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# The First Qantas Flight Simulator

by Bill Field

*The first flight simulator introduced by Qantas was an analogue device purchased from Link Aviation of Binghamton, New York, in which to train pilots and flight engineers for the introduction of Boeing 707 aircraft. It was transported courtesy of the RAAF's C-130 and Qantas Super Constellation aircraft and re-assembled in Sydney.*

*This article is the recollection of one who was deeply involved in the day-to-day production and testing of the simulator at the manufacturer's plant and in its subsequent installation and maintenance at the Technical Training Centre in Sydney.*

*The account owes much to Greg Banfield for his prompting, researching of facts and his enthusiasm to ensure that this phase of Qantas history is recorded.*

I joined Paton Electrical Pty Ltd as an apprentice electrical instruments fitter in December 1940, at which time the company was in its infancy. The proprietor was a Fred Henry Paton, a veteran of the Gallipoli campaign of 1915 and of the Western front, where he received serious wounds which dictated his discharge from the Army. He was wheel-chair bound from that time until his death.

Some ten years earlier the Company had been registered as a Proprietary Limited enterprise with Fred as Managing Director and his wife Charlotta as a Director and Secretary.

The premises at 90 Victoria Street, Ashfield (which no longer exist) then comprised buildings of fibro and timber. Production was limited to the manufacture of moving coil meters and part of the establishment was devoted to the assembly of the premium production item, the VCT (Valve & Circuit Tester), along with a wide range of multimeters.

The declaration of war in September 1939 created a dramatic change in the Company's fortunes, in that new premises were built to house a greatly increased workforce. The machine shop was equipped with lathes, milling machines and almost any tooling that was needed, and the whole supplied virtually free by the Federal Government.

Throughout this period the entire production of Test Equipment and tens of thousands of meters flowed to the Armed Services. I dealt with the representative from the Aeronautical Inspection Directorate (Flt Sgt Gordon Thompson) in the calibration and acceptance testing of the whole range of equipment on behalf of the Company.



The first Qantas Boeing 707 flight simulator  
Image taken 1 April 1977



Cockpit interior of Qantas Boeing 707 flight simulator No.2  
Image taken 1 April 1977

War's end saw new staff employed in the form of two engineers, John Larkin and Eric Palmer. I worked with the former on the development of the Vacuum Tube Voltmeter, the Modulated Oscillator and the Signal Generator, all of which were successfully marketed. Shortly after the war, disposals stores in and around Sydney flourished with the sale of items now surplus to the Services' needs. The flooding of the market with disposal test equipment and meters for a few shillings had serious impact on Paton Electrical. The immediate post war years also saw the recovery of the Japanese economy and the prodigious effort that was put into the production of a plethora of everything electronic. Imports of Japanese equipment, which was of high quality and reasonably priced, really had much to do with the ultimate demise of this small hither-to successful Australian company.

With the declining fortunes of Paton Electrical, I eventually resigned and joined Qantas on 8 October 1948. At Qantas I was employed in the Mascot Hangar Instrument Shop, which was under the control of Harry Adby. Under him were a number of sub-foremen: Jack Creasey, Dave Warbrick, Jack MacDonald, Joe Weston, Harry Anderson and Harry Phipps. I was seconded to the last named, and we were stationed on the mezzanine floor of Hangar 85. Harry was an enthusiast for the development of test sets that could be employed in the servicing of the company's fleet, which at that time consisted largely of Lockheed 749 Constellations as well as Lancastrian aircraft, and one or two Liberators. Having very recently worked for a company which manufactured a range of test equipment, I was detailed to undertake production of some relatively simple devices, which had only limited value due to the difficulty of obtaining the necessary aircraft component parts.

The servicing of aircraft entailed rectification of defects as recorded in the aircraft's log book and were segregated for the attention of the various maintenance groups: Instrument, Electrical, Engines, Airframes, etc. So far as the Instrument Section was concerned, the work involved replacement of time-expired components such as instruments, servo motors, etc. The inspection of cabling and probes within the fuel tanks was a job which was fraught with danger, as can be imagined. Despite the use of standpipes to ventilate the tanks, the atmosphere inside was still one primed to explode, given the tiniest spark from torch or metal-to-metal contact. No mask or breathing apparatus was provided and, as a result, one could not endure that atmosphere for more than a few minutes before becoming unconscious (as almost happened to the writer). Other work included carrying out compass swings and supplying correction cards to all directional instruments and the B16 stand-by compass, testing the airspeed

and altimeter system for leaks, accompanying test flights to check the autopilot, etc, and carrying out work in accordance with the aircraft's scheduled requirements as per Block Checks 1-4.

