National Aeronautics and Space Administration

The Value of Computer Science

Rebecca Mazzone

July 23, 2012

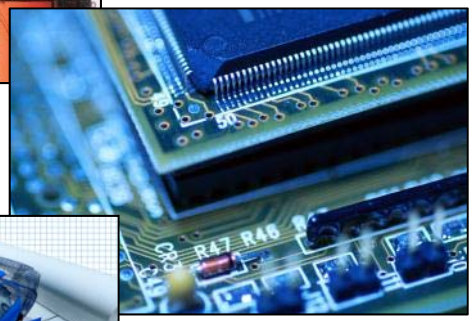
The STEM Initiative

Science

Technology

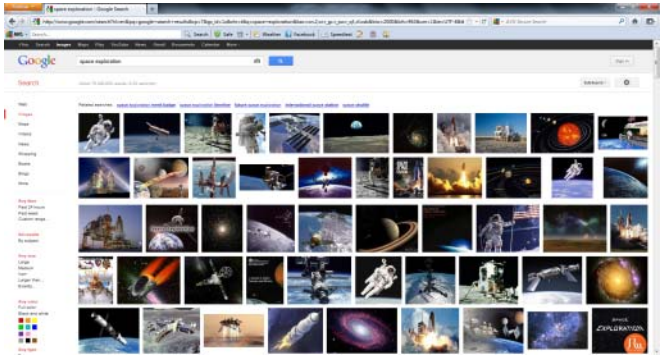
Engineering

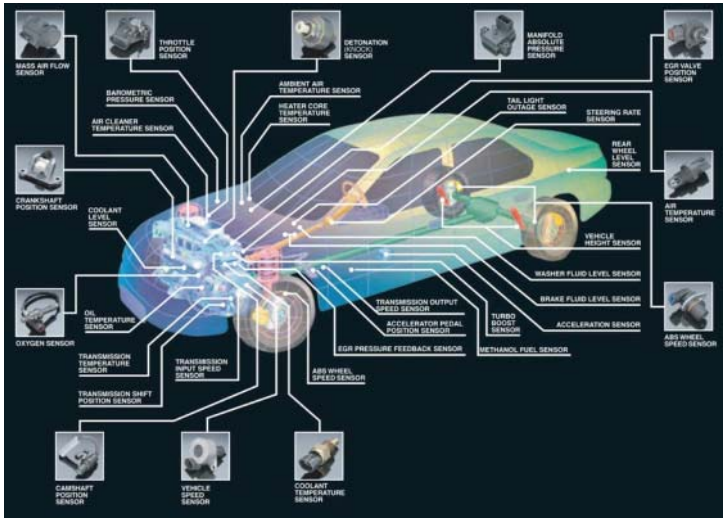
Mathematics



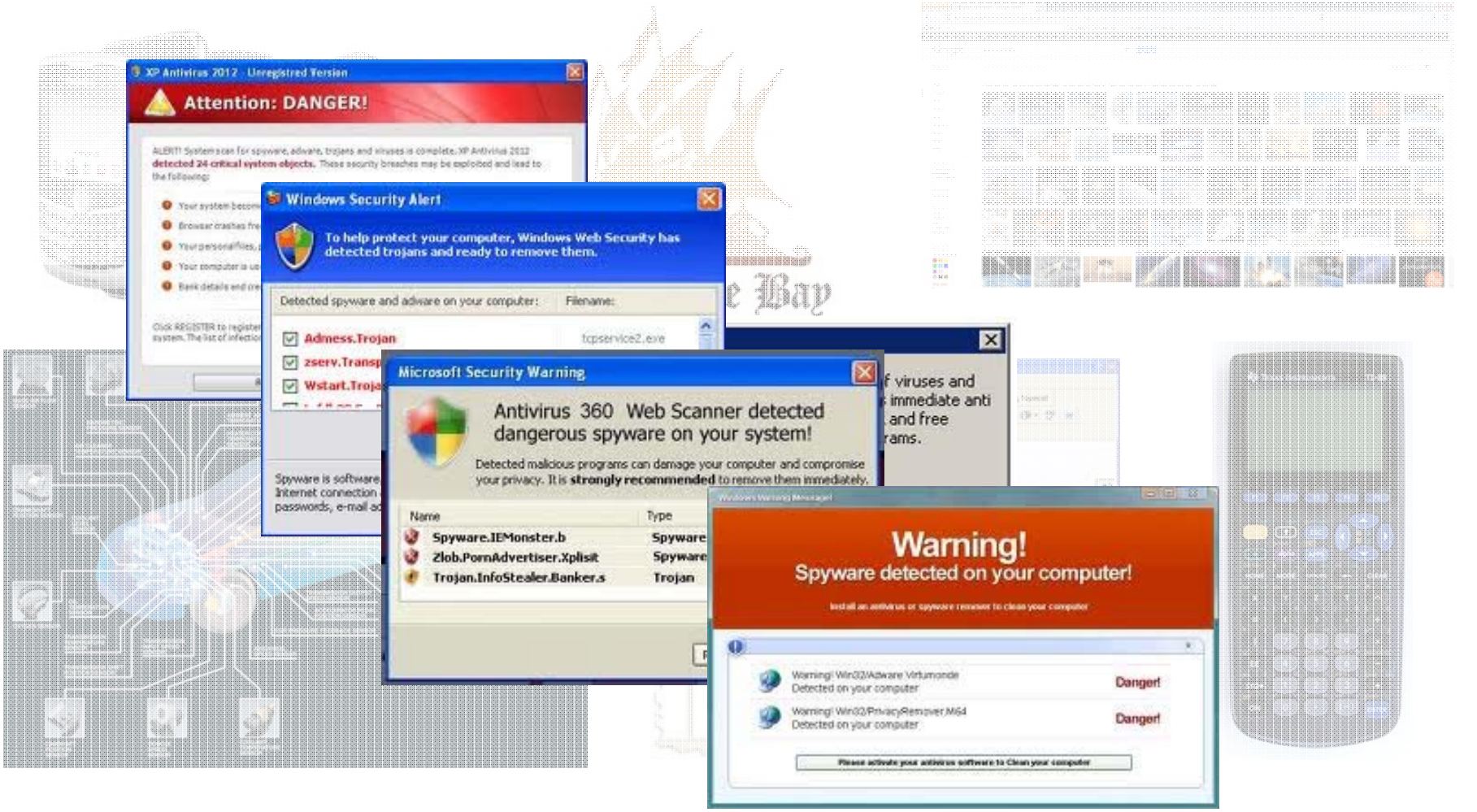
The World They Live in

The Pirate Bay





The World They Live in

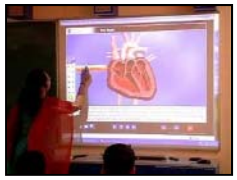
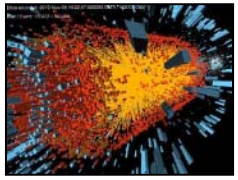


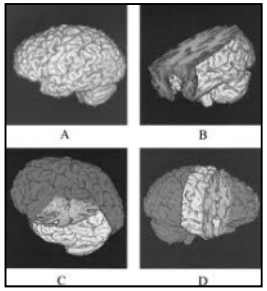
Application Today

Ensuring students understand the technologies they use - as well as the inherent risks and limitations of those technologies - enables them to be better, more informed citizens of a digital society.

