Pictoral History of Simulation

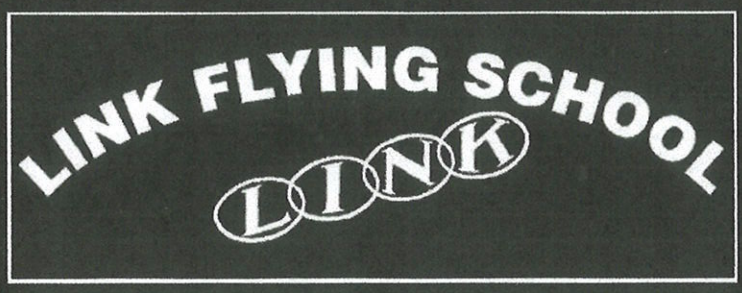
1929

1. First Instrument Flight trainer Patent

Ed Link completed the design work on his initial trainer early in 1929 and submitted his request for a patent on April 14. There had been prior attempts to simulate the flight of an aircraft, but they had all failed for avariety of reasons.

Ed had certain advantages over his predecessors, however. First, he saw that the technology used for building organs in his father's organ factory offered a possible solution to the aircraft simulation problem. Second, he was a pilot himself and had developed a great interest in how pilots ought to be trained. Finally, Ed was endlessly inventive and a tenacious problem-solver.

These characteristics came together to produce the first Link Trainer in 1929. Reviews of the patent application began the next year and issued in 1931 (1).



1.


Patented Sept. 29, 1931 1,825,462

UNITED STATES PATENT OFFICE

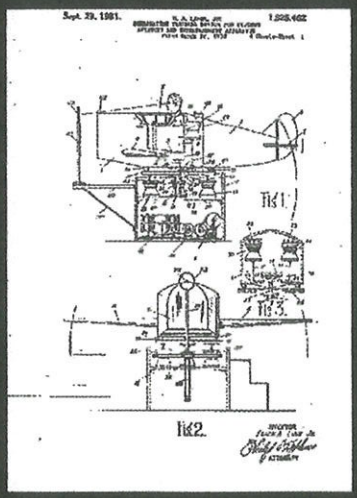

Sept. 29, 1931. 1,825,462

Fig 1.

Fig 3.

Fig 2.

1930's

The Training Scene

The decade was characterized by somewhat sporadic growth in the use of Ed Link's invention. Some of the uses were serious: after a series of crashes, the US Army Air Corps purchased six units to help train its pilots in delivering the mail under poor visibility conditions. Some of the uses were for entertainment: a number of the units were put in operation in amusement parks. The amusement motif would return 50 years later as a poplular software package to run on a PC.

1. First Link Aviation Trainer

An early photography of the trainer and its inventor in a corner of the family organ factory in Binghamton, NY.

2. ANT - 18 Instrument Trainer

The US Military first acknowledged the merit of ground-based aviation training in the 1930's, when it procured (sole-source) several Link Trainers. The Instructor's Desk, which was later to grow into an entire station, provided radio signals to the trainee and recorded his flight path on a plotter.

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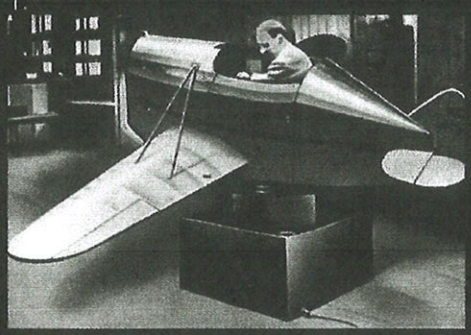

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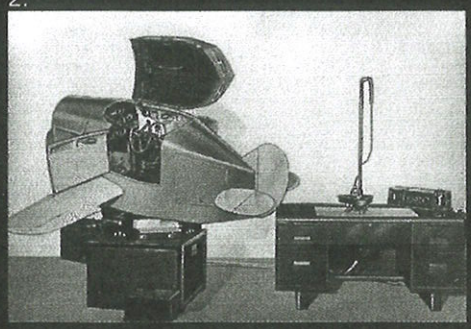

