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## **Airline innovation and sustainability: a systems perspective**

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### Abstract

Air transport has been the scene of remarkable and rapid innovation since man first controlled powered flight in Kitty Hawk in 1903. Significant developments in aviation technology, for example, the onset of the Jet Age, tend to dominate popular perception of aviation innovation. The commercial airline industry is hugely complex and inexorably tied to our economic, social and technological systems. Consequently, it is also on the leading edge of the sustainability debate. Modern air transportation has developed into a hugely complex system in a relatively short time. That rapid development and complexity, however, offers insights into how the industry can address the challenges of sustainability.

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# Airline Innovation and Sustainability: A Systems Perspective

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## Abstract

Air transport has been the scene of remarkable and rapid innovation since man first controlled powered flight in Kitty Hawk in 1903. Significant developments in aviation technology, for example, the onset of the Jet Age, tend to dominate popular perception of aviation innovation. The commercial airline industry is hugely complex and inexorably tied to our economic, social and technological systems. Consequently, it is also on the leading edge of the sustainability debate.

Modern air transportation has developed into a hugely complex system in a relatively short time. That rapid development and complexity, however, offers insights into how the industry can address the challenges of sustainability.

When originally conceived, airports grew organically in major population major centres and sea ports and air routes were determined as much by available technology as passenger demand. Despite immense innovation, global political change and growth in passenger, true step change in the industry is rare. The promise of supersonic passenger aircraft appears to have died with the Concorde in 2003. A victim of more if it's high operational costs, noise pollution and its inability to adapt to new routes and passenger demands than the 2000 Paris disaster.

Taking a systems perspective, we analyse how decisions to adopt new aircraft types and establish or change routes can have far reaching consequences for airlines system. Using the development of the Kangaroo Route between Australia and

Europe as a case study, we examine how a systems approach can be applied to complex global problem, to identify and consider the power of suppliers and constraints that the changes may introduce to other routes. It finds that a systems perspective can better prepare the industry for the challenges of sustainability.

Growing organically from major population centres and natural sea ports established well before the development of the aeroplane, major airports have established themselves as key economic drivers. These ports, London, Singapore, New York, and Los Angeles, for example have become 'superpowers' in the aviation world. However, this does not necessarily mean that their hegemony is guaranteed for all time. The recent growth of Middle Eastern airlines, and their hub ports in Abu Dhabi, Doha and Dubai illustrate that 'non-traditional' ports and routes can be established and successful.

Sustainability is one of the greatest present challenges for the industry. Dwindling oil reserves, increased community focus on reducing environmental impacts and global economic changes are confronting airlines and the industry.

This paper considers the development of the Kangaroo route and the determinants which influence the stop-over points and, now, hubs on the route. The key focus hub of this paper is Singapore. When the Smith brothers first flew the England–Australia route in 1919, the journey included around 20 stops. Today, the same journey can be made with just one stop-over – in Singapore. While Darwin has lost its position as the key departure or entry point to Australia; meaning a longer flying time between the key ports of Sydney or Melbourne, Singapore has consolidated itself as the key hub on the Europe–Australia route.

In the nearly 100 years, since the route was pioneered, significant geo-political, economic, technological and social developments have occurred. Yet despite these changes, Singapore has consolidated itself as a key airline hub not only for South East Asia, but for Asia more broadly as well as Australia and the South West Pacific.

Only very recently has the hegemony of Singapore been challenged by developments in China and the Middle East.

This paper seeks to assess the key determinates that placed Singapore as the key hub port in South East Asia and why it has remained so despite enormous developments in technology, political changes, economic development.

## **Pioneering Development 1919 – 1934**

The Kangaroo route is one of the primary routes between Australia and the Europe. It connects Australia through Singapore to London. The routes origins date back to the earliest air route between Australia and the UK but it wasn't until December 1947 that the national carrier, Qantas (then Qantas Empire Airways) first flew the route.

Despite, or because of, its isolation from the rest of the world, Australia was quick to pioneer aviation in the years following the First World War. Considered still very much part of the British Empire, Australians looked to the sky to bring their own continent and 'Mother England' closer. The early years of aviation in Australia are characterised by route surveys, air taxi trips and joy flights.

