In association with Loughborough Students Velocity Society

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Heathrow ATC – 99.8% Capacity and BA38

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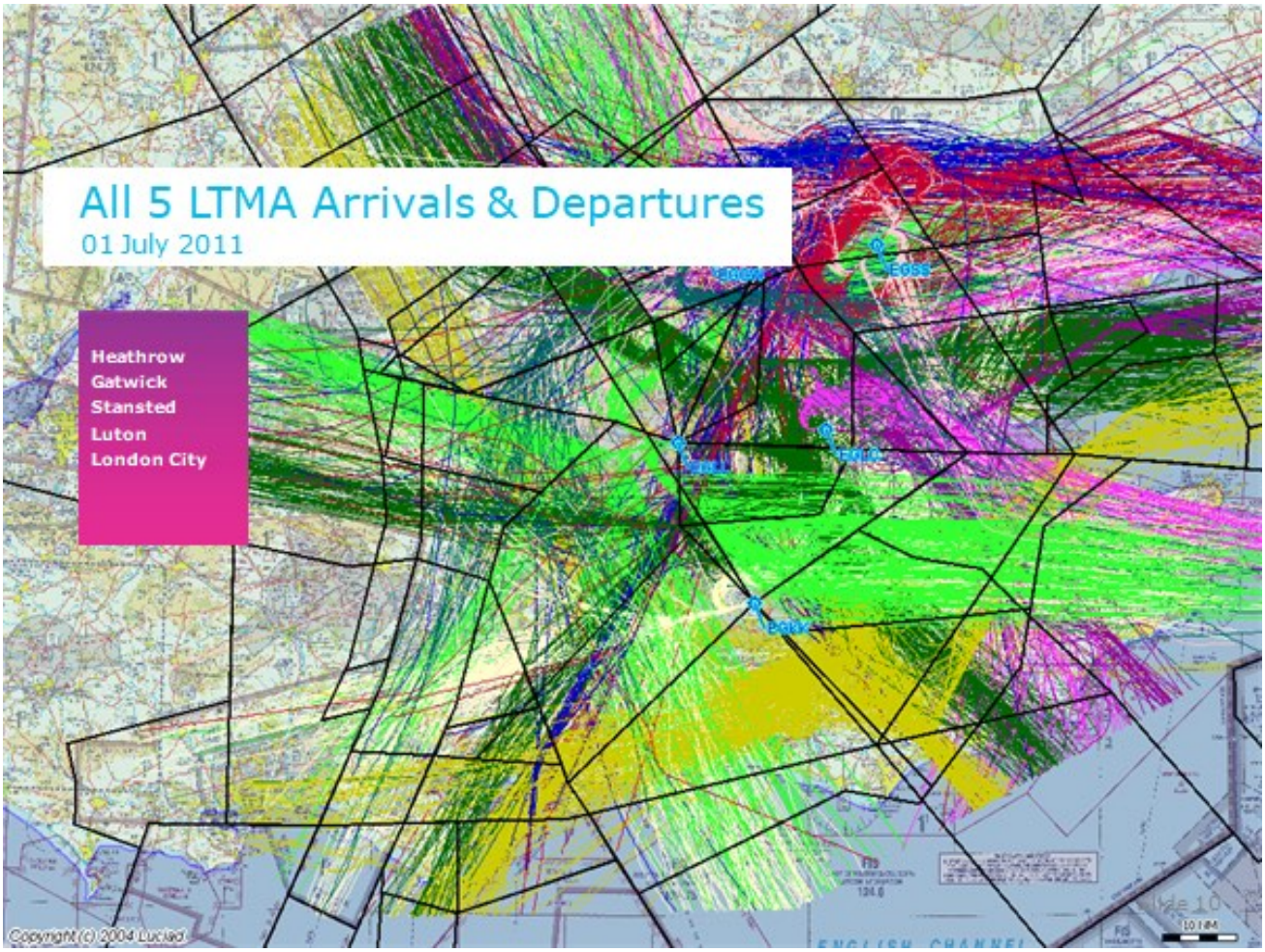
Our speaker was a NATS (formerly National Air Traffic Services) officer based in the London (Heathrow) Airport (LHR) air traffic control (ATC) crew, and who has accrued some 20 years of service. He is currently a senior member of the team, and has responsibilities for the training/ examination of staff, is associated with trialling new systems, and conducts regular shifts as a supervisor in the control tower. The latter is nowadays referred to as the visual control room (VCR). This is the hub of ATC activity at Heathrow, but is integrated too with local and area radar control facilities both on site, and at Swanwick, near Southampton. The latter has two elements: (1) the London Area Control Centre (LACC) which monitors and controls all flights over Southern England and Wales and (2) the London Terminal Control Centre (LTCC) which just deals with arrival and departures to and from airports in the London Terminal Area (LTMA) .



