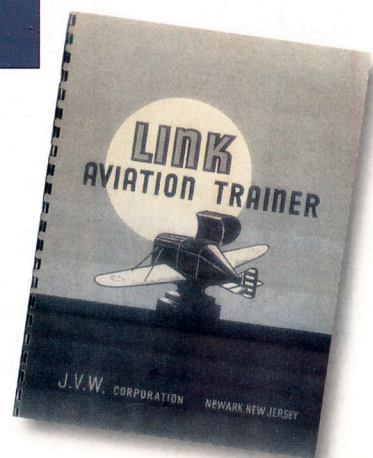




Finding the missing Link



In the late 1920s Edwin A. Link, an American aviator and inventor, devised a machine which enabled the student pilot to practice "blind flying" while remaining safely on the ground. **ROSINA BROWN** relates the history of the first flight simulator, and meets a husband-and-wife team who restore them

THE LINK SYNTHETIC INSTRUMENT Flying Trainer, invented more than 75 years ago, was the brainchild of Edwin A. Link, a self-educated aviator and inventor born in Huntingdon, Indiana, USA, in 1904.

Link's company, Link Aviation Devices of New York, devised the first truly effective flight simulator in 1929, although it did not arrive in Britain until 1936. Overtaken by the wonders of electronic computers and virtual-reality simulation, it is testimony to the soundness of Link's original design that his trainers still have a place in the training of amateur pilots who do not have the latest technology at their disposal.

Link constructed a model of an aircraft cockpit and, so that the movements of an aircraft could be realistically simulated, equipped it with an instrument panel and controls. The device could be used for instrument training by manipulating the controls on the basis of instrument readings. The artificial horizon on the instrument panel enabled the pilot to maintain straight and level flight or control climbs and descents with no visual outside reference.

Before the advent of the Link, an aircraft would be flown with a hood over the pupil's cockpit, making it necessary for the tyro to fly relying solely on his instrument readings, or "flying blind". This practice could, of course, be extremely dangerous, not to mention expensive should the lesson not go according to plan.

Link training would usually follow the basic

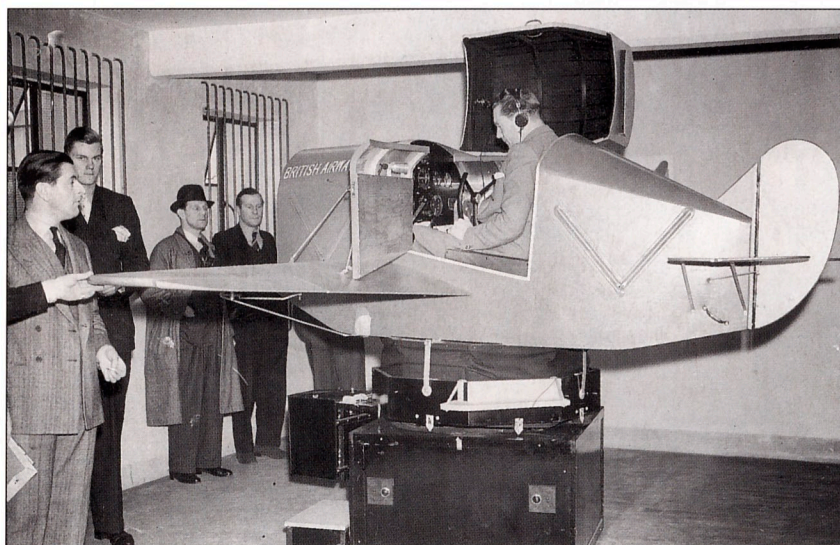
training of a pilot in an aircraft, and was used to teach him how to fly on his instruments alone, which often took longer to teach than the actual flying of an aircraft.

Link Trainers were produced in the 1930s and purchased by the US Government from 1934. Production increased rapidly with the approach of the Second World War, and this first successful flight simulator was used to teach basic instrument flying, instrument landing and radio navigation to more than 500,000 military pilots. As aircraft technology advanced, the trainer

TOP Ken and Audrey Whiffin with the RAF Manston History Museum's Link D-4 in 1999. Photograph by IAN FRIMSTON/FUJI LAB.

ABOVE The cover of an original 1939 brochure for the Link Trainer.