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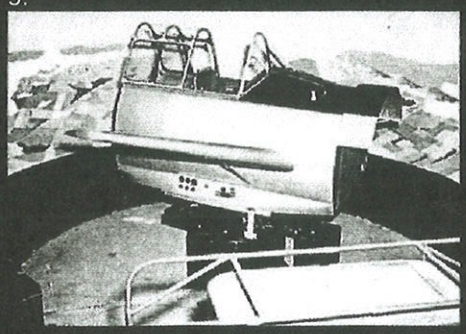

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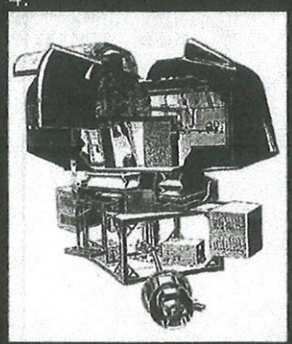

3. & 4. Cut-Away View of an Early Trainer & The Cyclorama

Pilots were never entirely content with a heads-down only trainer, and their requirement to see the outside world has led to the training industry's single most difficult challege: creating the out-the-window view. Here is a photograph of tone of the first visual systems installed on a 1-CA-2 flight trainer. The Cyclorama projected a static visual scene which provided a horizon line for the trainee.

1940s

The Training Scene

The first half of this decade was dominated by WWII. The United States faced an undprecedented need to train pilots during this period. It was this wartime need that provided the impetus for the long-term acceptance and growth of ground-based trainers.

The late 1940's saw the birth of a whole new approach to designing training devices: electronic computation.

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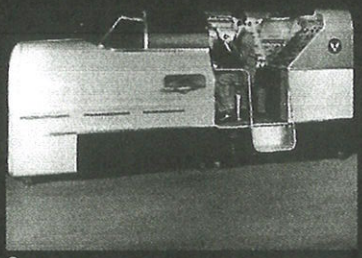

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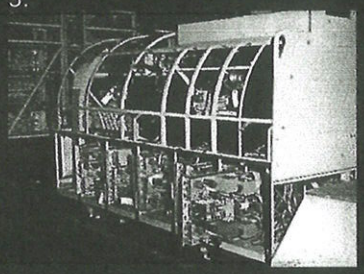

1. Link Aviation's WWII Production Line

The U.S. met te need for new pilots and 10,000 Link Trainers - now dubbed "Blue Boxes" - helped train more than half-a-million Allied airmen.

2. Second Generation Trainers

A new generation of electronic trainers was bought about later in the 1940's by Bell Labs, which designed the trainer for the Navy's PBM-3 aircraft, by the Curtiss Wright Corp., and by Link, whose C-11 Jet Trainer is pictured here.

3. Advent of Analog Computers

The Pneumatic-hydraulic innards of the first generation of training devices were replaced by all-electronic analog computers. Vacuum tubes and electromechanical servos abounded.

4. Celestial Navigation Trainer

This trainer was used WWII for training navigators and bombardiers. It used Translating photographic glass plates to project terrain images along the bomber's flight path. The octagonal tower was 45 feet high.

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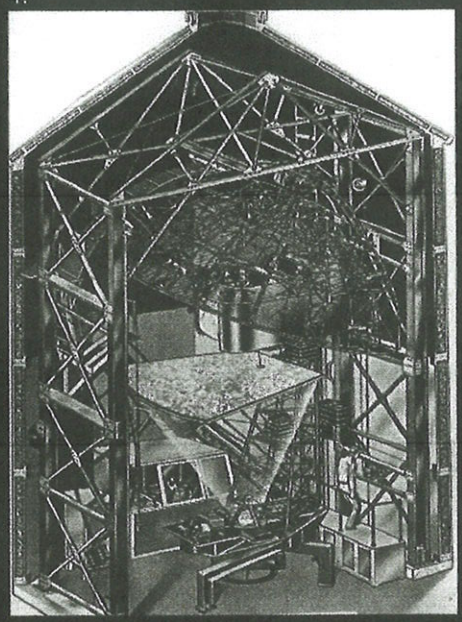

1950s

The Training Scene

The ability of analog computers to handle a variety of computational problems enabled the industry to develop a host of new ground-based training applications in the 1950's, three of which are pictured here. But research work already taking place would soon set the stage for a third generation of trainers which would use digital computers and stored programs to run the trainers.

