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UK Airspace – making space for flight

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Across the country, every minute of every day, aircraft are on the move, and the skies above the United Kingdom, already one of the most densely trafficked and complicated in the world are getting busier. In 2006, 2.4 million commercial flights carrying some 220 million passengers, plus many thousands more military jets and general aviation aircraft used UK airspace. They were protected from collision by the careful arrangement of airways and control zones, the watchful eyes of air traffic controllers and pilots, increasingly sophisticated collision avoidance software, and strict adherence to aeronautical law, yet the only time those outside the industry get to hear about this complex, largely invisible, aerial network is when things go wrong – a malfunctioning computer, bad weather, or industrial action grounds flights – or when people on the ground complain about aircraft noise.

Contested airspace

It is becoming increasingly apparent that the provision, regulation, and use of UK airspace is becoming something of a political hot potato. One the one hand, the Government and industry regulators want a safe, competitive, efficient air transport system; airlines long for the freedom and flexibility to fly where they want, when they want to, as cheaply as possible; military and general aviation users require airspace for training and recreation purposes; while 'green' coalitions and airport communities seek to restrict its use.

It is one the ironies of modern life that while increasing numbers of people want to fly, no one, it seems, wants to be disturbed by aircraft. While the phenomenon of anti-airport protest is not new, the use of airspace itself is now becoming an increasingly contentious issue too, with an individual's 'right' to peace and quiet juxtaposed against other peoples' 'right' to fly. Many airports have employed dedicated personnel to deal with noise complaints, installed sophisticated noise and track monitoring systems to identify when an aircraft strays off the permitted track, and encourage flightcrew to adhere to strict noise abatement procedures, yet the number

of complaints continues to rise. While the majority of objections are directed at commercial flights, military aircraft and general aviation are not immune. People living in the Welsh valleys have long complained about the noise from low-level military training flights, while others allege the drone of light aircraft ruins the tranquillity of the English countryside. Yet while most of the media coverage focuses on how airspace is being contested 'on the ground' by people who oppose its use, it is important to recognise it is also being contested 'in the air', with different groups of users trying to secure themselves a bigger share of the sky and exclude others from accessing it.

Historical background

Following the first scheduled passenger flight between England and France in August 1919, the production and control of global airspace became a matter of intense political concern and individual nation states sought to seize control of as much airspace as possible. While the British Aerial Navigation Act of 1911 had declared that Britain's airspace (including that of her colonies and dominions) was sovereign territory and inviolable, national control over airspace was not formally enshrined in international law until the Paris Convention of 13th October 1919. Throughout the twentieth century, the sky was progressively cleaved into areas of sovereign control, and further subdivided into discrete 'blocks' airspace that were subject to different rules and regulations.

Under the auspices of national defence and air safety, the UK, in common with many of her European neighbours, created separate areas for military and civilian air traffic, and signed a plethora of bilateral and multilateral air service agreements that stipulated which airlines could fly, which airports (and airspace) they could use, how often the services could operate, and the airfares that could be charged. It was not until the late 1990s, following a coherent programme of air transport liberalisation, that that any change to this regime occurred.

The removal of anti-competitive legislation, through three progressive 'packages' of liberalisation measures, revolutionised the continent's airline industry and allowed new airlines to enter the marketplace. Many chose to undercut the airfares charged by incumbent carriers by eschewing traditional in-flight 'frills' and operating frequent

short-haul flights between secondary, less congested, regional airports. Lower fares stimulated unprecedented passenger demand and a boom in low-cost flying, but the resulting increase in flights (particularly at smaller regional airports) posed a number of challenges. The existing airspace structure, while able to handle mid-twentieth century traffic volumes, was not able to accommodate this additional traffic and new areas of controlled airspace were 'bolted on' to existing sectors to handle the increased numbers of aircraft. While this offered an attractive short-term solution to the problem, it made the airspace structure even more complicated.