This 2-D map of the SE England area shows both departure and arrival tracks from five major airports in the region. The climbing and descending flows use vertical profiles determined by ATC to ensure aircraft are adequately separated at all times

His presentation opened with a description of the volume of traffic handled at London Heathrow (LHR) and from other airports in the South-East of Britain. All of them contribute to creating traffic in one of the most congested airspace regions in the world. Heathrow has two runways (and the

possibility of a third runway in the future) and is the busiest two-runway commercial airport in the world. The busiest day on record had 1,397 movements. He added that there can be 200 to 300 towed-aircraft movements daily, most are attributable to British Airways (BA) whose operations hub (Terminal 5) is at the west end of the airport, and whose engineering and maintenance base is at the east end.

Heathrow is one of four major airports in the London area – alongside Gatwick, Stansted and Luton. There are significant additional airports, notable Farnborough (largely business jets) and London City Airport (dedicated to smaller-capacity commercial operations). All this traffic require similar procedures as they arrive and depart along the same routes. It was pointed out that the major routes are almost unchanged from the airspace configurations evolved in the era when now often defunct radio navigation aids were used to define reporting points (NDB[1] has not been used for a long time and VOR/DME beacons are being dismantled, and not replaced). Almost all functions performed by these radio-based aids, and existing landing guidance systems, are now attainable with GNSS (Global Navigation Satellite Systems).

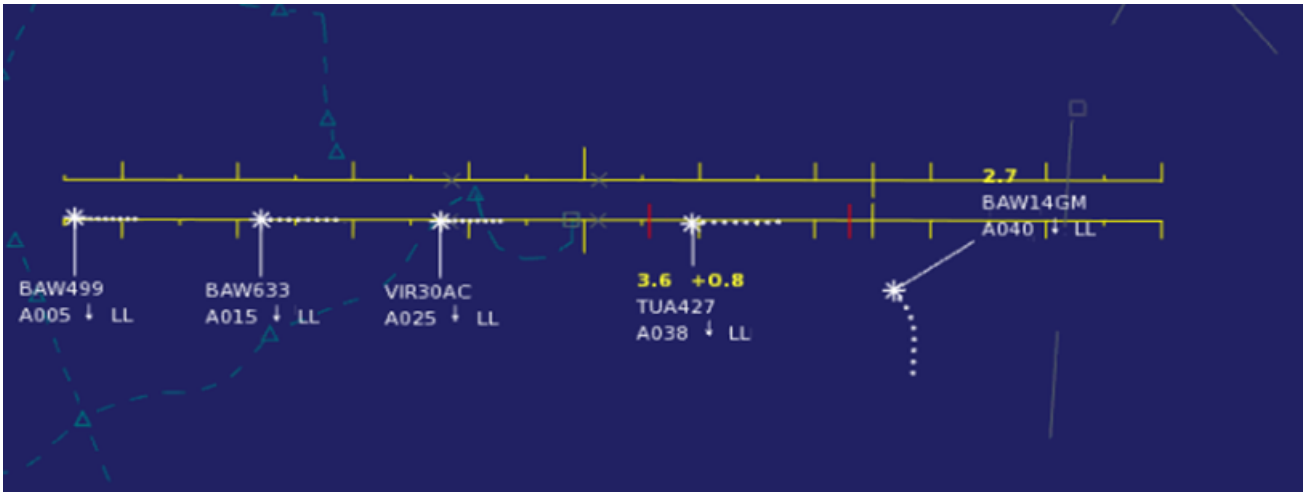
The newer systems can provide position and vector information very accurately and effectively throughout the world, and are expected to be the core element of future airspace system procedures that will maintain safety and deliver capacity requirements as civil aviation demand continues to rise. The first examples of GNSS based routes used in the UK are used by traffic arriving and departing from London City Airport. His expectation is that (if or when) the third runway is introduced at Heathrow, the new systems will deliver flexibility that is not possible with existing control methodologies. There was an air of optimism with regard to what the future has to offer.

