Identification of the need for a new aircraft
1972 – AST 403 issued
1979 – the European Combat Fighter (ECF) proposal which became the European Combat Aircraft (ECA)
1981 – ECA collapses
1982 – the Agile Combat Aircraft (ACA) programme arises from the dust (UK, Germany, Italy)
1983 – the Experimental Aircraft Programme (EAP) is born
1983 – the Future European Fighter Aircraft (FEFA) is born (UK, Germany, France, Italy, Spain)
1984 – France causes dissension in the ranks by demanding leadership of the programme
1985 – the European Fighter Aircraft (EFA) is born (UK, Germany, Italy, Spain)
1986 – EAP rolled out
1986 – Eurofighter formed, numbers requirements UK 250, Germany 250, Italy 165, Spain 100; workshare in proportion to numbers
1988 – Programme approved by EPC
1994 – First flight
2006 – First UK operational Squadron No 3(F) Sqn!

The Typhoon – twenty-five years from concept to becoming operational.

That is, roughly speaking, 25 years from inception to in-service. And it is hardly surprising that requirements might change over such a long period as, indeed, the threat changes. The French were impossible to deal with, and the Germans extremely difficult. Indeed, most of the programme delays, after the French had pulled out, were due to German budgetary or industrial problems. Typhoon started out life as an air defence and air superiority fighter and is now more of a multi-role combat aircraft, reflecting the need of the times. And then there is the cost of keeping all those people employed over the period because, no doubt about it, ***time is money***.

I always think the best example of this is the Urgent Operational Requirement (UOR). Many UORs are completed in weeks rather than months or years and at very reasonable cost; because there is only so much you can be charged for work over a short period. And then there is the bureaucracy of the whole procurement process. Papers are written and pushed around the MoD for comments and some people seem to regard them as a challenge to their virility. If they can't find something wrong, even if it is just the grammar, spelling or sentence construction, they are deemed to have been a failure. I exaggerate of course but it does seem like that at times. National programmes are bad enough. But collaborative ones are even worse, because the problems increase exponentially with the number of countries involved. And, inevitably, there are many compromises that have to be made along the way. The only plus point of collaborative programmes

is that they are difficult to get out of. But I do not think that at the end of the day you save a lot of money.

So now we come to the C-130J. Because it looked very similar to its predecessor everyone just assumed that it was a development of the same aircraft and would be very little trouble. But it was almost a new aircraft and suffered the development problems that usually – but not always – afflict such aircraft. We probably should have known better and if it had been a home-grown item, it would probably not have been so hard to bear. However, problems with the C-130J were put into the shade compared to problems with the A400M. I am afraid that I fail to understand why the RAF needs three different transport aircraft – the C-17, the C-130 and the A400M – and a tanker/transport aircraft. Seems a bit extravagant to me, especially when it comes to maintenance. I appreciate that the A400M carries a much bigger load than the C-130 – but not as much as the C-17. With an equipment budget that is always hard up for money, to have three or four different transport aircraft is somewhat excessive. But that's politics for you.

And the last programme which I would like to mention is the Nimrod MRA4. I was only involved on the periphery of this when I was with Lockheed-Martin. We were offering two proposals, one for refurbished P-3s and the other for new-build P-3s, and the third proposal, from BAe, was for the Nimrod MRA4. I tried to persuade Lockheed-Martin not to bid, as I thought it was going to be a shoo-in for the Nimrod. Having said that, how anyone could believe the BAe bid, of about £1bn if I remember correctly, was beyond my comprehension. What was being proposed was a complete rebuild, re-engine of the original Nimrods which, of course, were originally Comet airframes. So here we are intending to rebuild 50-year-old airframes to fulfil a very specialist requirement – and we wouldn't have any extra airframes to sell to anyone else. Now, if like me, you have ever ventured in to the business of refurbishing classic cars, there are two things you can be sure of. First, take any estimate for the job and *at least* double it to get the final cost. Secondly, if it is performance you are after, it is far more cost effective to buy new – you'll get a much better fuel consumption, superior acceleration and top speed and infinitely better reliability and comfort. I can only assume that the acceptance of the BAe bid was influenced by politics

and industrial considerations. Had we not learned anything from the Nimrod AEW?

So where does that leave us? I am a pragmatist at heart and understand the political and industrial realities. But I do wish, somewhat in vain, that the politicians would take some of the responsibility for their decisions and not try to blame the Services and officials for their incompetence. So now I come to 'GW's rools for Procurement':

- Try to keep politics and the politicians out of it – easier said than done – probably impossible. So-called 'national interests' often are not – they are more akin to self-interest on behalf of certain parties.
- Remember, ***time is money*** wherever you are with a programme.
- Try not to get buried in the bureaucratic process.
- Avoid international collaborative programmes if at all possible. Remember – problems accrue exponentially in relation to the number of partners involved. It is like trying to pin jelly to a wall.
- If you want cheap – and often cost-effective – buy off the shelf wherever possible.
- Do not continue with a programme when common sense tells you it is a bust.
- Do not fiddle around with a good aircraft (or system) for no good reason.
- And remember (again) ***time is money***.

I regret to say that I have no idea how the system has changed since my time or whether it has changed in any significant way. I hope it has but I suspect that the same problems remain.

DISCUSSION

During the morning, some discussion took place piecemeal after the reading of individual papers. For convenience, however, these contributions have been presented here at the beginning of the conventional end-of-afternoon session. **Ed**

Clive Radley. I don't have a question, but I would like to make two points. First, there is a problem with both the armed services and the civil service in that high flyers tend to move through the system very quickly and, being dominant personalities, they often succeed in making changes to programmes. But they then move on, before they have had time to follow through, with the result that they leave a mess behind them. This problem can be compounded if the successor is another high-flyer who changes direction again!