Ordering the sky

On a European level, the UK is a member of EUROCONTROL, the European Organisation for the safety of air navigation, but at a national level, UK airspace is governed and administered by the Civil Aviation Authority (CAA) and NATS, the part-privatised national air traffic services provider, in accordance with domestic and international law. All flights within the UK's c350,000 square miles of sovereign airspace are conducted according to one of two rules of flight – VFR (Visual Flight Rules) or IFR (Instrument Flight Rules) - which determine where and when pilots can fly. Under VFR conditions, pilots assume complete responsibility for navigation and the safe conduct of their flight, whereas IFR traffic can expect a high level of service from air traffic control. Private pilots are only licensed to fly under VFR conditions in good visibility, during daylight hours, where they can see the ground (though experience and the acquisition of additional licence ratings may modify these conditions). In comparison, commercial flightcrew fly according to IFR, which enables them to use controlled airspace (upon receipt of ATC clearance), 24 hours a day, in virtually all weathers.

To safely manage the diverse operational requirements of different airspace users, UK airspace is divided into two geographical regions, London and Scottish. Each region is subdivided vertically into a Flight Information Region (FIR) that is effective between the ground surface and 19,500ft (the equivalent of Flightlevel 195 with an altimeter calibrated to the standard atmospheric pressure setting of 1013.2 millibars) and an Upper Flight Information Region (UIR) that is effective above Flightlevel 195. Different sections of airspace within these regions are classified as being 'controlled' or 'uncontrolled', depending on the density of traffic flowing through it. Areas

characterised by high traffic volumes (such as those near major airports and navigation beacons) require strict monitoring and regulation, while areas peripheral to major traffic flows require less surveillance, and pilots are relatively free to fly where they want providing they adhere to basic aeronautical regulations. As traffic volumes have grown, the volume of airspace designated as ' controlled' has progressively increased.

Controlled airspace can take many forms, from en-route airways to airport control zones, and is designated in accordance with ICAO (International Civil Aviation Organisation) guidelines as one of five 'Classes' (identified by the letters A-E), where A is subject to the most control and Class E the least. Class F and G airspace describe advisory routes and uncontrolled airspace respectively. Each Class is subject to different rules and regulations and, to compound the complexity, UK airspace has also recently been reclassified to bring it in line with the rest of Europe.

Class A – includes all airways up to Flightlevel 195 (excluding those in the Belfast and Scottish Terminal Manoeuvring Areas (TMAs)) as well as the London and Manchester TMAs.

Class B – Previously described all airspace above Flightlevel 245, but now only exists around minor TMAs.

Class C – All UIR airspace between Flightlevels 195 and 660 inclusive.

Class D – Control zones (CTZs) and control areas (CTAs) around major UK airports (except Heathrow).

Class E – Parts of the Belfast and Scottish TMAs.

Class F – Advisory Routes (ADRs). These are similar to airways, but carry less traffic.

Class G – Uncontrolled airspace below Flightlevel 195. The UK is unusual in that IFR flights in Class G airspace are relatively common.

In addition to these principal designations, there are also Aerodrome Traffic Zones (ATZs) and Military Air Traffic Zones (MATZs) around certain civilian and military airfields in the UK, and other areas of sky that may be permanently restricted for reasons of national security or safety. These include military training areas, areas around certain power installations, defence establishments, and wildlife reserves, and

areas of intense aerial activity such as parachuting sites. Temporary restricted areas may also be introduced during major sports events or airshows. During the UK stage of the Tour de France in July 2007, six temporary restricted areas were activated above parts of London and Kent to protect the TV helicopters and other aircraft monitoring the race, while other temporary restricted areas are activated in the vicinity of airshows to protect both the performers and other airspace users.

All these different designations result in a highly complex web of control zones and sectors, all of which are effective between different altitudes, subject to different rules and regulations, and may only be active for certain periods of time. Knowing where you are, and when and where you may fly, are thus fundamentally important to the maintenance and safe production of airspace. Though the details of the lateral, vertical, and temporal extent of these areas are communicated through charts, NOTAMs (Notices to Airmen) and pre-flight bulletins, the system is not infallible. In 2006, 633 airspace infringements were reported to the CAA. Unsurprisingly, the majority occurred during the summer months (when general aviation activity was highest) and in the south east of England, where the airspace is particularly complex. Fortunately, inbuilt safety mechanisms (including collision avoidance software, controllers, and radar) help prevent collision, but it has been estimated one airspace infringement can affect as many as 30 other aircraft, delay up to 5000 passengers, and cost over £50,000 in wasted fuel.