In 1948 trains transported coal to the Bunnerong Power Plant along a railway line embankment which ran parallel to the frontages of Hangars 85, 58 and 20. Aircraft ready for departure were backed up to this embankment and often were 'run up' as a pre-departure check on engines and cabin pressurisation. As many a local resident would have declared, the noise generated by the L749 Constellations (and later L1049s), and Lancastrians in particular, was nothing less than ear-shattering. The Lancastrian's Rolls-Royce Merlin engines were run up to METO power and the shrill, ear-piercing noise reverberating within the hangar absolutely precluded any possible attempt at conversation. These engine runs would last in excess of an hour and always seemed to be scheduled for week-end afternoons when administrative staff were not at work.

The occupants of the hangar were not equipped with any form of hearing protection and to this day I (and I'm certain many others) suffer that condition known as tinnitus, and it is my constant companion.

It was this that caused me to make the decision of either relocating within the company or seeking a job in another industry. Accordingly, I approached Harry Adby who referred me to the Employment Office where a position in the Instrument Overhaul Section under George Roberts was open and which I was pleased to accept.

My time in IOS was, again, partially spent in manufacturing test panels for a range of certain instruments which were to be checked for their response to vibration. Other work was the clearing of defects in the main Auto Pilot Amplifier Unit (Pioneer Bendix PB10). A test rig was used to provide dynamic testing of the amplifier before it was declared OK for service. Sundry other work was the overhaul of servo motors and various instruments.

In March 1946 and May 1947, the company had acquired two Type D2 Link Trainers (Blue Boxes) from the RAAF and these were housed in a timber and fibro building adjacent to the canteen; beyond that building was Hangar 85. The acquisition of these trainers formed the nucleus of what became the Link Training Section, managed by Instructor Leon Deards, who reported to the Operations Manager, Captain Bill Crowther. These machines were primitive, pneumatically driven devices and were used to train pilots in instrument approaches. The cockpit was mounted on a universal coupling on a central vertical column and was supported by four vacuum bellows, one placed fore and one aft, and one each athwartships so that the machine could rotate 360 degrees and could pitch and bank. Slip rings fixed to the lower part of the column enabled communication with the Instructor's console, and flexible mechanical drives connected to the trainer's Wind Drift mechanism allowed the instructor to introduce wind direction and velocity to the exercise. The cockpit instruments were basic



Cockpit interior of Qantas Boeing 707 flight simulator No.2  
Image taken 1 April 1977



View of the exterior of Qantas Boeing 707 flight simulator No.2, showing the visual system display screen and the three image projectors mounted on top of the cockpit photo taken 1 April 1977

and they comprised a Directional Gyro, Altimeter, Rate of Climb, Turn & Bank and Airspeed Indicator. The route flown by the pupil was recorded by a unit known as a 'crab' which traced in red ink the path flown by the pupil. Charts for the various airports were hand drawn by instructors. Despite the relative simplicity of the equipment, the level of training improved as the Link instructors gleaned airport information from experienced pilots, and as a result, accumulated knowledge which was subsequently passed on at training sessions. From the early days the Link Section also trained many pilots from other operators such as BCPA, TAA, Ansett, and the smaller intrastate airlines, Butler Air Transport, East-West, etc.

In 1953 the Company purchased two improved model trainers from Air Trainers Link, at Aylesbury, UK. I became responsible for the maintenance of these machines, which were designated AT22 Trainers. The same principles of operation applied but some improvement in Navigational Aids was made by the development of automatic VOR/DME, Radio Compass and ILS systems.

These machines were installed in the building later known as the Link Section which was managed by the Chief Instructor, Leon Deards, and his instructors, Sid McGowan, Keith Knipe, Cappy Blood, Frank Parenthoiene, Martin Henry, Jock Roberts, Bruce Grant and Hank van Leuwin. So for the next four years these trainers represented the best we had to offer for pilot training.