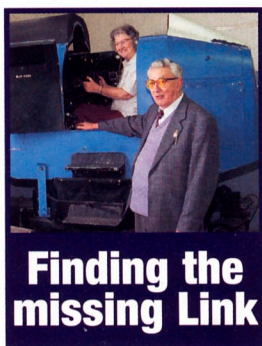
BELOW A British Airways student in a Link at Gatwick in November 1937.



RIGHT An ATC cadet puts his flying skills to the test in the D-2 at Manston, with Ken Whiffin standing by as instructor.



KEN WHIFFIN VIA AUTHOR



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BELOW The Link Trainer found favour all over the world, and was sold to 35 nations, including Germany, Italy, Russia, Japan and, as seen here in 1950, France.

was modified and commercial airlines began to use it to train their pilots.

The Link Trainer did not arrive in Britain until 1936, when Air Cdre Fellowes, following his meeting with Ed Link during a lecture in the USA, successfully demonstrated it to the RAF. This meeting also led to Fellowes becoming the sole agent for the Link in Britain.

A British company, JVW Ltd, was set up in Aylesbury, Buckinghamshire, and was responsible for all sales, installation, part servicing and maintenance. In 1946 JVW Ltd was taken over by a new company, Air Trainers Ltd, but the existing management and staff were retained, and took on research and development, leading to the eventual manufacture of the new D-4 Instrument Flying Trainer, the first model to be built entirely in England. With its bulging order-books, the company was producing up to 15 machines a month to satisfy home and overseas demand. More than 10,000 Links were built.

The advance of electronic technology in the early 1950s allowed the introduction of further improvements that made the simulators more realistic. Analogue computers led to more innovations, but also heralded the end of the

Link Trainer era, allowing aircraft cockpits, controls and instrument displays to become more individualised. The Link Trainer could now be used only to prepare pilots for basic blind flying.

By the end of the 1950s pilots in America were being trained in simulators that precisely duplicated the cockpits of the aeroplanes they would be flying. Any modifications were easily incorporated and, with added virtual-reality simulation, highly complex real-life conditions could be reproduced.

Today flight simulation is essential for familiarising pilots with any new modifications to an existing aircraft, or for training them to fly a new model. Simulators are used widely by the military and by commercial companies.

Good as it would be for the Air Training Corps (ATC) in Margate, Kent, to have these state-of-the-art facilities available, they are beyond the corps' financial reach. However, Ken Whiffin and the RAF Manston History Museum have been doing their bit to provide the next best thing, in the form of Link Trainers, lovingly restored and in perfect working order.

An ex-RAF man, Ken has spent many hours restoring these forerunners of the sophisticated flight simulator. His pedigree is surprisingly similar to that of Mr Link. When not elbow-deep inside a D-4 Trainer, Ken, who is visually impaired, tunes pianos in his local area. Edwin Link once worked in a player-piano factory in the USA, and although the Link is part electrical, part mechanical and part electronic in operation, it is based on the common wood-and-fabric bellows. The vacuum-operated turn motor used in a Link is the same as that used to drive a Pianola; the only difference being size.

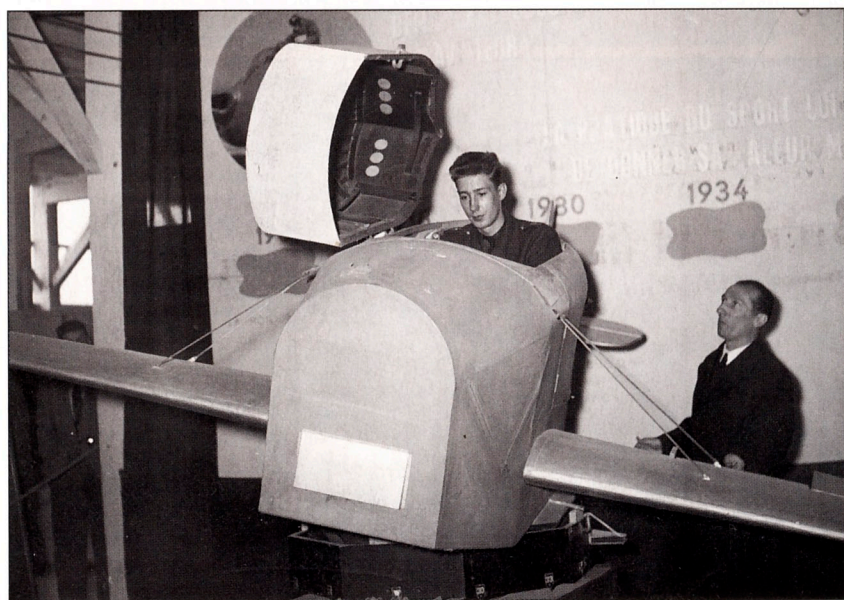
Ken's romance with the Link Trainer was rekindled when he was asked to go to ATC Squadron Headquarters in Margate to repair a radio. Ken served as a radio technician in the RAF. He was based at Finningley and in the Middle East, and on leaving the Service in 1959 as a flight lieutenant he worked for Phillips in Wandsworth, south London, also as a radio technician. Ken has been a dedicated radio amateur for many years, so there is little he does not know about the inside of a radio.