The Reality of the Future

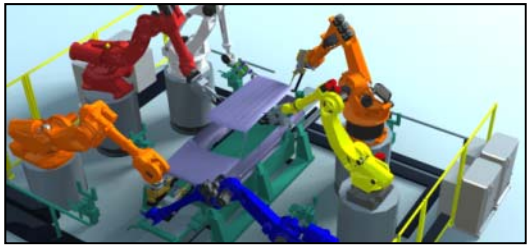




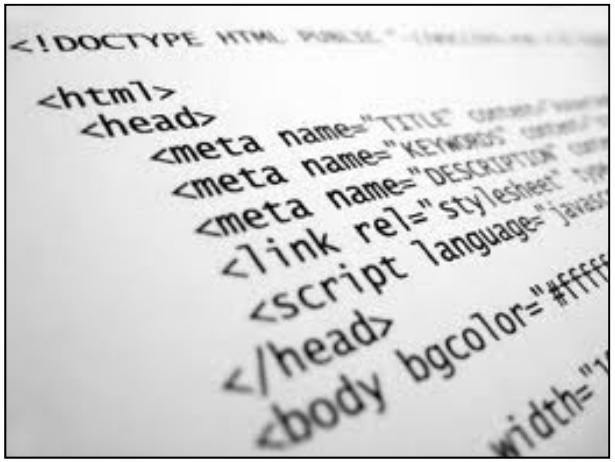
"The world will be entirely computerized by the time I retire, so your CS is very valuable, no matter what direction you choose to go in."





Laying foundations

Computer science is as practical in our high schools today as home economics or woodshop.



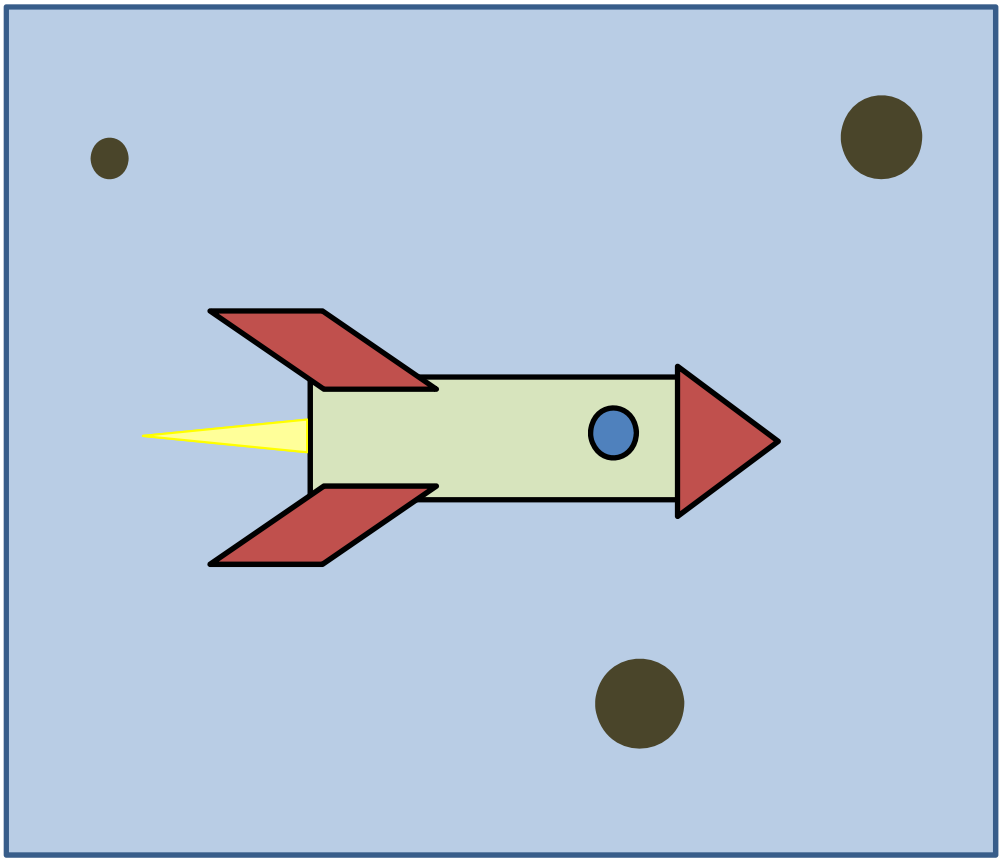
Students receive a tool that can aid them later in life and enough experience to foster confidence wielding it.

Learning By Doing

“Tell me and I'll forget; show me and I may remember; involve me and I'll understand.”

Students are free to move at their own pace and make their work as simple or as complex as they desire.