Sometime during 1957 a plan for establishing a new facility for Technical Training was developed and building construction quickly followed. The Link trainers were to be relocated here and provision made for a Flight Simulator for the training of flight crews for the Boeing 707 aircraft, delivery of which was scheduled to commence in early 1959. This new building was the foundation of the Technical Training Centre and included offices for executive pilots (Captains Eric Robinson, Bert Yates, Roly Probert, Alan Emmerick, Cleave Forrester and Bruce Fawcett), and Flight Engineers (Arthur Rowe, Tom Strong and H.W. (Bill) Strangward) to name but a few who were charged with the training of flight crews. Later changes to the building were made to provide for additional simulators and a Cabin mock-up with slides and pool for the training of cabin staff in Emergency Evacuation procedures.



View of the exterior of Qantas Boeing 707 flight simulator No.2, showing the visual system display screen and the three image projectors mounted on top of the cockpit photo taken 1 April 1977

In the interim, the company's fleet had increased with the purchase of a number of larger Lockheed L1049 Super Constellation aircraft and, with that acquisition, the need for improved training equipment arose. A contract was signed with the British firm Redifon Ltd of Crawley, UK, to supply an AC Analogue Type Trainer. This was a static trainer but was well equipped with navigational systems and was commissioned in late 1958/early 1959. It represented a big step forward in the field of simulation.

The development of jet aircraft in the fifties, and the procurement of this type of vehicle by many leading airlines throughout the world, meant that Qantas, recognising the potential of jet aircraft, would follow suit. Principally because Boeing had considerable experience with its military aircraft production and know-how, management chose this company to supply its new fleet of jet aircraft. In 1956 Qantas placed an order for seven Boeing 707 aircraft which were scheduled for delivery to commence in early 1959.

Simultaneously, in April of this year, Qantas ordered four turbo-prop Lockheed L188C Electra aircraft for use on regional services to New Guinea, Hong Kong, Japan, etc. These aircraft were delivered in late 1959 and were operated until the last was retired in 1970. The Electra was not too popular with the travelling public because of cabin noise and its popularity was not helped by the fact that two belonging to foreign operators had crashed due to wing failures, one in 1959 and the other in 1960. Maximum penetration speed of 240 knots was imposed by the United States FAA on all Electras pending resolution of the problem, which transpired to be the tendency of the outboard engines to 'gyrate'. The problem was corrected by the strengthening of the engine mounts.

In 1957 the company signed a contract with Link Aviation of Binghamton, New York for the construction of a \$1 million Flight Simulator for the Boeing 707-138 aircraft. This company had been in the aviation business for many years and was the manufacturer

of the ubiquitous 'Blue Box' trainers. By 1957 technology advances had made Link a leader in the manufacture of flying training equipment and, apart from the USAF which used their simulators for fighter and bomber training, many world airlines had contracts with this company for the supply of simulators for various types of passenger transport aircraft and helicopters. This background made Link a logical choice for our project. A simulator for the Lockheed L188C Electra was also ordered from Link.