There is another problem. I believe that the situation may have improved lately, but in the past meetings used to be attended by large numbers of people who had absolutely nothing to contribute and were only there because their bosses wanted to know what was going on. I used to work for EASAMS,[1] and I was astounded when I had to attend MoD meetings in company with dozens of civil servants who just said the same things every time. Their only real contribution, if they made one at all, was to slow progress. So, my point is that the structure of project management needs to be much more tightly controlled.

My second point concerns Chevaline. Mr Healey, wasn't in the picture. Wilson knew that he would be against it, so he was excluded from the meetings, and not informed about it.

Sir Peter Norriss. I will pass the second point to my right, but I can only agree with you over management. There is far too much 'churn'; far too little continuity – and the problem is not confined to the MoD, of course; it happens in other Departments too. Furthermore, if there is a difficult decision to be made, no one will take the responsibility of making it so, instead, a sub-committee is set up to study the problem. As a result, a problem can recycle endlessly with no progress being made. I'm sure that it must still go on but, that said, I'm not really sure how to change it . . .

[1] EA Space and Advanced Military Systems (the EA stood for Elliott Automation, but it was never spelled out).

Dr Alastair Noble. Chevaline? Yes, I believe that that's right. Both the Heath and Wilson Cabinets dealt with the issue on the basis of very restricted access. Wilson certainly mistrusted some of his colleagues and Healey, who as Chancellor of the Exchequer at the time, would have to pay for it, could be expected to oppose the project anyway.

Sir Michael Alcock. Alastair, you made some reference to MINIS (Ministerial Information System). Are you pursuing that in some depth, because I believe that MINIS – or what came out of it – provides an insight into the way in which the whole system worked.

Noble. The short answer is, no, not yet. I just haven't got there yet, but I will be reading into it, and the influence of Heseltine in due course. I know that he had already used MINIS at the Environment Department.

Alcock. I raise this because I think it is very important. I was in the MoD when Heseltine introduced his 'Ministerial Information System'. It was a completely paper-driven exercise and most people thought it was a pain in the butt, but it did serve to expose the Byzantine workings of the Ministry, which few people really understood. What came out of it, in the end, was a very significant change to the budget structure. 'Top Level Budgets' were rapidly introduced because Heseltine insisted that, if you could be held accountable for something, then you must be given both functional responsibility *and* financial authority – neither of which had we ever had in the past. That was a game changer – although I'm not sure what difference it has made in the long term . . .

Radley. Sir Donald, your account of the way in which the Tornado was developed, as a collaborative project, was interesting, but it gave the impression that BAe were the UK prime contractor for both the airframe and the avionic system. That wasn't the case. The company I worked for from 1968 to 1994, EASAMS, conducted, through MoD, the initial feasibility studies for the avionic system for the strike variant. This led to EASAMS eventually becoming the lead contractor and the Avionic Systems Integration Rig was located at our Lyon Way site. At our offices in Camberley, we had an international team with all the countries represented, but EASAMS answered to NAMMA and

reported to them directly; they did not report via BAe. Much the same happened with the Tornado ADV. All the software was developed and tested on our rig and I recall visitors from MoD coming to see it from time to time. At its peak, EASAMS had 170 staff working on the ADV.

Finally, the Hawk. The Hawk was designed and developed at Kingston – by the old Hawker team; it wasn't BAe. It was brought in on time and within budget. Things didn't start to go wrong, in the general context of procurement, until BAe became the prime contractor, closed the Kingston factory and moved everything up north. BAe initially tried to sell itself as a 'systems company' which they simply weren't. It took them years to learn how to do 'systems' and all of the initial work in that field was actually delivered by EASAMs. My point is that, at the time that the Tornado and Hawk were being designed, BAe were a platform manufacturer; they did not have a systems integration capability.

Sir Donald Spiers. Yes, but I was focusing on the relationships between MoD and their prime contractors, rather than what was going on at a subordinate level within the aerospace industry.

Gp Capt Jock Heron. The five international systems that Healey was responsible for – AFVG, Jaguar, Puma, Gazelle and Lynx – were all of considerable advantage to the French. The Jaguar, I would dare to suggest, was a bit of a waste of space in the RAF; BAe were to have run the AFVG programme, but Dassault threw their toys out of the cot and we were pilloried over that – and of the helicopters, although they were built in the UK, we eventually took 203 French-designed Gazelles and 48 French Pumas whereas the French navy took just 26 British Lynx – an order for the French army was cancelled! So, on balance, I think that the French did rather well out of the Healey/Messmer collaboration.

Chris Pocock. Sir Peter, I was intrigued by your referenced to 'Black Programmes' in association with the DOD. Could you perhaps enlarge on that? – specifically which British – or collaborative – black programmes?

Sir Peter Norriss. It was a weapons programme – MSOWB in my time. It was a multi-lateral missile programme involving a number of

other European countries. But the US were running their own projects in the background, so the multilateral project never came to anything. There were others, including a satellite project, if memory serves. But my point, was that it pays to be wary of *multi*-lateral programmes with the US, although bilateral arrangements have, I think, tended to work reasonably well.

Pocock. For Prof Gray. I wasn't aware that the UK didn't fully endorse the European Staff Target for what became the A400. Could you say a little more about that?

