Example Student Project

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James Lambert
"The Rationalisation of the British Aircraft Industry"

INDUSTRIAL GROWTH AND COMPETITION

THE RATIONALISATION OF THE BRITISH AIRCRAFT INDUSTRY

JAMES LAMBERT

INTRODUCTION

During the 1930's the British aircraft industry was producing more aircraft than the United States and consisted of twenty-seven firms. By the mid 1960's only two groups and a small number of specialist firms would exist. This project aims to discover why such a prominent industry, vital at the time to the British Economy came to merge so dramatically.

In fact, the British aircraft industry grew during the 1930's, driven by the growth in commercial aviation and technological innovation in structures and aerodynamics. The Second World War gave a further boost to the industry, with a dramatic increase in aerospace defence production. The War also led to the discovery of new technology. Jet engines were introduced, increasing the speed and size of airliners, opening up new markets.

However, increasing size and complexity led to an inexorable rise in intergenerational costs, increasing the financial risks associated with aerospace projects (see data appendix). This had massive implications for the scale of production needed to spread costs and to enable long term R&D, forcing the British aircraft industry to become one of the first to face rationalisation. The high degree of public funding for the industry also led to inefficiencies, with the government – expecting a return on their investment dictating their demands to the industry. This led to production of aircraft only suitable for the domestic market. Together with the difficulties being experienced by all manufacturers, the British aircraft industry had to rationalise if it was to survive in any form beyond the mid 1960's.

Data has been collected and will be presented in order to identify the main trends in the British aircraft industry. A survival curve will also be drawn. Using economic theory, the trends will then be explained, with the aim of clarifying what occurred in the industry.

GENERAL BACKGROUND

Once the envy of the world, Britain's entire manufacturing industry became one of the weakest in the west by the 1980's. Britain accounted for around 22 per cent of world trade in manufactured products in the 1930's, with this figure rising to 29 per cent by the end of the Second World War. From then on, manufacturing declined almost without a break. The balance of payments in manufactures had also declined over the post-war period.

In the simplest terms, the resulting rise in national income from economic growth increases demand for services, which have a high income elasticity of demand. This increased demand for services is often at the expense of the manufacturing industry in an economy. Hence, deindustrialisation tends to occur over time. Rowthorn and Wells argue that as deficits disappear in invisible trade, the surplus in manufactures was no longer required. Thus, the change in the balance of payments can be thought of as an improvement in the non-manufacturing side as opposed to a decline in manufacturing. This argument held until the late1980's where the decline in industry continued, whilst non-manufacturing surpluses did not make up for this.

The dismal performance of Britain's manufacturing industry during the twentieth century was a sharp contrast with the nineteenth century. Whilst some reduction in Britain's share of manufacturing was to be expected after the loss of the Empire and the spread of industrialisation to North America, Japan and the Pacific, the losses are too large to be explained in this way alone. Some countries have managed to maintain or even increase their share of trade in the post-war years. In addition, many advanced economies that have experienced deindustrialisation have still not lost such a large share as Britain.

In the mid 1950's, Britain was still in generally more efficient at manufacturing than other countries (with the exception of the United States). 'During the 1960's, Britain was, on average, 40 per cent less efficient than other countries in Western Europe' (Maddison 1979). Therefore, Britain was not well placed to compete internationally.

Government initiatives, such as depreciation of the currency and the introduction of wage cuts did nothing to help the industries. The root of the problem is most likely to lie in its inefficiencies, under investment, low R&D spending, poor management and relatively poor labour skills. Under investment has also caused a widening technology gap between Britain and her competitors, resulting in high cost, poor quality goods being produced.

A vicious circle existed, whereby low investment led to low growth and profits and in turn lower future investment. Low investment also led to a lack of competitiveness, resulting in a balance of trade deficit and hence deflationary policies (such as interest rate increases). In turn, this also led to lower investment. It is also possible for the resulting

low productivity growth to keep real wages low, causing trade unions to demand real wage increases, leading to cost push inflation. Again, deflationary policies may lead to lower investment – accelerating the deindustrialisation process. Against this background, the aircraft industry was bound to face turbulent times, but its fall has been dramatic – even compared to the fall of other industries.

AN ANALYSIS OF THE DECLINE OF THE INDUSTRY

Many factors contributed to the dramatic decline of the British aircraft industry. Some of the factors link with theories of industrial economics, such as shakeouts, research and development cost spreading and industry concentration. The role of the government was also instrumental in shaping the industry.

RATIONALIASATION 1945-52

During the post-war years, the British public held the aircraft industry in high esteem, particularly after the Battle of Britain. The war called for large-scale investment in the aircraft industry to ensure the very survival of the nation. It was therefore accepted that domestic military orders would fall after the war, although the launch of a project to build a new airliner, 'The Brabazon', aimed to boost the civil market.

Whilst the British industry faced intense competition from the USA, the war had actually removed the threat of any competition from Europe. In fact, the British aircraft industry gained a ten-year commercial breathing space, which allowed worn out machinery to be replaced, production techniques to be modernised and the technological lessons of the was to be assimilated.