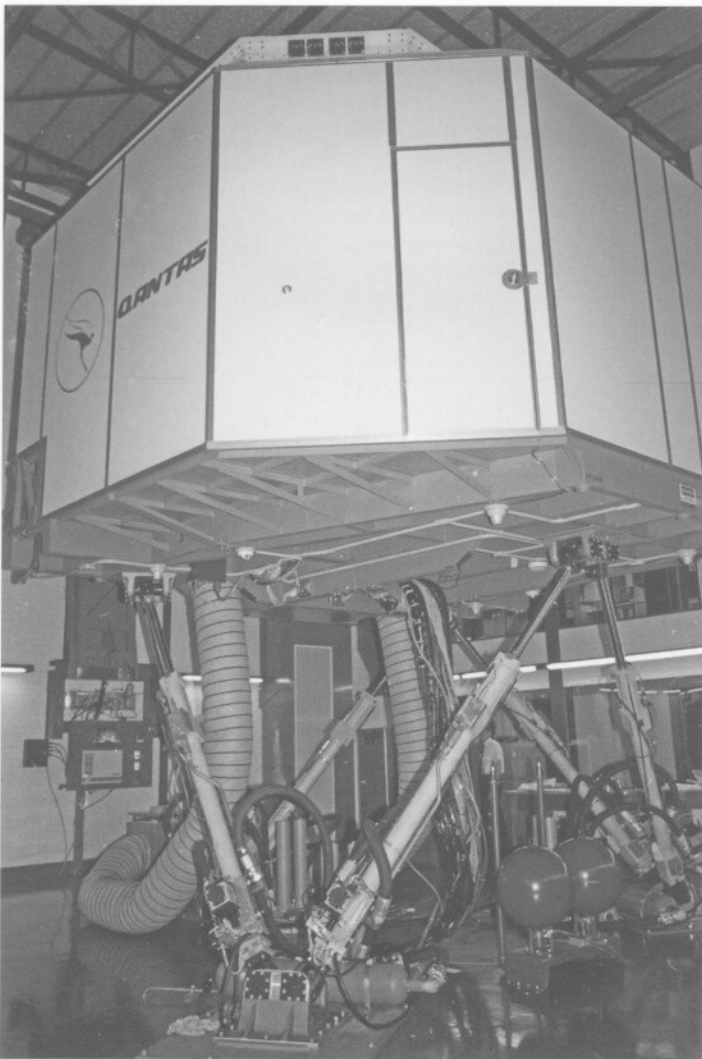
In July 1958, I and three others were sent to Binghamton to undergo classroom training for the maintenance of the 707 simulator. My three companions were Harry Stringer, Warren Pattinson and Howard Marlin and our course was scheduled to occupy eight weeks. We received some insight into the Principles of Flight by Don Lester, Engines by Gene Abbey, Radio Aids by Walt Zaida, Electronics by Buck Martin and General Maintenance by Fred Kubota. The Qantas simulator was being built at Link's No.2 plant on Brandywine Street under Jim Kline's direction but construction was at an elementary stage and little value was achieved by our visits. At the conclusion of the course, my companions returned to Sydney, while I was to remain for the completion and Acceptance Testing by Qantas flight personnel at the appropriate time.

The situation within Plant 2 at this time was one of hectic activity. Many of the US domestic carriers had simulators under construction and the supply of aircraft components such as Flight Director instruments (HDI and CDI), engine monitoring instruments, etc., from the manufacturers was causing many delays to all programmes. Not only was the delivery of urgently needed instruments late, so was the flow of aero/engine data from Boeing.

As had been arranged by Qantas' Boeing Project Controller, Ron Yates, I took the opportunity over a short period to visit the Simulator departments of United, Trans World, Eastern, and Northwest Airlines to gain some insight into the maintenance problems and their experience with follow-up support which may have been necessary. It was interesting to note that these airlines had maintenance contracts with Link which might suggest that our relatively short training period may have been inadequate.



The belt-mounted terrain model and closed-circuit television camera of the visual system for the Boeing 707 flight simulator No.2 Image taken 23 February 1979



One of the later Boeing 747 flight simulators, equipped with the CGI visual system Image taken 1982.

Returning to Binghamton, I busied myself with following the construction programme and familiarising myself with its every aspect. The Qantas simulator was an analogue device which required many amplifiers to perform flight functions and an array of servo mechanisms to drive analogue instruments. These devices were housed in large steel cabinets which were arranged in two rows of five. In each cabinet, an Auto Checking Unit was installed which was used to establish the serviceability of the many amplifiers employed. Two large cabinets containing generators provided regulated DC voltages for the many relays and amplifiers involved as well as providing power and air conditioning for the cockpit. A small air conditioned structure was erected behind the cockpit in which the Radio Aids operator was positioned with the Cross Country and Approach recorders.

In late November 1958, the simulator was said to be ready for our acceptance team, which comprised Captains Eric Robinson and Jim Pollock, Flight Engineers Arthur Rowe and Tom Strong, and Leon Deards. The unit was found to be far from acceptable and further work was required through the next few weeks before it was conditionally accepted. Outstanding work was to be carried out in Sydney by Link and with Qantas support.