Prof Iain Gray. My understanding is that when the UK withdrew from the Euroflag programme. It retained an observer status within, what was known as, the FLA Executive Group. As a result, when, in 1993, the time came to endorse the Staff Target formally, since the UK no longer had a seat at the table, it could not be a signatory; although there was still a UK requirement that sat alongside the European one. Others in the room may be able to comment – from an MoD perspective perhaps?

Norriss. My recollection is that, the UK was no longer in a position to influence the project, although we kept in touch as an 'observer'.

Air Cdre Bill Tyack. I was DOR(Air) when we made the decision to buy the C-130J and, at the same time, to join what became the A400M programme – and my staff wrote the requirement for it. In essence, we, the UK, led the drafting of what amounted to an RAF staff requirement. So, in effect, from the point at which a paper concept became a firm project, the UK played a leading role in defining the outcome.

Norriss. I recall something similar happening in my time. The RAF was looking to establish a helicopter fleet involving the Chinook and a lighter support aircraft – a replacement for, at the time, the Puma. An Air Staff Target, and I think, Requirement, was drafted and that eventually materialised, in effect, as the NH-90. But we were unable to run with that, because the MoD had been hung on the hook by the politicians and we were obliged to go down the EH-101 route. So, we finished up with Chinook, Merlin *and* Puma – three types, instead of two.

Gray. The point that I wanted to get across in discussing the FLA/A400 project were the long-term, strategic, implications in the context of industrial workshare. I think that the UK lost out significantly when it declined to join in a game that other European nations were playing.

Air Cdre Martin Palmer. You discussed the influence of government on the FLA project but the picture was rather more complicated as a result of industrial considerations, notably Dick Evans' reorienting of BAE Systems away from the civil market to focus on the military. Government would presumably have had a view on the implications of that development which could have had a knock-on impact on the A400. Do you have any thoughts on that?

Gray. Going right back to the 1960s, the UK had programmes in both civil and defence aerospace, but they tended to work in isolation. There were opportunities to bring the two sides together, but they were missed – and that is where, I think, we missed a trick with the Large Transport Aircraft agenda. As it was, and as I think you perhaps implied, in 2000 BAE Systems divested itself of its share in Airbus and effectively struck out on its own. If you talk to some of the other partners in Airbus, you will find that, while they can just about accept why BAE might have wished to do that – from a shareholder point of view – they simply cannot understand why the Government ever permitted it to happen.

Palmer. Did the Government allow it to happen? – or, because of the industrial strategy of giving independence to industry, was it perhaps unable to prevent it?

Gray. My view is that there was a total lack of *any* industrial strategy at the time.

Gp Capt Andy Tait. Still serving at Abbey Wood, but once upon a time, when Sir Peter was Station Commander at Marham, I was one of his most junior and insignificant engineer officers. (*Laughter.*)

Sir Michael – you set out the case for the RAF's having an in-house engineering and support organisation, and how good we got at it. Speaking as a former CSDE staff officer, I would certainly endorse that. But you also explained how that incentivised industry to sell us unreliable kit and so the pendulum has swung. So – a three-part

question: do you think the pendulum has swung too far; how easy is it to maintain the balance, and is there a point of no return?

Sir Michael Alcock. Well, bear in mind that I haven't had to deal with the kind of technology that we are seeing now, which has a much greater degree of reliability. We are, for instance, much more likely to be using equipment that has a built-in self-test facility – kit that tells you, as soon as you switch it on, whether it is going to work or not. There has, undoubtedly, been a quantum change in the degree of reliability and that will have largely overcome the concerns that characterised the 1960s, '70s and '80s.

Have we reached the point of no return? I don't know, but I hope not. Because, unless you really *understand* the engineering of the system that you are buying you are probably going to run into trouble once it is in service. So, for that reason alone, the point of no return must still be some way in the future. It just won't do simply to buy something off the shelf – it is essential that you know *exactly* what it is that you are being sold. There is no *Which* to tell to tell us which is the 'Best Buy' – so we have to be intelligent customers, and that means understanding the engineering. In the past we have wasted scads of money by believing what we were told by industry.

For example, a few minutes ago Graham Williams was telling us what he *really* thought of the Phantom. It was a brilliant machine but, at the same time, it was a ridiculous machine. It had fundamental handing problems that were never really sorted out, and we stuck an engine in it that never worked properly. Why did we have such problems with the HP turbine blades? The air force had actually funded the R&D programme to produce the 'directionally solidified blades' that were supposed to be the answer to a maiden's prayer. They weren't – they were selling us something that had been inadequately tested and didn't work. Graham described more flames coming out of the front than the back in the early days. That was still happening in squadron service! Pilots were just told to get used to it! The Rolls-Royce rep at Coningsby was beside himself; he knew exactly what was wrong. During the development programme we hadn't measured the appropriate parameters on the engine and the intake so the engine and intake were never going to match. Surprise, surprise, it didn't like it so, every now and again, you got a dramatic

surge. Then again why did it have blown flaps? We were forever changing leaking air ducts – potentially a very dangerous snag. Eventually, we blanked them off. Nobody complained, it worked just as well! (*Laughter*.)

Rob Day. I teach software engineering (at Jönköping University in Sweden) and I wonder how much software has changed the dynamics of procurement, and indeed maintenance.

Norriss. Enormously, in one word. Who would care to take this one on?