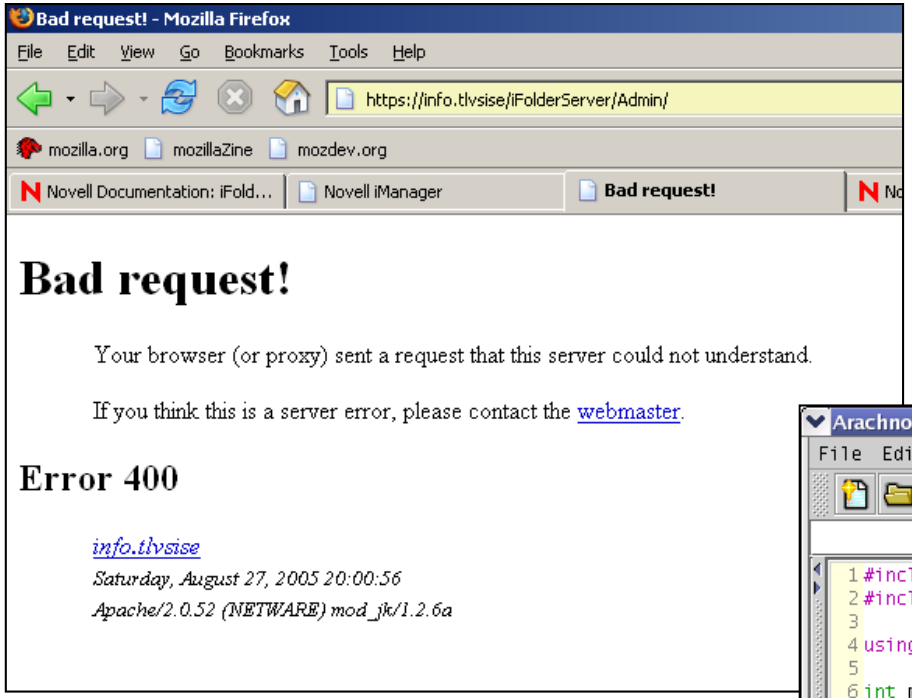
The Freedom To Create



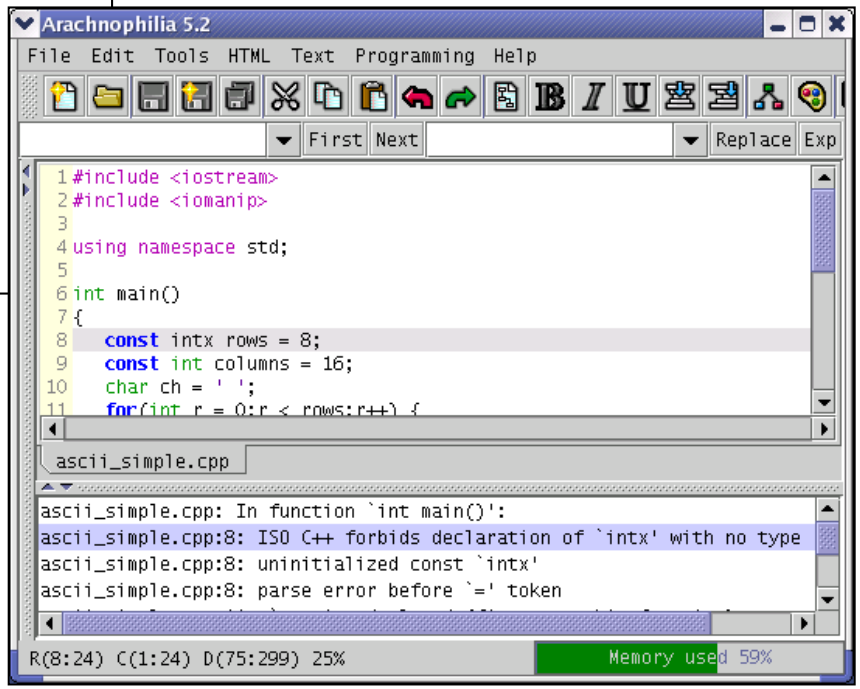
There’s no one “right” answer.

If you had a blank canvas in front of you, what would you paint first?

Immediate Feedback



Errors are inevitable and vital to the learning process.



There are few better feelings than successfully compiling a difficult piece of code.

Expansion of the Mind

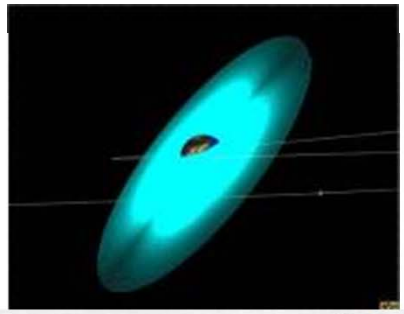
- Communication
- Perspective
- Problem solving
- Possibilities

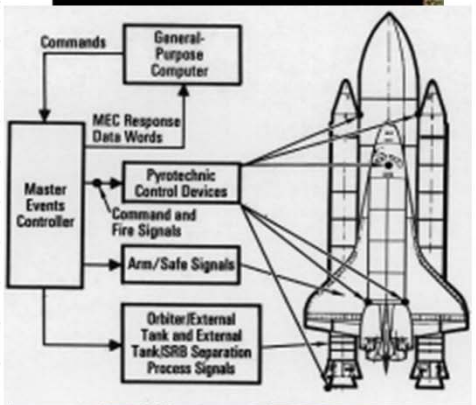

A look at
NASA Computer Science

Flight Software

Functionality implemented in flight software in the past (green), planned (brown), and future (red).

Command sequencing	Guided descent & landing	Parachute deployment
Telemetry collection & formatting	Trajectory & ephemeris propagation	Surface sample acquisition and handling
Attitude and velocity control	Thermal control	Guided atmospheric entry
Aperture & array pointing	Star identification	Tethered system soft landing
Configuration management	Trajectory determination	Interferometer control
Payload management	Maneuver planning	Dynamic resource management
Fault detection & diagnosis	Momentum management	Long distance traversal
Safing & fault recovery	Aerobraking	Landing hazard avoidance
Critical event sequencing	Fine guidance pointing	Model-based reasoning
Profiled pointing and control	Data priority management	Plan repair
Motion compensation	Event-driven sequencing	Guided ascent
Robot arm control	Relay communications	Rendezvous and docking
Data storage management	Science event detection	Formation flying
Data encoding/decoding	Surface hazard avoidance	Opportunistic science



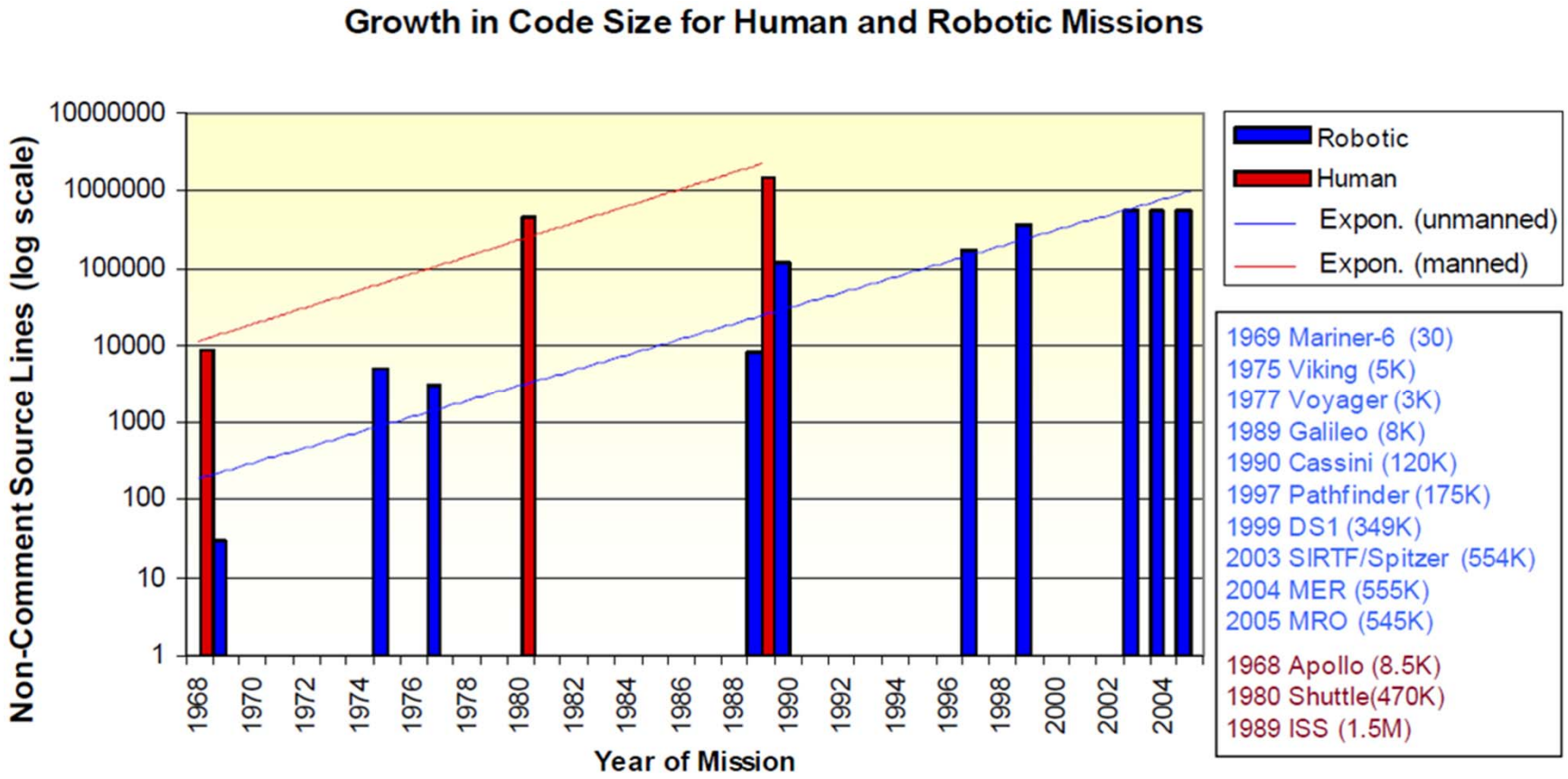


"Flight software has become a spacecraft's 'complexity sponge' because it readily accommodates evolving understanding, making it an enabler of progress."

