

William J Hughes FAA Technical Center

The Aviation Legacy of Validation and Verification

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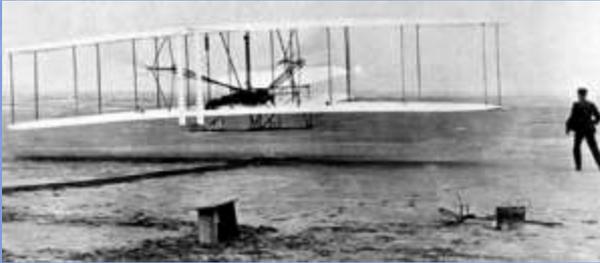
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Federal Aviation
Administration

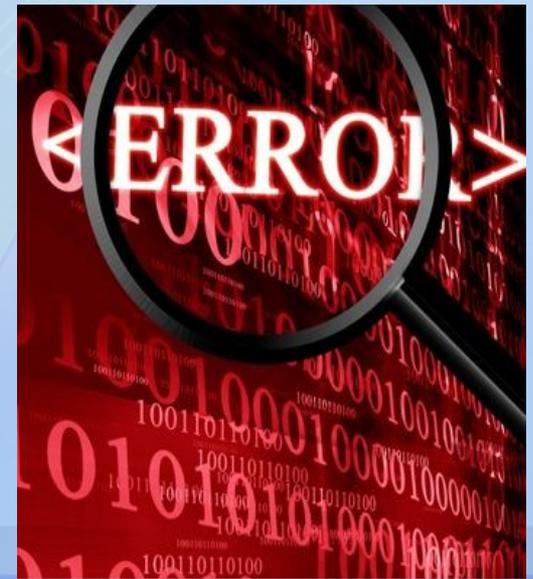
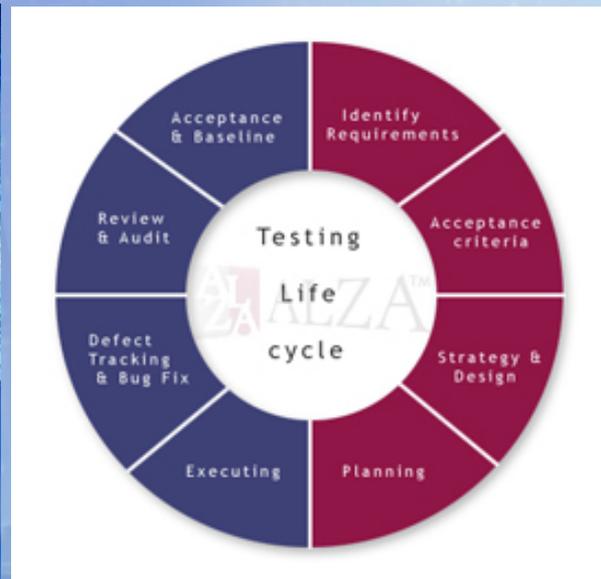


The William J. Hughes Technical Center



The Aviation Legacy of Validation and Verification

- Verification is testing that ensures that the product **meets** the requirements **specified** by the customer.
- Validation is testing that ensures that the product **fulfills** its **intended** use when placed in the intended environment.



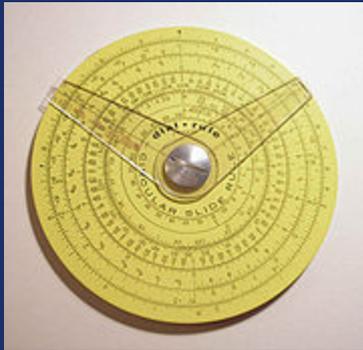
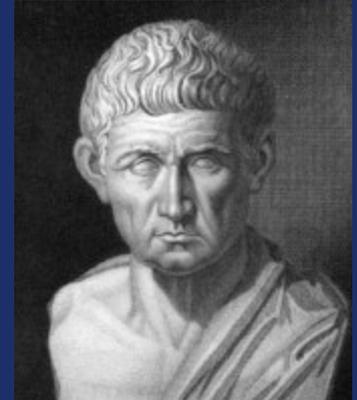
Culture of **V**erification and **V**alidation

The human attributes which transcend success in the historical progress of testing and development were discipline, patience and methodology.

The resistance to real progress was time and cost.