Alcock. Again, my experience in this field predates today's technology but, even so, I learned a fundamental lesson about software – in the context of developing the programmes associated with the introduction of Tornado. The question was, who was going to do it? Industry or the RAF? Indeed, was it even necessary for air force people to understand software at all? The answer is pretty much the same as the message I preached earlier about needing to understand the engineering of equipment. If you are not *directly* involved in the development of software you *will* get it wrong. The early days of Tornado were plagued by patches which caused other problems which required more patches, partly because remedial work was being done in isolated groups with too little integration, and with minimal user input – other than to flag up problems. We did rather better with the Nimrod Mk 2, with navigators, who would actually be using the kit, involved in its development.

Norriss. There is another, rather sinister, aspect to the acquisition of sophisticated software. If you are *not* an intelligent customer and you are 'buying off the shelf' how can you know what is in the system that you are buying? Could someone else take control of your device or system? – or deny you the use of it? That is a significant risk today, and you need to be able to protect yourself against it. A case in point arose when we were integrating AMRAAM onto the Sea Harrier. We did it in the USA using a full-scale ground-based rig that could accommodate the whole aircraft with the missile attached. We discovered things about AMRAAM that the Americans certainly hadn't told us about, although it is quite possible that they may not have known themselves. Why? Because, when it comes to testing, we

look to explore the corners of the envelope, whereas the Americans often appear more interested in shooting for the middle of it as that keeps the funding flowing. As a result, we found a number of limitations on the missile but I still don't know whether, or not, the Americans actually knew about them. But my point, is that the cyber aspect is now a real issue and you have to maintain your intellectual edge so that you fully understand the technology that you are employing – and can thus appreciate its limitations – and its vulnerabilities.

CHAIRMAN'S CLOSING REMARKS

Air Mshl Sir Peter Norriss

We have covered the agenda of policy and organisational changes affecting the RAF in the Cold War, and a bit outside it, and we have heard: a number of tales of political involvement, good and bad; about collaborative projects that made it into service or fell by the wayside; accounts of the impact of policy changes on capability and on industry; and some lessons that may, or may not, have been learnt.

Some of my views, and perhaps prejudices, have been reinforced today:

- We need to be careful about believing the conclusions of vested interests.
- Insufficient weight was, and probably continues to be, attached to including exportability in requirements.
- We need to be careful about the terms on which we embark on collaborative projects.
- Maintaining intelligent technology competence is crucial.
- The industrial ramifications of procurement decisions are not as fully understood by MoD decision-makers as they should be.
- Engineering support has changed dramatically from one of supporting the design to one of designing for support.
- Reliability has developed from being a maintenance issue to a performance attribute.
- It is important for budgetary responsibility to be vested in those with functional responsibility.
- There is still inadequate training of RAF staff going into requirement and procurement posts.
- There is too much 'churn' among military and civil service staff in procurement posts.
- The RAF needs to have the means of managing the support risks that might result from contractor bankruptcies, strikes or spares shortages.

I leave you with one last thought: in 1991, at the end of the First Gulf War, the RAF had 35 combat air squadrons. It now has only seven, going down to six . . .

Our thanks go to the speakers, to the organisers and, of course, to you, the attendees, for coming along and participating today. I hope you have enjoyed the event, and I wish you all a safe homeward journey.

PROCUREMENT

James Hamilton-Paterson

> 'The higher up decisions are made, the worse they are likely to be. The higher up money is spent, the more likely it is to be wasted.' – Sir Antony Jay, co-writer of *Yes, Minister*.[1]

The fundamental object of defence procurement is to furnish the armed forces with the best equipment available for a given budget and within a certain time in order to defend the realm for the foreseeable future. That is how the taxpayer understands it. Since the taxpayer foots the bill, it is not surprising that stories of grotesque delays, huge cost over-runs, equipment failures and other scandals have increasingly merited headline treatment. Whether these scandals really have become more frequent recently is a moot point, but there is little doubt that in the present economic and political climate such stories are likely to be better covered than ever by the media. However, not being privy to the arcane world of procurement, most people (and indeed most journalists) have little inkling of the often Byzantine political and technical complexities that lie behind it, over and above the ordinary incompetence, stupidity and miscalculation common to warring departments in bureaucracies the world over.

Major scandals that hit the headlines have the cumulative effect of eroding public confidence in Whitehall's efficiency while encouraging scepticism about the ability of the armed forces to defend the country. I can still recall one from 1964: that of Ferranti for their part in supplying the radar and guidance systems of the Bristol Bloodhound SAM, as revealed in that year's Lang Report. Gross overpricing by the company led to Sebastian de Ferranti agreeing to pay back £4¼ million – provided he was given a guarantee that there would be no future discrimination against his company (the *nerve* of the man!). This deal was brilliantly attacked by Harold Wilson in the House of Commons when he revealed that Ferranti had actually made a profit of £5,772,964 on its costs, or 82%: a huge sum in 1964 (upwards of £100 million at today's value).[2] The contract had been on a cost-plus basis, ie ascertained costs plus a percentage profit: a type of contract with an inherent tendency towards overspend. In the nervous climate of the Cold War, public opinion was severely critical of the then-Minister for

Aviation, Julian Amery, as well as of the RAF and MoD for not keeping better tabs on their contracts, given that the nation's security was at stake.

To avoid a repetition of this sort of affair government and industry spent the next four years devising an agreed method of pricing non-competitive government contracts to give the contractor a reasonable (or 'fair') rate of return. This was established in 1968 as The Profit Formula for Non-Competitive Government Contracts and is still in use. In fact, there *is* no way of guaranteeing a fair price for a project that will probably take years to complete and may entail work beyond the edge of what is technologically feasible at the time the contract is signed. Yet if cost-plus contracts can easily lead to overspending, so too can fixed-price development programmes, and for much the same reason: it is hard to negotiate a fair price for unforeseeable problems and consequent delays in delivery. Recent experience with the Lockheed Martin F-35 in all its variants demonstrates how relevant this becomes where a new advanced aircraft is concerned. This, still incomplete, programme has already become notorious as the single most expensive military weapons system in history.

