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Presidential Address delivered before the Royal Society of New South Wales on 9th April, 2003.

Publish and Perish

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Abstract: Two major celebrations will occur during this year, 2003. The first is the bicentenary of the publication of the first Australian newspaper, the 'Sydney Gazette and NSW Advertiser.' The other major event will be celebrated at the end of 2003, with the centenary of powered, controlled and sustained human flight. Although the Wright Brothers' flight was an American success, their achievement was initially based on the work of other pioneers. The work of those earlier pioneers became available to the Wrights through the medium of print. This paper explores some of the Australian linkages between the written word and those early aerial endeavours.

Keywords: Australian aviation, Lawrence Hargrave, Wright Brothers, human flight

INTRODUCTION

As well as celebrating the bicentenary of the first publication of Australia's first newspaper, and the centenary of powered, controlled, sustained human flight, another anniversary has been acknowledged in Sydney. The 170th anniversary of the formation of the Sydney Mechanics' School of Arts was celebrated on March 22nd. Three dates commemorating three forms of human communication: newspapers and the written word, schools of arts and the spoken word and the final form of efficient, personal communication, by aerial navigation.

Academics are urged to publish their ideas, otherwise they may perish. Early Australian pioneers in aeronautics often published their ideas in the press and later through the journals of learned societies. Although some ideas may have lasted, most of those pioneers have been long forgotten, as they published and perished.

The first local newspaper was the 'Sydney Gazette and New South Wales Advertiser', which first appeared on 5th March, 1803 and had disappeared by 1842. Another paper, 'The Australian', lasted from 1824 until 1848. The 'Sydney Herald' began in 1831 and continues to this day as the 'Sydney Morning Herald'. Those and several other newspapers provided the medium for the circulation of ideas through the Colony. Some articles on aeronautics fired the imagination of local people, while other correspondence was apparently ignored. Practical understanding and skills as well as ideas, were soon needed in the Colony and a means to help ideas along the next step was provided through adult education.

Schools of Arts were a key element in the movement to educate the adult population, which began in Britain during the latter part of the 18th century. The first such schools or Mechanics' Institutes in Britain, were formed in 1821 in Edinburgh and Glasgow and London by 1823. The Sydney Mechanics' School of Arts was the second in Australia, formed in 1833. The first in Australia was the Van Dieman's Land Mechanics' Institute, which was founded in 1827, but unfortunately no longer exists. The Institutes provided adult education by way of lectures and the maintenance of a library. Many of the lectures were described in some detail in the local newspapers, thus increasing the spread of information to the wider community.

Mechanics' Institutes were created to provide the means for intellectual stimulation for the community through a multitude of subjects, from astronomy to chemistry, phrenology and beauty to language. Mr Arthur A'Beckett's fourth lecture in a series on chemistry in July, 1840 provided the first example of 'aerial navigation' in the Colony. One of his demonstrations included the filling of a small balloon with hydrogen. It 'ascended to the roof of the building, and floated about for a considerable time', but apparently failed to ignite any local interest in lighter-than-air flight (Sydney Herald 1840).

Another of the lecturers at the School of Arts was Mr A. James Slatterie. He wrote a letter to the press (Slatterie) in January, 1841 and proposed the establishment of a philosophical and scientific society in the colony. He claimed 'the teeming resources of this and the neighbouring Colonies are yet scarcely known, and even the information that has been gained, for want of such an institution, is confined within a limited circle.' His proposed institution was to be along the lines of the Royal Society, to collect and communicate scientific information. The Philosophical Society of Australasia had been formed in July, 1821, but fell silent soon thereafter. It was not until the 1850s that such societies were instituted in several of the Australian colonies, and continued to this day as Royal Societies of each State.

Teaching aids were useful to many of the technical lectures and staff at the Sydney Mechanics' School of Arts had anticipated the arrival of scientific and philosophical instruments and apparatus from Scotland. The list of items en route, was published in the press and provides an understanding of the state of knowledge and ability within the colonial community. The list included: steam cylinder, for showing force of steam; combination of levers; an inclined plane with carriage; Archimedes screw and wheel; Torricellian apparatus; Medgeburgh hemispheres, pulleys, clocks, balances and magnets. Unfortunately the equipment was shipped aboard the brig *Australia*, which was lost at sea about one thousand kilometres off the Cape of Good Hope. The equipment had been purchased from a lecturer at the Edinburgh School of Arts and included many items of interest to 'the intelligent mechanic in the pursuit of scientific endeavours.' (Sydney Herald 1841b) The nineteenth century term 'mechanic' would now equate to a tradesman.

OVERSEAS NEWS

News from England in 1841 carried details of an aerial voyage proposed by Charles Green, who was one of Europe's foremost aeronauts. This was to be a balloon flight from England to America. Apparently Green displayed a model of the balloon, which was to incorporate several ingenious adaptations, for directing and propelling power. This would have been the first time that a rudder and large paddles were fitted for a balloon flight. The rudder was to provide direction, while the paddles would propel the balloon. An earlier invention of Green's was the guide rope, which was essential to determine true altitude. It was understood that a barometer, or more specifically, an altimeter, would not be capable of identifying rising ground such as a mountain. Green's proposed voyage required a large sum of money (£3,000) to get off the ground. The balloon would be 27 metres high and 15 metres in diameter. The flight time was estimated at six days, from St Pauls, London to the Cupola, Washington (Sydney Herald 1841a). This flight never eventuated. There was no correspondence in the local press about this proposed voyage and it failed to create any interest, even though the flight would have been a remarkable feat.