Now the problem of getting it to Sydney arose. As Qantas was desperate for simulator training, a decision was taken to fly it to Sydney. This was accomplished per favour of the RAAF which provided two Hercules C-130 aircraft for the uplift. Also, two Qantas Lockheed L1049H Super Constellations each carried 23,000lb of the equipment from New York to Sydney.

The simulator arrived in the first week of February 1959 and was installed under the direction of the appointed Link Resident Engineer Fred Kubota, along with other Link personnel. With the simulator now ready for service, the opportunity was taken to officially declare the opening of the Technical Training Centre by the then Minister for Air.

Whereas training equipment had previously comprised of relatively simple equipment which required only minimal maintenance effort, the newly-arrived Boeing 707-138 Flight Simulator and the training program envisaged by the Operations Department created the need for sufficient maintenance staff to man a 24 hour-7 day shift operation.

The Personnel Department advertised vacancies for technicians with an electronics background. There were many applicants, from whom a sufficient number were selected to enable the creation of a suitable shift structure. On-the-job training was provided by the resident Link engineer and from other sources within the company.

With the commencement of training, comparisons between the aircraft performance and that of the simulator began to appear. These differences grew at an alarming rate and were prejudicing training to the extent that aircraft utilisation was effected by diversion of aircraft to carry out flying training at Avalon. The Operations Department detailed Senior Check Flight Engineer Tom Strong to collate the daily defects with a view to carrying out a fairly major update of the machine. Unfortunately, Tom wanted a note of every flick, quiver and twitch of an instrument needle and, unlike the later generation of digital equipment where such changes are made with relative ease, the changes in the analogue world are quite different, requiring the production and documenting of circuitry changes, component parts and the lengthy time required for their implementation.

Accordingly, a Link engineer, Jake Hand, arrived and the simulator was withdrawn from service for a specified time of six weeks. This work went on for week after week but there was always something more required by way of modification. The collector of data had an insatiable appetite for changes to simulator performance and without any form of control over his activities, the non-availability of the simulator for training became quite serious.

The point was reached where both Qantas and Link managements became so concerned at the extent of the work being undertaken that Jim McGowan, a senior Link Company representative, was sent out to discuss and reach an agreed cut-off point. As time passed there were many modifications carried out, most notable being the later retrofit of a simple motion system which provided pitch and roll movement of the cockpit.

The Electra simulator, also an analogue machine, came online during 1959. It was not equipped with any motion system. Despite its moderate utilisation and much to the chagrin of the Electra Training personnel, clearance of defects arising from the training sessions were subordinate to the needs of the B707. With the sale of the last Electra in 1970, the simulator was dismantled and sold.

Despite the flurry of activities involved with the maintenance and the clearing of defects arising from all equipment, viz. B707 and L188C simulators, L1049 trainer and the AT-22 trainers, the section was without a properly structured control. As I had been deeply involved with the simulator, I assumed a de facto control over the maintenance activity of the section. This became an onerous task which involved me in many long hours and on many occasions in an effort to ensure simulator readiness for training.



View of the cockpit of Boeing 747 flight simulator No.1 Image taken 1982

The many occasions when simulator training had to be abandoned, or programmed training sessions cancelled, ultimately caused Engineering management to inject managerial control over the maintenance section. This initially took the form of a number of Technical Training Managers (the last being Captain P. J. Miller), who had only a limited understanding and knowledge of simulators and their complexity. Ultimately, the Technical Services Department under Bill Hill became involved. He sent John Cotton and Phil Jost to 'deal with the situation'. Again, without any appreciation of the practicalities of the operation, the most intricate and complex tests were evolved to be executed in the time allotted for the clearance of defects and maintenance procedures. Most of these routines would have been beyond the powers of Harry Houdini himself to carry out!

Amongst the pilots in the Electra operations who had reached retirement age for flight crew was Captain J. A. R. (Alan) Furze, a pilot who had a long career both in the RAAF and in Qantas. Through the years he had commands in all of the Company's principal aircraft, commencing with the Catalinas in which he had flown many times to Ceylon during the war, and on the Hythe flying boats, Constellations and Super Constellations, and finally the Electras.