Although the aircraft industry had indeed found favour with the public and senior politicians, it still had to compete with funding with the expanding welfare state, particularly considering the introduction of the National Health Service by the newly elected Labour government. Defence expenditure – a major determinant of aviation investment – was to be reduced to 7 per cent. Whilst this was lower than wartime levels, it was still reasonably high for peacetime. In fact, there was considerable uncertainty regarding the allocation of defence expenditure after the use of the atom bomb. As a result, the demand for numerous military aircraft would fall, although a major bomber programme would be needed as part of the British nuclear weapons programme.

The government's industrial policy outlined an industry with approximately 180000 employees, together with R&D spending to develop the new technologies the war had

produced. It would become clear to the government that rationalisation, a form of government intervention (in fact, an early form of supply side policy) would be used. This involved encouraging firms to merge and reorganise in order to encourage investment and growth.

During 1949, some smaller firms attempted to diversify into other forms of manufacturing – even including prefabricated housing in one case, with varying degrees of success. Other companies were already better placed for survival, such as de Havilland, which had three projects underway (the Vampire, the Dove and the Comet). The chairman of Vickers stated that 'there is no reason the company should not hold its position in the aircraft industry' and a programme of R&D (including a wind tunnel) began. English Electric also heavily invested in R&D, producing the first supersonic wind tunnel outside the USA. Their design for the Canberra jet proved instantly popular and was even purchased by the United States Air Force (The Royal Air Force still operate the original Canberra today).

The Fragmented Industry

The Ministry of Supply decided to split the industry into 'first and second division' companies. However, the average size of a British Aircraft manufacturer was still far below that of a rival in the USA. Despite the fact that twenty-seven manufacturers existed at this time, strong personalities and even war heroes headed many. These men had great influence in Whitehall and according to the head of Vickers 'refused to willingly become subservient to each other'. This made the process of rationalisation more difficult.

Rationalisation was further hampered through the fact that the government was intent on having a degree of surplus capacity to ensure a rapid response, should another national emergency occur. The government also felt that it had sufficient control over the industry by using the tools of purchasing and contract allocation, despite the number of firms.

However, even against this background, some rationalisation did take place. Airspeed could not cope with plans to produce a long-range civilian airliner (The Ambassador) and was absorbed by the then more successful de Havilland in 1951. Miles went bankrupt and was purchased by Handley Page. The Ministry of Supply did consider further rationalisation, but this was discontinued upon the outbreak of the Korean War.

The mid 1950's highlighted the problems of having numerous domestic firms in such an industry. Many firms were allowed to survive at this time. Subcontract production allowed work to be shared out, but discouraged larger scale production. Air Commodore Banks quoted 'the government was clearly wrong to keep weak companies going. It is true that at the time everybody was feeling their way, but the government should have take a stronger line with people who were unsuccessful'. This highlighted the earlier point regarding the passion felt for the industry at the time.

The major problem of a fragmented industry of this nature concerned R&D. Although the mid 1950's saw firms taking greater responsibility for R&D, there was much duplication, inadequate co-operation between firms and a generally limited scale. It is therefore appropriate to consider here an industrial theory of R&D.

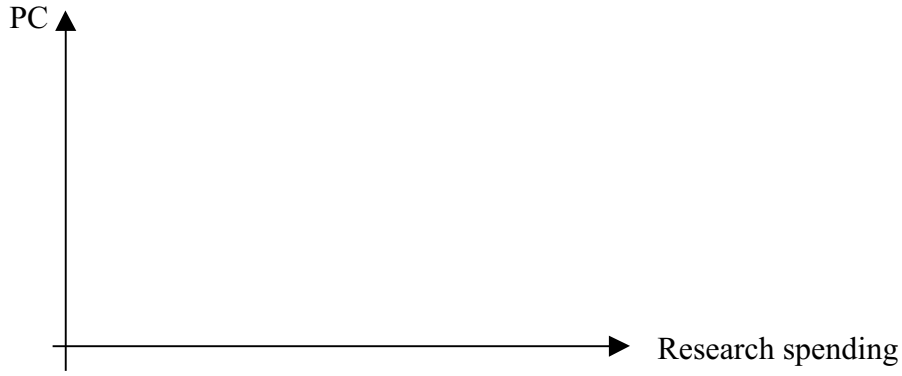
RESEARCH AND DEVELOPMENT

The amount of research and development a firm conducts is often pivotal in deciding the future success of a firm. R&D can lead to a firm developing new products or to lowering its costs by using new technology. The amount of R&D over time in the British aircraft industry can be viewed in the data appendix.

The amount of R&D a firm conducts is affected by many factors. One such factor is the 'technology push factor'. In different industries, there are different technological opportunities. In the aircraft industry, a large technological opportunity exists (compared to textiles or even automobiles). Therefore, high levels of R&D result and must be maintained by all firms in order to maintain a competitive position. A 'demand pull' factor also exists if economic demand for technology is high. In the case of the British aircraft industry, the government was prepared to spend large amounts of money on defence research and thus a demand pull factor for R&D existed. To this end, the government support for the aircraft industry meant that the availability of financing, another determinant of R&D levels, was not a constraint.

In addition to the nature of the industry, the size of the individual firm has an effect on R&D spending levels. The Schumpeterian hypothesis states that large firms and monopolies are better than small firms at innovation. The fixed cost of R&D may be spread over a large number of units if the firm is large, giving such firms a greater incentive to conduct R&D. In addition to having larger funds available, large firms may also find it easier to commercialise an invention. To better examine this theory, R&D intensity has been measured (R&D spending / firm size) in empirical studies. These have found that R&D intensity is not related to firm size, but more to the type of firm (i.e. aircraft firms conduct more R&D than agricultural firms, as aforementioned).