A rare item of aeronautical interest appeared from America. One Mr Davidson of Virginia, who was a member of the Bar, proposed a lecture where his ideas could be presented to the public. All that was mentioned in the news article was that Davidson proposed the use of legs and feet to provide the necessary power for propulsion. He claimed that it would be no more tiring than walking. His claimed objective was to fly at 160 kilometres per hour (Sydney Herald 1841c). Nothing more appeared about Davidson, and this article also failed to engender any response from Sydney residents. Accounts of Charles Green's balloon flights from Vauxhall Gardens in England were published locally, but those also failed to raise any public interest in aeronautics in the Colony (Sydney Herald 1841d and 1842).

The seeds of change for transport itself had taken root in Britain, which was in the midst of the Industrial Revolution and spawned new ideas about conquering the air. William Samuel Henson made his application for a patent on 29th September, 1842, (Henson 1866) which pre-empted the publication in 1843 of the first full set of plans for his aeroplane, the *Ariel*. Henson's aeroplane was to be steam powered, because steam was virtually alone as the meaningful provider of mechanical power. Newspapers in Sydney first reported on Henson's aerial steam carriage on 9th May, 1843 under the heading 'carriage through the air' (Sydney Morning Herald 1843a). The brief article, repeated some information from the 'London Gazette', noted that Henson's invention was for 'certain improvements for locomotive apparatus and machinery in conveying letters, goods and passengers through the air.' Some aspects of his invention were also applicable to locomotion on land and sea, or so it was claimed.

LOCAL INTEREST

The first brief mention of Henson's carriage apparently caused no influx of correspondence from the newspapers' readership. No letters or other articles on aerial navigation were published until just after the appearance of a second article about Henson, which was published locally on 26th May, 1843. This second article was gleaned from several English newspapers. The composite article was introduced by a letter, which added some feeling of authenticity, as its writer described his initial scepticism of the machine (Miles).

One feature of newspaper correspondence was the use of pseudonyms. It was more likely for correspondence to be endorsed with initials, or a name appropriate to the subject matter, rather than that of the author. 'Aeronaut' was one such correspondent, who claimed that 'twenty years ago' he 'invented and made known to a few scientific friends a new species of balloon.' It has not been discovered whether Aeronaut was in Britain, or New South Wales, twenty years earlier, but the former was his most likely location. The plan was to 'revert to the old principle of rarefied air and to accomplish the rarefaction by means of portable gas and Argand burners' (Aeronaut 1843a). In other words, a hot air balloon, inflated by gas fires, much like modern balloons.

Aeronaut continued 'a mere balloon would not accomplish the great end of periodical or exact transit' and 'we might ascend by mechanical contrivance by which means instead of being at the mercy of atmospheric currents, we might make them subservient to our wishes.' He was concerned that balloons would always be subservient to the air currents. Aeronaut commented that Sydney would one day be as near to England as Edinburgh was to London, one hundred years earlier, once the navigation of the air was mastered. He suggested that daily mails would be possible between Sydney, Port Phillip (Melbourne, Victoria), Adelaide (South Australia), the Swan (now Perth, Western Australia) and Port Essington (a failed settlement about 150 kilometres north east of Darwin, in the Northern Territory).

Several correspondents described the possibility of using steam power by way of some modification to Hero's (or Heron's) ancient *Aeolipile*. Hero of Alexandria was a Greek mathematician and scientist, who lived in the first century AD. He invented numerous ingenious devices, including the steam engine (Girling p. 218). The 'Avery' engine was described as one of those similar to Hero's steam engine. William Avery, of Syracuse, New York, invented a small reaction steam wheel in the 1830s. For several years it was believed to have been the simplest and cheapest steam engine available. It was used to drive circular saws and cotton gins (Parsons). Two arms were fed by steam, which could exit the outer ends of each arm, but in opposing directions. This resulted in the apparatus spinning quickly about its axis. Aeronaut described the air as the fulcrum for his flying machine. His machine would ascend due to the lift provided by an airscrew arrangement, acting much like a modern helicopter rotor. Forward motion was to be provided by another, horizontally acting airscrew. Of particular interest in Aeronaut's letters, was his description of rudders for directional control, and his identification of flight into various wind conditions '... it is quite possible that a head-wind may prove to be the safest current to ride upon.'

Aeronaut (1843b) also considered air as an alternative to steam for operating the Avery engine. If expanding air could be used to replace heated water, the weight saving would be worthwhile. Aeronaut described his proposed engine, simply as a tube 3.64 m long by 0.91 m in diameter. A wheel with fans would be positioned inside the tube, in a similar manner to the compressor and turbine discs in a modern jet engine. The Avery engine would then be used to provide power to rotate the fans and thus produce forward thrust from those fans. The idea proposed something close to the same principle that operates in a jet engine. It is unclear from this simple correspondence whether Aeronaut had any practical ideas for the detailed construction of such an engine.