However, these activities did not guarantee the future success of the fledgling enterprises, often operating in the remote outback of Australia. It was winning federal government air mail tenders that meant survival for the first air services (Qantas Airways Ltd, 2005).

The airmail tenders sought to link remote towns with railheads and, most importantly, the new Commonwealth with the rest of the world.

Keith and Ross Smith completed the first flight from UK to Australia in a Vickers Vimy in December 1919 (Copley, 1976) as competitors in the England - Australia Air Race. These early flights were largely competitive and sponsored either by the Imperial government in United Kingdom or the Australian government.

The England - Australia Air Race prize of £10,000 was offered by the Australian Government with stringent rules including:

- Australian aircrew;
- Flight hours of not less than 720 hours;
- Aircraft had to be built entirely in the British Empire
- Flight had to be completed in the same aircraft that left England (Copley, 1976)

These conditions were checked at a control point in Singapore and when landing in Melbourne.

The flight path and timing was determined entirely by the available technology. While the Vimy was the most suitable aircraft available for the journey, its primitive navigation equipment prevented long distance visual night-flying. Its cruising range was 2,400 miles (Copley, 1976). Long transits over open seas were avoided in case mechanical problems or poor weather forced a potentially fatal ditching into the ocean.

The route taken by the Smith Brothers is shown on Figure 1 on Appendix 1. While much of the route was determined by the range of the aircraft and the factors discussed above, it should be noted that, once out of Europe, the route followed the then British Empire (and Protectorates) from Egypt through Iraq, British India (including modern day Pakistan, India, Bangladesh, Burma), Malaya and Singapore.

The route taken by the England-Australia Air Race was to become the de facto air route between the two nations throughout the interwar period and was then known as the Empire route (Leonard, 1994). Qantas founders, Hudson Fysh and PJ

McGinness originally set out to compete in the race. That dream died with the untimely death of their benefactor, Sir Samuel McCaughey and they found themselves instead surveying an air route for the competitors between Darwin and Longreach (Benns, 2009).

The air route between Australia and the rest of the world quickly established itself through Darwin. However, the primacy of Singapore as key link was by no means guaranteed. Flights on the route still passed through the Indonesian archipelago and Timor before landing in Darwin. In 1931, KLM launched an experimental route between Europe and Melbourne via Batavia in the then Dutch East Indies (Benns, 2009). Qantas Founder and then Chairman, Fergus McMaster wrote:

“One of the principle questions is the possibility that Port Darwin will be made connecting point either by a direct service from England, or by a more immediate connection by the Dutch company (KLM).” (Gunn, 1985)

British based Imperial Airways was already operating a regular scheduled service between London and Karachi with a planned extension to Singapore via Delhi. Imperial also planned to extend the route to Australia (Leonard, 1994). An experimental Imperial Airways airmail service between London and Australia crash landed near Koepang, Timor (Thomas & Forbes-Smith, 2004). However, the impetus for an air route between England and Australia was unstoppable. By 1934, Qantas had formed a joint venture with Britain’s Imperial Airways to operate the mail service from England to Australia with Qantas flying both the Singapore–Darwin and Darwin–Brisbane legs (Thomas & Forbes-Smith, 2004).

The tender for the international route had been strongly contended by the three major Australian aviation companies since the early 1930s. Norm Brearly’s Western Australia Airlines (WAA) preferred a route via Wyndham and connecting with the KLM service through Batavia. At that time, KLM has been planning a Batavia – Wyndham service (Fysh, 1965) which would have provided a proven, reliable and inexpensive air route to Europe. Meanwhile, Kingsford Smith’s Australian National Airlines (ANA) pressed for a Brisbane–India route via Darwin. (Gunn, 1985).