The R&D cost-spreading model suggests that the Schumpeterian hypothesis may have been fairly accurate. Cohen and Klepper (1996) measured the amount a firm spent on research and the price- cost margin (PC) per unit of production (the profit per unit). In theory, research lowers the unit cost of production and the price may also be increased if the product is of a higher quality. Therefore, the PC margin should increase as research increases.



By using calculus, this concave function can show to imply that society is better off with large firms than small firms. It can be shown that large firms conduct more research than smaller firms, even if not per unit. Also, large firms can be shown to have a greater PC margin than smaller firms, suggesting they produce better goods more cheaply than smaller firms, implying that they are better competitors. The increase in PC per extra research unit can also be shown to decrease. However, this implies large firms conduct low value research also. In summary, the empirical research that appeared to disprove the Shumpeterian hypothesis can therefore be proven mathematically to indicate that large firms are in fact best. Large firms may also compete better internationally.

The R&D analysis has importance for other theories. The question of firm size and relative levels of R&D is pivotal in deciding firm success and will assist when considering the theory of shakeouts and its relevance to the British aircraft industry.

THE CIVIL EXPERIENCE

The aforementioned 'Brabazon' project, designed to boost the post war civilian market, became the cornerstone of Atlee's newly elected Labour government, and its approach to industrial recovery. The Ministry of Supply (MoS) supervised the contract and supplied much of the equipment for projects. More controversially, the MoS acted as a procurement agency for the nationalised airlines, whilst dealing with orders from private firms. This system was consistently attacked by both industry and airlines for its inefficiency. The government sought to defend its strategy as a defence of civilian aviation and a policy that led to benefits from economies of scale (see note 1).

An important factor in the decline of this industry began in 1945 with the Civil Aviation Act. This prohibited airlines from buying anything other than British aircraft. The nationalised BEA and BOAC (which later merged to form British Airways) felt that their interests were being sacrificed in an attempt to build up the British civil aircraft industry.

Virtually all the aircraft types that the two airlines were forced to buy were inferior to US airliners and were also more expensive. However, the MoS stated that 'it was not in the national interest to allow a first rate aircraft manufacturer to go bust – the development of the British aircraft industry has priority over airline efficiency' (Hickley, 'Government and aircraft production'. Pp. 419-22).

The Brabazon project turned into another commercially disastrous project, with the aircraft never seeing commercial service. Whilst the aircraft flew in 1949, the design had become obsolete compared to improving US standards. Once again, the project had been let down by government interference, a comparatively low level of technology and a design inconsistent with broad commercial appeal.

It became clear that BEA and BOAC could not be treated as part of the RAF anymore. A report into the tragic crash of an Avro Tudor highlighted that the MoS had caused great problems for the aircraft's development, including delays and technical problems, which had contributed to the crash. The Civil Aviation Act was rewritten in 1948, allowing British Airlines to buy from abroad, with a strong caveat that stated such a decision must 'be in the national interest'. In practice, this allowed the government to continue to interfere with BEA and BOAC's policy – in turn allowing the airlines to specify aircraft that suited them the most, damaging export volumes.

The economics of the industry was set to change in the mid fifties as the break even point for a project rose from sixty sales (a figure consistent with a domestic market) to well over two hundred for more advanced and thus costly aircraft, such as the new VC10. This meant that export orders would become imperative.

Note 1: Economies of scale are achieved when an increased scale of production leads to a lower unit cost. Plant economies result when a firm benefits from larger factories, as aircraft manufacturers could. This is often due to opportunities for labour specialisation, multi-stage production and to commission large, more modern machinery. The firm growing allows overheads to be spread and financial economies (the ability to achieve lower interest rates and cheaper inputs than small firms) to be achieved.

THE MILITARY EXPERIENCE

Whilst the civilian element of the industry was important in attempts to increase output, it only formed 30 per cent of the industry. The remainder was defence production, with military programmes often contributing the most to technological development. The previously mentioned problems of a cut in defence spending to 7 per cent of GDP, the worsening domestic economy and the consideration of a nuclear strike force, ruled out the hastening of a new fighter programme.

Unfortunately, the basic R&D had been sacrificed to the war effort and Britain was falling behind her competitors in the science of aerodynamics, despite the new wind tunnel facilities. During the mid 1950's, Britain had to remedy these shortfalls in research. This increase in R&D (see data appendix) led to specifications for the successful English Electric Canberra and the Vickers Valiant.

On the whole, these projects, although cheap, were wasteful – again due to inefficiency. Twenty-six projects were started at this time at a cost of GBP 23.7 million out of the GBP 1.8 billion budget for military aircraft. However, MoS cost cutting delayed the projects and some aircraft were obsolete by the time they were produced. Upon financial review, it was discovered that the ministry didn't even have any criteria upon which to determine the success of a project. Some projects had even been duplicated - a process the MoS believed would save money! The ministry believed that 'greater financial discipline and more competition' would result. It is difficult to analyse if this rather different policy had any success, although failed competitive projects cost more that GBP 5.5 million.

