



Aerospace Chronology

1896 – 1998

Massachusetts Institute of Technology

Labor Aerospace Research Agenda

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Aerospace Time Line: 1896-1998

1896-1910:

1896: Samuel Pierpont Langley, Director of the Smithsonian Institute, constructs a model 'aerodrome' that flies.¹

1898: Congress grants Langley \$50,000 to construct a man-carrying 'aerodrome' to aid in the Spanish-American War.²

1903: First powered, controlled human flight by the Wright Brothers on December 17.³ Nine days earlier Langley's 'aerodrome' was launched and failed. Congress refused to appropriate more money.

1905: Glenn Curtis built first Curtis-Baldwin airship with adapted Curtis motorcycle engine.⁴

1906: Alberto Santos-Dumont, a Brazilian living in Paris, becomes the first European to fly in a plane powered by a 24 horsepower engine.⁵

1907: The Wrights share data with Curtiss for a scientific venture. Later a bitter legal battle ensued when Curtiss was accused of using this data in his business.

1907: The Wrights and their financial representatives, Charles R. Flint and Company negotiate internationally for aircraft contracts.⁶

1908: In February, U.S. Army signs \$30,000 first contract for Wright biplane capable of speeds of 40 MPH with a range of 125 miles to carry one passenger.⁷

1908: Glenn Howard Curtiss wins the first *Scientific American* trophy for a public flight of 1 kilometer (5/8 of a mile).⁸

1908: The Curtiss-Baldwin airship becomes U.S. Army Signal Corps Dirigible No. 1, marking the beginning of the military's role as consumer of powered-flight technology.⁹

1909: Wright Cycle Company delivers first aircraft to U.S. Army Signal Corps and picks up \$5,000 bonus for exceeding performance requirements¹⁰.

¹ Freudenthal, p. 6.

² Freudenthal, p. 6.

³ Bilstein 1996, xxx

⁴ Bilstein 1996, p. 7

⁵ Freudenthal, 1940, p. 8

⁶ Bilstein, p.5

⁷ VanderMeulen 1991 and Bilstein 1996.. Bilstein sets the contract at \$25,000. xxx

⁸ Freudenthal, p. 9

⁹ Bilstein p. 8

¹⁰ Bilstein, p. 4

1909: The Wright Company incorporates in New York with a capital stock of \$1 million. The company builds new factory in Dayton, hires a workforce, and plans to build 2 flying machines per month.¹¹

1909: The Curtis Aeroplane Company delivers the first airplane to civilian customers one-week late for \$5000. Flight lessons were included in the price.¹²

1909: The French government uses aircraft in military maneuvers.¹³

1910-1919:

1911: Harriet Quimby and Mathilde Moisant were the first two women licensed to fly in the United States. Quimby became the first woman to fly across the English Channel in 1912.¹⁴

1911: Glenn Curtis flies the first airplane fitted with pontoons.

1911*: Earl L. Ovington carries the first mail in a plane over a 10-mile route from Nassau Boulevard to Garden City Estates during an air meet on Long Island.¹⁵

1912: Aeronautical exports are about \$100,000 and rise to \$226,149 in 1914.¹⁶

1913: First college-level courses in aero engineering subjects offered at University of Michigan and at MIT.¹⁷

1913: The R.O. Rubel, Jr. and Company of Louisville, Kentucky publishes a catalogue that offers “rubber aeroplane springs, fuel tanks, wheel spokes, round and square steel tubing, fabric, bamboo, spark plugs, turnbuckles, langing gear, and finished wing ribs in either Curtiss style or Bleriot style, the later available as a full set of 24 at \$24.”¹⁸

1913: Howard Coffin and other industrialists believed that aviation was the next great industry and should be organized using mass production guidelines.¹⁹

1913: Aircraft Manufactures Association (AMA) formed.

¹¹ Bilstein, p. 6

¹² Bilstein 1996, p. 8

¹³ Freudenthal, p17.

¹⁴ Freudenthal, p. 10

¹⁵ Bilstein (1983), p. 30

¹⁶ Bilstein, p. 16.

¹⁷ Bilstein, p. 234

¹⁸ Bilstein, p. 11.

¹⁹ Vander Meulen (1991) asserts strongly that the efforts of Coffin and others drove the industry to attempt mass production work organisation. It was a costly goal but reflected American beliefs of the era. The Germans modelled their industry on the mass production model calling it Amerikaprogramm. See also Bilstein 1996, p. 15.

1914: First air battle of WWI (two versions – a) English and Germans²⁰ b) a Russian and Germans

1915: National Advisory Committee for Aeronautics formed to serve as a liaison between the industry and government. It was aimed at rationalizing the haphazard structure of the industry and putting production on a profit-making basis.²¹ Howard Coffin is director.²²

1915: A syndicate of New York financiers pays \$1.5 million for the Wright Company.²³

1916: Mitsui and Company of Japan establish Standard Aircraft Corporation in Elizabethtown, New Jersey.²⁴

1916: America built 411 planes.