The three key Australian airlines (Qantas, WAA and ANA) were individually too small to operate the route but failed to reach an agreement on any amalgamation that would have enabled an Australian company to do so. Qantas moved closer in interests to Imperial Airways. In 1933, Qantas was seeking a plan from Imperial Airways which would

“allow for the amalgamation of the two concerns on a basis acceptable to Qantas, the Commonwealth Government, and the Australian people who wanted an Australian service from Brisbane to Singapore” (Fysh, 1965)

The Australian public and government clearly favoured an air route through the British Empire. For their part, the British government could also have made any route through Dutch territory difficult. International routes required international negotiation and KLM was dependant on British cooperation for their Amsterdam –

Batavia route (Gunn, 1985). As Qantas's Hudson Fysh warned WAA's Norm Brearly during amalgamation negotiations:

"The British government and public would be for an all-Red Route and personally, I think it an essential for Empire reasons" (Gunn, 1985).

In a similar vein, Qantas Founder and Director Fergus McMaster wrote to his fellow directors:

"I am definitely against linking with the Dutch service at Batavia. This Empire link should be all British in every way and should connect with Imperial Airways at Singapore, Wyndham or Darwin" (Gunn, 1985).

Moreover, the Australian government wanted all possibilities of the Empire route explored before it would agree to a link with the Dutch through Batavia (Gunn, 1985). While Singapore firmed as a first stop outside Australia on the Empire route, government policy at the time was for the internal air route to follow the established course from Darwin through Charleville and terminating at the midpoint of the rail link between Melbourne and Sydney at Cootamundra. (Gunn, 1985).

It is clear the key determinants for the establishment of Singapore as a critical hub on the England Australia route in the pioneering years of aviation were:

- Its location within flying and operational range of contemporary aircraft departing Darwin – the key entry/exit point to Australia. This also precludes alternative routes with long over water sectors;
- Bias toward British Empire ports on the route, supported both by Australia's cultural heritage, investment reliance on British finance and government policy in both Australia and the UK;
- Not least because the Qantas/Imperial Airways joint venture Qantas Empire Airways won the first airmail tender preventing any air link through Batavia.

### **Consolidation of the Empire Route 1934 – 1939**

Following award of the airmail route through Singapore to Qantas Empire Airways, the British government and Imperial Airways sought to consolidate British interests to the exclusion of the Dutch and any other foreign company on the route (Gunn, 1985) and further consolidating Singapore's position.

Political developments continued to dominate development of the Empire Airmail route throughout the remainder of the 1930s. However, while air technology developed rapidly with the range, size and reliability of aircraft improving, Singapore remained as the first port of call outside Australia.

When QEA first won the tender for the Empire Airmail route, its single engine aircraft were unable to fly the Singapore–Darwin sector (Byrnes, 2000) and it wasn't until the delivery of the four-engined DH86, in 1935 that it first flew the route. The four day route still took the aircraft through Koepang, Rambang (Lombok) and Sourabaya (Java) before landing in Singapore (Leonard, 1994).

With the growing threat of war in the late 1930's, the British were anxious to consolidate their hold on the Empire Air Mail route using flying boats (Gunn, 1985). The Dutch were keen to extend their air route to Darwin and, of course, Australia – Singapore route had to fly through the Netherland East Indies (now Indonesia). Nevertheless, strong pro-British sentiment continued influence both public and private decision-making on both the route and the choice of aircraft used.

Table 1 shows the variety of aircraft was used initially on the Empire Air Mail Route.

Aircraft	Pax	Range (nm)	Sector	
Handley Page Heracles	42W38	435	London - Paris	
Short S17 (flying boat)	Kent (flying boat)	16	391	Brindisi - Alexandria (Paris - Brindisi was a rail link)
Handley Page Hannibal	42E24	435	Cairo - Baghdad - Sharjah - Karachi	
Armstrong Atalantus	Whitworth9	557	Karachi - Jodhpur - Rangoon - Singapore	
De Havilland DH86	10	640	Singapore - Australia	

Table 1: Aircraft on Empire Air Route 1935

While all the aircraft were British built, new technology and new sources were developing. Edgar Johnston, Head of Civil Aviation had approved acceptance of American Certificates of Airworthiness by Australia following a visit to England and the United States in 1936 (Gunn, 1985).

The American designed and built DC-2 and DC-3 entered domestic Australian service that year (Gunn, 1985). The DC3 is considered to be the world's first modern airliner. Its forerunner, the DC-2 had contested in the 1934 MacRobertson Trophy Air Race (Dick & Patterson, 2007).