The MoS later admitted that its decision to place restrictions on supersonic research had set the industry back several years. The US had pressed ahead with its 'X' series of rocket propelled research vehicles, but the UK could not help to compete due to its lack of resources and facilities. The ministry claimed that supersonic aircraft would not be produced, as they 'did not have the heart to ask pilots to fly them'. This was later found to be a diversion from the root of the problem and aviation scientists found that aircrews would feel no adverse effects.

The start of the Korean War again highlighted the industry's problems, with antiquated aircraft having to be used, together with some more modern types purchased from the US. The ministry was also very vague when it came to ranking the importance of projects, leading to unsuitable aircraft becoming available for the task. For example, the Royal Air Force refused to even accept the Vickers Swift in 1955, due to the aircraft's failure to reach the required standard. Over GBP 33 million was therefore wasted on the project.

The Korean War, whilst highlighting failures, caused an increase in employment from 180000 in 1950 to over 300000 by 1956 (see data appendix). There was also a considerable rise in aircraft procurement. However, the industry had now reached a turning point. A major change in government policy was looming, which would have far reaching effects throughout the industry.

THE SANDYS WHITE PAPER and RATIONALISATION

Since the Second World War, the industry had changed little. Airspeed and Miles had exited from the industry as noted. However, the five largest firms out of the remaining twenty-five (Bristol, English Electric, de Havilland, Hawker Siddley and Vickers) accounted for over 80 per cent of domestic production. Ten of the other firms only had assets of less than one million pounds and employed only a few hundred people. The main rival, the US, only had twenty-three firms, with individual divisions employing more than 30000 staff!

The development and production cycle had been dramatically affected by the rising sophistication of aircraft systems and higher technical demands from customers. This led to a sharp rise in costs (see intergenerational costs in data appendix), meaning that decisions made as to which projects to pursue had greater implications. The increasing costs and complexity resulted in a higher unit cost per aircraft, which in turn reduced demand.

In 1954, the RAF had 155 aircraft at a total cost of GBP 6.1 million; in 1958, 178 aircraft were valued at GBP 29 million. In fact, from the start to finish of the 1950's the industry went from producing 2000 aircraft a year to 968. The RAF was to demand more complex and more expensive aircraft – but fewer of them. In short, the domestic market had to shrink dramatically.

In this environment of rising costs in both the civilian and military market, it became even more important for companies to achieve production levels that maximised economies of scale, enabling the production costs to be amortised through sales.

In fact, the British industry was again falling even further behind the USA, due to its inability to benefit from economies of scale. The US market grew to nine times that of the UK market during the 1950's, with production runs being three times higher in military jets and four times higher in civilian aircraft. The start of the 1960's saw US companies account for 80 per cent of world aircraft production – with export levels being four times the British level. The aim of Britain's industry to develop export led growth had been shattered. In turn, the scale of production in the US justified the opening of new research facilities and hence greater R&D (a theory previously discussed).

To make matters worse, unit costs soared as Britain produced twenty-three different types of aircraft – each with a production run of less than 100, in one year. The longer production runs in the US enabled their industry to benefit from non-recurring R&D costs

being a smaller proportion of unit costs – a ratio of 1: 3.2 in the US, compared to 1: 8.7 in the UK. This put the UK in a poor competitive position, especially considering its relatively small size. In addition, the rates of return on government contracts were still being calculated using the same formula used in 1941, with British firms complaining bitterly that these were insufficient to cover costs, let alone R&D. It often cost more for a contractor to borrow the required funds than the profit they were allowed under the formula.

The narrow foreign appeal of British military aircraft was highlighted by the fact that only two of sixteen types (the Buccaneer and Gnat) were exported between 1954 and 1965. The possibility of producing US aircraft in the UK under licence was examined at this point, but the possibility of long term dependence on a foreign supplier and the consequences for British technology meant that the scheme did not find favour with the MoS.

The narrow export appeal of aircraft also affected civil types, as these were often tailored to the two nationalised airline specifications. For example, BEA ordered that the de Havilland Trident would be shortened to suit its operations in Europe. This did not suit other airlines and the Trident faired very badly in competition with the Boeing 727 as a result. The Trident had been designed specifically to compete with the 727, but again, interference caused the project to become a commercial disaster.

To make matters even worse, the 'ten year lull' in European competition predicted after the war (and mentioned earlier as a reason for initial post-war growth) was beginning to come to an end. Dassualt began to attack the military market and Sud Aviation the civilian market. Their Caravelle prevented Vickers from achieving any degree of success with their Vanguard. Before long, West Germany would join the competitors.

The British industry also became renowned for poor market research and insufficient sales care to those that did purchase the aircraft. Air Commodore Banks of Bristol Aviation stated that 'the British aircraft industry must adopt US styles and methods if it is to be competitive. Duplicated projects must go and a stronger centralised management programme introduced'. He argued that a 'sink or swim policy' was needed for firms.