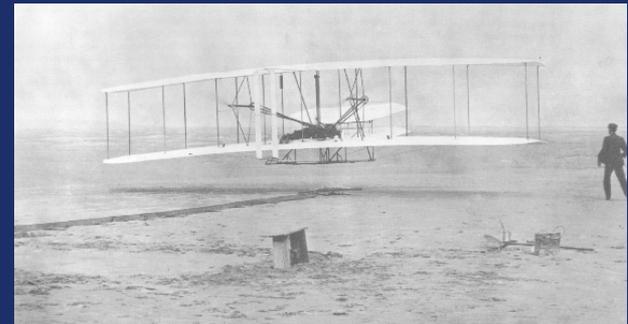


If a man sets out to build a bad chair and builds one ... did he succeed? - Aristotle



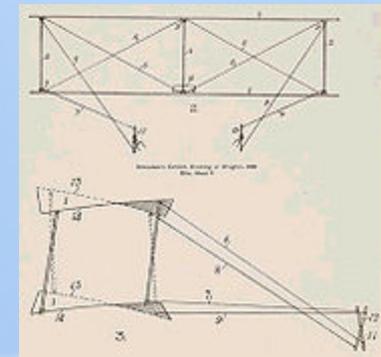
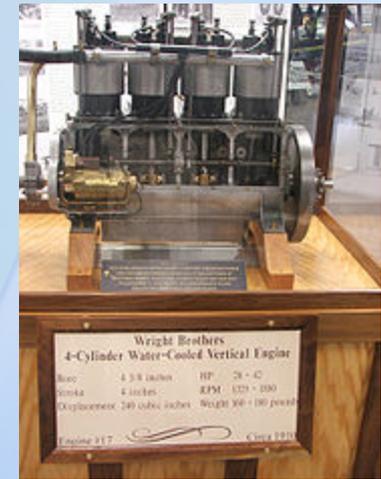
Which one of the following successful pioneers stated early in their endeavors that their work had failed and would never succeed?

- Wright Brothers**
- Robert Goddard**
- Charles Lindbergh**
- Werner von Braun**



Wright Brothers/Invention Process

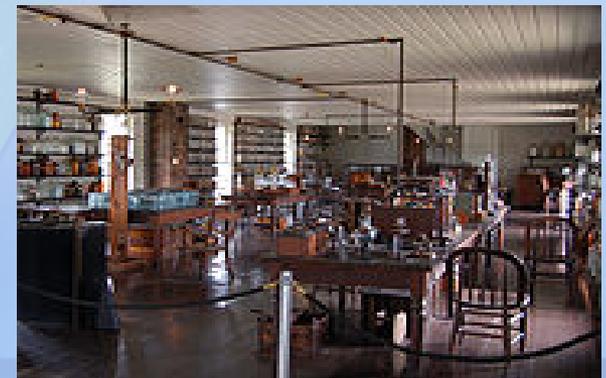
- Examining Existing Information
- Observation of nature
- Balloons and kites
- Fundamental design
- Control system/wind tunnel/propulsion
- Testing and modeling
- Major Success
- Innovation Continuum



Thomas Edison

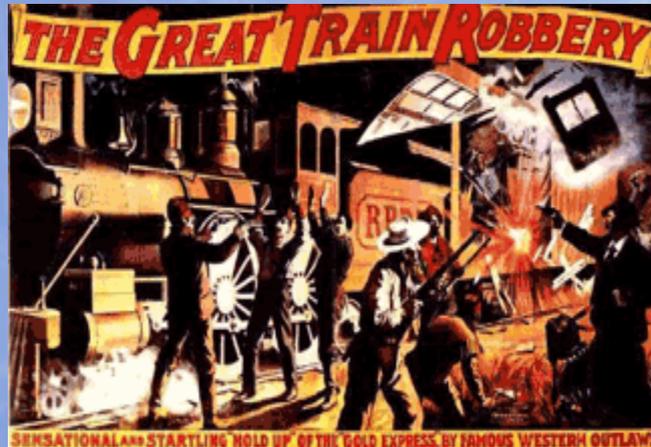
The Genius of Menlo Park

- Poor Student
- Little formal education
- Home Schooled
- Interest in mechanic and chemical experiments
- Reached an understanding only by doing and making.
- “Anything that won’t sell, I don’t want to invent. Its’ sale is proof of utility and utility is success.”