The axing in 2010 of BAE Systems' Nimrod MRA4s aroused even greater uproar in Britain than the Bloodhound affair. It was bad enough when it was belatedly revealed that the project was some £790 million over-budget and more than nine years late. It was worse when BBC photographers in a helicopter managed to obtain pictures of brand-new aircraft being chainsawed into scrap at Woodford behind hastily-rigged canvas screens, like fallen horses being put down on a racecourse. Public scepticism was still further intensified when the full import of the 2010 SDSR sank in: that Britain was now left without any maritime patrol aircraft for the foreseeable future, since no replacement had yet been ordered. Were the people in whose hands the defence of these islands rested even vaguely capable of doing what they were paid for? asked various newspaper correspondents. Come to that, what sort of official accounting could possibly permit that degree of budget over-run and almost a decade in time slippage?

This last is a good question, since MoD contracts have long had a fierce 'time clause' (technically, Standard Condition SC14) stating that if the contractual deadline is not met, the MoD is entitled to terminate the contract without compensation, recover payments

Nimrod airframes being broken-up behind temporary screens following cancellation of the MRA4 programme. (BBC)

already made, buy elsewhere and charge the defaulter any consequential costs incurred. Yet despite this clause's fully legal status the MoD has seldom invoked it. Why? The Challenger II tank finally entered service in the British Army in the summer of 1998, two and a half years later than the deadline stipulated in the contract. Parliament was told that this delay had cost the MoD £37 million but that, under a provision called 'Liquidated Damages', Vickers were penalised a maximum of £3 million. The taxpayer stumped up the remaining £34 million. By 2007 the first of BAE Systems' *Astute* class submarines was 5 years late and £1·5 *billion* over-budget. Never mind - open up the public purse. Similarly, companies that supply kit that fails when in service (*Astute* submarines, Type 45 frigates, the Army's initially appalling SA80 rifle and Bowman communications system, Short's Tucano T1) are theoretically liable for their product's performance, which must be 'fit for purpose' under the terms of the Sale of Goods Act (1979) for up to six years after delivery, and under the Latent Damage Act (1986) for up to fifteen years after the cause of the failure is identified.

So – does the MoD consistently follow up such legally-sanctioned avenues for clawing back some of the taxpayers' money? Will it be dunning BAE Systems for the full cost of maintaining ships it built at

public expense but that don't work properly?[3] And why should an averagely cynical member of the public automatically assume this is unlikely? One answer is that it has long looked as though Britain's defence budget exists more as a political expedient to prop up British industry and save jobs than to defend Britain, a state of affairs that successive scandals seem only to confirm. It is indeed sobering when a former MoD Director of Contracts could write in 2000:

> 'It is important that the Public Accounts Committee should be able to judge to what extent MoD officials can be held to blame for the disastrous commercial and military consequences of the secret political defence procurement agenda to support British industry pursued by successive British governments.'[4]

This semi-official claim of a clandestine policy that rates defending the nation as less important than defending its industry is hardly reassuring, hinting as it does at the supremacy of pork barrel politics. Still, that was in 2000. In 2014 the Defence Reform Act came into force, and with it the single-source procurement regime of the SSRO (Single Source Regulations Office) whose remit is to adjudicate on allowable costs arising from a defence contract undertaken at risk by a company. To judge from *Shephard*'s Defence Notes of 15 July 2016, in an article by Tony Skinner headed 'Farnborough 2016: Industry continues to fleece UK MoD', the SSRO has reportedly found that 'new regulations have failed to curtail incidents of overcharging' and 'UK defence companies that continue to charge the MoD unnecessarily for goods or services will be "named and shamed" in a January report' (the Compliance Report of January 2017). SSRO officials told *Shephard* that 'contractors' conformity to the regulations had been "poor" and the attitude of many – both within defence companies and the MoD itself – was that such previously-unregulated overcharging was simply a means of doing business.' In May 2016 the SSRO recovered £1·3 million from Rolls Royce over marketing costs and an 'overstatement of risk of future cost variation' as part of a deal to support Hawk jet trainers.

The cosy relationship enjoyed by government and industry in defence matters extends to the senior ranks of the Services as well, as a popular British journal has made plain:

> 'For decades MoD officials and top brass who had influence over contracts (that were perpetually late and over-budget) found their commercial acumen was valued by the big companies that had benefited from those contracts.'[5]

It may be a sign of the times that it no longer seems noteworthy to either the Services or Westminster when retiring senior officers doff their uniforms, don suits and take a well-salaried seat in the boardroom of the very company they were lately negotiating with; but to the general public it looks bad, just as it does when ex-Prime Ministers parlay connections and expertise made in office into great fortunes immediately on stepping down. High-ranking RAF officers' intimate knowledge of their service's requirements may well be invaluable to industry, but many feel such a move to be improper. After all, they were trained, have been paid and will be well-pensioned entirely from the public purse; and there is something graceless about converting that privilege into private loot, quite apart from the security aspects and clashes of interest.