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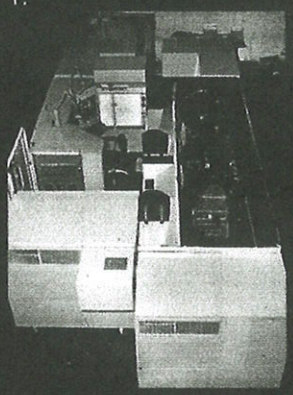

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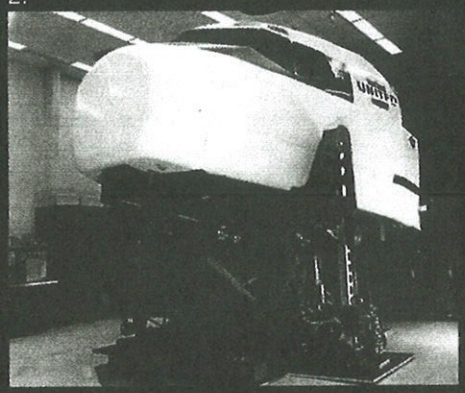

1. B-47B Jet Bomber Simulator

This device provided training for both pilot and navigator-bombardier in a tandem seating arrangement. An elaborate Instructor Station provided training problem control, malfunction insertion, radio aids, and ground track.

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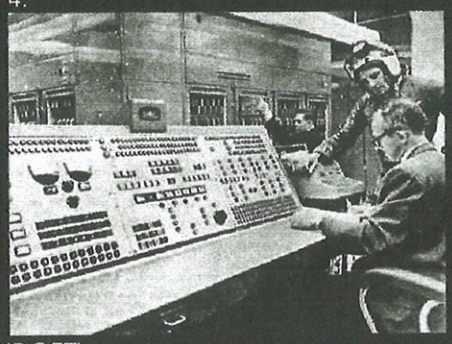

2. Airline Simulator

In the 1950's the airlines took the first steps towards what has now become a total commitment to simulators for training. The United Airlines cockpit shown here is mounted on a motion system that provided three degrees-of-freedom: pitch, roll, and heave (vertical).

3. Missle Control Trainer

This device was used for training personnel to control the Polaris missle. Another device was employed for submarine control training for the 598 George Washington class missile submarines.

4. The Universal Digital Flight Trainer (UDOFT)

The UDOFT research project was completed in 1959 and triggered the shift in the next decade from analog to digital computers.

1960s

The Training Scene

A third generation of trainers came into being in the decade. All new training simulators employed digital computers, programmed initially in assembly language but soon moving to FORTRAN. The availability of digital computation made ever more complex simulations possible, as seen in the two applications shown here. The 1960's also saw major advances in two critical trainer subsystems: visual and motion

1. Apollo Mission Simulator

The complexity of its mission required the Apollo training simulator to move the states of several simulation arts beyond their then-current boundaries; e.g., simulation of on-board computers, visual scene generation and display, real-time interfaces (Mission Control). The simulator was referred to as "The Train Wreck."

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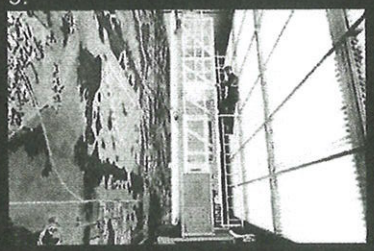

2. Anti-Submarine Warfare (ASW) Trainers

The Surface Ship ASW Tactical Trainer trains the entire ASW tactical team including supporting ships and aircraft. The simulation covers the tactical problem from initial detection of a hostile submarine by sonar through its tracking and the launching of ASROC antisubmarine missles or conventional torpedoes. The Trainer is controlled by a commercial general purpose digital computer.