What he gave us.....

- Light
- Heat
- Power
- Music
- Movies



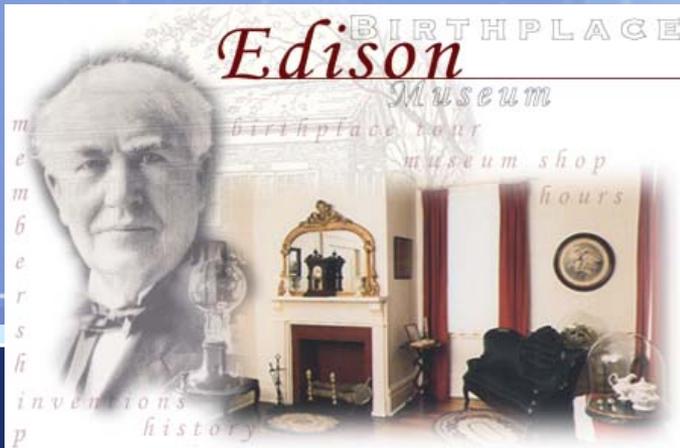
Major Accomplishments and Innovations

- **Granted 1,093 patents in U.S., Great Britain, France and Germany.**
- **Invented the first industrial lab to produce constant technological innovation and improvement.**
- **Emphasis was for the lab personnel to develop inventions for commercial applications.**

Verdict for Edison

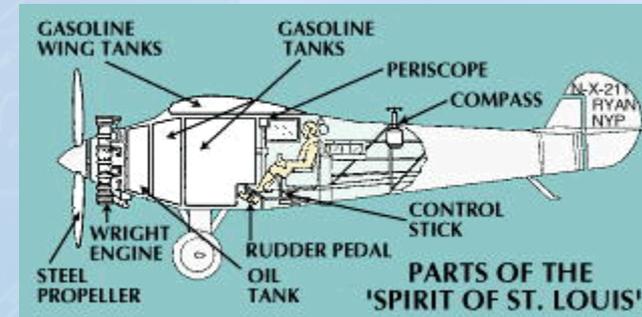


- Edison's greatest critic of his methodology was Nicola Tesla who contended that Edison wasted vast resources and time in his testing and innovation.
- Frank Upton stated that even though Edison seemed haphazard in his approach, his method of innovation and creation of new industries was systematic and complete.



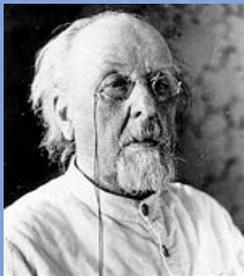
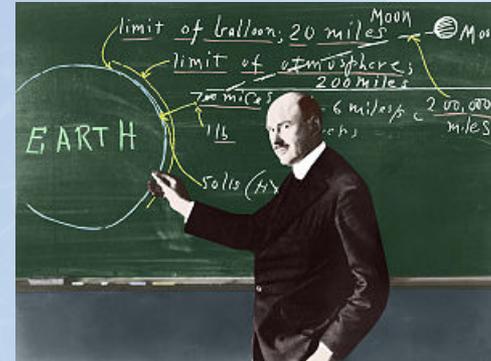


- Motivated by challenge/Orteig Prize
- Least experienced competitor
- Resisted prevailing mindset
- Designed aircraft to the task
- Assumed the risk
- Performed successfully



Rocket Pioneers

- Robert Goddard
- Konstantin Tsiolkovsky
- Hermann Oberth
- Werner von Braun



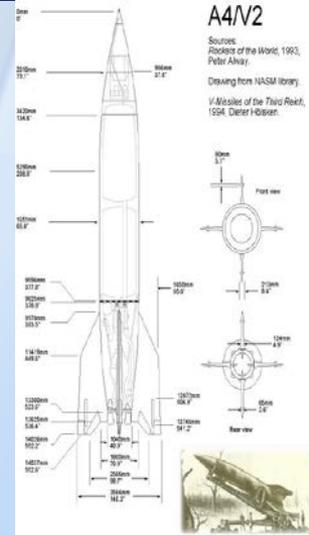
Robert Goddard

- Academic pedigree
- Documented his own work
- Developed mathematical foundation for flight
- Liquid fuel/de Laval nozzle/multistage rocket
- Lindbergh and Guggenheim
- Military application