Another correspondent was Francis Forbes, the elder son of Sir Francis Forbes, the first Chief Justice of New South Wales. He wrote to the newspaper in early June, 1843, describing his idea, which incorporated a kite and 'Archimedean screw fan'. Forbes compiled some notes of interest in his correspondence to the press, a few days later. '... the screw-fans or vanes must turn on an axis lying in the plane of the kite and they must be placed behind the kite, or at the side, and propel it forward; and when the machine is going through the air, both the plane of the kite and the axes of the screw-fans must be nearly horizontal. A very slight inclination of the plane of the kite upwards being sufficient to support the greatest weight it is capable of sustaining, the screw-fans must be used entirely as a propelling force, and the kite, its plane slanted slightly upwards, as the only supporting power. The axes of the Archimedes screw-fans must be all parallel, if they were inclined at any angle there would be a loss of power. Your correspondent 'Aeronaut' has placed the axis of his principal screw propeller exactly at right angles to what it ought to be, having made the axis perpendicular instead of horizontal. Also, by making two separate forces, one a propelling and one a supporting force, acting at an angle to each other, he would experience a loss of power ... In my model, I have made two rotatory screw-fans to revolve in opposite directions that the machine might balance better, their axes being in the same plane and propelling in the same direction' (Forbes 1843a).

The Archimedes' screw was a device invented for the raising of water, by means of an inclined cylinder, which snugly contained a large diameter 'screw'. The maritime industry found that some modification to the Archimedes' screw resulted in the marine propeller. Steamships were originally propelled by means of paddlewheels. Several people invented screw propellers during the early years of the 19^{th} century, but two excelled as the real developers of this invention. Francis Pettit Smith in England and John Ericsson in the United States brought the screw propeller into practical use. The British Admiralty staged a demonstration during March, 1845 to show the effectiveness of the screw propeller. The steam sloop *Rattler*, fitted with a propeller designed by Smith, was set to pull against another steam sloop, *Alecto*, driven by paddle wheels. Except for their paddles and screw, the ships were identical, powered by 149 kilowatt steam engines. The *Rattler* won the tug-of-war, convincingly towing the *Alecto* backwards at almost 5 kilometres per hour (Kemp). The *Rattler* was built of Oak and launched from the Royal Dockyard Sheerness in 1843 (SMH 1843e). It should be understood that the various terms for Archimedes' screw fan, or propeller would translate into something resembling a modern marine propeller.

Local interest in aerial navigation was still not, it appears, easy to gain. Forbes mentioned a Mr Petrie of Moreton Bay (now Brisbane, Queensland) as the only person he had met who approved of his design. Forbes had tried to interest a Mr Cohen in Sydney with the construction of a working model of his aerial machine, without success. He then spent some months attempting the construction himself, with the aid of a workman 'who has been perpetually ill' (Forbes 1843b). Forbes claimed to have more than half completed the model when the news from England about Henson was published locally. He felt that some of the ideas in Henson's machine were similar to his. From Forbes' description and the published drawings of Henson's machine, there were obvious similarities.

Forbes claimed to have made mention of his ideas to several people in England and Australia, and only met with ridicule for his trouble. He felt that the idea had been pirated, and sought assistance from a friend, William Bland. Forbes claimed to have provided Bland with a list of those people with whom he had discussed the aerial concept (Forbes 1843a). Unfortunately no record of Bland's investigation into this matter has been uncovered.

Forbes built upon some of the published comments and from Aeronaut's letter, he distilled several changes and suggested improvements to the proposal of Aeronaut. He proposed contra-rotating propellers, '...two vanes at least, of great diameter, turning on perpendicular axes in opposite directions'. He suggested the best solution would be for the two propellers to be on the same shaft, one above the other. With this arrangement there would be no need for 'a plane of canvas' at each end of the craft. He proposed that the rotors, as we would now describe them, could be tilted forward to provide forward motion. With rotors replacing the fixed wing, Forbes had proposed a design configuration we now call the helicopter. He was also of the opinion that human power may be a real alternative to steam power. The heavy weight and low power available from steam engines caused Forbes' hopes to be dented, until the invention of Avery's engine. This was hoped to fulfil Forbes' power requirements, but it too, was a doubtful provider of sufficient power (Forbes 1843c).

'RMCE' responded to criticism of Forbes, with support, claiming aerial navigation was possible with and without steam power. This correspondent was Robert Mudie, a Civil Engineer. He had his own design for an aerial machine, which he believed would probably require several million dollars in current values (£5,000) for its development. That was not an amount to be afforded by an individual, so Mudie considered the only possibilities for gaining such support would be through the creation of a company to transfer passengers from Sydney to India and beyond, by air.