1917: After years of bickering and legal battles, a patent pool is established under the auspices of the Manufacturers Aircraft Association.²⁵ The nonrecognition of property rights to aircraft design became an issue affecting competition in the industry.²⁶

1917: The Joint Army and Navy Technical Aircraft Board calls for the production of 8,075 training planes and 12,400 service planes within 12 months in support of the war effort.²⁷

1917: U.S. Congress appropriates its largest single appropriation to date, the Aero Bill. The \$640 million to build more than 20,000 aircraft passed despite hostility to aviation from the General Staff.²⁸

1918: In March, after incorporating 950 changes to the Liberty engine, Henry Ford would permit no more in those he had contracted to build. Seven auto engine firms contracted to build 22,500 Liberty engines.²⁹

1918*: U.S. Air Mail inaugurated; provides example of civil and commercial use of aviation. Lieutenant George Boyle lifted off late and flew 25 miles in the wrong direction before making a forced landing in Maryland.³⁰

1918: At its peak in 1918, the U.S. industry delivered nearly 14,000 airplanes and employed 175,000 people. By comparison, the French reported a production capacity of 31,000 planes a year while the British reached 41,000 per year.³¹

1918: End of WWI

²⁰ Bauer, 1991, p. 11.

²¹ Bluestone says 1914 - p. 17

²² Bilstein 1996, p. 14, Vander Meulen 1991, p. 17.

²³ Bilstein. p. 6

²⁴ Vander Meulen 1991, p.21.

²⁵ Bilstein 1996, p.16, Vander Meulen 1991, p. 26.

²⁶ Vander Meulen 1991, p.58.

²⁷ Bilstein, p. 17.

²⁸ VanderMeulen 1991, p.14.

²⁹ Vander Meulen, 1991, p. 30

³⁰ Bilstein 1983, p. 31

³¹ Bilstein, p. 18.

1919: Through tremendous efforts to overcome technical as well as supply challenges, 31 companies produce aircraft and parts valued at \$14 million.

1919: Aeronautical Chamber of Commerce founded as successor to AMA and a proponent of commercial aviation.

1919: Wichita Airplane Company established in Wichita, Kansas starting the area's prominence in private plane construction.³²

1920-1929:

1923: Stout Metal Airplane Company established in Detroit and built the first all metal American plane. After the firm was purchased by Ford, this plane became the Ford Trimotor or Tin Goose.

1925: Air Mail Act (the Kelly Bill) shifts airmail from government planes to commercial contractors; forms basis for the air transport industry

1926: Robert Goddard launches the first liquid propellant rocket from his Aunt Effie's pasture in Auburn, Massachusetts. It climbed 41 feet in 2.5 seconds.³³

1926: The U.S. Navy got authorization for two airships (and let contracts in 1928 to Goodyear Zeppelin). The price for the first ship, the U.S.S. "Akron" (ZRS-4) was \$5,375,000 while the second the U.S.S. Macon (ZRS-5) cost \$2,450,000. The ships were commissioned in the early 1930's.³⁴

1926: Air Commerce Act establishes safety regulations, investment in aviation increases.³⁵

1926: Air Corps Act passed and expressed the unwillingness of Congress to reformulate the rules of military procurement.³⁶

1927: Research and Development expenditures of the Army and Navy Air Corps was at the lowest point between the two wars at \$2,184,000.³⁷

1927: Lindbergh completes nonstop solo flight across Atlantic Ocean from New York to Paris. Two British flyers had flown from Newfoundland to Ireland in 1919.³⁸

1928: NACA cowling design, one of the significant NACA research contributions to aeronautics.³⁹

³² Rae 1968, p.15.

³³ Bilstein, p. 111

³⁴ Rae, p. 37.

³⁵ Bilstein 1996, p. 235

³⁶ Vander Meulen asserts that military procurement rules precluded associationalism in the industry and effectively assured that private firms took on the risk of providing military aircraft. See pp.55-90.

³⁷ Ibid, p.60

³⁸ Rae, p. 35.

³⁹ Bilstein 1996, p.235

1929: General Motors acquired 40% (control) of Anthony Fokker's Atlantic Aircraft Co.⁴⁰

1920's

During the 1920's, general aviation planes are produced; builders such as Beech, Cessna, and Piper appear.

Late 1920' mergers ending with 3 conglomerates, Boeing, Avco, General Motors.

1930-1939:

1930: Curtiss-Wright workers go on strike after firm imposed stringent wage cuts and work rules in an effort to force conflict that might bring changes in government contract award policies. After 18 weeks workers were forced to return to work and accept the company's proposal. Long term labor relations were "poisoned" and the company could not alter the need for highly skilled craftsmen.⁴¹

1930: Transcontinental and Western Air launched the first coast-to-coast all-air passenger service between New York and Los Angeles on October 25.⁴²

1933: Boeing 247 makes first flight.