In recognition of the danger, inconvenience, and expense infringements cause, the CAA's 'flyontrack' website aims to educate general aviation pilots about the dangers of infringing controlled airspace and provides advice on how to ensure they can continue to fly safely and legally. Annotated radar displays of actual infringements show how quickly a situation can deteriorate. As there are no 'keep out' notices or fences in the sky to block unauthorised movement, the onus is on the pilot to ensure they do not enter controlled airspace without authorisation. This is particularly important around major airports, where the airspace is used by both general aviation traffic and commercial flights. In the increasingly complex skies over the UK, accurate navigation and an appreciation of the dimensions of the surrounding airspace is crucial to the safety of all users and the retention of one's flying licence.

Demarcating the sky

In the early days of passenger flight, pilots navigated with reference to major landmarks, such as roads and railway lines, but, as the network of passenger services grew throughout the 1920s, identification codes were painted on top of barns and hangers to help pilots determine their location from the air. This system, however, had its drawbacks. Aircraft had to remain beneath the cloud base, which resulted not only in an uncomfortable ride, but increased the risk of accidents. The deaths of seven people in a mid-air collision in northern France in 1922 highlighted the dangers of unregulated airspace and resulted in the formation of specific air routes across the English Channel. As a pre-cursor of the modern airway system, pilots flying between London and Paris were instructed to remain east of Ecouen, Abbeville, Etaples and Ashford when flying towards the French capital, and west of them on their return. To help pilots stay on the correct track, radiotelephony stations were constructed at Croydon and Lympne to enable ground controllers to communicate with pilots over the Channel. Furthermore, a number of 'Rules of the Air' were devised, which stipulated which aircraft had right of way in flight, and the types of light they should display.

By the end of decade, rising numbers of aircraft necessitated the creation of specific arrival and departure routes at airports to ensure aircraft remained a safe distance apart and, in 1928, Coordinated Universal Time (UTC) was adopted to help synchronise flight schedules and other global economic activities. These systems of navigation and air traffic management, which were established in the early years of passenger flight, still form the basis of the present air traffic control system. Flights still operate in accordance with this standardised 'global time' and still follow published arrival or departure routes, known as 'STARs' (Standard Terminal Arrival Routes) and 'SIDs' (Standard Instrument Departure routes) respectively. Often, these routes contain an element of noise abatement, which may require pilots to reduce thrust after take-off or avoid overflying certain areas to reduce the noise on the ground.

Today, areas of controlled airspace around airports are linked together by airways, which are defined by a network of Very High Frequency Omnidirectional Range (VOR) beacons. These installations transmit a coded radio signal on a specific

frequency, enabling aircraft to 'home in' on them from any direction and 'turn corners' at the intersection of two or more beams. The beacons themselves are identified by a name and three-letter abbreviation, which, like the airspace sectors above them, often have some basis in 'real world' geography, such as 'Trent' ('TNT') in the Peak District, 'Midhurst' ('MID') in Kent, and 'Honiley' ('HON') in Warwickshire.

To help monitor a flight's progress, over 820 reporting points and/or waypoints are located in UK airspace. Some of these 'Name Code Designators', to give them their full title, have a basis in terrestrial geography, including 'LESTA' in the English Midlands, 'BOGNA' near the famous south-coast resort, and 'FORTY' above the eponymous North Sea shipping area, but as traffic volumes have grown, and additional routes have been introduced, new names have emerged which bear no relationship to ground-based features below. Some are named after British flora and fauna (examples include 'WESUL', 'WILLO', and 'SAMON'), or have implicit 'local' connections such as 'ABBOT' and 'ADNAM' near Stansted airport (which are named after local Essex beers), while others are altogether more curious. While it is claimed that software alone determines waypoint names, some humour invariably creeps in - hence 'BEENO' and 'DANDI', 'NEDUL' and 'THRED', and the infamous reporting point over the Irish Sea, 'GINIS'. Most, if not all, of these waypoints have no basis in physical reality (i.e. they are not marked by a point on the ground), and are wholly artificial markers designed to regulate and control flows of air traffic.