We were provided with an example of how much effort is being expended to ensure airspace is used productively with an insight that described a time-based separation process of aircraft on approach at LHR. This has been a recent development in which the speaker had been involved.

In the majority of ATC systems the spacing of approaching aircraft is based on a minimum separation distance being maintained behind successive aircraft on approach, The separation criteria have evolved from experience and take into account the aircraft speed and the strength of 'wake turbulence' behind aircraft. Approach capacity determines an airport's ultimate capacity. In search of a reliable way of reducing separation criteria researchers have re-categorised parameters and, after trials on simulators and at LHR, now define 120 aircraft categories and apply a 120 x 120 matrix (14,400 possible values) that justify separation minima between successive aircraft. It is not surprising that the job is assigned to a computer, not a controller. However, the controller is assisted, not replaced.

Describing what we saw may seem to describe something mundane, as it was a radar screen on which approaching aircraft were visible with an identifying 'tag' and a trail that was updated on each rotation of the radar: all very conventional looking. The spacing of trail points shows speed (the closer the trail spots - the slower is the aircraft). The governing feature was a faint red line either on, or ahead of, an aircraft. This shows where the computer has assessed that the aircraft could be – the point to stress is that this is a time-based (not speed based) assessment. It guides

[1] NDB is non-directional beacon, and VOR/DME is very high frequency omni-directional range (VOR) co-located with distance measuring equipment (DME). These systems evolved in the later 1940s.



A computer assessed time-based separation system has led to two red lines (exaggerated on the diagram) as they appear on a controller's radar screen. The runway is to the left and in the approach stream the fourth and fifth aircraft (the latter still closing on the centreline) have a line showing there is room to improve the possible arrival rate. Trials have suggested up to three extra arrivals per hour can be achieved over traditional speed-based criteria.

the approach controller to reduce the separation where that is safe, and hence improves the runway arrival rate.

A useful analogy quoted was that long-standing procedures were akin to the often seen use of chevron symbols on a road – telling cars to maintain a 'safe distance' of two chevrons would result in a reduction in capacity by 50% if cars were travelling at 30mph instead of 60mph. A time-based system will maintain a steady flow, provided each aircraft maintains a steady speed – that is the advantage of a time-based flow over a fixed-separation flow.

Trials were reported to be attaining an average separation reduced from 5nm to 4.2nm and shown capable of maintaining up to 40 arrival movements per hour. The ATC target for movement rate at Heathrow is 38 movements per hour. Having a lower movement rate causes delays that contribute to considerable disruption on landside – stand allocation disturbed, passengers unable to make connections, missed hotel arrangements, etc. Attaining a 5 per cent capacity improvement is invaluable to the airport business case.

The final part of the presentation centred on an emergency that occurred on 17 January 2008. Scene-setting required reference to circumstances from over a month previously, on 8 December 2007. The ATC team had only recently moved into their new premises, a high and slender control tower that had the VCR. It had been necessary to provide an uninterrupted view of each runway from threshold to threshold, and most of the apron stands on the airport. The building had two lifts, one was external and the other was internal, and there was an internal staircase – that comprised some 480 stairs.

On 8 December 2007 the speaker arrived for duty in the VCR early that morning. He was alone and chose to use the external lift (reputedly the least-used and more reliable of the elevators). He described vividly the angst of being incarcerated in the lift when it ground to a halt about half-way up the tower. He had left his mobile phone in his locker, and could not call anyone or be contacted. This meant that the crew in the VCR were awaiting their supervisor, failed to contact him, and were unaware of his problem until, as the sky lightened, the crew member of an aircraft taxying by radioed that someone was waving from the tower elevator. A rescue team was delegated and the speaker, still in the elevator, soon realised that the lift cabling was being wound-up to the VCR inch-

This view of the control tower 'stalk' and visual control room (VCR), at the top, also shows the external elevator (red) that played an unwanted part in events when an aircraft emergency occurred

by-inch. Eventually, he arrived at the VCR after some 4 hours in the chilly metal cab. The lift was to be a contributing factor to how services were to be affected several weeks later.

The external lift was still out of service on 17 January 2008. It was also the case that, on that day, the internal elevator was also defunct, so all staff using the VCR had to endure the 480-step climb to their place of work. The VCR crew were effectively incarcerated in that, if any assistance was to be needed that day, additional staff would have to race up the 150ft high tower's stairwell.