Rationalisation had become inevitable. Even the MoS now accepted this was the only way forward for the British aircraft industry. Officials restarted the previous studies into rationalisation that had been abandoned in 1950. The Under Secretary at the ministry, Denis Havilland, wanted to establish an industry with companies of an appropriate size to produce the more complex aircraft then coming into production. The MoS believed that the easiest way to achieve consolidation between firms was through a contract system. Initially, the Minister for Supply rejected this, believing that declining demand would lead to rationalisation in any case. However, the MoS announced to the Select Committee on Estimates that firms it believed were poor performers would not be 'force fed', whilst the growth of larger firms would enable increasingly important high-tech

projects to be taken on. This was to be achieved through the 'selective allocation of contracts to bring about a measure of coalescence in the aircraft industry'.

The main catalyst for rationalisation was the Sandys Defence White Paper of 1957. The White Paper stated that the new long range missiles and hydrogen bomb had rendered traditional defence obsolete. In what was perhaps the biggest shock the industry ever had at that time, the report made room for only one project – a Canberra replacement. Whilst in time the White Paper would be found to be strategically flawed, there was an important short-term effect. The fact that 70 per cent of aircraft production was dependent on military contracts meant that the Sandys White Paper suggested a massive shakeout in the industry (see 'The theory of Shakeouts' in the next section).

The initial effect was slight, with many projects already at an advanced stage being allowed to continue. There was an 18 per cent decrease in employment in the industry, whilst the value of sales rose. In 1963, profits on capital fell to 8.7 per cent from 15.7 per cent in 1957 (the UK average for all industries was 11 per cent in 1963). The White Paper also blocked the use of 'short step' production methods used in the US and France, which were racing ahead with supersonic projects.

Intelligence suggested that German production of guided missiles had begun, prompting the MoS to again place a higher priority to such non-aviation defence activities. The government hoped that this shortfall would be made up by orders from the civilian sector, ignoring the fact that the two sectors were closely linked. After the Sandys report, the government would not provide launch aid or even guarantee defence orders. The economic thinking of the time allowed even the US to benefit from launch aid, with funding being provided through the profits from defence projects and military R&D being made available to the civilian producers.

The Economist in August 1957 noted that 'the MoS bears a heavy responsibility for shaping the industry's future, but as yet there is no sign of a policy towards the industry'. At this time the Minister for Supply responded to critics that rationalisation would be best left to industry, but the government would not encourage fruitless R&D whilst the industry did not consist of any strong companies capable of taking on high tech projects (as mentioned in the theories of R&D).

The arrival of a new Minister of Supply gave rationalisation plans a major boost, with the Minister fully embracing the idea his predecessor had rejected. Furthermore, he set up an inter-departmental committee into the issue. Together with the Permanent Secretary, bids for the Canberra replacement were used to encourage rationalisation, with the order going only to a group of firms. However, far from encouraging rationalisation, a farce developed in which manoeuvre and counter manoeuvre even led to Hawker Siddeley producing several new designs within itself! High-level government intervention saw the contract going jointly to Vickers and English Electric. The idea had, in fact, worked and rationalisation had begun.

A re-grouping:

By 1959, many companies were experiencing financial difficulty – Hawker Siddeley had lost out on the Canberra replacement contract, de Havilland could not finance the Trident, Bristol could not find a foreign market for its Britannia and Hawker's new combat aircraft was not required. Even Vickers was finding that seizing an export order against a background of intense competition was proving impossible. 1959 also saw a General Election and thus a softening stance towards the industry. The policy of 'survival of the fittest' was adjusted and a new Ministry of Aviation (MoA) was formed in place of the civilian and military aviation divisions of the MoS.

Another new Minister – this time Sandys himself, the new Minister for Aviation arrived. He was prepared to act as a 'marriage bureau' between companies. The government's more compassionate election stance towards the industry would be used to provide launch aid for projects if firms came together. He also bluntly announced that he saw room only 'for two aircraft manufacturers'.

To ensure commercial discipline, firms would have to provide 50 per cent of the finance and the full amount of any cost increases of a project. The government would evaluate these partly depending on the balance of payments position and also on the degree of company co-ordination. A levy on sales would attempt to ensure the government would recover its costs. This re-introduction of a state partnership led to a flurry of Mergers and Acquisitions. Hawker Siddeley purchased de Havilland with Blackburn and Folland joining to form the Hawker Siddeley Aviation (HSA) group. The new chairman of the group stated that he hoped that 'this merging of companies will put us in a stronger position to win government contracts'.

English Electric and Vickers, joined through the Canberra project, formed the nucleus of the soon to form BAC group. Bristol, told by the government that it would not be considered for future supersonic work unless it merged, joined the new corporation. Hunting was also directed by the MoA to join the BAC group, with BAC acquiring a controlling interest in the firm in May 1960. An independent Board and a division of projects into old and new helped BAC establish itself.

Helicopter production was continued by Westland, which remained a single firm. This was due to the fact that neither the HSA group of BAC was prepared to take on such a specialist and very different business interest. Whilst in a vulnerable position as a single producer, Westland managed to secure US licence work and continued a conservative R&D strategy.

Only three fixed wing aircraft manufacturing firms remained outside the two large corporations. Shorts, which was 69 per cent government owned, remained as an independent firm, due to the fact that it was based in Northern Ireland. The government believed that its importance to the Northern Ireland economy was invaluable, with HSA and BAC being encouraged to subcontract to Shorts. Scottish Aviation also continued independently, as did Handley Page. Whereas the aforementioned 'influential figures

and war heroes' of aviation had reluctantly accepted the rationalisation process, Sir Frederick Handley Page believed that 'the soul of a business lies in the creativeness of an individual and that process is not achieved by elephantine size or soulless bureaucracy'. Inevitably, the firm faced financial difficulty and thus became an embarrassment for a government that had then to intervene in a 'free market' with launch aid or face losing a firm (a result they believed to damage the impression of the new policy). However, no amount of launch aid could sustain a firm with GBP 13 million deficits and the company ceased trading in 1970.