NASA Study on Flight Software Complexity, Office of the Chief Engineer, 2007

Looking Forward

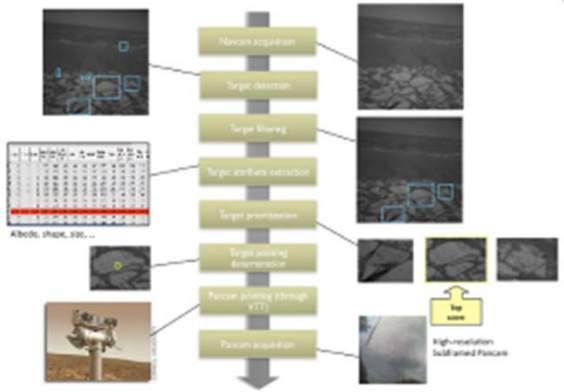
"software grows by an order of magnitude every 10 years"



"As missions change and become more complex, using software to adjust for the changes is much cheaper and faster than changing the hardware."

References:
NASA Study on Flight Software Complexity, Office of the Chief Engineer, 2007

Artificial Intelligence



The Autonomous Exploration for Gathering Increased Science (AEGIS) system enables automated data collection by planetary rovers. AEGIS software was uploaded to the Mars Exploration Rover (MER) mission's Opportunity rover in December 2009 and continues to successfully demonstrate automated onboard targeting based on scientist-specified objectives. AEGIS was named NASA's Software of the Year for 2011.

References:
http://aegis.jpl.nasa.gov/
http://marsrovers.jpl.nasa.gov/gallery/press/opportunity/20050506a.html

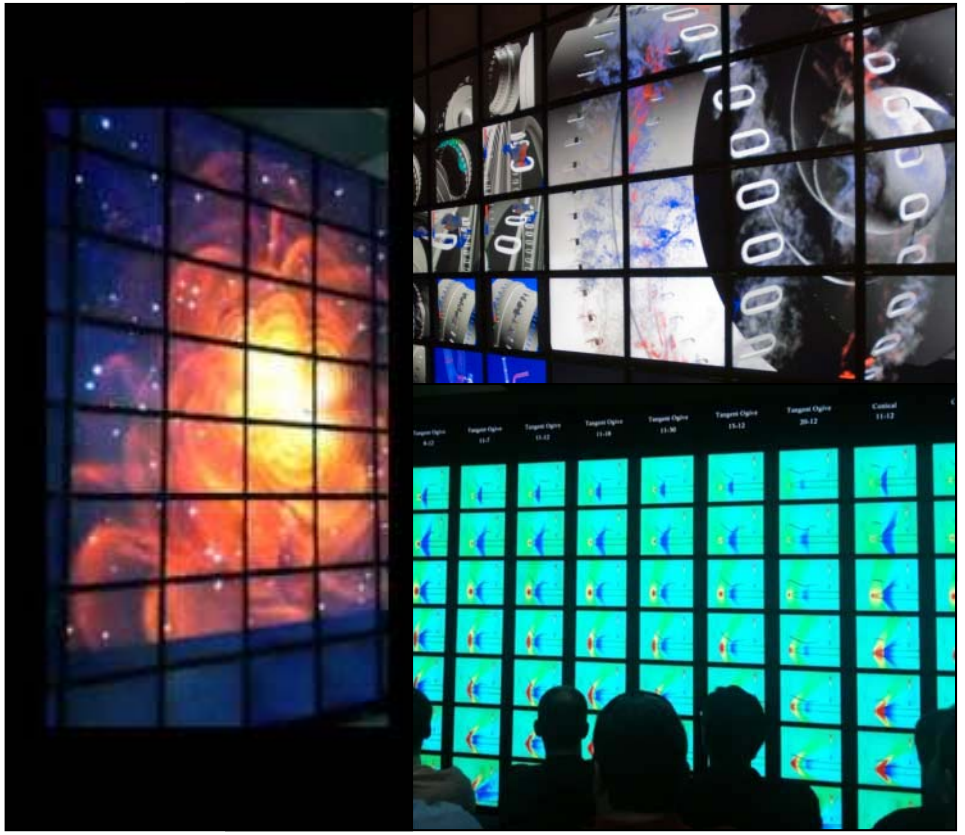
Robotics

- **Robonaut2 (R2) is a state of the art highly dexterous anthropomorphic robot; R2B is currently on the International Space Station (ISS)**
- **R2's control system is challenged by many requirements that cannot be met with only classical robot control methods**
  - **provide safe, reliable control for 47+ degrees-of-freedom**
  - **be controllable via direct teleoperation, shared control, and full autonomy**
  - **maintain performance in a harsh thermal environment**
  - **execute at the required rate on reasonable hardware**

Supercomputing

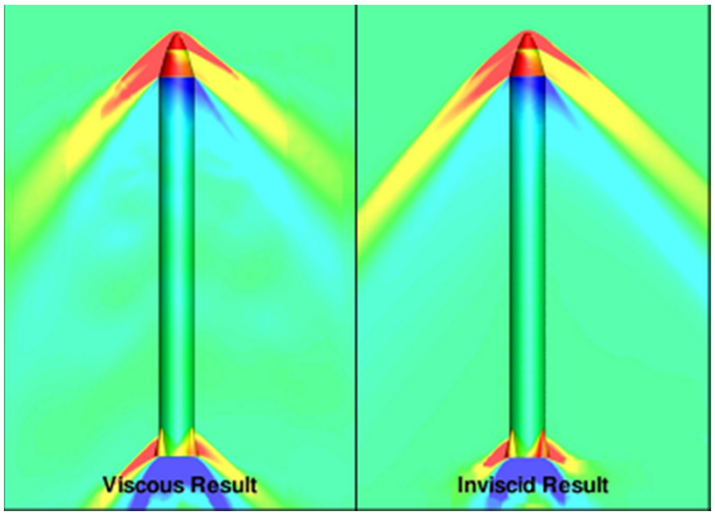
This summer Pleiades was ranked the 7th most powerful high performance computer in the world.