He was appointed the first Flight Simulator Maintenance Manager in mid-1965. Alan was intelligent and a quick learner but was without any insight or experience with simulators. In order for him to function in this position, he was in need of background information regarding the history of the section through the previous five or six years. I was happy to accommodate him in this and over many hours and cups of coffee I provided a detailed picture of events and personalities involved in the running of the section. I developed a good working relationship with him.

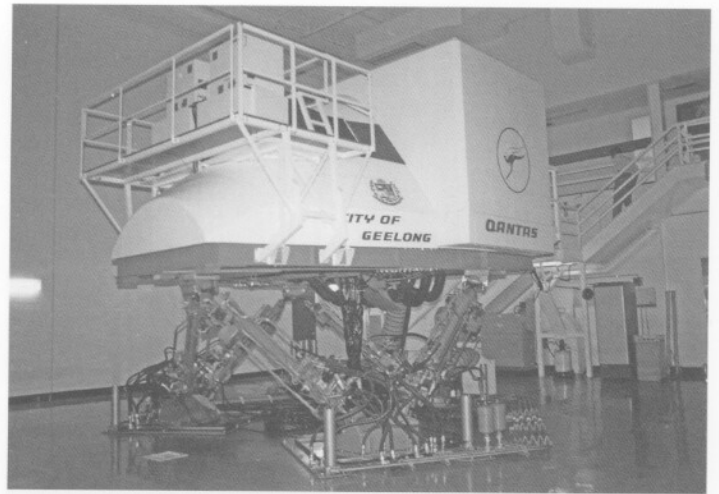
His appointment was a breath of fresh air. In his long service with the company, he had become acquainted with heads of other departments and this proved to be very helpful in subsequent years. This was reflected in the changed nature of the section where better training of personnel took place, arrangements were made for technicians to observe flying operations at Avalon, and a Technical Development group was established, the responsibility of which was to generate changes to the simulator program as a result of Boeing's changes to the aircraft performance, physical changes on the flight deck, or changes arising as a result of Qantas's operational experience. As a result, I inherited a well-established section when I succeeded him in 1975.

The following years saw the company purchase two more Boeing 707 simulators, for the 707-338C aircraft, the first driven by a digital computer (Mk.1). Qantas took delivery of the first machine early in May 1965, a simulator manufactured by Link Corporation in the USA. In 1968 the second 707-338C simulator, driven by a later model digital computer designated GP Mark 4, was purchased from Singer Link.

The digital simulator was in every way superior to the analogue simulator in reliability, repeatability and where the needs for modification arose. But something was lacking, and that was the need to provide pilots with some visual reference to the vital aspects of training: take off and approach. There was precious little on offer around the world at that time. However, the UK



View of the cockpit of Boeing 747 flight simulator No.1.  
Image taken 1982



The second Qantas Boeing 747 flight simulator, identified by its Computer Generated Image visual system  
Image taken 11 December 1980

company General Precision Systems Ltd at Aylesbury (formerly Air Trainers Link Ltd), manufactured a visual model with runway and surrounding features, and provided a scene in colour. This model was on a continuous belt with a closed-circuit television camera mounted on a gantry and responded to aircraft deviation and altitude (within limits). The camera lens mirror represented the pilot's eye position. The scene viewed by the camera was projected on to a large screen carried on the frame of the cockpit. Three large Philips projectors (red, green, and blue) were mounted on a gantry which was carried by the cockpit. The three were converged to project a colour image on a screen mounted in front of the cockpit. The system was cumbersome and demanding in its need for accurate projector registration, and worked moderately well for take-off and landing but had little else to commend it as it lacked other visual cues normally available to the pilot 'in the real world'. This system was mounted on the 707 simulator driven by the Mk.1 computer.

With the phasing out of the Super Constellations, the L1049 Type Trainer was sold to TAA, where it underwent a conversion to represent the Vickers Viscount. The analogue Boeing 707-138 simulator, already a 'world traveller' in having come initially from New York to Sydney, was sold to Aer Lingus in Dublin in 1970, and was later on-sold to various companies in other parts of the world.

Visual systems at this time were still being developed using CCTV, although there were some early attempts at employing beam penetration tubes, which very soon gave way to the development of today's Computer Generated Image System. But availability of such system was still some way off, and a visual system was required for this new simulator.

