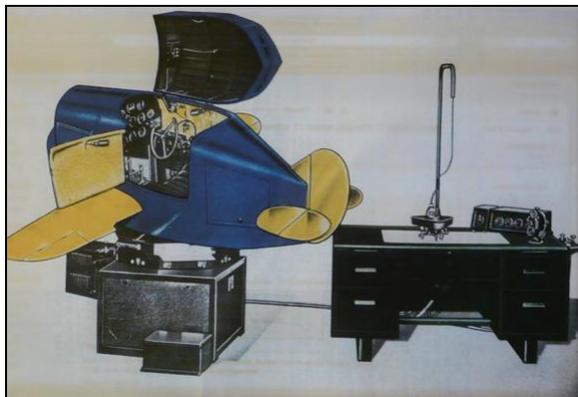


Researched and Written by: Capt (N)(Ret'd) M. Braham
Edited by: Julia Beingessner



A hand-coloured Link Company illustration of the Link Trainer set-up.

(Source: <http://www.vintagewings.ca/>)

Introduction: The term Link Trainer commonly refers to a series of flight simulators produced between the early 1930s and 1950s by Edwin A. Link, Jr. They were based on technology he pioneered in 1929 at his family's piano and organ business in Binghamton, New York. These simulators became famous during World War II, when they were used as a key pilot training aid by almost every combatant nation.

The original Link Trainer prototype was created in 1929 as a way to safely teach new pilots how to fly by instruments. An experienced organ and nickelodeon¹ builder, Link used his knowledge of pumps, valves and bellows to create a flight simulator that responded to the pilot's decisions and gave an accurate reading on the instruments.

More than 500,000 US pilots were trained on Link simulators, as were pilots of

¹ Nickelodeon is defined in the American Heritage Dictionary as an early movie theatre charging an admission price of five cents; a player piano; and, as a jukebox

nations as diverse as Australia, Canada, Germany, the United Kingdom, Israel, Japan and the USSR.

The Link Flight Trainer has been designated as *A Historic Mechanical Engineering Landmark* by the American Society of Mechanical Engineers. The Link Company, now part of L-3 Communications, continues to make aerospace simulators.

Origins: Edwin A. Link, Jr. (See Annex B) developed a passion for flying in his boyhood years, but was not able to afford the high cost of continued flying lessons. So, upon leaving school in 1927, he started developing a simulator, an exercise which took him 18 months. His first pilot trainer, which debuted in 1929, resembled a toy airplane from the outside, with short wooden wings and a fuselage mounted on a universal joint². Organ bellows from the Link piano and organ factory, driven by an electric pump, made the trainer pitch and roll as the pilot worked the controls.

Link's first military sale came as a result of the Air Mail scandal. As a consequence of the scandal, the Army Air Corps had taken over carriage of U.S. Air Mail. However, due to their unfamiliarity with Instrument Flying Conditions twelve pilots were killed over a 78 day period. This large-scale loss of life prompted the Air Corps to look at a number of solutions, including Link's pilot trainer. The Air Corps was given a stark demonstration of the potential of instrument training when, in 1934, Link flew to a meeting in conditions of fog that the Air Corps evaluation team regarded as unflyable. As a result, the Air

² Which allowed the "pilot" to maneuver the trainer in all directions by means of the control stick.

Corps ordered the first six pilot trainers at \$3,500 each.

The Link Company expanded rapidly. By World War II, the ANT-18 Basic Instrument Trainer, known to tens of thousands of fledgling pilots as the "Blue Box" (although it was painted in colors other than blue in other countries), was standard equipment at every air training school in the United States and Allied nations. During the war years, Link produced over 10,000 Blue Boxes, turning one out every 45 minutes.

Models: Several models of Link Trainers were sold in a period ranging from 1934 through to the late 1950s. These trainers kept pace with the increased instrumentation and flight dynamics of aircraft of their period, but retained the electrical and pneumatic design fundamentals pioneered in the first Link.

Trainers built from 1934 up to the early 1940s had a color scheme that featured a bright blue fuselage and yellow wings and tail sections. These wings and tail sections had control surfaces that actually moved in response to the pilot's movement of the rudder and stick. However, many trainers built during mid to late World War II did not have these wings and tail sections due to material shortages and critical manufacturing times.