Mudie mentioned bird flight in his correspondence, but the main thrust was his conviction that mechanical flight was possible. 'So may an aerial carriage be constructed with mechanical power, to move through the air to any place wished; as a steam-boat in a calm makes her destined port without the aid of wind, so may aerial carriages; and contrary winds only retard their flight' (Mudie 1843a). He later wrote more specifically about his ideas for aerial navigation, which clearly described the basis for the rigid airship of the future (Mudie 1843b).

The editorial of June 28, 1843 succinctly identified some of the changes society had undergone during the previous four decades (SMH 1843b). Mountains and oceans had ceased to be barriers, as steam power surpassed sailing ships. Gas had now been used to light up the cities. The very latest discoveries were 'conveyances upborne upon the winds' and 'the electric fluids'. The editor's words are indeed worthy of repetition '...the improvement of Aeronaut's engine recommended by Mr Forbes, will show how one mind can act upon another, and how rapidly the agitation of a particular theory may carry on its application to perfection.' The Wright Brothers learned this very well and did exactly what the Sydney Morning Herald editor proposed. They built upon the knowledge of all before them, and attained powered, controlled and sustained mechanical flight sixty years and six months later.

As two proposals for flying machines had been published through the newspaper in Sydney, it was argued that so much more could be proposed from those more populous regions, such as Europe, Britain and the East. The Government Astronomer, James Dunlop, was urged to submit his calculations on aerial navigation. He had apparently been a strong supporter of this new field of endeavour, although no mention of this interest appears as record in biographical notes on Dunlop (Pike 1968). The newspaper's editor was incredulous that Henson's machine had been proposed with steam as its motive power. The steam engine was a lumbering, cumbersome creature, which required fuel as well as water for its operation. It had so far baffled '. . . all schemes to render it buoyant. Neverless as there are pelicans as well as swallows among birds, we may yet behold a stately Leviathan rising in the air' (SMH 1843b).

Even greater promise for the future lay with the electro-magnetic discoveries, expanded air and gases. Electricity had been used to turn machinery since 1833 and during November, 1842 an experiment had demonstrated the use of electricity for propelling a locomotive engine. The editor concluded with his thoughts on the future 'an era when with lightning speed, news will travel round the world, and radiate to its remotest wilds – when the birth of a Prince in England will be telegraphed to Sydney before the dawn of another day' (SMH 1843b).

Correspondents continued to support or criticise earlier writers. One wrote under the initials XYZ, criticising the negative comments of an earlier correspondent, AB. The latter, XYZ made an interesting, and perhaps forgotten suggestion that kites should be flown 'one above the other.' This was most likely stated, just as an off-hand part of his criticism of AB, but it was this very same layout that was so successfully employed by Lawrence Hargrave in a later decade. XYZ also confirmed his strong belief that success would surely come, once a source of power was discovered that was lighter than steam (XYZ).

John Curr of Castlereagh Street, Sydney was not convinced of the likelihood that mechanical flight was possible. Curr supported his argument against the likelihood of successful navigation of the air with some basic calculations. He described the power necessary for flight as a function of ' the complex ratio of the wings, their resistance, and velocity' and used a table generated by Sir Joseph Banks to work out the drag to be overcome. He then calculated the necessary wing area and requisite horsepower for a steam powered aerial machine. The results were either an extra-ordinarily large flight surface of some 338 929 square metres and correspondingly low power, or 637 kilowatts of power and a more reasonable wing area. Both were impractical, and he concluded 'the aerial carriage will turn out a most notorious failure' (Curr).

One John Holtzapffell wrote a letter from London to a friend in Ceylon, identified only as G.S., dated 1st November, 1842. G.S. then sent the letter on to be published on 28th March, 1843 in the 'Straits Messenger'. Re-published in the Australian in late June, 1843, it provided more details of Henson's machine. Holtzapffell described the Ariel's construction from sheets of copper, formed over flattened steel wire. The 'wire' was claimed to be 9.5 millimetres thick. The blades of the propellers were formed of 'light iron ribs covered with a strong silk web, which has been rendered more tough and elastic by a solution of caoutchouc.' He mentioned that the silk had a feature not available in calico. Should a spark from the furnace rest on the propeller surface, it would burn just a spot in the treated silk, and not cause the entire covering to burst into flames (Holtzapffell).

Until this time all correspondence about aerial navigation had been generated through the publication of a few relatively short articles, without any real details or diagrams. The first articles of substance, describing the 'Aerial Steam Carriage' were published in the 'Sydney Morning Herald' and 'The Australian' on 14th August, 1843. Several drawings of the craft appeared in the 'Sydney Morning Herald' and a different view in 'The Australian'. In modern terms it would be described as a monoplane, with twin pusher airscrews. The undercarriage was a tricycle arrangement, which only became commonplace after the Second World War. Henson's intention was to start the machine on a downward slope, and once airborne, continue its motion through the action of its steam engine powered propellers (SMH 1843c). The full-page account in 'The Australian' was accompanied by a drawing of the *Ariel* (Australian 1843b). The effect of publication of details and drawings of Henson's machine was such that 'The Australian' newspaper did reprints of the supplement to satisfy demand. A note about the need for extra copies of their supplement 'deemed this such an extraordinary occasion as may justify us in stepping out of our usual course' (Australian 1843c).

