Germinating the 2050 Cis-Lunar Econosphere

Space 2100:
Projecting our future,
Pondering how it might evolve and
what we might start doing now to help it,
Seeding a global discussion,
and robusticizing MSFC in the process.

IEEE Aerospace Conference, Big Sky, MT
March 13, 2015

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On behalf of the Space 2100 team

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Late 2012 – MSFC Center Director wanted to engage employees at a grass roots level to shape and share unfettered, creative ideas about Marshall and NASA in the next century, far beyond and unfettered by any current strategic planning efforts.

Two primary goals:
- Grow fresh, futuristic ideas as described above
- Get folks out of their organizational cocoons, which can benefit day-to-day work as well

Guiding principles:
- Annual sprints - quick, conceptual exercises that stay very close to the surface. Within that context, maintain thoroughness and quality.
- The discussion itself and any resulting pollination is just as important as any conclusions reached.
SPACE 2100 TEAM CONCLUSIONS AND RECOMMENDATIONS ARE NOT PART OF NASA OR MSFC STRATEGIC PLANNING, AND DO NOT REPRESENT OFFICIAL PLANS OR POLICY.

(THAT SAID, WE THINK THERE’S STILL VERY GOOD STUFF IN HERE!)
WINTER 2013 SPRINT

Describe the future of space exploration and Marshall’s role in that future through the year 2100.

Define what will the world may look like in 2100? What technologies will be online? How will we be working? What grand challenges will the world be facing?

What might the world be doing in space in 2100? What is NASA's role? What pieces seem "naturally" Marshall?
Working Assumptions
From Now Through 2100

NASA and MSFC continue to exist

U.S. and world economic & political structures evolve rationally

No Technological Singularity

Oh, how could I forget?...

I cannot make ‘em glow blue yet, Captain. Give me another 100 years, give or take!

and

or similar man-made crisis

and

Houston... You have a problem!
How will the world and space work in 2100?
What might NASA’s role be, and what pieces would fit MSFC?

(Process Flow)

X Team (Up to 15 years NASA Civil Service)

Y Team (> 15 years NASA Civil Service)

Independent Efforts

Compare
Converge
Refine

Present to MSFC Director

The sprint was primed by sharing a lot of articles via Explornet, MSFC’s internal social network

X-Y Characterization:

• Very similar conclusions about what 2100 looks like
• X modeled technology progress by considering historical and social influences
• Y projected based on history of technology
• The two approaches were not coordinated... they just happened!
Team X’s Lenses for Projecting to 2100

U.S. Constitution

Provide for the common defense
Promote the general welfare
Secure the blessings of liberty

Mapped these to NACA & NASA roles

Frontier Theory
Frederick Jackson Turner, 1893

A shifting frontier line between wilderness and settlement led to an innovative, aggressive, and independent mindset

American Generational Theory
Strauss & Howe, 1991

American history as a series of four ~20-year social or mood eras or “Turnings:”

| Crisis      | 1773 | American Revolution | … | 2002 | War on Terror, Financial |
| High        | 1792 | Era of Good Feelings | … | 2027 | Supra-national           |
| Awakening   | 1822 | Transcendental       | … | 2052 | Globalization            |
| Unraveling  | 1845 | Civil War            | … | 2077 | New Colonial            |
Team Y’s Look Back - About 100 Years of Tech

- Air travel, space exploration
- Gigaflop computing
- Nuclear energy
- Global communications
- Manufactured body parts, vaccines, antibiotics, molecular biology
- Evolving understanding of the universe
Team Y’s Look Forward – Gamechangers Beyond 2100

(Breakthroughs are unpredictable, so we assumed conservative progress in these areas. While there could be huge advances by 2100, we didn’t bank on it. If there are, hang on and enjoy the ride!)

Now

What

When?