In the meantime Redifon (Air Trainers Ltd) which had manufactured the Belt model system described earlier, had changed philosophy and converted the rotating belt approach to a very large fixed model system featuring the runway and other general scenery. Qantas bought one of these visual systems in 1966, at a cost of £270,000. An improved picture resulted but the system retained certain limitations and lacked flexibility. Additionally, the same cumbersome projector/screen assembly had to be mounted on the cockpit. Registration of the projectors was an ongoing daily requirement.

In 1976 a Boeing 747 digital simulator was purchased from Singer Link at Kirkwood (Binghamton). This simulator was equipped with a motion system which provided more freedom of motion than that of earlier systems, and allowed the cockpit to pitch, roll, heave, yaw and accelerate. The cockpit was mounted on large actuators driven by a 1500psi hydraulic pump and which were geometrically arranged to enable the cockpit to move in accordance with the flight profile. I doubt that the current motion system developed through Link will ever be bettered.

The requirement of a visual system had to be satisfied by the using the same system as that provided for the Boeing 707 simulators. To this end projectors were mounted on the B747 cockpit and a 'sharing' arrangement was developed which enabled switching of the video signals (projection) between the B707 and B747 simulators; the associated work was carried out by engineers from Redifon Ltd, UK, in conjunction with Qantas staff.

In 1979 the Boeing 747 simulator was upgraded with a computer-generated image visual system, wherein a computer 'draws' the scene onto a television-like visual display unit mounted outside the simulator windscreen. This equipment was manufactured by the McDonnell Electronics Company and known as the Vital 111-6000. A second Boeing 747 simulator entered service in 1979, also fitted with the Vital 111-6000 CGI system.

The development of today's Computer Generated Image system provides the pilots with a most realistic view of the real world and, together with the cockpit mounted on its motion system, presents a compact unit which is far removed from the requirement of a huge room (50ft X 25ft approximately) to accommodate one analogue simulator.

Following the sale of the last two Qantas Boeing 707 aircraft to the Australian Government in 1979, the 707-338C simulator with the GP4 computer was sold to Aer Lingus. The visual system was donated to Sydney's Museum of Applied Arts and Sciences in 1980. The 707-338C simulator was bought from Aer Lingus by the Royal Australian Air Force in 1984 to support the training requirements of the RAAF's five Boeing 707s and was re-installed in the Qantas Flight Training Centre at Mascot, with Qantas being awarded a contract to maintain it. By this time, the simulator was fitted with a McDonnell Douglas computer-generated Vital IV visual system. Then, in August 1999, it was relocated from the Qantas Jet Base to Sydney University, where it was to be used for research, training and development.

Today's simulator purchase can almost be described as being 'bought off the shelf' and is far removed from the 'good, but sometimes worrying, old days' of lengthy Resident Engineering secondment to the manufacturer's plant.

Some personalities involved in the procurement of the subject equipment were:

From: Link Aviation, Binghamton	From Qantas
Lloyd Kelly*	Ron Yates
John F Shields	Ken Gould
Ray Long*	M. Myers
Dick Neddo	Trevor Ford
Bill Turner	
Peter Quast	From Air Trainers Ltd, Aylesbury UK
Hap Syle	Frank Powell
Rod Nevin	Andrew Sweetland

Jim McGowan  
Harold Warden

\* denotes Company President



The 'night time' map display of the visual system used by the No.2 Boeing 707 and the No.1 Boeing 747 flight simulators  
Image taken 11 December 1980



Qantas personnel at the acceptance of the No.2 Boeing 707 flight simulator at Singer-Link at Kirkwood (Binghamton) in 1968. Left to right: Simulator Technician Vern Cottee, Captain Andy Stapleton, Flight Captain Standards Alan Emmerick, Bill Field; (front row) Senior Training Flight Engineer Bill Strangward, and Tom Strong.



The 'daytime' map display which supported the No.2 Boeing 707 flight simulator and the No.1 Boeing 747 flight simulator. The video signals were switched between one machine and the other, although the crews in the B747 were reluctant to share with the B707  
Image taken 11 December 1980

Images for this story were supplied by Greg Banfield