3. Camera-Model Image Generators

Image generation systems which used models of other aircraft or terrains first appeared in the 1950's, and their use became common in the 1960's. In the case of terrain, elaborate scaled models were viewed through an articulated optical probe by a camera mounted on a gantry system.

4. Six Degree-of-Freedom (DOF) Motion Systems

The advent of wide-body commercial airplanes and the corresponding desire to more faithfully represent motion cues, were the driving force in the development of these systems, which achieved 6-DOF through the synergistic action of its six legs.

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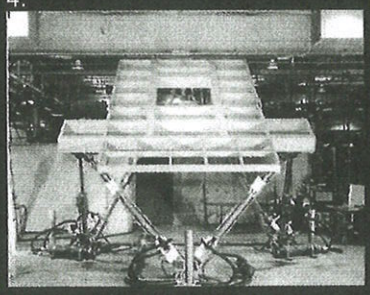

1970s

The Training Scene

The 1970's could be characterized as "The Decade of the Visual System." The period saw a number of technological breakthroughs and significant development efforts which combined to produce dramatic steps forward in the visual arts.

1. Dome Visual Displays

A number of concepts employing large diameter domes containing multiple projectors were introduced during this period. They provided extremely large background fields-of-view for one trainee, plus areas-of-interest which might be target-driven, head-slaved, or eye-slaved.

2. Computer-Generated Imagery (CGI)

The dizzying rate of improvement in the performance of microelectronics components began to make practical in this decade a concept that had been explored in the prior decade: computer-generated imagery. The first daylight scenes were quite rudimentary, but by limiting the scene to light points only, very realistic pictures could be produced.

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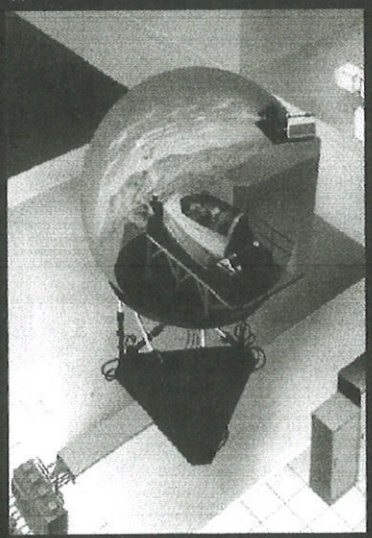

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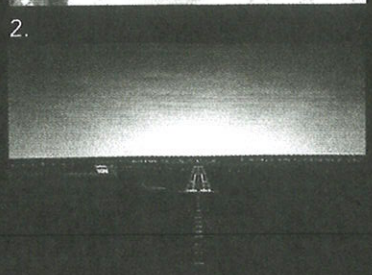

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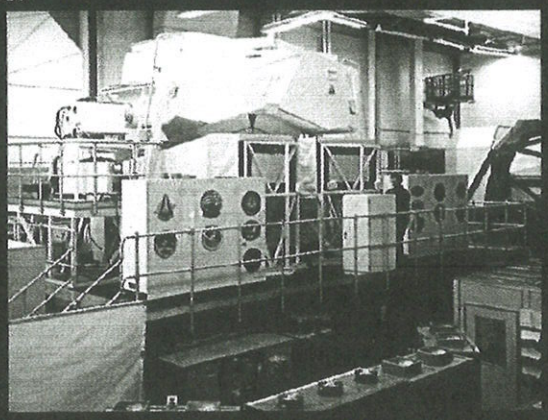

3. Space Shuttle Simulator

The visual image generation and display requirements of the Shuttle Mission Simulator were daunting. Images of the earth during orbit, the earth during reentry, the payload bay, the articulated Shuttle arms, and a variety of other space vehicles all had to be provided. Display requirements for the front windows and oversized aft and overhead windows had to be satisfied. The newly-available CGI concept provided the diverse images that were needed, and the large field-of-view requirements of the aft/overhead windows were solved by a special reflective pancake window designed by the Farrand Optical Company.