Stretching from Mildenhall, northeast of London, to Melbourne, the air race was the longest course in the world. The route comprised twenty-seven refuelling stops of which five – Baghdad, Allahabad, Singapore, Darwin and Charleville – were compulsory (Verhovek, 2010).

The DC-2 incorporated new technologies including variable speed propellers, retractable landing gear, powered braking and wing flaps (Thomas & Forbes-Smith, Qantas Flightpaths, A tale about and airline and an industry, 2004). Able to carry 14 passengers, the DC-2 was the Douglas Aircraft Company's response to the ten-passenger, twin-engine Boeing 247 (Verhovek, 2010) which it beat into second place in the race, itself being beaten by a specially modified two seater racing plane; the de Havilland Comet (Thomas & Forbes-Smith, Qantas Flightpaths, A tale about and airline and an industry, 2004).

The DC-3 could carry 21 passengers at an average speed of 170 miles per hour (Dick & Patterson, 2007) compared to the DH86. The DC-3 introduced speed as a key factor in airline costs. Better streamlining allowed operators to reduce both

crewing and maintenance costs as a result of the faster travelling times for a given sector (Thomas & Forbes-Smith, Qantas Flightpaths, A tale about and airline and an industry, 2004).

The Empire Air Services Act (Cwlth, 1938) gave control of the Singapore–Darwin sector of the Empire Airmail Route to Australia (Gunn, 1985) with QEA as the sole air service provider.

Singapore had become entrenched as a key stop on the Empire route. However, with the growing threat of war in Europe and the Pacific, the future of the Empire air route was not assured. With the fall of Singapore in 1942, a new route emerged that would, briefly, provide the vital link between Australia and Europe.

### **Clash of Empires 1939 – 1945**

The declaration of war in September 1939 threatened the safe and predictable air route, first established in December 1934 between Australia and Europe (Gunn, Challenging Horizons, Qantas 1939–1954, 1990). With fall of France in June 1940, the sector across the Mediterranean was severed and the route was immediately rerouted via Cairo to Durban, South Africa and then to Sydney.

The Australian Government and QEA had already begun assessing various alternative routes in including trans-Pacific routes via Auckland and Noumea with onward links to the UK via Canada.

In June 1939, a survey flight was undertaken across the Indian Ocean as a possible alternative defence route. The flight path took it from Sydney via Port Hedland via Cocos, Chagos and the Seychelles and on to Mombasa. The longest leg was the 2,600 from Sydney to Port Hedland.

It was not only Singapore that was lost to QEA and Imperial when the Japanese invaded South-East Asia. In late 1941, QEA stopped flying to Bangkok and Penang while the route to Rangoon was modified to avoid the Burma coast and Dili. (Gunn, Challenging Horizons, Qantas 1939–1954, 1990). While a fragile link still existed between Darwin and Karachi as late as February 1942 by mid-March the route was altogether cut (Gunn, Challenging Horizons, Qantas 1939–1954, 1990).

The spread of the Japanese across South East Asia forced further changes to the plan with the proposed route linking Port Headland to Trincomalee in Ceylon or Bangalore in India.

Initially, chief difficulty in establishing the alternative Indian Ocean route was not the distances involved by the availability of suitable aircraft. Qantas had all but two of their Empire flying boats pressed into military service and its remaining available land plans were unsuitable for the route. All Dutch civil aircraft had been handed over to United States for their use. Lastly, civil aircraft production in the United Kingdom was halted as the industry focussed on the war effort. (Gunn, Challenging Horizons, Qantas 1939–1954, 1990).

However, the United States was producing both civil and military aircraft and, as Australia looked to the United States for assistance in the war effort, Qantas looked to the Americans as a source of suitable aircraft. Despite the war effort, the United States remained well advanced in both civil aircraft design and was already looking to dominate world aircraft production in the post war years. However, both the British and Australian authorities feared American hegemony on Pacific and Atlantic civil routes. In August 1942, the Americans announced plans that United Airlines and Pan American would use DC3 and DC4 aircraft to Australia and India at least thirty times weekly.