The following day the 'Sydney Morning Herald' published another large article on Henson's Carriage. This second article was based on another London newspaper and included dimensions of the craft. The article had some difficulty describing the craft's wings, calling them a floor or platform, apparently 'merely because of their large area.' The wingspan was to be 45.72 metres, chord of 9.154 metres and tail span of 15.24 metres (SMH 1843d).

Safety issues associated with aerial navigation soon found their way into the correspondents' discussion. What if something broke? What if the engine stopped 'and the machine at a stand-still in the air, loaded with 48 pascals (a pound to the square foot).' According to the London correspondent this last event would have resulted in a rate of descent of 6.7 m per second, which was then equated to jumping off a wall 2.29 m high (Atlas). On the same page of the 'Sydney Morning Herald' was another article, dismissive of the whole business. Under the heading 'The project of aerial locomotion refuted', and 'pigs may fly, but they are very unlikely birds', the article proceeded to dismiss the likelihood of success for Henson. Again, the requisite power from overly heavy steam engines provided the stumbling block. That case was supported with technical details of well-known facts of air pressure on flat plates and the lifting power of kites (Illustrated News).

Correspondence from AB regarding the 'Aerial Steam Carriage' and Francis Forbes' concept was strongly critical of both Forbes and XYZ. In his criticism of those two, AB supported his claims with an English example of about twenty years earlier. Apparently an attempt was made to use a large kite to pull a specially constructed, lightweight carriage along London's Baker Street. That did not work, and AB asserted that Forbes' proposed machine would not work either. AB was also sceptical of Henson's machine and considered it no more than a means of raising money. He claimed 'no names of acknowledged repute in mechanical science, nor of known respectability as regards moral character, have transpired as being in connexion (sic) with this company' (AB). The kite venture to which AB may have referred was actually conducted in 1827 by George Pocock. He hooked up a lightweight carriage to two Malay kites, one attached to the other. That trial showed that such kites could assist ground transport. Pocock's carriage travelled at 32 kilometres per hour over a distance of 64 km from Bristol to Marlborough. He called the arrangement 'Charvolant', after a combination of chariot and the French term for a kite. Pocock identified his kites as 'buoyant sails' (Moolman p. 42).

The 'Melbourne Times' eventually published something about Henson's Ariel, which included their own quaint description, intended to make the readers understand how the Ariel would appear. 'A light wheelbarrow with an additional wheel at each leg – then let a long very long sash frame be tied across the barrow, and then let the handles be very long and stretched over the canvass' (Melbourne Times). The article continued with a description of the propulsion as a 'small windmill turned by a spring in the barrow.' The barrow would contain the engineer, fuel and men. For the sceptical readers, it was suggested that they run against a high wind holding an umbrella, then suddenly unfurl it. That would surely convince them of the buoyant power of the air!

'Arden's Sydney Magazine' confirmed the wheel barrow and umbrella stories in reference to the editor of the 'Sydney Morning Herald' (Arden). It was deemed an incautious suggestion, as both items were readily available and may have led to the clever and courageous youths 'taking a run off the Rocks some fine morning, searching, on a small scale, for the secret of the aërial passage.' Thoughts of the many hang gliding sites along the coast now spring to mind.

Robert Mudie described his proposed aerial carriage, intended as 'amusement to the curious, tend to dispel the doubts of the sceptic in aeronautics, and be the means of forming a company to have it submitted to the test of experiment' (Mudie 1843b). His letter to the newspaper clearly described the features of the rigid airship, that would much later become identified with those of Count Zeppelin. Mudie's airship was described as 45.7 m long, 12.2 m diameter in the centre and tapering to points at front and rear. Around the middle of this structure was to be a strong belt, to which would be fastened two propellers and the carriage. A cruciform tail would be attached to the rear of the airship, and each of those four surfaces was to be connected to the carriage by way of a cord. These tail members were each 6.1 metres wide and 6.1 m span. The overall length of this airship was 52.7 m. To aid the airship's directional control, a fin was to be attached to the upper surface, some 18.3 m long, 3 m high in the middle and tapered to each end. The structural materials were not specified, but the covering was to be silk or fine linen and netting. The entire covered surface would then be coated with caoutchouc for air and waterproofing.

The carriage was to house a 15 kilowatt engine, a receiver for holding gas and a force pump to inflate and deflate the gasbag. It was also to incorporate a retort for making gas. The engine was to burn gas for its fuel. The passengers were to be housed in a small cabin within the main body of the machine. They would be able to move from the cabin to the carriage by way of a rope ladder. The estimated empty weight was 1361 kilograms, with a capability of lifting 817 kg of passengers or other load. Mudie claimed that the obvious problem with Henson's Ariel was the need to take off on a down hill slope, which would cause considerable difficulty in places without suitable grounds.