1934: Charges of profit gouging and unfair competition in airmail contract result in Vinson-Trammel Act and second Air Mail Act. (Vinson-Trammel Act limited the profit rates suppliers could realize on sales to the government, new Air Mail Act ruled that manufacturers must divest themselves of their transport activities)⁴³

Aviation Corporation split 2, Avco & American Airline

United Aircraft divided into three entities; two manufactures, Boeing & United Aircraft, and one transport company; United Airlines. United Aircraft maintained control of Pratt & Whitney, Hamilton-Standard, Chance-Vought, and Sikorsky.

General-Motors/North American separated into Eastern Airlines, Trans World Airlines, and North American Aviation.

1934: The American Interplanetary Society changed its name to the American Rocket Society. Original members were largely science fiction writers and enthusiasts but over time scientists and engineers joined the group.⁴⁴

⁴⁰ Rae, p. 44

⁴¹ Vander Meulen 1991, pp.114-116.

⁴² Rae, p. 51

⁴³ Bluestone, p. 22.

⁴⁴ Bilstein, p. 111

1935: The first air traffic control was established at Newark International Airport in New Jersey⁴⁵.

1936: Research and Development expenditures for the Air Corps reach \$6,000,000.⁴⁶

1936: First industrial union agreement signed between the IAM and Boeing.⁴⁷

1937: Frank Whittle completes successful demonstration of a practical jet engine.

1937: The formation of Svenska Aeroplan AB, later to be known as Saab, was announced in April

1937: UAW recognized at North American Aviation (now Boeing North American). In July 1938, the company withdrew its recognition and refused to bargain with the union.⁴⁸

1937: In August, the UAW's 2nd Constitutional Convention in Milwaukee, WI. The union calls for an intensive campaign to organize workers in the aircraft industry.⁴⁹

1939: Two years before Pearl Harbor the entire U.S. aircraft industry employed 63,000 workers (SIC 372 provided work for one in 167 manufacturing workers).⁵⁰

1939: First practical design of helicopter, Igor Sikorsky's VS-300 was test flown.

1939: Bombers such as the B-24 Consolidated Liberator or North America's B-25, and fighters such as the Bell P-39 Airacobra, Lockheed's P-38, Republic's P-47 Thunderbolt, and North America's P-51 Mustang were designed and produced. The Douglas DC-3 became the C-54 military transport.

1939: The first jet plane, a German Heinkel He 178, makes a test flight.⁵¹

1939: IAM signs first agreement in air transport industry with Eastern.⁵²

1939 – 1940: UAW wins first contracts in the aircraft industry. By July 1940, the union had negotiated agreements with Bell Aircraft Corporation in Buffalo NY; Lycoming Manufacturing Corporation in Williamsport, PA; and Brewster Aeronautical Corporation in Long Island City, NY.⁵³

1940 to 1949:

1940: 45% of the nation's airframe manufacturing facilities are located in southern California due to superior flying conditions. Propeller and engine manufacturers were

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⁴⁶ Rae 1968, p.60

⁴⁷ Taken from IAM website at <http://www.iamaw.org/aboutiam/timeline/timeline.html>

⁴⁸ Information provided by the UAW Research Department

⁴⁹ Information provided by the UAW Research Department

⁵⁰ Bluestone, Jordan and Sullivan 1981, p. 2; Rae, p.149.

⁵¹ Bilstein, p.84

⁵² Taken from IAM website at <http://www.iamaw.org/aboutiam/timeline/timeline.html>

⁵³ Information provided by the UAW Research Department

attracted to the Northeast “by its industrial heritage and abundant supply of skilled craftsmen.”⁵⁴

1940: Line production was introduced to replace job lots techniques in order to meet wartime demand.⁵⁵

1940: Walter Reuther then vice president in charge of the General Motors Department, drafts a plan for “Five Hundred Planes a Day” for the war effort.⁵⁶

1940: President R. J. Thomas’ report to the UAW’s 5th Constitutional Convention declares that “Though aircraft workers in general do the same type of work on parts and assembly and in the tool and die shops as workers in the auto industry, their rates of pay and working conditions are far below the union levels established by the UAW in auto plants. There is no reason for these differentials except that most of the aircraft workers have not yet organized their plants.” Wages or around 50 cents an hour are the rule in the aircraft industry, compared with minimum pay of 7- to 75 cents an hour in UAW-represented auto plants.⁵⁷

1941: Aircraft becomes the nation’s single largest manufacturing industry.⁵⁸

1941: UAW wins recognition and a first contract at North American Aviation. The contract establishes a 75 cent minimum wage rate.⁵⁹

1942: Ford converted a plant in Iron Mountain MI from wooden station wagon bodies to construction of the GC-4A glider. Total production was 4,291.⁶⁰

1942: The first American-built jet plane, the XP-59A made its trial flight In October.⁶¹

1943: In November, 1.46 million are employed in the U.S. aircraft industry.⁶²

1943: Lockheed employed 94,000 workers, nearly 35,000 or about 40% of the total, were women.⁶³

1943: Procedures for orderly contract termination were adopted to avoid needless disruption of the aircraft industry.⁶⁴

1944: UAW wins representation elections at a number of Douglas Aircraft plants including Long Beach, CA.⁶⁵

1944: In February, UAW holds its first national conference of aircraft workers. Vice President Richard Frankenstein and delegates call for strict adherence to the union wartime “no-strike” pledge.⁶⁶