It was a clear winter day, the temperature was mild and there was no snow or ice - no likelihood that this would be anything but a normal day at work for ATC staff and aircraft crews. The runways were busy as usual at Heathrow as the clock ticked towards 1300hrs. Arriving aircraft were being monitored on radar as they came down the approach to runway 09L (the 'south' runway), and departing aircraft were using runway 09R (the 'north' runway).

A British Airways B777-200 (flight BA38 – callsign 'Speedbird 38') was among the aircraft on approach, and arriving from Beijing with 136 passengers and 16 crew. About 2nm from the runway threshold – only 45 seconds from landing –- the crew experienced an un-commanded roll-down of power on both engines. This was sudden and unexpected, and caused the crew to initiate emergency checks and complete necessary actions. The ATC staff were unaware of any issues as the captain on the aircraft conducted the checks that were essential to ameliorate the impact of any likely failure. The first officer was the handling pilot and having disengaged the autopilot he took manual control. The aircraft was losing speed so the flaps were partially retracted to reduce drag, and the pilot lowered the nose to maintain adequate speed, but the crew were now much closer to the runway and realised the aircraft did not have sufficient energy to complete the approach.

South-easterly view from the VCR towards 27L threshold

At this time one of the VCR control team had noticed the aircraft was approaching nose-up and looked to be descending more rapidly than was usual. The aircraft was only 10 seconds or so from

Aerial view of LHR showing points at which BA38 impact occurred (small cross) and where it stopped (larger cross)

the runway when a 'Mayday' call (with a false callsign[2]) was heard on the radio. The aircraft gradually slipped below the glidepath, and was very low when it overflew the Hatton Cross underground station, adjacent road and airport boundary fence. It landed with a high descent rate, within the airport boundary, and partially on the runway safety area, where there were frangible landing lights and an area of low strength pavement. There was considerable airframe damage that resulted in the injury of three passengers who were in seats adjacent to the main landing-gear. At impact the aircraft had swerved away from the runway and stopped in a short distance. It had shed one main landing gear and one engine and pylon was almost detached, although the impact had been slightly moderated by the soft ground and grass. Fire crews had been mobilised by the VCR team and as the aircraft had impacted within the airport boundary both tenders and ambulances were able to reach the aircraft using hard surfaces on the airside. Their tracks had to be segregated from where aircraft were being redirected, but their prompt arrival to lay foam, minimising the possibility

BA38 several minutes after accident - fire tenders present and foam is around the aircraft. The left main landing gear is visible in background to the left - the nose gear and remaining main gear were collapsed and remained under the aircraft.

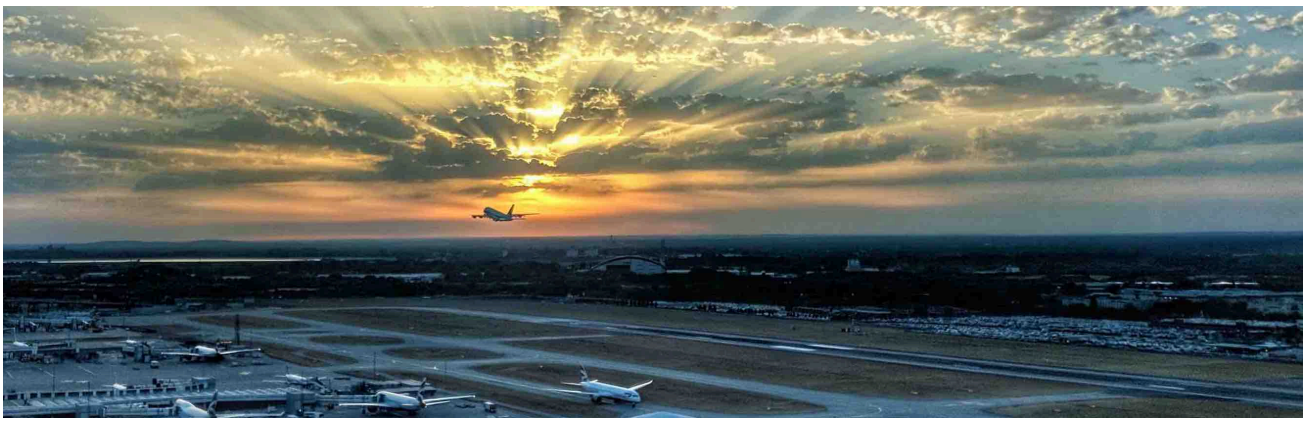
[2] The crew call stated 'Speedbird 95' – the callsign that BA crews used in emergency training : the ATC team had no doubt it was BA38 however and appreciated the stress the crew were under.

of spill fuel igniting was vital, as was having all passengers taken away quickly.