The airways linking these beacons and waypoints are given alphanumeric identifiers, and the exact route a flight will follow is described on the flightplan. For example, flights departing from East Midlands Airport may route 'DTY-A47-WOD-BIG-UL9-DVR', 'ASNIP-L28-PENIL-L70-BAG', 'TNT-N57-POL-N601-MARGO', or 'WAL-L975-LIFFY-LIFFY1R' depending on their destination. Decoded, 'DTY-A47-WOD-BIG-UL9-DVR' means the aircraft will fly to the Daventry beacon (DTY), take airway A47 as far as Woodley (WOD) VOR, before flying towards the beacon at Biggin Hill (BIG). From there, it will fly east along 'Upper Lima Nine' to Dover (DVR), where it will cross the English Channel and enter French airspace. Before each flight takes off, flow management computers at Eurocontrol in Brussels analyse

the spatial and temporal profiles of all the flights that are planning to use European airspace for all or part of their journey, and impose slot restrictions (where necessary) to ensure certain sectors are not overloaded.

Controlling the sky

The task of monitoring and controlling these aircraft rests with air traffic control. A number of specialist artefacts and equipment, including radar, radio, and flight progress strips, are used to ensure the available airspace is used as safely and efficiently as possible. Radar is employed at all control centres to monitor the progress of individual flights and help controllers visualise traffic flows. The two-dimensional radar images of aircraft flying through three-dimensional space are superimposed over a static grid of lines and symbols showing different airspace sectors and the position of airports, navigation beacons, and waypoints. Short-term conflict alert systems alert monitor the position of all flights and provide aural and visual warnings if aircraft fly too close to one another. Pilots and controllers are in constant spoken communication with one another and, to lessen the risk of incomprehension and misunderstanding, all transmissions are conducted in English and each airspace sector is administered using a dedicated 'airband' frequency.

To help controllers keep track of the clearances and instructions they issue, they continually annotate Flight Progress Strips (FPS) which accompany a flight throughout its journey. FPS contain a wealth of information including the flight number, airline, aircraft type, intended routing, requested altitude, anticipated airspeed, scheduled time of arrival or departure, and details of any en-route delays. Once approved, this data is automatically sent to all the air traffic control centres along the route. Once a strip becomes 'live' and the aircraft to which it refers is under active control, every salient detail about the flight, including heading changes, altitude clearances, speed restrictions, or special instructions, are added to update the basic printed information. Depending on traffic volumes and weather conditions, individual strips can get covered in annotations.

While practice of ATC is highly regulated, there is some scope for flexibility within the prescribed operating parameters. For example, a violent thunderstorm may require aircraft to fly alternative headings or request new altitudes, or an in-flight emergency

may necessitate giving the affected aircraft a priority approach. However, any disruption to normal flow patterns, no matter how seemingly slight, can have significant knock-on effects for the whole network.

Contemporary challenges

UK airspace faces a number of significant challenges at the beginning of the 21st century. Politically, national jurisdiction over sovereign airspace remains important (witness the controversy surrounding the alleged use of UK airspace by CIA 'rendition' flights) and politicians are very unlikely to do anything to relinquish any of that control. However, the issue is complicated by the fact that airspace is both a national and an international space, governed simultaneously by various domestic, European, and international laws. Airspace is also an important economic asset. Not only do commercial aircraft pay to use it, but a buoyant aviation industry arguably strengthens the UK economy and stops investment being lost to overseas competitors. Thus, the Government is caught between an economic imperative to increase airspace and airport capacity and an environmental commitment to reduce greenhouse gas emissions by 2030. Some have suggested building additional runways would reduce emissions by enabling aircraft to land immediately, rather than stack as they often do at present. Opponents however claim this would simply generate additional traffic and would lead to a net increase in flights and emissions.

The spatial geography of the UK also causes its own problems. As towns and cities have grown and airports developed, it has become apparent that many of them are in the 'wrong' place. Coventry airport is arguably too close to Birmingham, the short-lived EU-Jet commercial services from Manston in Kent caused problems for controllers owing to its proximity to other airports in the south east and its proximity to the boundary of foreign airspace, while the prevailing winds and resulting runway alignments at Heathrow, Birmingham, and Manchester often require aircraft to fly over densely-populated urban areas.