The rationalisation process had seen the industry shrink to just a handful of firms. Whilst the process had been a success in this respect, the scale of production had not improved significantly, with each firm owning numerous factories. The major weakness of policy was the simple fact that the government was not certain of how many firms the industry should consist of itself. British aviation needed to stay ahead of its European competitors and take on the US. A greater use of technology was needed and domestic 'competition' brought to an end. On the horizon lied another major blow to the industry – the mid-sixties cancellations.

THE THEORY OF SHAKEOUTS

Shakeouts within an industry are relatively common. The number of producers of a new product (such as an aircraft) increases over time before reaching a peak and dropping off. In the aircraft industry in Britain, the shakeout was severe (85 per cent up to 1970 and now even greater in 2001). However, these can occur in growing markets, as in the aircraft industry and are not normally the result of markets drying up. More often, exit continues and entry drops to zero (as it did in the Britain's aircraft industry).

Klepper and Simons (1993, 1997) have developed a theoretical model to help explain shakeouts. In the early days of an industry, some individuals and firms may have experience at manufacturing and others not. However, any individual is able to enter the industry and will do so if they believe they can make a profit. As a result, the level of competence of firms will vary dramatically within the new industry.

A potential entrant will roughly know the cost of production and the market price and will be able to make an informed decision regarding entry. Thus, the most incompetent will not enter. All entrants make an initial profit, with the most competent making the greatest profit. Over time, incumbents grow and new firms enter, causing industry output to rise and unit price to fall. The falling price (assuming constant demand) makes it harder for new entrants to make a profit and hence discourages them from entering. A point is reached when even the most competent cannot enter and entry ceases.

As well as competence, size provides a firm with a significant advantage. One such reason is R&D cost spreading, which was previously discussed. As output rises, the unit

cost continues to fall and competition becomes increasingly tough. Firms must therefore be large and competent to survive, with smaller firms being forced out. As newer entrants do not have time to grow, they are first to exit. Exit continues over many decades, with firms that are unable to produce new technology also being forced out.

A graph illustrating survival in the aircraft industry over time is shown in the data appendix, with year 0 being 1939. Unfortunately, entry dates were difficult to obtain as the earliest firms entered in about 1908 and records are patchy. Handley Page entered in 1917 and all others were in the industry by 1920 (with the exception of Airspeed which entered in 1931 before merging in 1940).

The survival curve shows that mergers continued throughout the period, with a particularly intense period in 1960. The number of years each firm existed for (the total age) can be found. For the larger firms this was as follows:

Bristol	40yrs
de Havilland	43yrs
English Electric	40yrs
Handley Page	50yrs
Vickers	40yrs

Although these figures do not indicate that large firms survived for a much shorter or longer period than the smaller firms, they are not sufficient to indicate that large firms survived longer.
Shorts survived as mentioned as it is from Northern Ireland and received special assistance. Westland did not face much competition as the other firms, due to it being the sole firm to produce helicopters in the UK. Scottish Aviation has also survived for a long period, with its specialist market in turboprop aircraft used on domestic routes, until it was nationalised into BAE in 1977. Handley Page survived the longest of the large firms as it did not merge. As mentioned in the report, it refused to become a member of the HSA or BAC group and managed to survive alone until bankruptcy in 1970. Portsmouth aviation also went bankrupt in 1949. As the table shows, all other firms merged.

Although larger firms were not the first to exit, they did not fare much better than their smaller counterparts on average. Therefore, the theory of large firm survival cannot be supported in this industry. However, it should be noted that the remaining firms merged and did not go bankrupt. The very reason for the mergers was to create large firms. As a result, although the firms did not remain in the industry as individuals substantially longer than smaller firms, it was their relative success that ensured they absorbed the smaller firms during the shakeout. It was only by eventually creating one large firm (BAE) that any firm survived beyond the 1970's. Therefore, the significance of the benefits of larger firms cannot be ignored.

ALTERNATIVE REASONS FOR SHAKEOUTS / INDUSTRY CONCENTRATION

In addition to R&D cost spreading, various other factors cause large firms to dominate an industry after a shakeout. Larger firms will benefit from economies of scale (possibly being able to reach the Minimum Efficient Scale, the lowest point on the Long Run Average Cost curve). It was found that the British aircraft industry did not benefit from the lower production unit costs that the US did, due to its shorter production runs, but the larger firms within the industry would still have benefited from some economies of scale. Hence, the government was extremely keen to create larger firms. However, empirical studies have found that, 'in practice, scale economies are generally not the reason for actual industry concentration' (Baines 1956). In addition, manufacturing costs may reduce as a function of cumulative output. This may be due to factors such as engineering improvements over time and workers becoming better at their jobs. This cost reduction curve is known as a learning curve.