One of the inherent problems in procuring any major new piece of kit is that so many opinions need to be sought, but with no guarantee they are wise or even well-informed. By the late 1960s the RAF urgently needed a new jet trainer to replace the Gnat T1, which was inadequate to prepare pilots for fourth-generation jet fighters. The appropriate 'desk' or team in the Operational Requirement department had drawn up the specifications for an aircraft that in 1968 became the Hawk. While it was on the drawing board an absurd debate broke out between Hawker Siddeley's design team at Kingston and RAF staff officers in MoD over whether an Angle Of Attack (AOA) gauge should be included among the Hawk's instruments: absurd, because by then all front line fighters had AOA gauges as standard. Given that Gnats had been used since 1965 to train pilots for the early Harrier GR1, and given that AOA gauges were absolutely essential for the Harrier, let alone for any future fast jets, it was beyond question that the new Hawks should have them as standard equipment. Indeed, by then it was plain that *every* aircraft ought to have one. Hawker Siddeley certainly fitted one to their first Hawk for flight testing.

However, it became clear that this view was not widely shared in RAF procurement circles, most of whose older pilots had probably

never used an AOA gauge and were evidently sceptical of these new-fangled gadgets. They had trained quite happily on Chipmunks and Harvards and Jet Provosts without ever understanding much about the importance of 'alpha', so when drawing up the Hawk's specifications they omitted the gauge – and this even though a proposed alternative to the Hawk had been the Anglo-French SEPECAT Jaguar T2 which did come with an AOA gauge because it needed it. Since Training Command knew this and must surely have recognised the essential nature of the gauge, they share some of the blame for omitting it from the Hawk since they evidently had not read the specifications carefully enough. In any case, the OR department duly rejected the AOA gauge.

Meanwhile, at Kingston, the Hawk's design team were so insistent that the new trainer needed one they actually offered to install AOA gauges as a matter of course and swallow the extra cost: an act of generosity by a supplier practically unheard-of in the annals of procurement. All three of the Hawk project's test pilots – Andy Jones, Jim Hawkins and Hawker's CTP at Dunsfold, Duncan Simpson – insisted the instrument be fitted. Nevertheless, the RAF staff officers in MoD rejected this offer on the grounds that it would incur a financial penalty. When challenged to explain how a free offer might cost them money, the response came that because the installation included the two cockpit gauges, their associated wiring and also the sensor vane on the aircraft, the kit would impose a servicing penalty on the RAF throughout the life of the aircraft. Chris Roberts, who did the vast majority of the development of the Hawk 200 and would himself become CTP at Dunsfold, remarked much later that this was a bit like telling BMW not to bother putting anti-lock brakes on your new car because you couldn't see the point of them and were worried you would have to pay for the spares when they went wrong or wore out. In his view the decision to skimp on AOA gauges disadvantaged almost forty years of the RAF's fast jet pilot training until the introduction in 2009 of the new Hawk T2, which has the gauges as standard. 'All those pilots that have been passed onto fighter OCUs without any AOA experience have had to learn it there – on an aircraft that costs many times more per flying hour than a trainer. I instructed on the Harrier OCU and teaching the use of AOA was a waste of expensive flight time; yet until the pilots got a grip of AOA control we couldn't send them solo. The MoD just could not see that converting

pilots to AOA management at flying school was going to save buckets of money more than the cost of maintaining a cheap system.'[6]

Not all manufacturers are as scrupulous as Hawker Siddeley were in this instance back in the early 1970s. John Farley (who in 1978 succeeded Duncan Simpson as CTP at what by now was BAe) observed recently that the writers of specifications for a new aircraft or piece of kit often have neither the requisite engineering education nor the experience. 'The junior and middle-ranking officers told to put a spec together are often only in the job for a year or two before being posted on in the normal way of the military. So how can they learn the job? […] The manufacturer can easily run rings round such service officers. This can result in some manufacturers (who operate a bad culture) being able to manipulate the spec to get work or research funding that may well not be in the interests of the service.' He added: 'Things may have improved a bit since the '70s and '80s regarding spec writing but certainly not with inter-service rivalry. In my opinion the way the three services act in their own interests to increase their share of the defence budget rather than consider what is best for the UK as a whole is disgraceful. It results in an enormous waste of intellectual horsepower and time in the MoD.'[7]

Unfortunately, there is nothing new about this. It even pre-dates the creation of the RAF, going back more than a century to the outbreak of the First World War when the Army and the Admiralty competed with each other for Treasury funding which could result in the RFC and the RNAS having to vie for the best aircraft. When Sopwiths came up with the world's first and highly effective Triplane fighter, their entire output was contracted to the RNAS. No RFC pilot ever flew one in combat, much to the Army's chagrin. Such rivalries are not peculiar to Britain, of course, and USAF/USN/Army squabbles have occasionally become incandescent. Not even a state of war can guarantee the cessation of such inter-service hostilities. What is strange is that after a hundred years no agreed way has yet been found of laying these issues entirely to rest. In the UK the hope is that for increasingly desperate economic as well as strategic reasons the gradual amalgamation of capabilities under the Joint Forces Command, together with NATO forces' collaborative programmes and the doctrine of interoperability, will steadily erode such ancient demarcation disputes while offering economic benefits.