Increasing numbers of business aircraft are causing new problems too. To avoid the air traffic delays and apron congestion associated with major airports, many business flights operate from smaller airfields. However, this causes problems for air traffic control as these flights often need to 'cut across' the main flows of commercial traffic.

As ad-hoc business flights are not as regular or predictable as scheduled commercial traffic, business aviation creates sharp peaks in demand at particular airfields (and surrounding airspace) at certain times of the day or year. Changing tourist trends are also causing problems. The increasing popularity of 'Santa flights' to northern Scandinavia is changing air traffic flow patterns across the North Sea during the winter months, while the high frequency of low-cost flights from secondary airports in the UK is spreading airspace congestion across the country. In order to accommodate predicted future volumes of air traffic, a radical overhaul of the existing airspace structure is arguably required.

Possible solutions

In recognition that airspace is becoming increasingly congested, a number of capacity enhancements have been introduced. In February 2004, EUROCONTROL received formal backing from EU Governments to develop a 'Single European Sky' (SES) to increase capacity and harmonise the continent's fragmented airspace structure (whose 49 ATC centres, 31 national authorities, 18 hardware suppliers, 22 operating systems and 30 programme languages were causing severe delay diseconomies and costing the European economy nearly €2bn a year in lost productivity). In anticipation of the formal launch of the SES initiative, 'Reduced Vertical Separation Minima' (RVSM) procedures were introduced in European airspace in 2001. By halving the vertical separation distance between aircraft to 1000ft, six new flightlevels were introduced and airspace capacity increased by 15%. While critics voiced concern at the increased risk of mid-air collision, the new statistical rate of one collision every 150 years was considered 'acceptable'. To facilitate the formation of a single sky above central Europe, a new Central European ATS (CEATS) facility will become operational near Vienna later this decade to coordinate air traffic above Austria, the Czech Republic, Slovakia, Hungary, Slovenia, Croatia, Bosnia and parts of Italy, but it is questionable whether the UK Government would similarly sanction the transfer of control of its airspace to a foreign nation

Other technological advances, including the use of more sophisticated noise abatement procedures, continuous descent approaches (CDAs), 4D ATC, and precision navigation (PR-NAV) techniques have helped, but it is unlikely the political will exists to take the Single European Skies proposal to its logical conclusion – that

is, the creation of a single airspace structure and ATC regime for the whole of the continent. Indeed, while the EU's 'Flexible Use of Airspace' programme aims to abolish distinct areas of military and commercial airspace in upper airspace, and improve airspace efficiency by enabling aircraft to fly the shortest straight-line route from A to B, technological and geopolitical obstacles currently prevent its adoption at lower altitudes.

Other possible solutions have included introducing a differential pricing structure for airspace users whereby those that have paid the most are given preferential ATC treatment and awarded access to the 'best' (i.e. most direct) routes. However, this would create a 'two tier' structure enabling large carriers to buy the best routes thereby forcing smaller competitors to use longer, less efficient routes. Whether such a scheme is operationally viable, or even desirable, is open to debate. Others are placing their hopes on technological advances including new versions of TCAS (Traffic Alert and Collision Avoidance System), which will be able to give resolution advisories in the lateral as well as the vertical plane, new 'free flight' navigation protocols based on advanced GPS (Global Positioning Systems) software, and new generations of aircraft and aircraft fuels. Both Boeing and Airbus are promoting the environmental performance and 'green' credentials of their latest airframes, and several airlines are offering customers the opportunity to 'offset' the carbon emissions their flight generates. However, one of the most significant improvements to environmental performance could be achieved be revolutionising the existing airspace structure to enable aircraft to fly the shortest route between A and B and adopt the most fuel-efficient climb and descent profiles.

While the technology undoubtedly exists to revolutionise the existing airspace structure and make it more efficient, it is questionable whether the political will (and the finance) to enact such changes will be forthcoming. Until it is, we are left trying to accommodate 21st century volumes of air traffic in an airspace system designed in the previous century.