1944: President Walter Reuther’s report to the UAW’s 9th Constitutional Convention points out that “Aircraft workers have been more than paying back [their] increase in wages by a swift increase in productivity unparalleled in the history of American industry.” Total man-

⁵⁴ Bluestone et al 1981, p. 19, 24-25; Rae, p. 152..

hours required to produce a four-engine bomber fall from about 200,00 to 13,00. Total man-hours per fighter plane fall from 157,700 to 7,800.⁶⁷

1944: Debut of the “Life of Riley” radio show in which William Bendix plays an airplane assembly worker.⁶⁸

1945: Army and Navy budgets for production of combat rockets totalled about \$1.3 billion.⁶⁹

1945: Werner von Braun and 132 other German scientists working on the V-2 rocket at the Peenemunde research center were brought to the United States during Operation Paperclip.⁷⁰

1945: Postwar cutbacks in orders were severe. For example, at Boeing orders for B-29 dropped from 155 a month to 10.⁷¹

1946: Employment in the U.S. aircraft industry drops to 219,000 in March.⁷²

1946: The number of aircraft engine firms dropped from 23 during the war to 5. Light plane builder numbers also dropped as companies such as Waco and Stinson closed or were absorbed into other firms.⁷³

1946: Employment at de Havilland in Canada drops from 7,000 (in 1945) to 200 with end of wartime production⁷⁴.

1946: The Saab 92, a front-wheel-drive car with a transversely mounted two-cylinder, and a two-stroke engine emerged from the Linköping wind tunnel. Saab shifted aircraft engineers and designers from wartime aircraft production to auto design and production.⁷⁵

1946: The first Bell Model 47 helicopter was sold for commercial use and subsequently saw service in Korea. It is immortalized as the incoming chopper on M*A*S*H*.⁷⁶

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⁵⁶ Information provided by the UAW Research Department

⁵⁷ Information provided by the UAW Research Department

⁵⁸ Information provided by the UAW Research Department

⁵⁹ Information provided by the UAW Research Department

⁶⁰ Rae, pp.160-161.

⁶¹ Rae, p. 166.

⁶² Ibid, p. 2

⁶³ Rae, p. 151

⁶⁴ Rae, p. 171.

⁶⁵ Information provided by the UAW Research Department

⁶⁶ Information provided by the UAW Research Department

⁶⁷ Information provided by the UAW Research Department

⁶⁸ Bilstein, p. 221

⁶⁹ Bilstein, p. 112.

⁷⁰ Bilstein, p. 117.

⁷¹ Bilstein, p. 138.

⁷² Bluestone et al 1981, p.2.

⁷³ Bilstein, p. 149

⁷⁴ Figures taken from web history of de Havilland at the Bombardier Website - 1997 Bombardier Inc.

⁷⁵ From Saab Website,

⁷⁶ Bilstein, p. 90.

1947: National Security Act makes U.S. Air Force a separate military branch.⁷⁷

1947: The rocket-powered Bell-built XS-1 breaks the sound barrier piloted by Captain Chuck Yeager on October 14.⁷⁸

1947: First Flight of Russian MiG-15 in late December.

1947: One page Glenn L. Martin ad appears in *Holiday* magazine encouraging Americans to travel by air to save time, have longer vacations and more productive business trips. The company offered readers a booklet entitled “How to Travel by Air.”⁷⁹

1949: Captain Edward A. Murphy reported to Edwards Air Force Base to investigate a mysteriously failed experiment. When he discovered that *all* 16 sensors in the experiment had been installed improperly. Murphy was heard to comment that “If there are two or more ways to do something, and one of those ways can result in a catastrophe, then someone will do it.” We know this today as Murphy’s Law.

1950 to 1959:

1950: Nationwide the industry employed 212,000 workers.⁸⁰

1950: The beginning of the Korean War.

1951: Complicated tools and costly materials lead to increasing complexity in aircraft. The engineering effort for the North American F-86D required six times the number of drawings (6,500) and three times the hours of engineering time (1,132,000) as the P-51 nine years earlier.⁸¹

1952: Military helicopter sales increased to 983 units at the peak of the Korean War.

1952: Employees on 85% of airlines now represented by IAM agreements.⁸²

1952: The Air Force begins a four year contract with MIT to research the development of numerically controlled machine tools needed for increasingly sophisticated aircraft systems.⁸³

⁷⁷ Bilstein 1996, p.236

⁷⁸ Rae, p.187

⁷⁹ Bilstein, p

⁸⁰ Bluestone et al 1981, p.33

⁸¹ Bilstein, p. 96

⁸² Taken from IAM website at <http://www.iamaw.org/aboutiam/timeline/timeline.html>

⁸³ Bilstein, p.95

1952: British de Havilland Comet 1 launches jetliner service from England to Africa and the Far East.⁸⁴

1953: Pratt Whitney's J-57 gas turbine engine powered the first commercial jet to break the sound barrier.⁸⁵

1953: Flying a Canadian-built (Canadair) F-86 Sabre and with Major Chuck Yeager flying chase, famed aviatrix Jaqueline Cochran became the first woman to exceed the speed of sound. That same day, she established a new women's absolute speed record of 652.337mph over a low-level course at Edwards Air Force Base.⁸⁶

⁸⁴ Bilstein, p. 141

⁸⁵ Bluestone, p. 39.