Out of the remaining factors, some (such as technology lock in and network economies) I have found no evidence for in the British aircraft industry. Unlike the aviation industry in general, aircraft producers do not tend to partake in advertising. Whilst some firms such as Rolls Royce and BAE Systems (the only major British manufacturers in 2001) have carried some advertisements of late – possibly aimed at winning orders from international airlines and boosting shareholder relations, this did not occur during the 1960's. Therefore, advertising cost spreading theories are of little use in this industrial study.

THE CANCELLATIONS – A FINAL BLOW

Long production runs and lower unit costs continued to keep the US ahead. The French government encouraged rationalisation through specialisation – a process that yielded positive results. Whilst in a stronger position than pre-rationalisation, the British industry would still not survive in its present form. A Chequers meeting of the MoA in 1963, together with Service Chiefs and Airline Managers, led to the conclusion that more collaboration was needed – even if this meant looking abroad for partners.

The same year, BOAC announced a deficit of £50 million, causing embarrassment for a government that had continued the policy of forcing the airline to buy uneconomical British aircraft. This finally caused the law to be changed, with BOAC wasting no time in looking to Boeing and Lockheed for aircraft (the airline did not then purchase any form of British Aircraft until 1999!).

1964 saw a General Election, with a Labour government returning to power after thirteen years. As ever with this industry, the government of the day would have a profound effect on its fortunes. This new government effectively put the whole industry on notice – they would be interventionist and put an end to decades of 'feather bedding' the industry. The

MoA was shut and 'Mintech' a new ministry for technology would now oversee and encourage industrial growth.

Another report – this time by Lord Plowden, would be published in 1965. It would aim to put a stop to situation of declining export earnings (only 20 per cent of output – representing only 2.5 per cent of Britain's foreign exchange – against 30 per cent in 1957). The industry was using up 25 per cent of Britain's R&D budget, whilst similar output levels were being achieved by the French with one third of the manpower. Much resentment was caused by these high levels of spending on aviation, with Flight International reporting Tony Benn (still an MP today) referring to the MoA 'running off with sums of money that made the great train robbers look like schoolboys, whilst other manufacturing sectors struggled for funds'.

The Prime Minister of the time, Harold Wilson, personally intervened to stop three major projects (HS681, P1154 and TSR2). Heads of Industry warned that BAC may fall apart as a result, with a severe loss of technical knowledge for Britain, but the Prime Minister insisted the industry needed a 'series of shocks'. The Minister for Economic Affairs denied wanting to run down aircraft manufacturing, but stated that 'the current wastage of taxpayer's money must cease'.

PLOWDEN:

A diagnosis of past failings and suggestions for future remedies was provided by the Plowden report. Technological change and the associated rise in development costs, the benefits of economies of scale in the US and the structural limitations of the British industry – even after rationalisation, were cited as reasons for past failure. The financing of 47 per cent of assets through borrowing against only 4 per cent for British industry as a whole was also heavily criticised.

Plowden considered, 'Why should Britain have an aircraft industry at all?' The nature of this question was radical and so was the resulting debate. Arguments in favour of the industry began with the notion that it was vital to defence and therefore vital to the nation. However, many of the aircraft could have been purchased for a lower price from other NATO countries. The industry was also a major employer, but Plowden considered aviation workers skilful and thus believed alternative employment could readily be found. Although the industry fell behind its export targets, it still made a positive contribution to the balance of payments. The nation would also suffer a 'technological fallout' should the industry come to an end, it was claimed.

Lastly, the infant industry argument was used. This economic argument is often used to justify subsidies to a new industry or protectionist policies and thus appears in development, industrial and international economics regularly. Such an industry is small, underdeveloped and normally has a lack of back up facilities. However, it will have the potential to gain a comparative advantage through economies of scale over time. Plowden dismissed this on the basis that the industry had been in existence for some years, with a peak employment of one million. It had therefore shrunk over time and

could therefore not be described as an infant industry at all, making the argument irrelevant.

Plowden noted that none of the above arguments gave any justification for the industry to exist at all. However, the industry was skills based, capital intensive and was high value added. In short, it was exactly the sort of industry Britain needed, although increased efficiency was essential if it was to justify its very existence. Plowden cited international collaboration as the way ahead. The US did not need to collaborate, but most European countries were facing the problem of limited domestic markets, making them ideal partners for successful projects. The present day Airbus Industrie collaboration demonstrates the success this proposal would foster, although its formation did not occur in the way Plowden had predicted.

Nationalisation was seriously considered – especially in light of the fact that the government was virtually the only customer, but traditional economic arguments used at the time in favour of such action, including the correction of market failure and the preservation of a strategically important industry were thrown out in the report. This was due to fears that private investment would be crowded out. The situation had been made clear: The report meant that the industry could not start another costly project and expect any greater subsidy or protection than any other industrial sector. If the industry was to survive, foreign collaboration was essential.

BAC had received £9.75 million of government aid, but the £30 million cost of developing the BAC 1-11 civil short haul airliner was causing the company problems. A further merger between BAC and HSA (the two largest groups) was encouraged by the government, but opposed by industrialists. The government did not press its case strongly and a resulting argument regarding the company's valuation (a difference of £50 million between the government and BAC estimates) prevented a merger until the following decade.