On his arrival at the headquarters Ken could not help noticing the wreck of a D-2, its component parts scattered around the room. It was explained to Ken that since the working Link had been moved from the ATC's previous Headquarters it had been gradually stripped down by various people, resulting in some parts being lost and some taken away.

Ken explains: "Because I couldn't keep my mouth shut about being involved with the Link during my time in the RAF, that day I got myself involved in the Link restoration business; a task which took me 2½ years to complete, starting from the floor up. When I took on this labour of love I didn't know what was missing, but with the help of a colleague who did the intricate manual work, owing to my failing eyesight, we gradually rebuilt the D-2 to its former glory. The biggest job was to make new bellows and recover them."

The Link's movements are caused by the main pitching and banking bellows and by the turning motor. Three main valves control the

"This first successful flight simulator was used to teach basic instrument flying, instrument landing and radio navigation to more than 500,000 military pilots"



application of vacuum to the bellows and motor. These valves are secured to a common manifold connected to the main vacuum manifold to the Trainer, and are located beneath the cockpit floor. They are the nerve centre of all the Trainer's movements.

Four main components make up the D-class Trainer: the base, the revolving octagon, the fuselage and the desk. The base, which supports the octagon and fuselage, houses the base terminal box, the wind-drift mechanism and base teletorque assembly, as well as mechanical and electrical linkages to the fuselage and instructor's desk. The base terminal box also serves as a terminus for most of the wiring of the electrical equipment.

The octagon supports the fuselage. It is mounted on a main spindle and is free to rotate in either direction. A universal joint allows the fuselage to pitch and bank, and incorporates "take-offs" which transmit the pitching and banking movement of instruments and mechanisms in the fuselage. The most important contents of the octagon are the four main bellows providing the pitching and banking movements. Also attached to the octagon is the turning motor. Two pneumatic shock-absorbers stabilise the fuselage and manual and automatic locking devices. The fuselage houses the numerous pieces of equipment which transmit signals to the teletorque motors related to the various cockpit instruments, causing the instruments to give appropriate readings. The instructor's desk includes the automatic recorder, the radio control units, the remote instrument case and various remote controls.

Once Ken had successfully restored the D-2, it was only a matter of time before his next project cropped up. On a spur-of-the-moment visit to the RAF Manston History Club Museum, situated on Manston airfield, Ken happened