The Australian government was also looking to the post-war aviation world. The Director-General of the Department of Civil Aviation A B Corbett had outlined a plan for twenty two hubs, each with a radius of 300 miles. This, he reasoned, would allow a minimum daily service for any inhabited place in Australia. Mails would also be delivered between two hubs within a day. The Corbett Report was criticised for failing to adequately address international routes and the immediate needs of an Indian Ocean route was settled by the UK Director General of Civil Aviation.

Two American aircraft types were considered suitable, the PB2Y3 or PB5 (Catalina) Flying boats and the B24 Liberator. The Catalina could fly the Australia – Ceylon sector non-stop with up to eight passengers and a ton of freight. Survey flights between Exmouth Gulf and China Bay, Ceylon had been operated by Dutch (military) Catalinas following the Japanese advance into the Dutch East Indies during 1942 and 1943.

Aircraft	Pax	Range (nm)	Comment
<b>PBY2Y3 / PBY5 Catalina</b>	3	2,520 <sup>1</sup>	Accepted route payload 1000lb Distance flown Perth – Lake Koggala Ceylon 3,513 miles
<b>B24 Liberator</b>		1,800 <sup>1</sup>	Accepted wartime payload: 5,500lb Distance flown Learmonth – Colombo: 3,077 miles

<sup>1</sup> General performance characteristics

Table 2: Aircraft Specification for Indian Ocean Route 1943–1945

The RAF flew seven Catalina survey flights in May 1943, establishing Perth as the preferred landing place for regular services. Although Exmouth is 500 miles closer than Perth, it offered less favourable weather conditions for optimal loads.

The Indian Ocean route operated from 1943 until July 1945.

The key challenge facing the development of international routes in the immediate post-war period was the limited number of aircraft available in Australia for civilian use. The government had identified routes into China, the Philippines and New Guinea while QEA's obligations on the Empire route, while suspended, remained. More importantly at the time, a second perceived threat to Australian aviation was

developing. That came, not from the Japanese empire, but from the emerging American commercial aviation. With the collapse of the British civil aircraft industry, both the Australian and British governments were keen to ensure the re-establishment of the British industry after the war while building on developments and links with the US industry.

The selection of both British and American aircraft considered for the early post-war years demonstrates the progress of the American industry (refer Table 2 below). The British aircraft were all developed from military aircraft. The Avro York, for example, was based on the hugely successful and iconic Avro Lancaster heavy bomber. The Short Shetland was purposely designed for military use and did not go in production for either commercial or military use.

In contrast, the American designed DC4 was developed from the highly successful commercial DC-3. The DC-3 had been developed as a commercial aircraft for American Airlines in 1934 (Thomas, It Taught the World to Fly, 2010).

Similarly the Lockheed Constellation was designed initially as a commercial aircraft for TWA in 1939 and was converted for military use during the war. It was not available to Australia operators until the 1950s.

Aircraft	Pax	Range (nm)	Comment
<b>Avro York</b>	56	2,600	
<b>Handley Page 64</b>			
<b>Bristol Buckingham</b>	4	2,000	Designed and built as a medium bomber. Poor performance and developments in aircraft design resulted in discontinuation of this aircraft
<b>Short Shetland</b>	70	3,835	Only two prototypes built. No orders for the Series 2 Commercial variant received
<b>DC4</b>			
<b>Curtis Commando</b>			
<b>B24 Liberator</b>			
<b>Lockheed Constellation</b>			

Table 2: Aircraft Considered for Post War Overseas Routes 1943

“The war has to win and cleaned up before much else can be done other than look out that British Empire Aviation, which includes our Dominions, is not left on the doorstep while other more virile and perhaps less scrupulous [organisations] get a flying start.” Fergus McMaster quoted in (Gunn, Challenging Horizons, Qantas 1939–1954, 1990)

Fysh paper 'Postwar Overseas Air Transport as Affecting Australia' – first step was for the Empire to reach agreement and then to cooperate with the United States p141

1919 Paris convention in which the right of Innocent Passage was described as the right of one signatory to over fly the territory of another signatory. Non-ratifying countries withheld that right (the US was a signatory to the convention but did not ratify it.

Empire agreement seen to include Australia, New Zealand, Canada and India p141

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