A SUMMARY OF THE SIXTIES – THE ELSTUB REPORT

British, American, Swedish and French firms were compared in this report, which served as a summary of the 1960's, where this study will terminate. The rationalisation of firms in the 1950's was acknowledged, as were the cancellations of the 1960's and other collaboration. In real terms by value, the report noted that only modest output growth has occurred through the rationalisation policy (see data appendix).

The productivity gap between the US and the UK was about 3:1 at the time. In fact, in year 2000 this still stood at about 30 per cent (Financial Times, November 2001). UK labour was still relatively cheap compared to the US, which was enjoying a period of growth, but the productivity gap wiped out this benefit.

The production methods in both countries were mostly automated. The cause of the productivity gap therefore lied elsewhere. The report found this cause to be due to the inability of the British Industry to benefit from economies of scale, especially considering the belief that long run costs are 'L shaped'. Companies such as Boeing would be more willing to invest and carry through projects to the end, due to the large scale of projects and their rewards. Britain would also face increased levels of inefficiency as workers debated unemployment towards the end of projects that were often short term. In the US, aircraft such as the Boeing 747, which began production in the 1960's, are in their fourth variant and still going strong, with plans for a new version.

Rationalisation had achieved a 40 per cent reduction in the number of factories. New initiatives for the time were embraced, such as Computer Aided Design, leading to a 10 per cent cost reduction. Elstub noted that in terms of value added per employee, Britain fell 32 per cent behind the EC average. The UK, EC and US output table for the 1960's (in the data appendix) shows that whilst Britain's aircraft output remained virtually unchanged, the output of the EC grew by 11 per cent. Hence, Britain fell behind her competitors quite dramatically over this period.

Close ties with government also contributed to industrial problems in other ways. For example, as governments and Ministers came and went, the resulting uncertainty disrupted business planning, reducing output levels. The absorption of the MoA into Mintech was also questionable, with only 800 fewer employees involved in aviation within Mintech than in the MoA as a whole when it was in full existence.

The 1950's had seen rationalisation and the 1960's collaboration. The industry had shrunk to only a handful of firms from twenty-seven. The future would hold international collaboration, as even these firms could not survive alone. As a result, Airbus and Concorde are now household names and British firms long forgotten.

CONCLUSION

The British Aircraft Industry provides an excellent example of industrial rationalisation over a thirty-year period. It is made more interesting by the fact that the industry is little known outside the circles of classical aviation enthusiasts. Most British members of the public would not imagine that so many firms had existed and that Britain produced so many aircraft.

Unfortunately, even at the time, factors such as military dominance and civilian firms having the government as their main customer meant that the data available is not as comprehensive as it is for the United States. However, the Royal Aeronautical Society has many records, including the 1963 Business History Review, which provided adequate data.

Britain fought a long battle against the competitive might of the US aircraft industry. Whilst Britain's aircraft were often just as good, the limited market and scale of production made it impossible to match the US manufacturers. Government interference (added to by the changes in governments), duplication of R&D and fragmentation had an adverse impact on output.

Rationalisation also took a very slow start, with disagreements between government and industry clouding the economic aims of the operation. It took Sandy's White Paper to start the process. The process of commercial and economic evaluation is made difficult by the fact that many industrialists class the industry as 'strategic'. This rather vague notion implies that the ability to build one's own aircraft for defence and to benefit from the technological stimulation the industry provides cannot be easily measured in financial terms. Whilst the 'public good' element of production will always be provided (i.e. Defence), the economics of the post 1980's era does not allow such a loss making and inefficient Industry to exist. Although the rationalisation within this industry was dramatic, it is important to remember that almost all industries (with the exception of Pharmaceuticals) have declined over time and faced rationalisation.

Today, Westland still works in the specialist area of helicopter production. The main British firm is now BAE Systems, with the others having all since disappeared. This company has been successful in winning orders for civilian and military aircraft at home and abroad and is now very successful. It has also been involved in ventures with companies such as Saab in the production of jets. As Elstub and Sandy suggested, international collaboration has become necessary, resulting in another successful company, Airbus Industrie. Britain specialises in the manufacture of wings, which are then flown in a giant transport aircraft to the assembly line in Toulouse. New defence projects, such as the Eurofighter involve a partnership of five European nations.

The lack of status of engineers in the UK still creates problems attracting graduates into the profession, as does the problem of low productivity. Such problems are only likely to be overcome with fundamental government and social change, with these problems not being unique to aviation. There is no longer any suggestion that aviation is a special case and industry as a whole would have to be assisted by any change.

The rationalisation and collaboration has managed to ensure the industry survived beyond 1965, which the structure of 1940 would not have permitted. Despite being plagued with numerous industrial problems and slow remedial action, the industry will exist for years to come in its new form.

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DATA APPENDIX

As mentioned in the text at the relevant points, figures exist to support the theory, backed up by graphical presentation. The first table summarises the firms in the industry, together with their entry and exit dates. Where no exit date exists, this means that the firm has not left the industry. All entry dates (apart from Airspeed) are set at 1920, as all firms had entered by this time. Unfortunately, precise entry dates are not readily available. The value of 1 in the merger list indicates that the firm merged. The small/large columns indicate firm size (where large firms had more than 10000 employees).

The other tables are self-titled. It is interesting to examine the change in output and employment levels after the publication of the Sandy's report in 1957. The data was drawn from various tables in 'The British Aircraft Industry, Hayward K, 1989'.