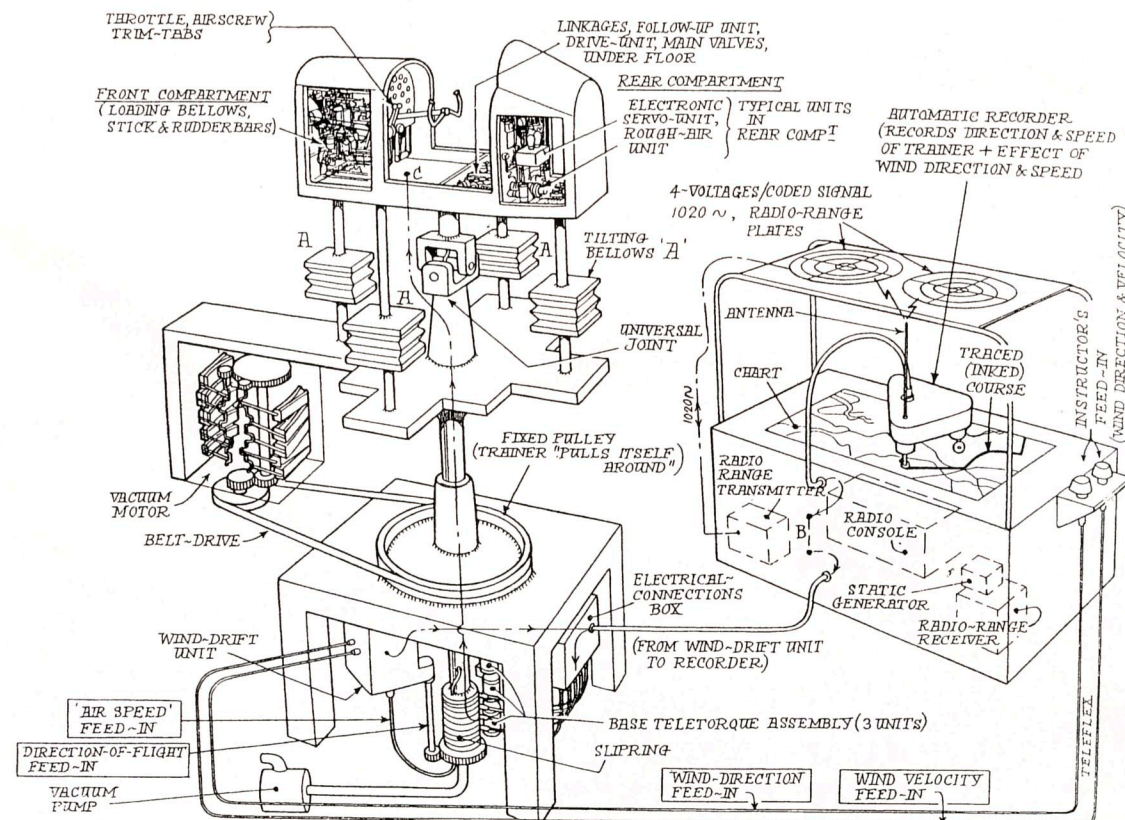


ABOVE Ken Whiffin gives the D-2 at Manston a test flight. The D-2 was introduced in 1942, chiefly for British use, and was an improvement over the D-1 in having a wind-drift mechanism fitted.

to notice a D-4 hidden away in the corner of the old hangar. This time it was his wife, Audrey, who could not keep quiet. "Oh look, a Link Trainer! He knows all about them, he's just done a D-2 for the ATC."

Peter Smith, the museum's Aircraft Restoration Officer, was delighted to explain to Ken the history of their D-4. The Trainer had been used for many years by the combined cadet force at Dulwich College in south London. When it began to emit smoke they stopped using it and decided to donate it to the History Section at Manston. It was complete.

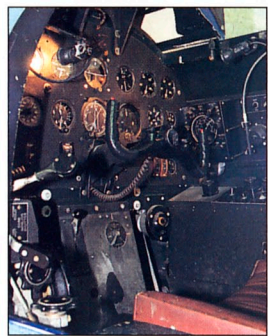
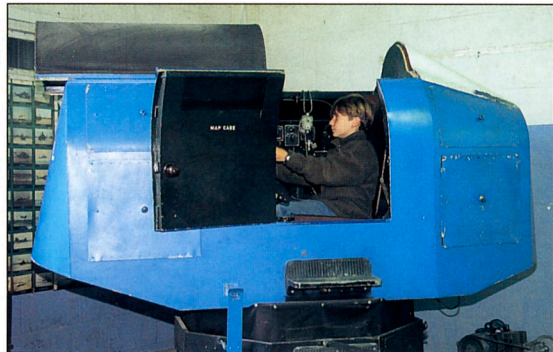
The cockpit of the D-4 resembles that of any modern single-engined aircraft. Instruments on the D-4 include an airspeed indicator, altimeter vertical speed indicator, gyro-magnetic compass, artificial horizon, turn-and-bank indicator, magnetic compass, wheel and flap position



ABOVE A Link Trainer before restoration at Manston. The fuselage was stored elsewhere at the museum.

LEFT A 1950 diagram of the layout of the Link D-4 by The Aeroplane's J.H. Clark. The radio system works as follows: voltages are impressed on radio range plates from the transmitter at "B"; picked up by antenna and passed to pre-amplifier and receiving amplifier, then through cable to base terminal box and up to fuselage control box at "C".