This was an emergency landing that had turned into a crash – the aircraft was written-off. It became known only after investigations that engine power had been lost unexpectedly and suddenly because ice accumulating in fuel pipes had caused the engine power roll-back. The aircraft had crossed Siberia at high altitude and the fuel tank temperature had been much lower than was normal during the flight. Until this incident there had been no reason to believe that the circumstances could occur, and have such a significant effect.

Crash over … but for ATC an emergency of this scale has many repercussions. Our speaker was at the hub. He, and colleagues, had seen the aircraft crash and come to halt without any sign of fire, and knew immediately that all aircraft movements on the airport were about to be affected too. They needed extra staff in the VCR immediately – and, called upon, they arrived from the ground floor as soon as they could – but climbing 480 steps took some time. The petulant lifts contributed to some overload in the early stages, but the VCR did accrue the extra crew that were needed.

The passengers in aircraft in departure queues, and those expectant passengers at terminal gates, were about to be affected. ATC had to clear the north runway of departures as it was essential to accommodate aircraft already expecting to approach runway 27L. The arriving aircraft had to be diverted to runway 27R, but the aircraft immediately behind BA38 was a Qatar Airlines flight, and so close to the airport that it was instructed to do a go-around. The next aircraft in the arrival stream was a BA aircraft, which, although already close to the airport, was vectored to land on the cleared north runway. As the cloud base was about 1000ft, this aircraft's visual contact was only 3nm from the runway threshold, and required an S-manoeuvre that one would hardly ever see an airliner conduct. Later aircraft were handled similarly, eventually having longer and more straight approaches, and for the rest of the day the movement rate was reduced. After a period of arrivals only, the north runway (09L/27R) was in mixed-mode use with arrivals and departures movements integrated. ATC had to review all the planned operations and decide which inbounds were committed to LHR, and which had to be regarded as unmanageable. Some could be diverted elsewhere, but the prioritisation from there would be through Swanwick LACC.



An aircraft departing LHR to the west from runway 27R

In the Heathrow VCR the decisions were being made in principle, but implementing a plan that would minimise the impact on all inbound and outbound operations still a long way from LHR required coordination with Swanwick LACC. An early call was made, first to declare the operation was now a one-runway airport. Inbound aircraft that could as diverted to where there was the

capacity to handle them was coordinated by the emergency team and was likely to affect a large number of SE England airports.

We were able to listen to the radio recordings of the events at LHR as they had occurred, and with associated radar based real-time schematics. There was also a recording of several other vital aspects, including the ground-controller in the VCR re-routing taxying aircraft, and the mix-up when a trainee picked up the telephone at Swanwick and misheard 'crash' as 'flash' – subsequently causing delay, but thankfully not affecting safe operations.

As the south runway was unusable for landings until the BA38 aircraft – soon classified as wreckage - was removed, and damaged fencing, landing lights and runway related navaids, were repaired, the south runway was unusable. It was about four days later that the runway could be used for take-offs, but to protect contractors working on the repairs it had to operate with a considerably displaced threshold. That limited usage to short and medium range operations, so long-haul operations that require more runway length still used the north runway, causing disruption to the arrival stream. These issues, almost wholly coordinated through the air traffic system, often go unnoticed. It was made very clear that Heathrow, which attains traffic levels acknowledged to be 99.8 per cent of the theoretical maximum capacity, were certainly affected, but impact was minimised in the aftermath of the BA38 accident.

The lecture enlightened everyone present to the considerable scale of ATC facilities, in situ and in surrounding units that contribute numerous skills. The presentation avoided many of the formal aspects that govern ATC-related operations, and that simplification can only be commented on in an appreciative way. This was a well-balanced survey of the profession and the selected example of 'a bad day at the office' was a prime example of a major incident handled with minimal fuss and illustrating how the events that involved one aircraft and one corner of Britain's largest and busiest airport were so well managed. Around 120 attendees were well aware that this had been enjoyable and enlightening and a much appreciated presentation.

Lecture notes by Mike Hirst