Buying-in equipment from abroad has its own hazards and is bound to entail some loss of sovereignty, as in the contentious case of the Trident submarines. The late Admiral Sir Raymond Lygo gave another example of this, saying that the problem with buying a foreign-built missile or system is that you never quite know if it's going to work or is exactly the same as the one equipping the seller's own armed forces. This is important because the seller may vary its guidance or fusing system so as to make it susceptible to jamming at certain wavelengths. It is difficult to discover this when you buy a weapon unless you open it up, which is probably forbidden under the seller's industrial property rights or else is classified. This was a problem in the Falklands campaign where the Royal Navy had fifteen surface combat ships armed with Exocets but lacked a home-grown missile capable of shooting down the Argentinian Exocets that were doing such damage.[8]

Buying-in its aircraft is, of course, now the norm for the UK. Britain's ability to design, build and produce its own military or civil aircraft in production runs that are also big enough for export and to turn a profit (always the indigenous aviation industry's Achilles heel) has long since collapsed. This means it has to resort to buying off-the-shelf – as in the case of the nine P-8A Poseidon Maritime Patrol Aircraft currently on order from the United States – or else to collaborative ventures typically involving several European consortiums as partners, as with the Airbus A400M transport. That Boeing was able to base the Poseidon on its 737-800 airliner neatly illustrates the enormous advantage the US aviation industry enjoys in having a wide range of existing aircraft that can be re-purposed without the need to design something from scratch and tool-up completely new production lines.

The times have changed dramatically for the RAF. In the late 1980s the UK's fast jet strength was 800+ aircraft: in theory enough to justify the procurement of a single new home-grown type to replace this fleet. But alas! While twenty years earlier there had still been enough industry to have made such an order viable with economies of scale, by 1985 we no longer had an aircraft industry capable of this kind of drawing-board-to-squadron-service production. In any case by then, and hardly for the first time, the nation's defence interests were subordinated to inter-Service squabbling. One result was that the RAF

decided to replace its fast jets with not one but three different types:

(i) An Agile Combat Aircraft (today's Eurofighter Typhoon)
(ii) A Future Joint Combat Aircraft (F-35 Lightning II)
(iii) A Future Offensive Air System (FOAS). This was probably to have been a medium bomber of sorts, but the category was soon axed as unaffordable.

The RAF's decision to buy three different fast jets would anyway have made home-grown aircraft impossible because the numbers of each would be too small to be economically viable. After long delays, and enormous sums of money, the Agile Combat Aircraft became the multinational European Combat Aircraft. The unit cost of the Future Joint Combat Aircraft, the F-35 Lightning II, was expected to be only half that of a Typhoon, but thanks to Lockheed-Martin's well-publicised mishandling of the programme, as well as endless delays for unforeseen technical glitches and altered specifications, the unit cost of the UK's first fourteen F-35Bs should now be around £91·7m, which nevertheless is still slightly cheaper than the Typhoon. By 2009 the lowest estimate was that £5 billion. had already been sunk in these fast jets, so the planned FOAS was cancelled.

If there is an irony here it is that when the RAF decided that three separate fast jet types would be needed for land and sea operation it already had three carrier-capable aircraft in the Harrier, the Phantom and the Buccaneer, as well as the SEPECAT Jaguar. Admittedly these were obsolescent, if still useful, types and something new was long overdue. Yet that attitude of 'Why buy one platform when you can have three?' still obtained, and would undoubtedly have been endorsed by both the other Services when procuring new kit of their own.

The comparative simplicity of the Cold War, when one side competed with the other for advances in rapidly-developing technologies such as jet aircraft, radar and missiles, made the procurement of military aircraft almost straightforward. Then, it was largely a matter of leap-frogging the opposition, who was either known or guessed to be on much the same course. Today's scene is infinitely more complex and muddied, with asymmetric warfare gaining increasing prominence and with the ascendancy of nations such as China and India to the status of world military powers

throwing even the US and Russia off-balance as the erstwhile lone superpowers. It was always clear that 'procurement' could never be restricted just to the bureaucratic framework within which new aircraft and materiel for the armed forces are ordered, built and delivered. It also had to contain a large measure of futurology: an attempt to predict the changing nature of warfare and, particularly in Britain's case, the country's foreseeable role in world affairs and its probable budgetary constraints.

In the wake of recent political developments that role seems ever more in doubt with the budgetary constraints still tighter – and all the more so following the decision to replace the Navy's fleet of four Trident-carrying submarines. The ordered F-35B is also a good example of how the wisdom of an Operational Requirement, when drawn up, can come to seem more debatable by the time – maybe even fifteen or twenty years later – a modern combat aircraft finally trickles into squadron service. One obvious consequence of this, apart from the virtual impossibility of completion within budget, is that when eventually a new aircraft enters service it is likely to be well on the way towards obsolescence. Indeed, more recent development of asymmetric, unconventional and UAV warfare, not to mention a new generation of radar and missiles, must throw into question the future role of piloted combat aircraft at enormous unit cost. The F-35B's much-touted reconnaissance fit may well have an advantage over that of a UAV or even a satellite (although possibly not in purely financial terms); but recent rumours suggest there may now be Russian and even Chinese ECM systems able to mislead or neutralize it.

Yet the whole issue of defence spending is affected by more than mere budgetary constraints. It does not help that the current public mood in Europe – and even in the United States – is one of scepticism about military matters in general, and confidence has become increasingly eroded by scandals of one sort or another. In 2010 BAE Systems was fined a prodigious $400 million by the US Department of Justice in connection with the ongoing and notorious *Al Yamamah* deal with Saudi Arabia that originally dated from the mid-1980s. Nothing so decisive was achieved in the UK, where the National Audit Office's 1992 report into the deal was suppressed – and it still is: the only such report not to be released. In 2006 Britain's Serious Fraud Office suddenly dropped an investigation into allegations that

BAE Systems had maintained a slush fund that successfully influenced members of the Saudi royal family to change their minds about buying French. *Plus ça change*: no-one is greatly surprised when expediency trumps integrity yet again. Yet the penalty is increased public mistrust about defence and procurement: an area of national life that demands scrupulously rational decision-making combined with as much transparency as possible.