RIGHT The Link Trainer appeals to students of all ages, even the younger "computer generation", as this potential future pilot demonstrates in the D-4 at Manston.



ABOVE The cockpit of the D-4, with all the instruments needed to replicate a single-engined modern aircraft.



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BELOW Westland Whirlwind HAS.7 XN380 is one of two examples at the RAF Manston History Museum. **BELOW RIGHT** The museum is housed in buildings formerly occupied by RAF Manston's Motor Transport Section.



indicator, vacuum gauge, clock, automatic radio compass and instrument landing system (ILS) indicator. Although they were made for the Trainer, most are identical in appearance with standard units. The engine instruments comprise a tachometer, boost gauge, fuel and oil pressure gauges, fuel quantity gauge, carburettor, oil, engine and air temperature gauges. There are normal rudder pedals and a standard push-pull type wheel control. A standard engine control quadrant, flap and undercarriage operations, and control surface trim tabs complete the controls. There is a map-case in the door. A sliding translucent covering over the cockpit simulates cloud flying, and a further opaque cover cuts out all light for "night flying".

Ken's first task was to find out if the D-4 still worked. By using a domestic vacuum cleaner he found some signs of life, and, as luck would have it, he found a proper vacuum pump under a pile of junk in the hangar. He stuck it on and the Trainer "flew"! The main problem with any project like this is the lack of circuit diagrams, and as 4,500 new drawings were required for the original production of the D-4, the size of the task can be appreciated. Ken explains: "With nothing on paper you are literally 'flying blind'. We knew how it should work, but were afraid of blowing it up."

The present state of play is that the D-4 is at the point where it will "fly", but without the benefit of three of the instruments, the altimeter, air speed indicator and climb/dive meter. But as a determined Ken says: "The unit that drives those units is the one emitting smoke. The breakdown is in the oscillator that drives the units. We also have a fault in the wiring that I can't trace. But I will!"

Finding parts and drawings for the Link is a matter of contacting other collectors and enthusiasts around the country. Ken happens to know from previous conversations that Solent Sky (formerly the Southampton Hall of Aviation) at

Eastleigh desperately wants a "crab". Manston has four, but they need manuals on the Link if they are to complete their restoration. Eastleigh can oblige. And so it goes on.

Other exhibits at the museum are in various stages of restoration. They include Gloster Meteor TT.20 WD646/"WD615", de Havilland Canada Chipmunk T.10 WP772, Westland Wessex HU.5 XS482 and two Westland Whirlwinds, HAR.10 XJ727 and HAS.7 XN380. There are also two training gliders on show, Slingsby Cadet TX.3 "VM791" and Slingsby Grasshopper TX.1 XA231. In addition several cockpit and nose sections are on display — Canberra B(1).6 WT205, Buccaneers S.1 XN928 and S.2B XV352, Victor K.2 XL190 and Valiant BK.1 XD857.

The RAF Manston History Society and Museum all started in the late 1980s, when an airshow was being staged at RAF Manston for the first time since the 1950s. Service people, interested in the history of aviation, thought it would be an added attraction for the public if some "bits and pieces" from bygone days could be put on show. A small collection of personal mementoes of aviation's past was assembled. Manston's Commanding Officer at the time, Tom Hindmarsh, gave the enthusiasts his blessing to initiate the Club and Museum. The rest, as they say, is history.

On March 31, 1999, the RAF left Manston, but the museum subsequently moved into the station's old MT section. It is now open daily in summer and at weekends in winter — see panel below for details — and exhibits record the military and civilian aviation history of the site since it was first opened as a Royal Naval Air Station in 1916.

Ever since Ken Whiffin's first involvement with Link Trainers, Audrey — a fully trained Link pilot herself — has given him tremendous support, so much so that she is now recognised as his "chief test pilot". Ken, of course, is known affectionately as her "blind flying instructor". What else? **A**

RAF Manston History Museum

Located in the old RAF Manston MT Section building beside the A253 west of Ramsgate, adjacent to the Hurricane and Spitfire Memorial Building, the museum is open 1000–1600hr daily April–October, and 1000–1600hr at weekends November–March. Admission costs £1 (accompanied children free); for more details of the museum and of Manston's history call 01843 825224 or visit the website at www.rafmanston.co.uk