Orders of magnitude propulsion & speed increase

Control of aging

Superabundant, clean, inexpensive energy

Human/Machine merging

And when X and Y combined forces...
Earth Technology Themes in 2100

Information
Instant, Immersive

Energy
Abundant, Clean, Economical

Manufacturing
Distributed, Additive

AI/Robotics
AI Exceeds “Human Intelligence”

Health
Disease Management
Earth Social Themes in 2100

Education
Highly Tailored to the Individual

Environment
Food, Water, Population, Climate

Political
Global Responsibility & Cooperation

Employment
Robotic Workforce, Engineering by AI

Security/Privacy
Individual Empowerment & Monitoring
Space Social Themes in 2100

Economics
Space Resources are Significant to Global Economy

International
Big Science, Regulatory & Terrestrial Threats

Exploration
Government, Industry, Academia & Personal

Colonization
Back up to Earth Civilization

Utilization
Significant Industry Presence & Operations in Inner System
Space Technology Themes in 2100
Derived from Earth 2100 Technologies

Transportation
Nuclear, Deep Space
5 AU manned, 500 AU unmanned

Energy
Carbon neutral, Space-Based Solar

Manufacturing
ISRU Based, Additive

AI/Robotics
Full Simulation Prior to Build
Robotic Assembly, Highly Autonomous Missions

Health
Radiation, Bone Loss Countermeasures
Advanced Habitation & Life Support
What Might NASA’s Role Include in 2100?

Space industry support analogous to what NACA did for aeronautics (e.g., low-mid TRL projects, mishap investigation, support diverse stakeholders)

Push boundaries

• Pursue breakthroughs in space-related knowledge, capabilities, and resources
• Conduct Exploration & Science where the business case doesn’t yet close

What Areas Seem “Naturally” MSFC?

High risk, high payoff science & technology
Inner solar system transportation technologies
Self-supporting habitats & technologies
Self-repairing, self-reproducing space systems
## Social Trends and Evolving Technologies

| 2000 - 2025 | 2025 - 2050 | 2050 - 2075 | 2075 - 2100 |
|-------------|-------------|-------------|-------------|
| ![Social Trends and Evolving Technologies](image) |

### Opportunities enabled by evolving technologies and social trends

| 2000 - 2025 | 2025 - 2050 | 2050 - 2075 | 2075 - 2100 |
|-------------|-------------|-------------|-------------|
| ![Opportunities enabled by evolving technologies and social trends](image) |
WINTER 2014 SPRINT

SCENARIO
It’s 2050.

Space tourism is thriving.
Multinational companies are mining.
Commercial lunar outposts are under construction.

We are NASA.

Space is open for business.
WINTER 2014 SPRINT

CHALLENGE
Outline NASA’s role in the space economy of 2050.
How do we enable commercial activity in space?
What practices are needed?
How do they differ from those today?

Consider commercial agreements, international partnerships, intellectual property, safety, security and regulations.

We are committed to economic success.

Space is open for business.
2050 Cis-Lunar Econosphere (CLE)
(Process Flow)

Phase I
- 2050 CLE Snapshot
  (More detail than 2014 Sprint)
- Members mostly from 2014 Sprint

Phase II
- How to Get There?
- Barriers and Enablers?
- What to Start Doing Now?

- Compare
- Converge
- Refine
- Present to MSFC Director

- L2
- Gateway
- Orbit
- Earth
- Geosynchronous
- Orbit
- Depot
- ISS
- Geo

- Manned GEO Servicer
- Robotic Satellite

- 2 Independent Teams
- Mostly new members
- CS & Contractors
- Diverse Disciplines

- All participants

Winter 2014 Sprint
The Technology issues to get to 2050 are relatively easy!
(or at least straightforward)

Diverse teams created their own culture:

- Conversations flowed; standard processes were not followed
- All ideas were built-upon (“plussing”) 
- Terminology was simpler due to language differences (technical, law, business), and refreshed our memory of our own disciplines’ roots
- Fear was broken down by accepting risk of “crazy” ideas
Phase 1 Results – A Snapshot of the “What”
Phase 2 Results - How We Might Germinate the 2050 CLE
aka “The Gear Chart”
A Word or Three About Our 2015 Sprint

In response to a request from NASA’s Advanced Exploration Office (AES), Space 2100 has pondered which technologies will be critical for totally self-sufficient exploration of the solar system (~60 years from now?), particularly those at the intersections of the three major categories below. (The index numbers refer to a “Top 30” list derived during the Sprint.)

We love this job!
CAUTION

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(THAT SAID, WE HOPE THAT A) YOU FOUND GREAT STUFF IN HERE, AND B) YOU’LL HELP GROW THE CONVERSATION!)