1980s

1. B-2 Aircrew Training Device (ATD)

The B-2 is an extraordinarily complex aircraft. Here is how those complexities are dealt with in the ATD:

-Structured programming (Ada), 1.4 M lines of code

-Emulation of on-board computers, 1.7 M lines of code

-Visual Data Base: 500,000 sq. miles

-Synthetic Aperture Radar Data Base 5,000,000 sq. miles

-Mission Rehearsal capability with 12,000 dynamic threats

2. Fighting Vehicle Simulators

A major US Army training initiative produced Conduct of Fire and, later, Driver Trainers for its fighting vehicle crews.

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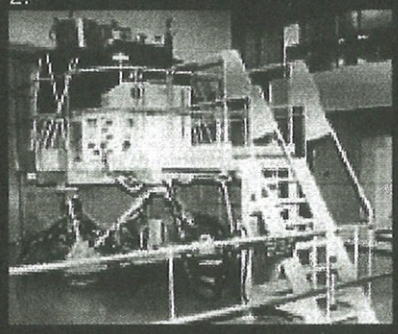

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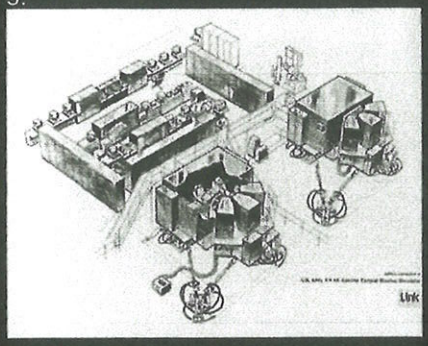

3. AH-64 Apache Combat Mission Simulator

This simulator has separate cockpits, computation systems, etc. to allow the Pilot and Co-pilot/Gunner of the AH-64 to fly independent missions or to fly in a totally integrated mode. In 1985 it was given the US Army's Daedelion Award for Weapon System of the Year.

1990s

1. The Training Scene

Two 1990's trends stand out. The concepts proven on SIMNET were explored in greater depth and applied to the development of networked simulation systems. The myriad of problems associated with Distributed Integrated Simulation was addressed and a new High Level Architecture conceived. Second, the traditional field of simulation has been expanded to include a variety of new players and applications, including entertainment, medical training, and many others. The new players introduced a clever phrase- Virtual Reality -which is now universal.

3. Human Patient Simulator

The medical profession discovered the enormous merits of simulation for training. The product pictured here (courtesy of MedSim - Eagle) simulates cardiovascular, pulmonary, and metabolic events. The "patient" responds to real treatments, interventions, and drug administration.

4. Advanced Computed Images

The technology that has had the greatest impact on the field of simulation is the graphic computers which produce real-time imagery. They have enabled applications which would otherwise not exist. (Photo courtesy of E&S)

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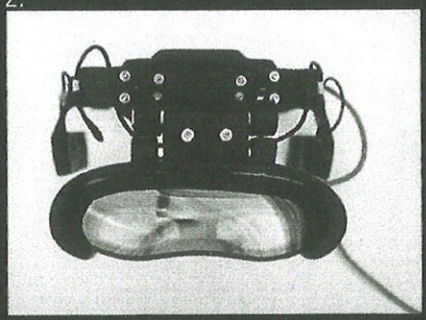

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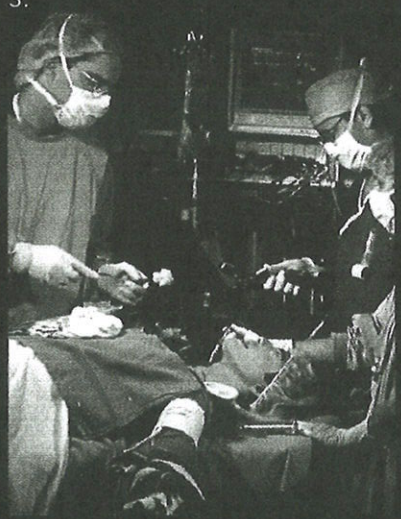

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