Werner von Braun

- Leader of the Rocket Team
- Arranged for surrender of 500 scientists to the allies.
- Project Paperclip/Redstone/Jupiter
- NASA/Saturn V



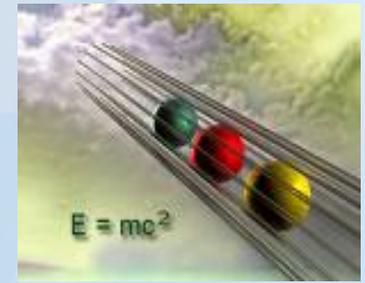
Robert Moses Master Builder of Public Works

- **Bridges/Highways/Tunnels/World Fairs/U.N. Headquarters**
- **Funded new transportation project with tolls.**
- **New York Infrastructure easily flowed into Interstate System.**
- **Much controversy about social impact of massive projects.**

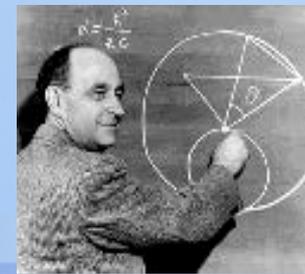
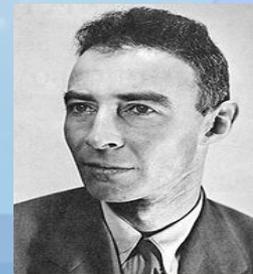
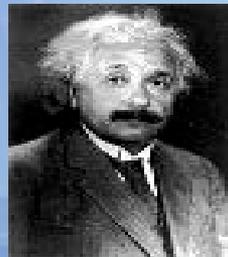
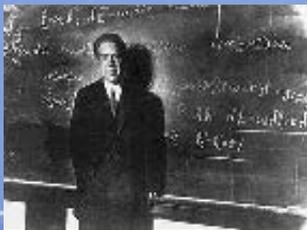
Major accomplishments



Manhattan Engineer District



- Disparate knowledge of nuclear fission
- Impetus came from scientific community
- Office of Scientific Research & Development
- Appointment of J. Robert Oppenheimer
- Facilities and research was kept secret
- Testing



Lab Locations

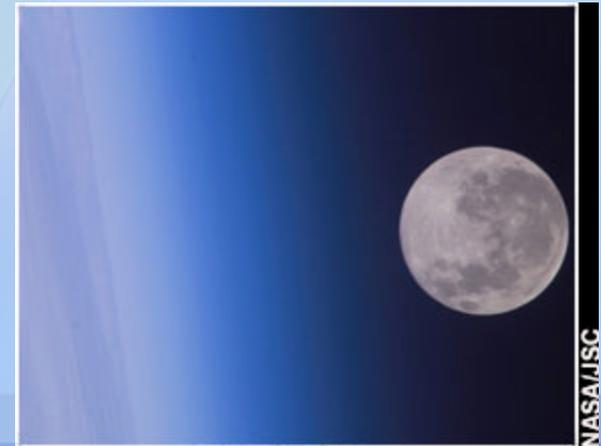


United States Space Program

- Space Program emanated from cultural shock.
- U.S. established civilian space agency.
- Manned flight programs.
- The Man on the Moon pledge.