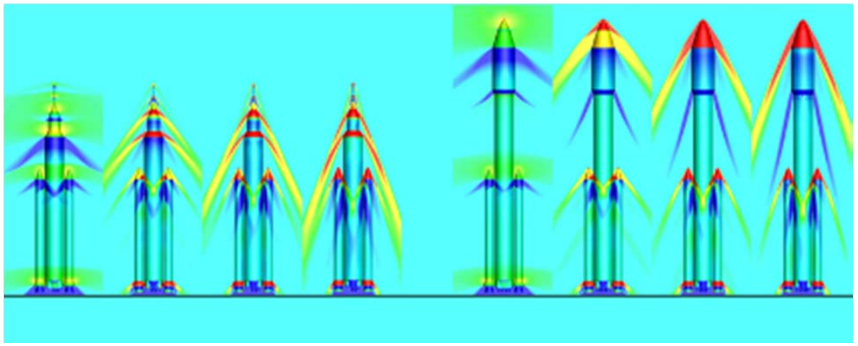
Pleiades



Hyperwall-2 visualization Environment

Computational Fluid Dynamics



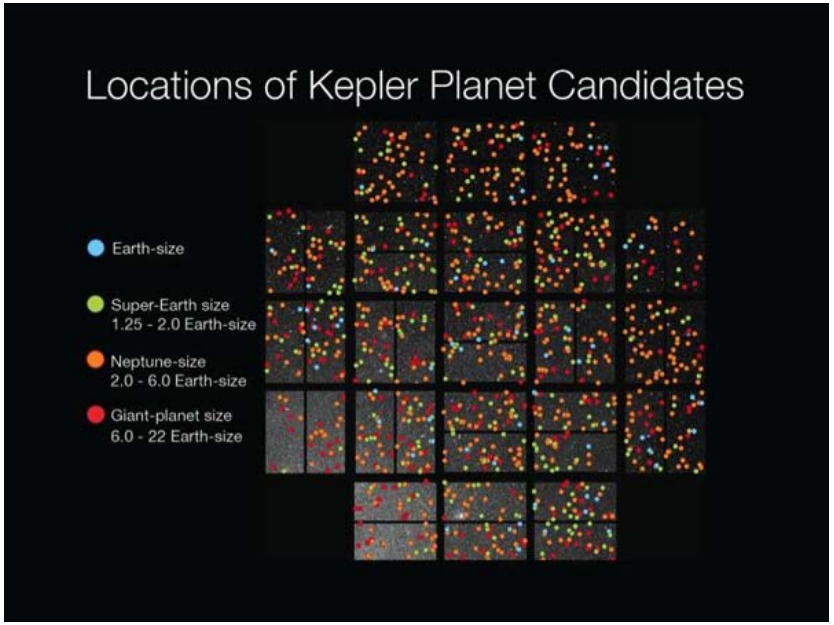


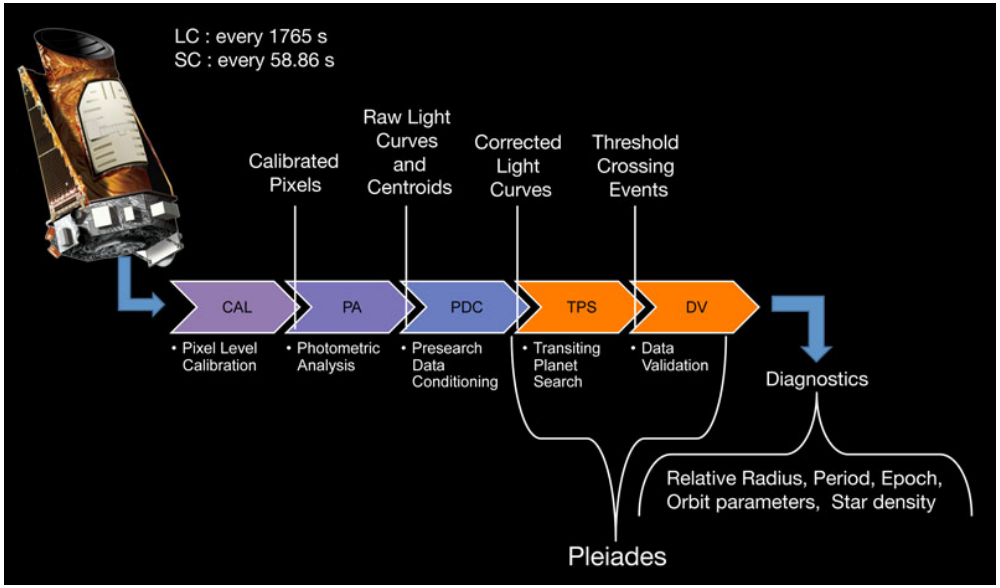
- **Modeling and simulation experts are performing computational fluid dynamics (CFD) simulations supporting the design of NASA's next-generation, heavy-lift Space Launch System (SLS). Studies to date include:**
  - **Initial shape trade studies to help assess and compare alternate SLS designs developed at several NASA Centers**
  - **Inviscid aerodynamic performance characterization for both crew and cargo versions of SLS vehicle designs**
  - **Viscous analysis of an early SLS design concept**
  - **Computation of line loads and surface pressure signatures throughout ascent for preliminary SLS designs**
- **Results from these analyses enable designers and engineers to optimize the vehicle's shape for better performance, and to assess the structural and acoustic loads that the vehicle will encounter during ascent.**

Sources:
Cetin Kiris, Jeffrey Housman; NASA Ames Research Center; Human Exploration & Operations Mission Directorate

Kepler Analysis

Launched in March 2009 with the goal to explore the structure and diversity of planetary systems and search for other life-supporting planets, the Kepler spacecraft continuously monitors over 150,000 stars in the Milky Way constellations of Cygnus and Lyra.