Pilot Trainer

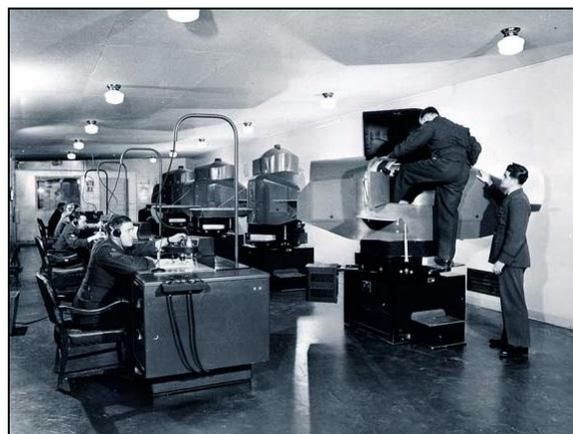
The Pilot Trainer was Link's first model, and was an evolution of his 1929 prototype.

ANT-18

The second and most prolific version of the Link Trainer was the ANT-18 (Army Navy Trainer model 18), which was in its turn, a slightly enhanced version of the model C3. This model was also produced in Canada for both the Royal Canadian Air Force and the Royal Air Force with a

somewhat modified instrument panel, where its model designation was D2. It was used by many countries for pilot training before and during the Second World War, especially by the British Commonwealth Air Training Plan that trained 131,553 aircrew, most of whom received some instruction on the Link Trainer. (To read a personal account of the Link Trainer, see Annex A.)

The ANT-18 featured rotation through all three axes, effectively simulated all flight instruments, and modeled common conditions such as pre-stall buffet, overspeed of the retractable undercarriage, and spinning. It was fitted with a removable opaque canopy, which could be used to simulate blind flying, and was particularly useful for instrument and navigation training.



Link Trainer Room at Virden, MB

(Source: <http://www.vintagewings.ca/>)

The ANT-18 consists of two main components.

The first major component is the trainer itself. The trainer consists of a wooden box approximating the shape of a cockpit and forward fuselage section, which is connected via a universal joint to a base. Inside the cockpit is a single pilot's seat, primary and secondary aircraft controls, and a full suite of flight instruments.

The second major component is an external instructor's station, which consists of a large map table, a repeated display of the main flight instruments, and a moving marker known as a "crab." The crab moves across the glass surface of the map table, plotting the pilot's track. The pilot and instructor can communicate with each other via headphones and microphones.

Survivors: A number of Link Trainers are known to survive around the world, most of which are the ANT-18 model.

In Canada there is a fully functional Link Trainer owned and operated by the Canadian Harvard Aircraft Association of Tillsonburg, Ontario. Other Link Trainers are on display at the Canadian Air and Space Museum, the Western Canada Aviation Museum, the Canadian War Museum and the Commonwealth Air Training Plan Museum. There is also a Link Trainer on display at the North Atlantic Aviation Museum in Gander, Newfoundland, Canada; it was used in the television series *Above and Beyond* (2006).



Link Trainer at the Western Canada Aviation Museum. (Source – Wikipedia)

ANNEX A

THE LINK TRAINER – A PERSONAL REMINISCENCE



Tom Dent in front of the CWM Link Trainer

Tom Dent served in the RAF from 1941 to 1946 when he retired as a Flight Lieutenant, Navigator. He is now a Friend of the Canadian War Museum and a Volunteer Interpreter in the Galleries of the War Museum. The following are some of his personal remembrances of "flying" the Link Trainer.

My introduction to the link trainer was at Estevan when I was learning to fly the Anson Five.

By the time you were using the Link Trainer you were a competent flyer, under daylight flying rules; however operational flying often required that you be able to maintain full control of your aircraft in cloud, in fog and at night when the horizon was not visible. This was the purpose of the Link Trainer. At later times and in different circumstances it was used to familiarize students with aircraft controls and in some cases to assess aptitude for flying.

Many displays of the Link Trainer including that at the Canadian War Museum do not show the instructor's desk which was a crucial part of the training. The instructor,

who had duplicate instruments to the ones in the trainer plus a device commonly called "The Crab" which traced the "aircraft" path, was the key to successful training.