National Aeronautics
and Space Administration



Timeline

5/5/1961 America's First Space Flight

2/20/1962 Circling the earth

6/3-7,1965 Gemini Spacewalk

12/21-27/1968 Apollo 8 orbits the moon

7/16-24,1969 Apollo's 11 Giant Leap for Mankind

4/11-17,1970 A close call for Apollo 13

7/15-24,1975 Rendezvous with Russia

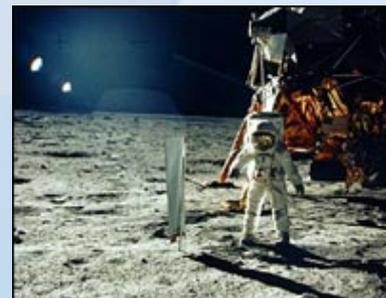
4/12/1981 Shuttle Era begins

1/28/1986 Tragedy strikes Challenger Shuttle

4/24-29 1990 Hubble Take 1

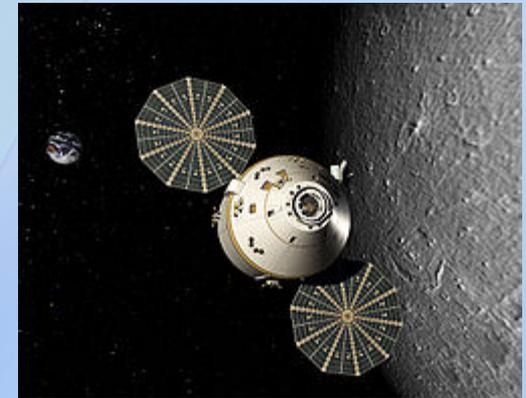
12/2-12,1993 Hubble Take 2

2/1/2003 The Columbia Disaster



United States Space Program

- Civilian organization
- Centralized funding and planning
- **150** manned missions/probes/HSC/Space Station
- Shuttle Program
- Tragedies
- Orion Program





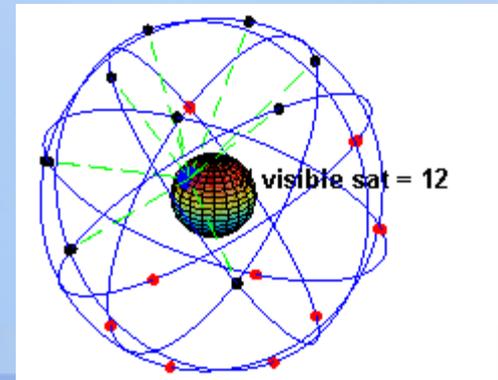
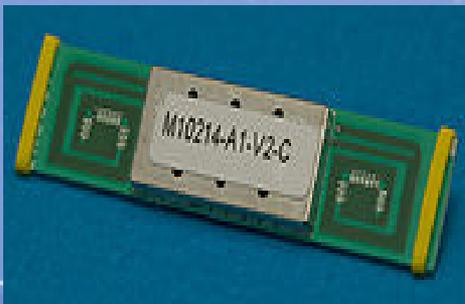
Russian Space Program

- Soviets took military approach.
- Soviet Program was assisted by captured German scientist until 1955.
- Soviet approach was decentralized and based on Five year plans.
- Emphasis was on production targets which hid defects and affected quality control.
- Program was classified.



Global Positioning System

- Sputnik/1957
- Transit System/US Navy/5 satellites/1960
- Korean Air Lines Flight 007/1983
- First satellite/1989
- Twenty fourth satellite/1994
- Selective availability ended/2000



Galileo

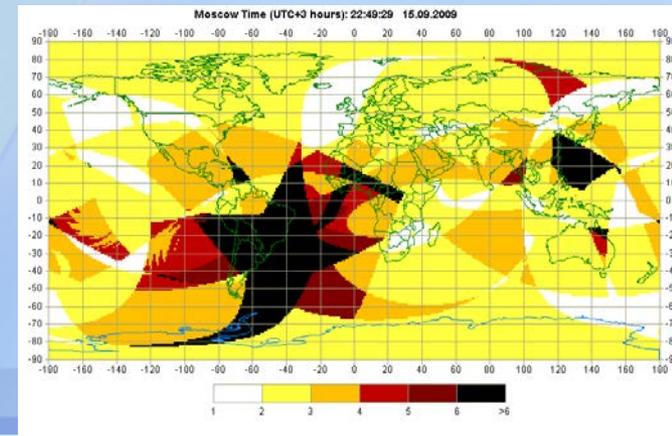
- **European Union/European Space Agency**
- **Operational in 2013**
- **More accurate than GPS**
- **Complementary to GNSS**
- **Controversy in wartime**



GLONASS

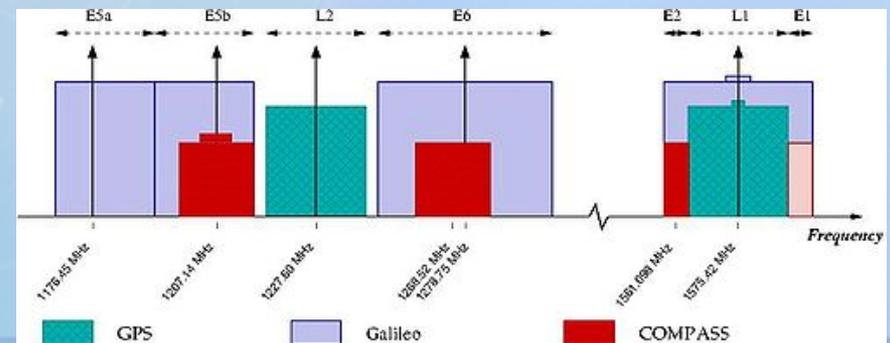


- Presently 18 satellites in orbit
- 24 required for full operational service
- 6 satellites scheduled launch for October 29, 2009
- Open and Restricted Access.