⁸⁶ Taken from Edwards Air Force Base Web Page.

1953: UAW wins first national agreement with Rockwell International.

1953: The Eisenhower Administration sets up the Strategic Missiles Evaluation Committee (also known as the “Teapot Committee” because its chairman John von Neumann drank so much tea) to study intercontinental ballistic missiles (ICBM’s).⁸⁷

1954: Industry employment reached 822,000 due to the Korean War.

1955: From 1955 to 1963, the sales of general aviation aircraft doubled.⁸⁸

1955: The Atlas missile program lists 56 major contractors.

1955: Cessna is the light plane production volume leader, delivering 1,746 commercial and 24 military planes.

1956: One third of new U.S. factories go up in smaller cities with non-existent air service.

1957: Soviet Union launches Sputnik, world’s first artificial satellite on October 4. The first satellite weighed 184 pounds and the second launched one month later carried a dog named Laika.⁸⁹

1957: Walter Reuther calls the Russian satellite launch a “bloodless Pearl Harbor”.⁹⁰

1957: 190,000 scientists and engineers were living in the Boston area providing a base of expertise that supported space oriented endeavours.⁹¹

1957: Around this time journalists and commercial analysts began using the term ‘aerospace industry’.

1957: The Atlas missile program lists 150 major contractors.

1958: Explorer 1, first U.S. satellite launched.

1958: National Aeronautics and Space Administration (NASA) supersedes NACA.

1958: The KC-135 tanker was a huge success as a military plane but even more successful when revamped and introduced as the first U.S. passenger jet, the Boeing 707.⁹²

1958: The Federal Aviation Act passed Congress and established the Federal Aviation Agency, which became the Federal Aviation Administration in 1967.

⁸⁷ Bilstein, p. 119.

⁸⁸ Bilstein, p. 83

⁸⁹ Bilstein 1996, pp. 108 and 237

⁹⁰ Bilstein, p.108

⁹¹ Bluestone, p.41

⁹² Bilstein, p. 143

1958: Congress passes the National Defense Education Act in response to the urgently felt need to protect national security and compete with Soviet scientific prowess.⁹³

1959: The Aircraft Industries Association became the Aerospace Industries Association of America.

1959: The aircraft, aerospace, and parts industry emerged as the largest employer in the U.S. Between the ICBM and IRBM efforts 2,000 contractors and 40,000 people were at work.⁹⁴

1959: Atlas missiles(containing some 40,000 parts) become operational and are installed in underground silos across the U.S.⁹⁵

1960 to 1969:

1960: By 1960, the high tech B58 supersonic bomber had an active vendor list of 4,926 firms in 44 states with a nation wide allocation of \$3 billion in contracts.⁹⁶

1960: The total NASA budget came to \$523 million with \$100,000 for space flight studies.⁹⁷

1960: The first Cherokees roll off the line at a new Piper factory in Vero Beach, Florida built especially for this product to take advantage of low land costs, available labor and sunny weather. The planes sell for under \$10,000.⁹⁸

1961: The industry employed 701,600 workers.⁹⁹

1961: President Eisenhower warns the country of the dangers of the “military-industrial complex” in his farewell address.¹⁰⁰

1961: Yuri Gagarin made his historic flight on April 12.

1961: President Kennedy addresses Congress and announces, “I believe we should go to the moon.”¹⁰¹

1962: UAW changes its name to include “aerospace workers.”¹⁰²

1962: The first Minuteman missiles become operational and are stored in silos sunk 80 feet below ground in wheat fields and cow pastures in seven states west of the Mississippi.

⁹³ Bilstein, p. 109 and the following website: <http://ishi.lib.berkeley.edu/cshe/ndea/ndea.html>

⁹⁴ Bilstein, p. 84 and p. 122.

⁹⁵ Bilstein, p. 121.

⁹⁶ Bilstein, p. 93.

⁹⁷ Bilstein, p. 128

⁹⁸ Bilstein, p. 181.

⁹⁹ Bilstein, p. 84

¹⁰⁰ Bilstein, p. 101

¹⁰¹ Bilstein, p. 127

¹⁰² Information provided by the UAW Research Department

Boeing co-ordinated the production of the missiles by a variety of specialized subcontractors and suppliers.¹⁰³

1962: William Lear moves his executive jet project from Switzerland to Wichita, Kansas. The first Learjet took off in 1963.