Link classrooms often had six or eight training stations which operated as follows. The student was given an initial opportunity at the controls with the upper lid open to observe how the machine responded. However, most instruction took place with the lid and the door closed with the only illumination being the blue fluorescent light which lit up the instruments.

The instructor would then give appropriate commands to fly straight and level or to climb to a given height while maintaining a steady course. In the early stages of instruction it was not uncommon for students to make some errors which would have been serious in real time flying conditions and which often provoked some interesting reactions from instructors.

To verify your ability at the controls of an aircraft you were fitted with a device resembling the Salvation Army woman's bonnet except that it extended about a foot or so in front of your face so that in the pilot's seat you could see only the instrument panel.

Though most students had early difficulties by far the greatest percentage were successful for which credit must go to the instructors.

It was nevertheless a stressful experience. First the environment was totally new and strange. Flying an aircraft from inside a box was somewhat unreal. Secondly the controls, though similar, were as much like a real aircraft as a bumper car is like a Toyota Corolla. Most stressful of all was the realization that unless the instructor

*was prepared to recommend an air check
your career as a pilot was ended.*

*Though I was quite successful as a Link
pilot, my career as a pilot ended at Final
Check, owing to a difference of opinion
between myself and the examining officer
regarding the stalling speed of the Anson
5.*

ANNEX B

EDWIN A. LINK, Jr. – INVENTOR OF THE LINK TRAINER



1904-1981

"Ed" Link was born in Huntington, Indiana, but moved in 1910 to Binghamton, New York, where his father purchased a bankrupt music firm. The business was renamed the Link Player Piano and Organ Company and it was here Ed would begin and develop his multi-faceted career as an inventor, industrialist and pioneer in the fields of flight simulation, underwater archaeology and ocean engineering. To quote his friend Harvey Roehl, Edwin A. Link, Jr. was a "backyard inventor in the finest American sense."

In his early twenties, at considerable expense and some risk, Link obtained his pilot's license. While struggling to become a pilot, he began tinkering with parts of organs at his father's factory, trying to develop a training device so that pilots could start learning to fly safely and inexpensively without leaving the ground. Initially his Link Trainer, although

successful, was seen as a toy and relegated to the status of fairground ride.

In the mid-1930's, after a series of air accidents, the Army Air Corps ordered six of Link's instrument trainers to enhance its pilot training program. Once public attention had been drawn to this practical device, orders for more came from all over the world. Ultimately, Link's flight trainer (the Blue Box) led to the development of the field of flight simulation. With the help of his wife, Marion Clayton Link, whom he had married in 1931, Ed Link successfully ran Link Aviation, Inc. until he sold the company in 1954.

Thereafter, Ed's skills and attention focused on underwater archaeology and exploration. In this, his wife, Marion, became his partner in research, and, with their two sons, William Martin and Edwin Clayton, they undertook a number of voyages. During these years, Ed Link worked constantly to improve diving equipment in order to allow divers to go deeper, stay longer underwater, explore more safely and efficiently, and return to the surface with less risk. On one of these sea voyages in 1973, during a routine dive in a submersible, the Links' younger son, Clayton, and his friend Albert Stover were killed. In a very moving statement to the press, Ed expressed his conviction that their deaths had not been in vain, but had identified problems which must be solved in order to meet the challenge of safer underwater exploration.

Link continued actively exploring, tinkering, writing and generally enjoying his many interests until very shortly before his death in 1981. He had an unusually generous spirit: not only did he give tirelessly of his time and energy; he made financial donations to many

foundations, scholarships and charitable causes. His gifts to Binghamton University include the Edwin A. Link Organ Music Professorship, Binghamton's first endowed faculty chair.

References:

1. Wikipedia, The Link Trainer - http://en.wikipedia.org/wiki/Link_Trainer
2. Binghamton University, <http://library.binghamton.edu/specialcollections/linkedwin.html>
3. BCATP Museum, <http://www.airmuseum.ca/bcatp.html>

Captain (N) (Ret'd) M. Braham, CD



Mike Braham is a graduate of the Royal Military College (1965) and a former naval officer and senior official with DND. He has an abiding interest in military history.