Another Muswellbrook correspondent to the Herald, identified as F.R.P-H. sought to save people their money by not investing in the various projects identified in the pages of the newspaper. He was correct when he wrote 'That man will one day be enabled to imitate the feathery tribes of the air, in the power of aerial locomotion, is not at all unlikely – so soon as a source of power shall have been discovered capable of being indefinitely increased, like steam, without nevertheless increasing the weight of the apparatus necessary for the generation of such power.' He continued with a dissection of Henson's machine, identifying gravitation and the 'hindering force' (or drag) as obstacles not yet overcome. Henson's steam engine was unable to lift itself. The power needed to overcome drag or the resisting, hindering force, increases dramatically with any increase in speed, or velocity. In fact, as F.R.P-H pointed out, a doubling of the speed of the craft would require eight times the power. 'In short, this Aerial Steam Carriage is a monstrous absurdity, and entitles Mr Henson to a place in Bedlam Asylum' (F.R.P-H).

A model of Henson's machine was eventually displayed in London, at the Royal Adelaide Gallery. This model measured 3.81 m by 0.91 m and weighed 7.71 kg empty. The full-sized craft was to be 43.89 m long. The reality of aerial navigation was still some way distant, as even the model had not flown (SMH 1843f).

In the London of 1843, balloon flight was still the only practical means of navigating the air, where another of the leading aeronauts, Monck Mason showed his latest idea. He demonstrated a small balloon, which could travel at 6 km per hour inside a large room. The demonstration was described in the press in Australia, rekindling local interest in aeronautics in 1844 (The Australian 1844a).

The Reverend John Saunders had arrived in Sydney on 1 December, 1834 aboard the *George Hebbert*. Saunders was Chaplain on that ship, which served as a female emigrant and convict vessel. (Pike 1967) Saunders arranged to conduct a series of lectures on aeronautics at the City Theatre, soon after the publication of the news about Monck Mason's demonstration. Saunders was a correspondent to the Sydney Morning Herald and had made his opinion on various social issues known to the readers. Causes appropriate to his calling, such as aboriginal deaths and abstinence comprised most of his writing.

A small notice appeared in the 'Australian Daily Journal', inviting the public along to hear Saunders present his lecture on Wednesday 12th June. It was mentioned that there would be some models of balloons and the Aerial Machine of Henson (The Australian 1844b). Despite bad weather, a crowd of 400 turned out to hear Saunders. There were models of kites, balloons and the Aerial Machine, upon which Saunders promised another lecture (Saunders 1844a). The 'Sydney Morning Herald' editorial apologised for being unable to publish a thorough report on all of the lecture's content, but mentioned some of the most novel points (SMH 1844). These main points were the adaptation of kites, or as Saunders also named them, buoyant sails, for inland discovery or maritime navigation, a new arrangement of the fire balloon, Dunlop's plan for guiding the air balloon, and a dissection of the flying machine. A fire balloon was another term for an expanded gas, or hot air balloon.

Saunders suggested the use of kites as possible improvement for the operation of sailing vessels. He suggested that kites would be used to increase ships' abilities to sail 'within 5 points of the wind'. That is, to be able to sail more efficiently. This suggestion was very much along the lines of Pocock's light carriage demonstration.

The 'fire balloon' resuscitation was through the use of Argand burners, fuelled by oil and an inner series of burners fuelled by portable gas. Perhaps Saunders had remembered the letter of Aeronaut, one year earlier, when he made this suggestion. Such a burner was invented by Aimé Argand in about 1782 and featured a cylindrical wick. Air was able to pass both inner and outer surfaces, providing improved combustion and brighter light (Simpson p. 622). The gas-fed burners were for emergency use only, and the gas cylinders also provided a solid structure for passengers and equipment. Saunders went on to propose the use of such fire balloons for exploration of Australia. His idea was to employ two balloons for this inland exploration, with one acting as a tender for the other. At some pre-determined location (or perhaps, duration into the flight) the surplus stores of the tender balloon would be re-assigned to the other balloon for its onward journey. This was novel, 'the idea of planting a balloon in the bush is something new, and we give it as a bright thought to bushrangers and dwellers in the "far west" ' (SMH 1844).

Dunlop's plan was described 'Taking the primitive method, which advanced maritime navigation, of joining canoe to canoe, I propose to join balloon to balloon in horizontal parallel rows, each to be covered in the usual way, by netting, for the individual security of each balloon, and to be fastened to one another by cords on the top of the nets, to obtain a compact well arranged body. There may be three rows, consisting of five each on the outside and six in the inside, giving in the whole sixteen balloons. From the lower extremities of the nettings I would suspend a stage or platform, on which the management of the machine would be conducted. This stage is to be furnished below with a keel extending along the whole length; at each end of the keelson a rudder is to be fixed, turning on a pivot in the usual way, through the top of which an axle is to pass, furnished with vanes set at greater angles than those of an ordinary windmill. The vanes are to act against the air, and to be turned by appropriate machinery. By these I propose to gain headway or sternway, and in conjunction with the keel and rudders steerage way: I think that by sternway, steerage way may be more effectually obtained. The stage need not be above three-fifths of the whole breadth, and may be surrounded by netting to prevent accidents.'