1963: The Kennedy Space Center was officially named one week after the assassination of John F. Kennedy. The site at Cape Canaveral Florida had been a government rocket launch facility since the 1950's.¹⁰⁴

1964: Industry share of the nation's total R&D effort at its peak, 37.6% (industry own dollar contribution was at its ebb, 8.9% of the total).¹⁰⁵

1964: From 1964 to 1967 employment in Connecticut supplier shops rose by as much as 350 percent only to contract by 2/3 between 1968 and 1970.¹⁰⁶

1964: The Air Force allocated \$3.5 billion for aircraft and over \$2 billion for missiles.¹⁰⁷

1964: The Syncom 3 satellite delivers a live broadcast of the opening ceremonies of the Tokyo Olympics.¹⁰⁸

1964: IAM Convention votes to change name to International Association of Machinists and Aerospace Workers. Membership is 800,000.¹⁰⁹

1966: Strike by IUE at General Electric.

1966: NASA's biggest budget allocation was \$4.5 billion of which \$2.9 went to Apollo.¹¹⁰

1966: Light plane production is about 16,000 units.

1967: Extreme labor shortages challenge the industry. For example, Pratt Whitney instituted a 5:30 to 9:30PM "moonlight" shift for workers from other industries.¹¹¹

1967: Three Apollo astronauts killed in a fire during ground tests. The investigation resulted in stricter procedural controls.¹¹²

¹⁰³ Bilstein, p. 121.

¹⁰⁴ Bilstein, p. 126.

¹⁰⁵ Bluestone, p. 159.

¹⁰⁶ Bluestone p. 124.

¹⁰⁷ Bilstein, p. 122.

¹⁰⁸ Bilstein, p. 195.

¹⁰⁹ Taken from IAM website at <http://www.iamaw.org/aboutiam/timeline/timeline.html>

¹¹⁰ Bilstein, p. 128.

¹¹¹ Bluestone, p. 42.

¹¹² Bilstein, p. 129

1967: A merger between McDonnell and the Douglas Company is officially sanctioned. In the next year, the McDonnell Douglas Corporation reported \$94 million earnings on sales or \$3.6 billion.¹¹³

1968: Military airframes such as the B-25 had 165,000 parts not counting approximately 150,000 rivets, engines, instruments, and equipment while the average medium priced auto had 5,000 parts.

1968: Walter Reuther declared that the various aerospace unions would act cohesively to seek auto and aerospace wage parity. This was achieved and exceeded by August of 1969 but momentum was lost with the end of the Viet Nam War.¹¹⁴

1968: Entire GE system (233 plants in 33 states) shut down by strike of 13 unions representing workers at the company.¹¹⁵

1969: A federal study reveals only modest profits in the defense industry. Manufacturing industries in the U.S. received an average profit of 8.7 cents on every dollar compared to 4.2 cents on the dollar for defense contractors.¹¹⁶

1969: Of the 4,000 some transport aircraft in worldwide service, more than 3,000 (75.8%) originated in the U.S.¹¹⁷

1969: In July, a Saturn V rocket powered the Apollo 11 lunar expedition that allowed Neil Armstrong to be the first man to walk on the moon. This event was broadcast live to 33 countries on six continents and was seen by 25 million viewers in the U.S. alone.¹¹⁸

1969: Edwin ‘Buzz’ Aldrin, an IAM member, becomes the first space mechanic on the moon.¹¹⁹

1969: At the time of the first lunar landing, NASA’s total personnel had dropped to 190,000 from a peak of 390,000 contractor personnel.¹²⁰

1969: The general aviation fleet stands at 130,000 up from 37,000 in 1945.¹²¹

1969: The Boeing 747 enters service and subcontractors account for as much as 70 percent of the airframe’s components.¹²²

¹¹³ Bilstein, p. 177.

¹¹⁴ Bluestone, p. 43.

¹¹⁵ Bluestone, p.153.

¹¹⁶ Bilstein, p. 106

¹¹⁷ Bilstein, p. 137.

¹¹⁸ Bilstein, pp. 133-134.

¹¹⁹ Taken from IAM website at <http://www.iamaw.org/aboutiam/timeline/timeline.html>

¹²⁰ Bilstein, p.128

¹²¹ Bilstein, p. 147.

¹²² Bilstein, p.188.

1970 to 1979

1970: Aviation Week and Space Technology, an industry journal, announced that 1970 was the “gloomiest year in decades” for the aerospace industry.¹²³

1970: The European Airbus Consortium was established

1970: Seattle considers a ban on Wisconsin cheese in response to Senator Proxmire of Wisconsin’s opposition to funding for the SST. The Washington State legislature considers banning Evinrude motors from state waterways.¹²⁴

1970: Lockheed brings most of its vendor business inside canceling 1800 contracts with individual suppliers.¹²⁵

1971: Commercial jet sales dropped by 68% from 1968 highs.¹²⁶

1971: Boeing reduces workforce to 38,000, down from 105,000 in 1968.¹²⁷ Community feelings about this decline are expressed by a which appeared on Highway 5 which said, “Will the last person leaving Seattle turn out the lights?”¹²⁸

1972: Mac Donald Douglas and Yugoslavia initiate the use of offset agreements.¹²⁹

1974: Airbus Industrie A-300 wide-body transport enters service.¹³⁰

1975: The Western European space community organizes itself as the European Space Agency (ESA) in Paris. Eleven nations combined to formalize R&D centers.¹³¹

¹²³ Bluestone, p. 45

¹²⁴ Bluestone, p.65.