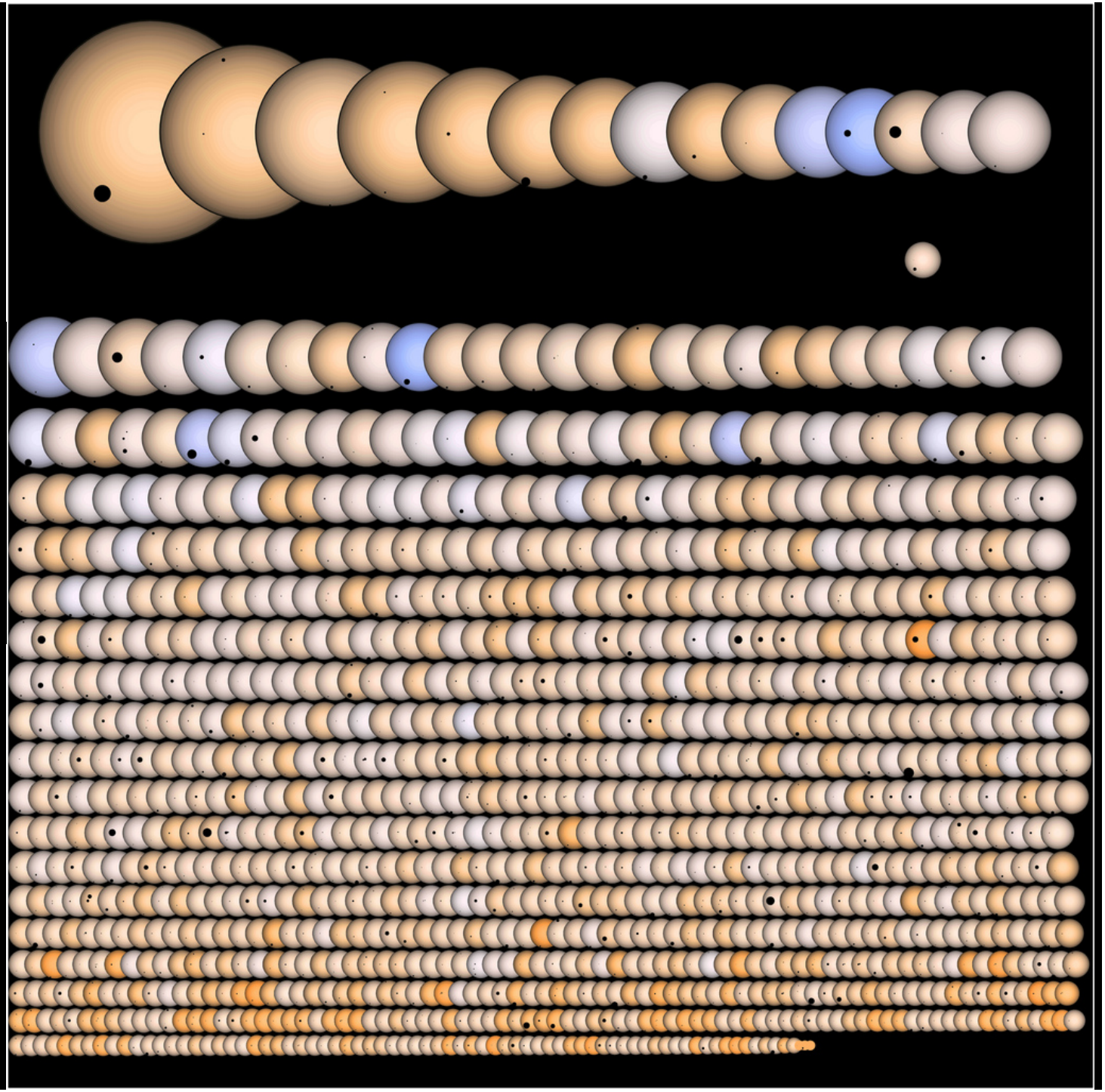




It would take on-board computers one month to complete the same amount of planetary transit search computations that Pleiades can perform in less than a day.

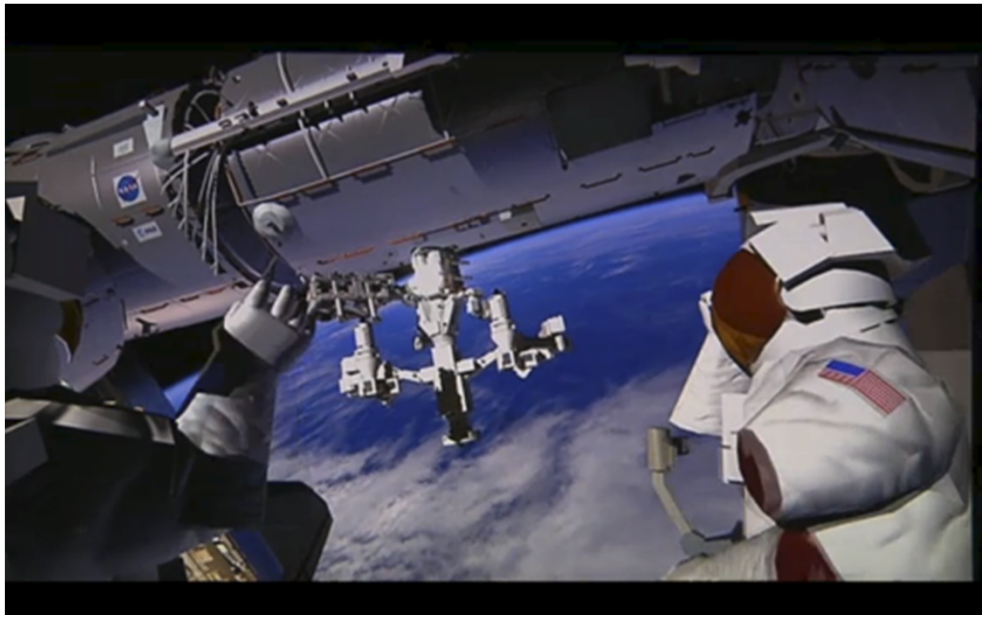
A Pause for Perspective:

To Date, Kepler has identified over 2,300 candidate planets.



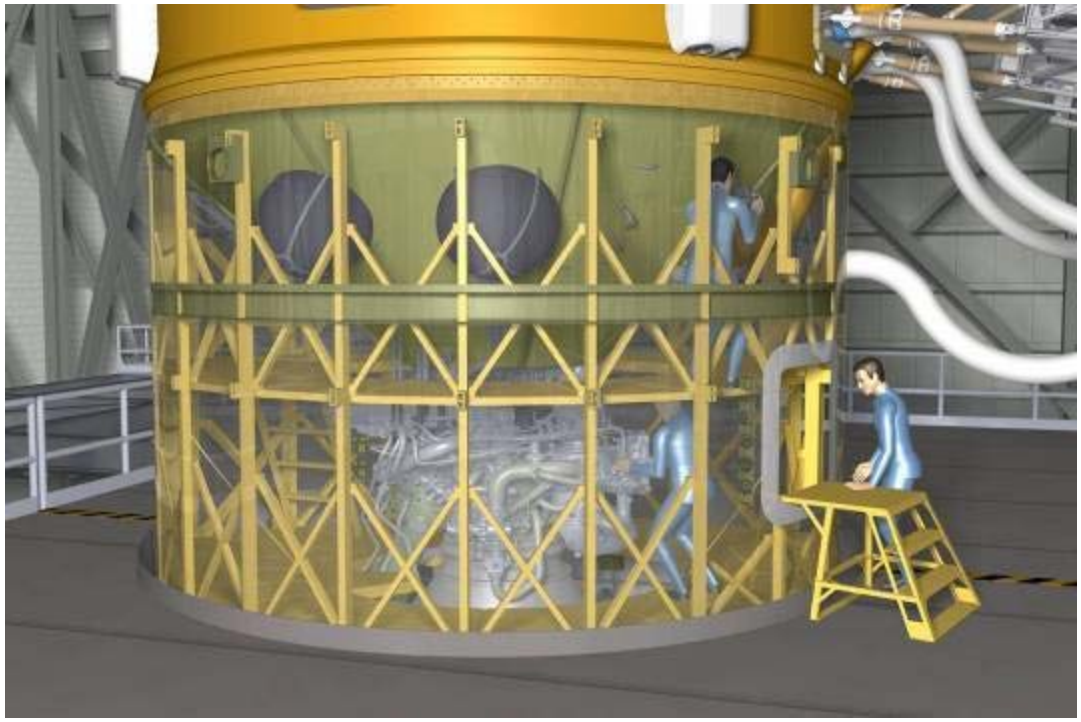
Virtual Reality

The Virtual Reality Lab at JSC is an immersive training facility that provides real time graphics and motion simulators integrated with a tendon-driven robotic device to provide the kinesthetic sensation of the mass and inertia characteristics of any large object (<500lb) being handled.