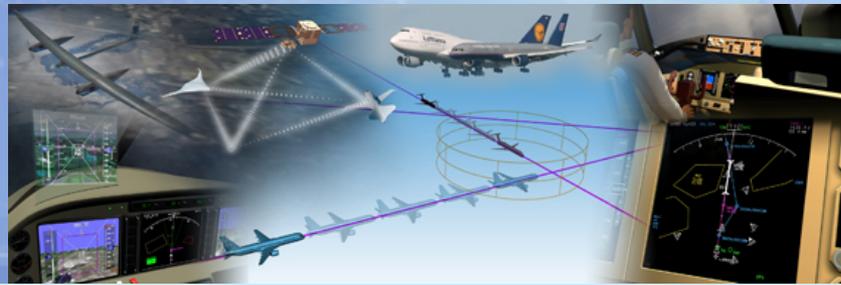
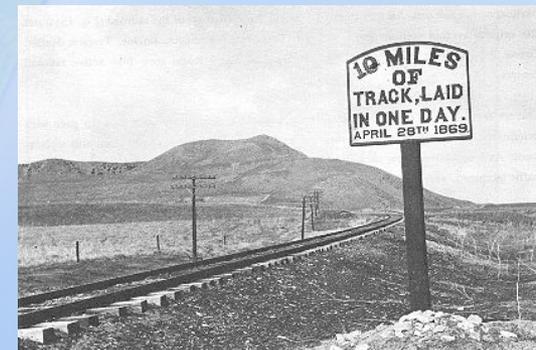
Compass Navigation System

- 35 satellites/30 MEO/5 GEO
- Open and Restricted Option



National Transportation Initiatives in U.S. History

- Louisiana Purchase
- Transcontinental Railroad
- Interstate Highway System
- National Airspace System
- Space Program
- Next Generation Air Transportation System



National Transportation Initiatives in U.S. History

- Federal Aviation Agency created in 1958 oversaw the NAS and the growth of commercial aviation.
- National Aeronautics and Space Administration created in 1958 undertook the challenge of the “Space Race” and landed a man on the moon in July 1969.



National Airspace System

- Largest & most complex system
- Civilian & Military
- Evolved through pioneering, legislation, technological leaps, commerce, accidents and regulation.
- Features Hub & Spoke, structured airspace, various equipped aircraft, capacity limitations.
- Labor Intensive system.



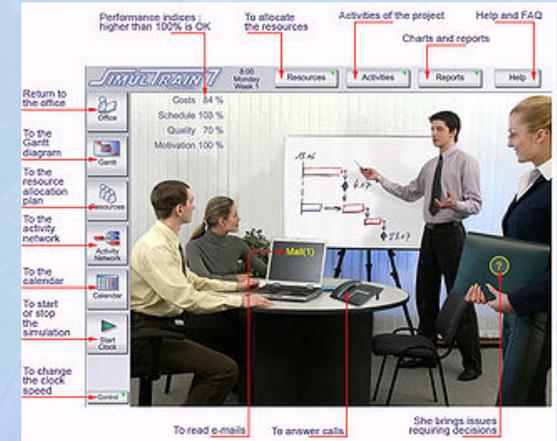
Next Generation Transportation System

- Net centric System
- Operational Paradigm Shifts
 - **Controller manages airspace.**
 - **Best equipped /Best served.**
 - **A/C Assumes separation responsibility.**
 - **A/C becomes ASP and end user.**
- Simulation and Modeling
- Advanced Automation
- Progress through Demonstration

National Transportation Initiatives in U.S. History

- **Similarity to Next Gen Transportation System:**

- Cost (Bonds vs. Taxes)
- Apportionment (Fed vs. State)
- Project Duration
- Usage restrictions and access
- Technological standards



Handoff from History *FROM NAS to* *NEXTGEN*