¹²⁵ Bluestone, p.71.

¹²⁶ Bluestone, p. 44-45.

¹²⁷ Bluestone, p. 57.

¹²⁸ Bilstein, p. 179

¹²⁹ Pritchard, David J. The globalization fo commercial aircraft production: implications for US-based manufacturing activity, International Journal of Aerospace Management, v1,3 p 214.

¹³⁰ Bilstein, p. 238.

¹³¹ Bilstein, p. 166

1975: By the mid-1970s, the price of a fighter plane was around \$5 million. This represents a steady rise in cost estimates beginning with the \$5,000 price tag for a WWI fighter, \$50,000 for a WWII fighter, and \$500,000 for a Korean War fighter.¹³²

1975: Although there was a history of collaboration between American and European companies, this period sees the beginnings of closer collaboration between U.S. firms as product costs and complexity rises. Despite closer relationships in some areas, there are also extremely high levels of competition. Pratt-Whitney and General Electric fiercely compete for engine business and General Dynamics mounts an elaborate campaign to win contracts to provide a new generation of fighters to European markets.¹³³

1976: Scheduled service of the Anglo-French Concorde supersonic transport begins.¹³⁴

1977: Congress enacts the Foreign Corrupt Practices Act in response to scandals surrounding aircraft sales overseas involving many major companies.

1978: Airbus Industries captures almost 20% of the global airliner market.

1979: Strikes at Pratt Whitney suppliers force slowdowns on F-100 engines.

1979: Aerospace industry sets new records for export sales and net trade balance.

1979: Nearly one half of Boeing's sales, \$8.1 billion, was made up of sales to foreign customers.¹³⁵

1979: Pratt Whitney buys plant in North Berwick, Maine.¹³⁶

1979: It took only 11,000 workers to turn out seven Boeing 747s per month, down from 25,000 in 1969.¹³⁷

1980 to 1989:

1980: Aircraft industry is second largest employer in U.S. after the auto industry with 650,000 employees.¹³⁸

1980: Beech forms a partnership with Raytheon extending both companies expertise into new product development.¹³⁹

1981: The Space Shuttle Columbia landed safely on Rogers Dry Lake following its first orbital mission. This marked the first time in history that an orbital vehicle had left the earth under rocket power and returned on the wings of an aircraft.

¹³² Bilstein, p. 171.

¹³³ Bilstein, p.172 -175.

¹³⁴ Bilstein, p.165.

¹³⁵ Bluestone. p. 7.

¹³⁶ Bluestone. p.96.

¹³⁷ Bluestone, p.123. Bilstein cites 1980 rather than 1979. See p.178.

¹³⁸ Bluestone, p. 3.

¹³⁹ Bilstein, p. 184.

1983: IAM demanded and negotiated union voice in technological change in bargaining with Boeing.¹⁴⁰

1983: President Reagan commits to the Strategic Defense Initiative (Star Wars) as a response to Soviet deployment of more long-range nuclear missiles than the U.S. produced.¹⁴¹

1983: Boeing's airliner production line receives components from 170 foreign suppliers from 13 different countries.

1986: The MX or Peacekeeper missiles went on duty.

1986: The Challenger space shuttle explodes shortly after liftoff killing a crew of seven. An investigation lead to major reorganization at NASA. Funding declines also lead to greater international cooperation with partners such as Canada and European countries.¹⁴²

1986: The Packard Presidential Commission issues its report on military procurement and encourages the idea that contractors share the R&D expense of constructing prototypes.

1987: The American Blimp Company is formed.

1989: McDonnell Douglas Astronautics Corporation launched a \$150 million British communications satellite. This is the first American commercial rocket launch.

1989: NASA's budget rises to \$10.7 billion.

1980's: The Federal Communications Commission grants considerable latitude to commercial satellite development which facilitates an explosion in cable TV supported by direct satellite distribution networks.

1990-1998

1990: Industry sales of space systems amount to \$28.9 billion. Department of Defense spending is the largest portion at \$15.4 billion.¹⁴³

1990: Department of Defense spending set at \$81 billion.

1990: The Hubble Space Telescope is launched despite cost overruns and delays. Serious flaws in the components were repaired by a team of astronauts and the telescope delivers valuable data.¹⁴⁴

1991: Operation Desert Storm is launched displaying unprecedented military technology.

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¹⁴¹ Bilstein, p. 162 -163.

¹⁴² Bilstein, p. 164.

¹⁴³ Bilstein, p.168.

¹⁴⁴ Bilstein, p. 199.

