

APPENDIX 1

FROM CONCEPT TO COMMERCIAL DEVELOPMENT: SEVEN GENERAL PURPOSE TECHNOLOGIES

In this appendix I list critical dates in the development of the several military or defense related general purpose technologies discussed in this book.

I trace the time from the date of scientific discovery or technical invention to the date of economically viable commercial development. The time from initial scientific discovery or technical invention to economically viable commercial development ranges from approximately 15 to 30 years.

In 1968 Mansfield summarized the evidence available in the mid-1960s on the time interval

between invention and innovation (or commercial adoption) for almost 50 technologies (Mansfield 1968: 74-77). With few exceptions the period from invention to innovation was less than 10 years. He also presents data suggesting that the time from invention to innovation declined since the early 20th century to the post-World War II period.

Mansfield, Edwin. 1968. *Technological Change*. New York, NY: W. W. Norton.

1. Interchangeable Parts

1798. Bill authorizing President George Washington to establish public arsenals.

1815. Roswell Lee appointed superintendent of Springfield Armory.

1818. Roswell Lee contracts with Thomas Blanchard to develop irregularly shaped gun stocks.

1819. John Hull appointed Assistant Armorer at Harpers Ferry Armory.

1823. First guns with fully interchangeable parts delivered to the U.S. Army by Harpers Ferry Armory.

1834. Guns with fully interchangeable parts produced at two different armories for the first time.

2. Jet Propulsion

Mid-1930s. Germany and Britain initiated jet-aircraft development programs.

**Early 1940s. U.S. National Committee on Aeronautics
established a Special Committee on Jet Propulsion.**

**Westinghouse and Allis Chalmers initiated jet engine
development.**

**1941. U.S. Army decided to put Whittle designed engine in a jet
engine to be built by General Electric for an aircraft to be
built by Bell Aircraft.**

**1948. First commercial jet airliner, powered by 4 Rolls Royce
engines, built by Vickers.**

**1953. First De Havilland Comet began scheduled service
between London and Johannesburg.**

**1954. Lockheed introduced L-188 Electra passenger jet powered
by Allison 581 engine.**

3. Nuclear Power

**1933. Otto Hahn and Fritz Strassman at Kaiser Wilhelm
Institute in Berlin split atoms by bombarding nuclei with
neutrons.**

1942. Manhattan Engineering District established to develop atom bomb.

1942. (December). Enrico Fermi demonstrates controlled nuclear fusion at University of Chicago Stagg field laboratory.

1945. (August). Uranium bomb dropped over Hiroshima; Plutonium bomb dropped over Nagasaki.

1955. Nautilus, first nuclear submarine, launched.

1956. First demonstration nuclear power plant at Shippingport, Pennsylvania placed on line.

1962. Yankee and Consolidated Edison commercial scale nuclear power plant put on line.

4. Electronic Digital Computer

1937. Design of first electronic digital computer by John Astinoff at Iowa State University. Demonstrated by Astinoff in 1940.

1946. John W. Mauchly and J. Prosper Eckert Numerical Integrator and Calculator demonstrated.

- 1952. IBM commercial version of Defense Calculator, IBM 701, placed on the market.**
- 1953. Engineering Research Associates deliver Atlas computer to National Security Agency.**
- 1957. Whirlwind computer developed at MIT; produced by IBM for Air Force Sage project.**
- 1958. First section of SAGE project became operational.**

5. Semiconductors

- 1936. William Shockley hired by Bell Laboratories to initiate solid state research program.**
- 1947. Shockley, Bardeen and Brattain produce first point-contact transistor.**
- 1958. Jack Kilby of Texas Instruments developed first integrated circuit. Robert Noyce and Gordon Moore of Fairchild Conductor invent planar process integrated circuit.**
- 1970. First microprocessor invented at Intel.**

6. Internet

1962. DARPA Information Processing Office established.

Joseph Licklider appointed first Director.

Late 1950s-early 1960s. Paul Baran, RAND Corporation,

wrote a series of papers proposing packet routing and

switching. Similar proposal made by Donald Davies of the

British National Physics Laboratory in the mid-1060s.

1966. Lawrence Roberts given mandate to build large

computer network by IPO Director Robert Taylor.

1969. Bolt, Bernak and Newman completed work on

development of the first Interface Message Processor (IMP)

designed to route message packets along alternative routes.

1972. Demonstration of INTERNET at International Conference

on Computer Communication.

1990. Tim Breners-Lee, then working at CERN in Switzerland,

Created the first server, browser and protocols that have

become central to the operation of the World Wide Web.

1994. Netscape, founded by Marc Andreessen, introduced the first easy-to-use commercial browser.

7. Satellites

1898-1916. Theoretical and Experimental work by Konstantin Tsiolkovsky and Robert Goddard demonstrated feasibility of rocket flight in space.

1940-44. Development and deployment of V-2 rockets in Germany by team directed by Werner von Braun.

1945. German rocket team surrenders to U.S. Army. Team is brought to Ft. Bliss (Texas) to continue experimental work.

1949. Rocket team transferred to Redstone Arsenal in Huntsville (Alabama). Development of “super V-2” Redstone rocket.

1955. President Eisenhower approves plans to develop satellite as part of U.S. participation in International Geophysical year. Project Vanguard assigned to Navy.

1957. USSR launches Sputnik I and II.

1958. SCORE, first active communication satellite, launched by

Army. Transmitted Eisenhower Christmas message to the world.

1959. After several failures the U.S. Army successfully launches Vanguard III.

1960. Weather Bureau Trios satellite launched.

1963. Comsat Act authorized commercialization of communication satellites.

1972. First Landsat earth observing satellite launched by NASA.