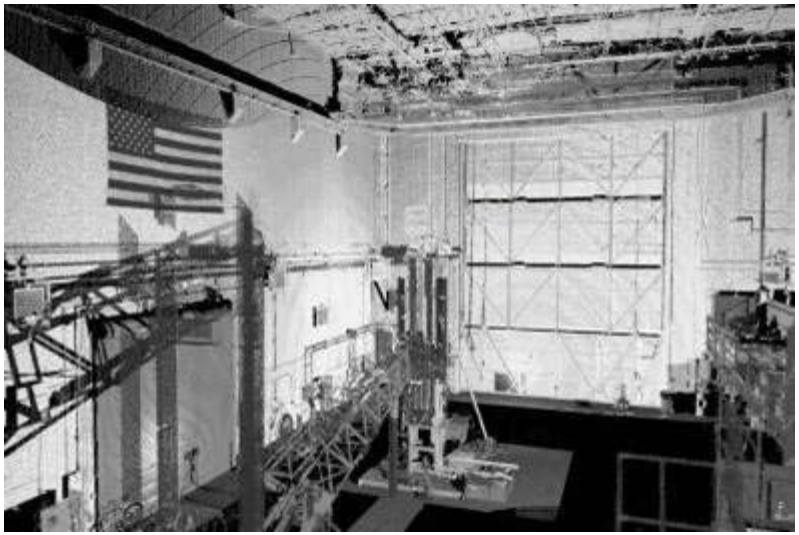


3-D Modeling & Simulation

Operations Planning for Vehicle Processing



Model generated from Laser Scanning Data



Mars Science Laboratory Ground Ops Planning

2008

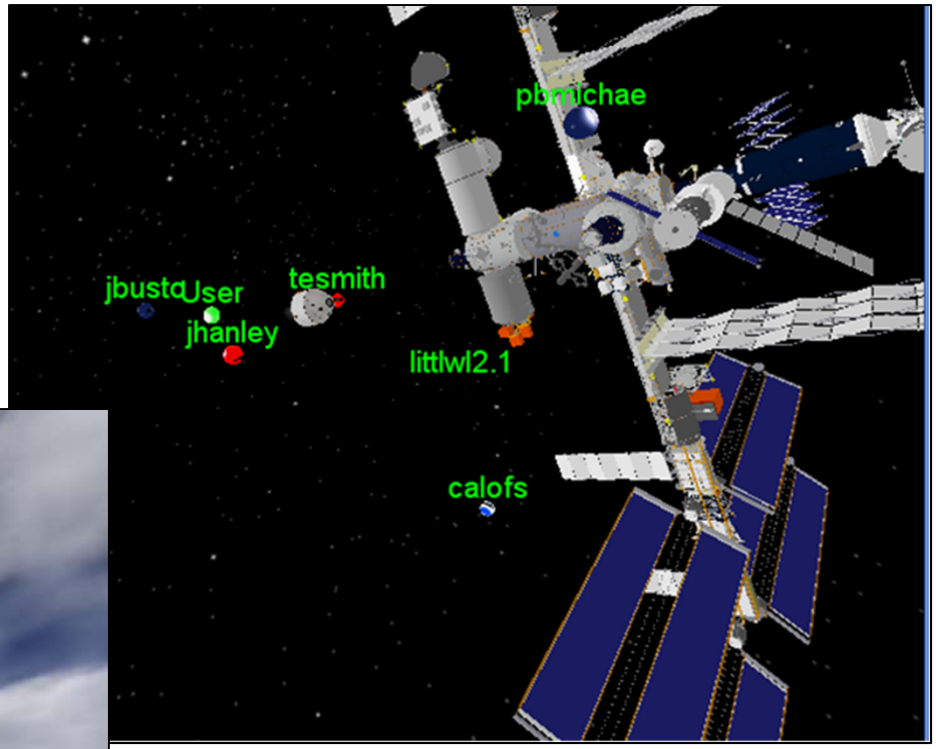
2011

2008

2011

Distributed Observer Network (DON)

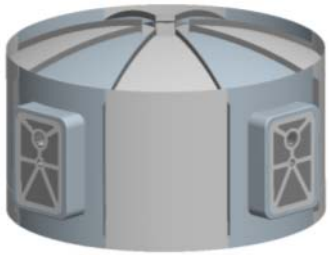
Developed upon commercial game technology to meet the data presentation needs of the Constellation program.



Provided a fully-navigable 3-D virtual environment for simulation distribution, review, and collaboration.