- 1991:** Aerospace manufacturing recorded sales of \$140 billion with commercial sales exceeding defense sales for the first time since 1980.¹⁴⁵
- 1991:** Boeing announces the 777 airliner to be built with a number of risk-sharing partners. In addition the company introduced the “design/build concept” in which the complete plane was designed and manufactured to final specifications.¹⁴⁶
- 1991:** Strategic Arms Reduction Talks (START) accelerates the dismantling of nuclear missiles, including ICBMs.¹⁴⁷
- 1992:** The Soviet Union dissolves and the Confederation of Independent States is formed.
- 1992:** Deliveries for light planes dropped below 1,000 to 899, a historic low.
- 1992:** General Dynamics began divestiture; Cessna to Textron, tactical missiles to Hughes, and the combat aircraft division to Lockheed.¹⁴⁸
- 1992:** Martin Marietta merges with GE Aerospace.¹⁴⁹
- 1993:** The U.S. share of the world civil transport market drops to 67 percent.¹⁵⁰
- 1994:** Congress enacts a product liability law favorable to the industry which sets a period of no more than 18 years in which a manufacturer is liable for a product.¹⁵¹
- 1994:** Martin Marietta and Grumman announced a merger that was successfully contested by Northrop and resulted in Northrop Grumman which then purchased the rest of Vought.¹⁵²
- 1994:** Lockheed and Martin Marietta announce a merger costing \$10 billion.¹⁵³
- 1995:** Aerospace Industry Association figures report that total sales in the industry were \$107 billion down from \$140 billion in 1991 and \$123 billion in 1993.¹⁵⁴
- 1995:** NASA space shuttle, Atlantis, docks with Russian MIR space station in earth orbit.
- 1996:** Department of Defense spending set at \$42 billion.
- 1997 :** Pathfinder lands on Mars. Produced by the teams of engineers, programmers, and machinists at Jet Propulsion Laboratory (JPL) in Pasadena, California. Responsibility for

¹⁴⁵ Bilstein, p. 209.

¹⁴⁶ Bilstein, p. 214.

¹⁴⁷ Bilstein, p. 238

¹⁴⁸ Bilstein, p. 216

¹⁴⁹ Bilstein, p. 216.

¹⁵⁰ Bilstein, p. 200.

¹⁵¹ Bilstein, p. 212

¹⁵² Bilstein, p. 217

¹⁵³ Bilstein, p. 217

¹⁵⁴ Bilstein, p. 218

programming and machining many of the parts needed to assemble pathfinder fell upon a department consisting of two full-time programmers and 18 machinists.¹⁵⁵

1997: European aerospace employment remained stable at 377,500.

1997: The General Aviation Manufacturers Association (GAMA), which includes all major US manufacturers (but not Dassault Aviation or Canadair), has reported that 1997 was a banner year for the industry. Billings were \$4.7 billion, up from \$3.1 billion in 1996; units shipped reached 1,569, up from 1,130 in 1996; and exports were up 30 percent to 449.¹⁵⁶

1997: Military aircraft sales fall to \$30.47 billion (preliminary figures only) from \$33 billion in 1996. Overall U.S. aerospace sales rose from \$116.5 billion in 1996 to \$129.6 billion. DoD aerospace purchasing increased slightly for the first time in nine years to \$42.3 billion¹⁵⁷

1997: Aerospace employment in the U.S. is up to 869,000, from 792,000 in the summer of 1996. Last year, for the first time since Hitler blitzed Poland, U.S. aerospace companies filled more commercial orders than military orders.¹⁵⁸

1998: Congress passes the Commercial Space Act which allows others beyond the U.S. government to both launch and land space vehicles in the U.S.

1998: The South Korean government ordered the merger of the four principle aerospace companies: Samsung Aerospace Industries, Korean Air, Daewoo Heavy Industries, and Hyundai Space and Aircraft Co. This action taken in response to the severe Asian economic downturn.

1998: Lockheed Martin Corp, the nation's second-biggest military and aerospace company, wins a \$3.44 billion, 10-year contract to run NASA's space operations, beating its rival the Boeing Co.

1998: Lawrence Livermore National Laboratory engineers brief military leaders on a conceptual hypersonic vehicle that would "skip" on the upper atmosphere, enabling payload deliveries to any spot on the Earth's surface within 2 hours.

1998: Lockheed Martin Corporation and Northrop Grumman Corporation plan \$8.3 billion merger.¹⁵⁹

1998: A new Delta 3 rocket, jointly produced by Boeing and Hughes Electronics, exploded shortly after take-off impacting commercial space ventures¹⁶⁰

¹⁵⁵ Hogan, Brian, J., Mars and the machine shop, *Manufacturing Engineering*; V120/3, Dearborn; Mar 1998; pp. 126-130

¹⁵⁶ Interavia, Banner year for General Aviation, Geneva: Mar.1998, V.53/618, p.13.

¹⁵⁷ Horley, US aerospace continues its military sales slide, *Jane's Defense Weekly*, London, Jan. 14, 1998. P. 20.

¹⁵⁸ Banks, Howard,, Annual Report on American Industry: Aerospace, Forbes, New York; V161/1,Jan. 12, 1998, pp104-106.

¹⁵⁹ Wayne, Leslie, For Lockheed, A Showdown Over Merger, New York Times; New York: Mar 23, 1998.

¹⁶⁰ New York Times, August 31, 1998.

1998: Lockheed Martin's F-22 Raptor stealth fighter makes its first test flight, at speeds up to 285 miles per hour.