The story of post-WW II RAF procurement is now the province of historians. The story of its future is probably equally academic, but in a different sense. With the F-35s, the fifty Apache AH-64E helicopters and nine P-8A Poseidon maritime patrol aircraft already ordered, it is open to doubt how much significant RAF procurement there will ever be again. By the same token it is hard to see how, as a subcontractor, Britain can even sustain a core engineering capability in aviation. Despite being a Tier 1 Partner on the F-35 programme we still have a mere 10% of the workshare.

Post-Chilcot and post-Brexit Britain carries little credible global clout in any sector, fatally handicapped as it is by well-publicised military, financial and political failure. To that can be added social failure in the shape of a disgruntled majority. This seems unlikely to give much priority to supporting Great Power pretensions the country can no longer afford over such things as decently housing and educating its own citizens. Few can see much purpose in a tiny contingent of RAF aircraft adding, at huge public expense and at great risk to the pilots, their tithe to the rain of bombs currently falling on an already devastated Middle East. Indeed, the indefinite survival of the RAF itself as a separate military force increasingly seems unlikely.

Notes:

1 Quoted in Quentin Letts's obituary of Jay, *Daily Mail*, 25 August 2016.

2 See *Hansard* 30 July 1964.

3 See *Private Eye* No 1424, August 5-18, p9.

4 Purton, A R W: letter in *RUSI Journal*, October 2000. I am much indebted to the same author's invaluable MoD booklet *Legal Awareness in UK Defence Procurement* [1991].

5 *Private Eye* No 1426 (September 2-15 2016), p20.

6 Roberts, Chris: email to the author, 25 February 2016.

7 Farley, John: email to the author, 22 February 2016.

8 Lygo, Adm. Sir Raymond: *Collision Course* (The Book Guild, 2002), pp433-4.

ROYAL AIR FORCE HISTORICAL SOCIETY

The Royal Air Force has been in existence for more than ninety years; the study of its history is deepening, and continues to be the subject of published works of consequence. Fresh attention is being given to the strategic assumptions under which military air power was first created and which largely determined policy and operations in both World Wars, the interwar period, and in the era of Cold War tension. Material dealing with post-war history is now becoming available under the 30-year rule. These studies are important to academic historians and to the present and future members of the RAF.

The RAF Historical Society was formed in 1986 to provide a focus for interest in the history of the RAF. It does so by providing a setting for lectures and seminars in which those interested in the history of the Service have the opportunity to meet those who participated in the evolution and implementation of policy. The Society believes that these events make an important contribution to the permanent record.

The Society normally holds three lectures or seminars a year in London, with occasional events in other parts of the country. Transcripts of lectures and seminars are published in the Journal of the RAF Historical Society, which is distributed free of charge to members. Individual membership is open to all with an interest in RAF history, whether or not they were in the Service. Although the Society has the approval of the Air Force Board, it is entirely self-financing.

Membership of the Society costs £18 per annum and further details may be obtained from the Membership Secretary, Wg Cdr Colin Cummings, October House, Yelvertoft, NN6 6LF. Tel: 01788 822124.

THE TWO AIR FORCES AWARD

In 1996 the Royal Air Force Historical Society established, in collaboration with its American sister organisation, the Air Force Historical Foundation, the *Two Air Forces Award*, which was to be presented annually on each side of the Atlantic in recognition of outstanding academic work by a serving officer or airman. The British winners have been:

1996	Sqn Ldr P C Emmett PhD MSc BSc CEng MIEE
1997	Wg Cdr M P Brzezicki MPhil MIL
1998	Wg Cdr P J Daybell MBE MA BA
1999	Sqn Ldr S P Harpum MSc BSc MILT
2000	Sqn Ldr A W Riches MA
2001	Sqn Ldr C H Goss MA
2002	Sqn Ldr S I Richards BSc
2003	Wg Cdr T M Webster MB BS MRCGP MRAeS
2004	Sqn Ldr S Gardner MA MPhil
2005	Wg Cdr S D Ellard MSc BSc CEng MRAeS MBCS
2007	Wg Cdr H Smyth DFC
2008	Wg Cdr B J Hunt MSc MBIFM MinstAM
2009	Gp Capt A J Byford MA MA
2010	Lt Col A M Roe YORKS
2011	Wg Cdr S J Chappell BSc
2012	Wg Cdr N A Tucker-Lowe DSO MA MCMI
2013	Sqn Ldr J S Doyle MA BA
2014	Gp Capt M R Johnson BSc MA MBA
2015	Wg Cdr P M Rait
2016	Rev (Sqn Ldr) D Richardson BTh MA PhD

THE AIR LEAGUE GOLD MEDAL

On 11 February 1998 the Air League presented the Royal Air Force Historical Society with a Gold Medal in recognition of the Society's achievements in recording aspects of the evolution of British air power and thus realising one of the aims of the League. The Executive Committee decided that the medal should be awarded periodically to a nominal holder (it actually resides at the Royal Air Force Club, where it is on display) who was to be an individual who had made a particularly significant contribution to the conduct of the Society's affairs. Holders to date have been:

Air Marshal Sir Frederick Sowrey KCB CBE AFC
Air Commodore H A Probert MBE MA
Wing Commander C G Jefford MBE BA

SECRETARY
Gp Capt K J Dearman
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Middleton Stoney
Oxon
OX25 4AS
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MEMBERSHIP SECRETARY
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