'My theory stands thus, sixteen balloons of the usual pear-shape form, of 6.1 m diameter will (if I recollect right) possess a levity of 2 722 kg. This power will be sufficient to sustain the apparatus, voyagers and ballast, and leave a surplus for ascension. By having this sized balloon, the needful pressure will be more nearly equalised with the strength of materials; by their number an accident happening to one, will not endanger the safety of the whole machine, and by their arrangement a better sailing surface is presented. The resistance, when sailing on a current, is as the whole resistance multiplied by the cosine of the angle from the vertical or line of keel' (Dunlop).

Saunders' second and concluding lecture was presented on Friday 14th June. The Australian newspaper published an article the following day, describing Mason's balloon and also allowed Saunders to sight their copy of a drawing of the same machine in their office. The lecture was again well attended, or crowded as reported in the press. Saunders exhibited the model of Henson's machine as well as a diagram of Dunlop's proposed balloon (The Australian 1844c). Saunders' dissection of the flying machines was incomplete, as he had no picture of Mason's machine at the time. However he perceived great similarity in the designs of both Dunlop and Monck Mason. He thought that Dunlop's design contained elements of 'safety and success' that were not possessed by earlier balloons. Dunlop's work appeared slightly advanced compared with that of Monck Mason, in Saunders' view, although both still had the usual problems with aerial navigation. Summarised as 'the great problem of perfect guidance', they are always at the mercy of the atmosphere. In that respect, Saunders considered Monck Mason's employment of Archimedean screws superior to Dunlop's vanes. Those vanes could be more accurately described as flat, windmill-like propellers. Saunders did note that aeronauts had some advantage over their seagoing brothers, in that they may find air currents flowing in slightly different directions and speeds at different altitudes. So, by adjusting the balloon's height above ground, the aerial navigator 'can generally choose one of two or three currents, and having the power to rise or fall, he may enter into one which may suit him best.' Saunders did regret that Dunlop had kept his idea under wraps for some time, and promised to forward the plan to London. He did not state to whom the plan would be sent. He was keen to let London know of the work and that 'Australians must look sharp to vindicate the priority of the colonial inventor, and secure some of the honour to themselves' (Saunders 1844b).

Henson's steam carriage was not well received by Saunders. He apparently identified deficiencies with the area (presumably the wing area), arrangement (or layout of the craft) and the means of control and propulsion. Another of Saunders' comments is noteworthy regarding the design of propellers : '... experiments lately made, the velocity obtained by descending an inclined plain (sic) was diminished rather than sustained by the propellers. As this maintenance of velocity is a main feature to the plan, and it has failed, the whole may be considered an abortion.' It appears that those propellers were providing drag, rather than thrust. Sufficient power must be applied to turn a propeller before it can produce thrust. Otherwise, it merely 'windmills' and produces drag, as evidenced by Saunders. It is also unclear at this distance, to whom Saunders was referring, when noting the recent experiments. Saunders ended positively, even though he had dismissed Henson's craft, the publication of Henson's work had re-kindled the idea of aerial navigation and 'he has given exercise to many ingenious minds, and led to an examination and discussion of principles which may terminate in a good result.' (Saunders 1844b) The main thrust was for success, not for an individual, but rather for humanity.

Saunders concluded his lecture 'until some power was invented, which would give greater speed to the rotary fans, than any plan at present devised, he did not think we should be able to travel the regions of the air.' An aside by the reporting journalist suggested the use of springs and 'the endless screw (Archimedean) such as that applied in the large musical boxes' (Saunders 1844b).

Many people appeared to believe that mechanical, heavier-than-air flight was achievable. By the same token, steam power was generally considered as an unsuitable source of power for aerial navigation. The publication of details about Henson's Ariel certainly formed the basis for serious thought on aerial navigation. Here at last was something that promised more than just a simple balloon flight.

A statement appeared earlier on the subject of the proposed scientific use of balloons. (Australian 1843a) 'Once let it be demonstrated that balloons are not more dangerous than railways and steam-boats, and we shall have a few words to say on the use of which they may prove to science, in relation to an examination of the different strata of the atmosphere.' To arrive at such a situation, serious scientific input to aerial navigation would be required. The most appropriate means for the dissemination of such knowledge were those various learned societies, which eventually began in the colonies.

LEARNED SOCIETIES

Several people made presentations to learned Societies, on their thoughts for aerial navigation, some of which will be mentioned briefly. Dr William Bland addressed the Royal Society of New South Wales on 8th June, 1859 with a lecture 'On Atmotic Navigation', although it appears that no transcript has survived (Bland). This appears to have been the first lecture on aerial navigation, presented to such a Society in Australia. Bland's *Atmotic Ship* was at first designed with a spherical balloon, but after his initial application for patent, the craft was depicted with the more familiar, cigar shaped envelope.

Michael Costello addressed the Royal Society of Victoria on 29th September, 1862 with his proposal for a steering apparatus for balloons. He apparently displayed a model of the apparatus at the meeting, but no more details appear to have survived (Costello).

Alexander Adams invented an ornithopter, the details of which were sent to Lawrence Hargrave by George H. Knibbs of the Royal Society of NSW on 24th September, 1896 (Adams). His ornithopter was to be powered by a hydraulic motor, but it failed to impress Hargrave. Adams sought a partner in this venture and asked if Hargrave was interested, but received a polite refusal. George Hardacre of Coffs Harbour also patented a similar machine in 1897. His craft featured flapping wings, which incorporated hinged valves to reduce drag on the upstroke and increased drag on the down going stroke (Hargrave). He built and flew a man-powered version, while tethered between two trees.