Habitat Demonstration Unit

January 2009

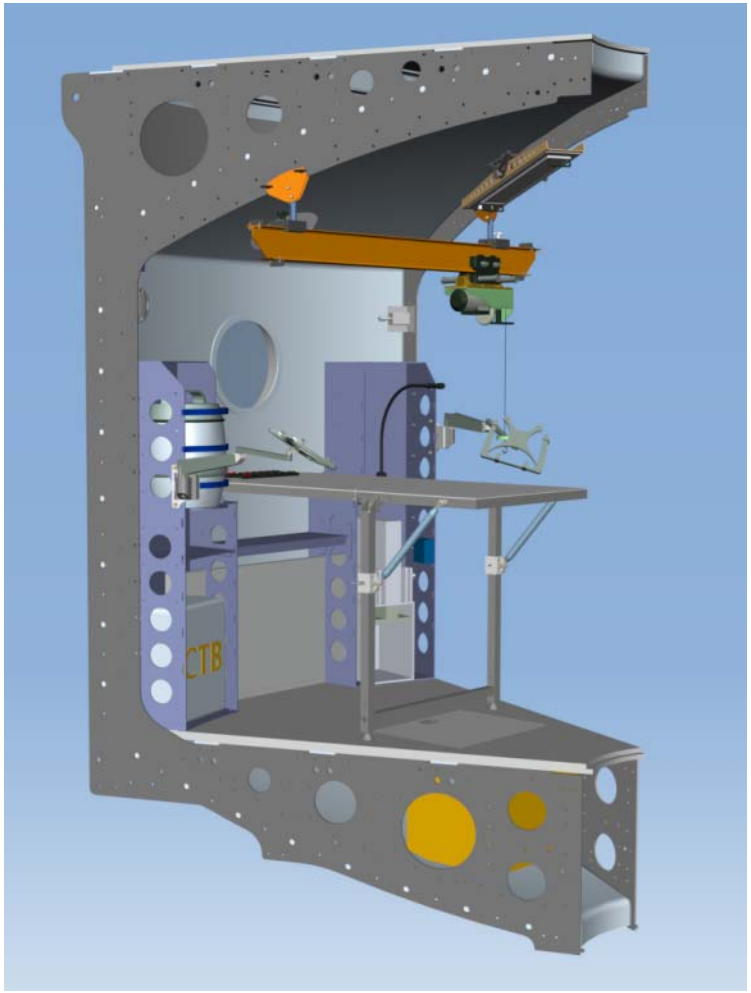


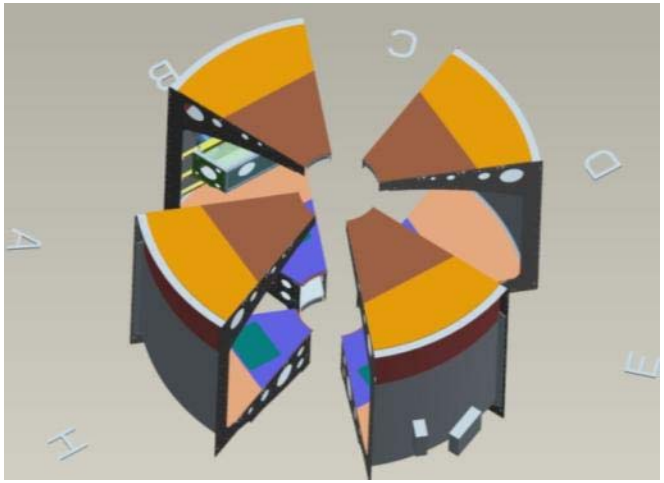
June 2009

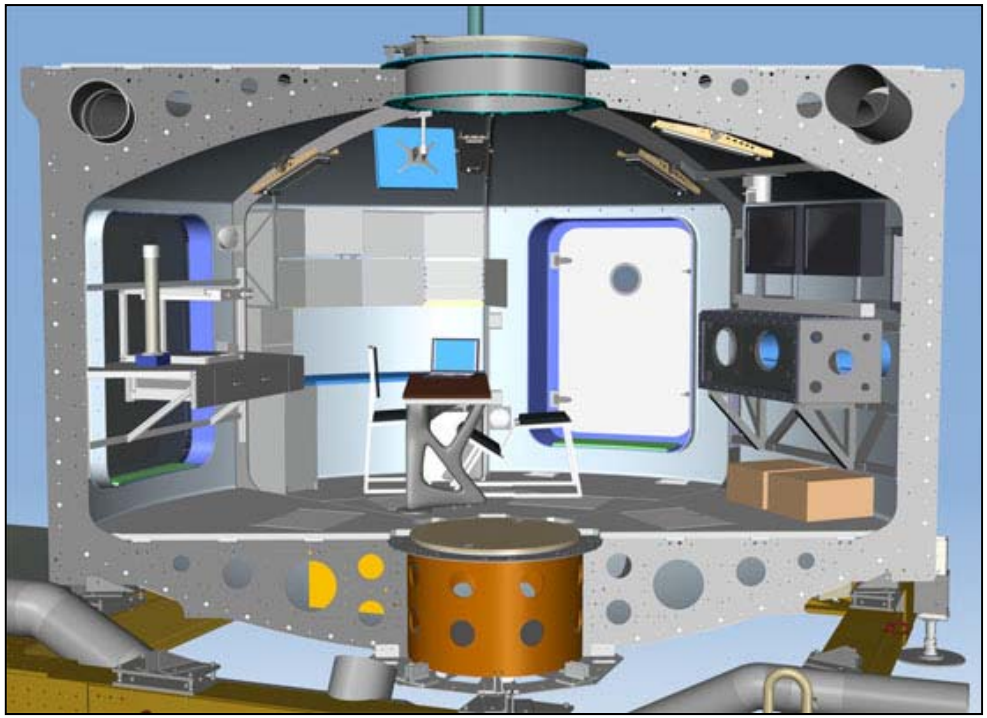
May 2010

September 2010

HDU Virtual Integration - Interior







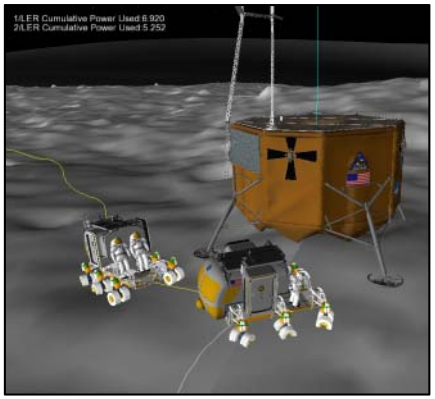
Desert RATS Virtual Test Site

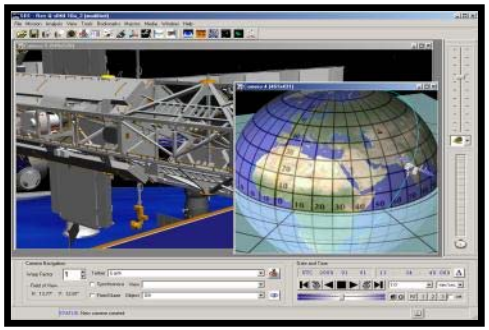
Outreach application developed to provide a virtual tour of the 2011 Desert Research and Technology Studies (RATS) outing.

Combined real terrain data for the test site at Black Point Lava Flow with hardware engineering models.

Released on Android, iOS and web platforms.

Exploration Visualization Environment (EVE)



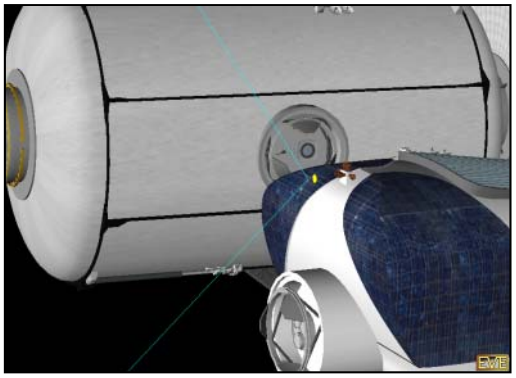


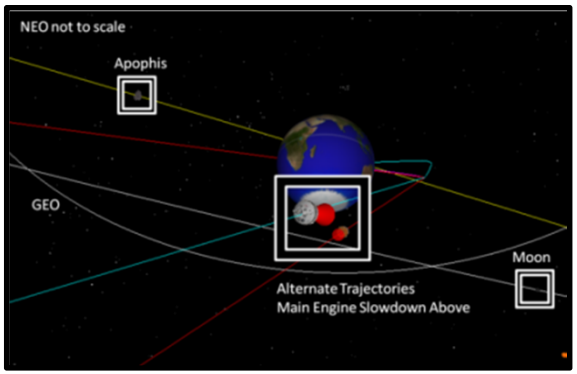
Provides Visualization of complex data:

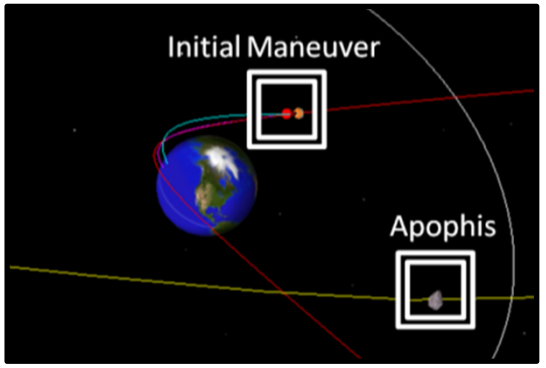
- Integration & graphing tools, powerful data control
- Communicates with analysis tools
- Expect to integrate with Data Architecture tools.

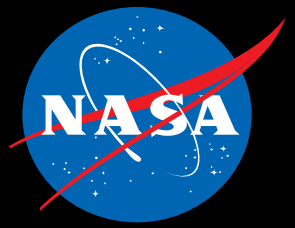
Primarily for scientists and analysts

- To help develop, understand and integrate information








NASA