Lawrence Hargrave provided 23 lectures to the Royal Society of New South Wales from 1884 to 1909, 19 of which were on his experimental work in aeronautics (Shaw).

The philosophical Institute of Victoria reported some of the earliest serious investigations into the Australian atmosphere. A. C. Gregory read his report on barometrical observations on 30th March, 1859 (Gregory).

Across the Tasman Sea, several researchers were publishing their thoughts and one of those was Captain Frederick Wollaston Hutton, 'Sailing Flight of the Albatross' (Hutton). His work was purely ornithological, and not intended to further the idea of human flight. Hutton was a Fellow of the Royal Society, Fellow of the Geographic Society and an Honorary Member of the Royal Society of New South Wales, from which he was awarded the Clarke Memorial Medal in 1891 (RSNSW 1890).

Professor William Charles Kernot, who was Dean of Engineering, Melbourne University, undertook investigations of the atmospheric effects on engineering structures. One of his papers to the Australasian Association for the Advancement of Science, in 1889 was titled 'Notes on the Barometric Measurement of Heights' (Kernot 1889). Maybe not quite aerial navigation, but he followed up in 1892 with an article on 'Wind Pressure' (Kernot 1892), which described some of the difficulties encountered by engineers in those days. Notice was being taken for civil engineering structures, such as railway vehicles, bridges and buildings exposed to the forces of winds. Also, it was quite apparent that the science of designing structures to accommodate such forces required much investigation. Quoting from Kernot's 1892 paper, 'Not many years ago a bridge over the Yarra, in Melbourne, occupying a very sheltered position, was condemned as liable to be overturned by the wind, and altered at great cost, although it would have taken 4.3 kilopascals to move it according to the correct calculation, and 2.7 kPa according to the engineer that reported upon it, while chimneys and railway vehicles that would overturn with not more than 1.4 kPa were continually to be found in positions infinitely more exposed.' Kernot continued with descriptions of the various methods of calculating aerodynamic forces and the experiments he conducted.

Kernot constructed what was probably the first wind tunnel in an Australian university, possibly the first anywhere in Australia. A description of the tunnel was provided in his article on wind pressure (Kernot 1892). It incorporated a wooden, four bladed, screw propeller, of 0.7 m diameter and contoured with a pitch of 1 m. The tunnel itself was a tube 0.76 m diameter by 0.91 m long. The wind tunnel initially did not provide a 'uniform blast' of air, but rather produced 'a cylindrical shell about 0.15 m thick of helically moving air surrounding a central core of dead or motionless air'. He added some form of straightening vanes and funnel, which provided a jet 'of air of fairly uniform direction and velocity' about 0.3 m by 0.25 m cross section. A small flag was used to verify air direction and Revy's current meter measured the velocity.

NOTICE OF SUCCESS

In the United States, the Wright Brothers also employed a true scientific attitude to the study of aerial navigation. Success came finally to Wilbur and Orville Wright on December 17, 1903 at Kill Devil Hills. How did Australians learn of this triumph? That knowledge was provided through the medium of the newspaper, of course. The great French-born American, Octave Chanute sent news of the success to Lawrence Hargrave, together with American news reports, and the necessary corrections. Hargrave then wrote to the Daily Telegraph and provided an interview to the journalist so assigned. An article was soon published, which described the American success as well as Hargrave's latest aircraft work. It appeared exactly two months after the Wrights' success, printed on page nine of the Sydney newspaper (Daily Telegraph 1904)! Aviation was still not page one material.

Newspapers provided the means for communicating ideas for aerial machines from England, initially, and subsequently from local inventors. Many good ideas were thus published, but none came to fruition. Mechanics' Institutes provided technical education for many in the community, who were then better equipped to put their ideas forward. Learned societies provided the next level of communication, publishing ideas and experimental reports across the globe.

Wilbur and Orville Wright built their experiments on the published works of earlier researchers. They corresponded with a number of those researchers, but kept secret, their understanding of aerodynamic control under the protection of a patent.

CONCLUSION

In summary, several of the early Australian pioneers provided word pictures of aerial machines. Some others provided drawings and models of their ideas. They all failed, but their ideas lived on through the works of others – possibly because they did not hide their ideas away. Lawrence Hargrave published his ideas widely, through the Journals of the Royal Society of New South Wales and the Aeronautical Society of Great Britain. He was a prolific letter writer, who urged others to experiment with his ideas and wished them every success. As he stated in correspondence with Octave Chanute, 'excellence of design and workmanship will always defy competition' (Chanute p. 218). Some of his ideas took root, such as the box kite, which appeared in the lineage of Chanute's hang glider. That hang glider subsequently became the structural model for the Wright kite of 1899. That kite proved the success of wing warping, which was the key to Orville's powered, sustained and controlled flight at Kill Devil Hills on 17th December, 1903.

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