NASA/TM-20230006426

# Aviation 2072: Scenario Planning for Wicked Problems

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October 2023

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## Acknowledgments

This work was funded by the Convergent Aeronautics Solutions Project of the National Aeronautics and Space Administration.

This work was sponsored by the
Transformative Aeronautics Concepts Program.



*Level of Review*: This material has been technically reviewed by technical management.

This report is available in electronic form at https://www.sti.nasa.gov/ and https://ntrs.nasa.gov/

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## Abstract

The world is changing rapidly. And with it, so are the potential futures for humanity. Many of these potential futures pose hidden threats, while others offer new opportunities for aviation and the broader aerospace community. To mitigate these risks and capitalize on opportunities, organizations must work to deeply understand these potential future scenarios and uncover any underlying drivers. Organizations will be more equipped and informed when making strategic investment decisions by better understanding these threats, opportunities, and drivers. The future scenarios and their threats and opportunities described in this paper were identified through a series of extensive brainstorming workshops, collectively titled Mapping for Aviation Driven by Needs Emergence and Satiating Society (MADNESS). These workshops engaged NASA civil servants and contractors with diverse backgrounds through a facilitated process of future scenario development and critique. The participants were led through exercises focused on a time horizon spanning from 2022 to 2072 and on problems that aviation might solve and/or create during this period. From the broad results, two patterns of critical uncertainty emerged: “availability” (scarcity vs. abundance) and “transparency” (openness vs. security and privacy). The successful iteration and ideation across the MADNESS workshops also suggest a repeatable mechanism for strategic risk exploration across a variety of NASA and industry stakeholders.


## Motivation

The Convergent Aeronautics Solutions (CAS) project’s charter is to transform society through aviation. The entry point of CAS’s investigatory function (known as Mapping) (Ref. 1) is the survey of emerging trends, capabilities, and human needs (hereafter referred to as input data). This input data is gathered from a variety of sources, including data analytics tools, interviews, workshops and lectures. The Mapping team uses collaborative ideation methods to synthesize the input data into scenarios (Ref. 2) and to find problem areas, such as healthcare or education, where aviation may have a broad and highly beneficial impact on society. A simplistic depiction of the process is shown in Figure 1. The Mapping for Aviation Driven by Needs Emergence and Satiating Society (MADNESS) workshops provide another avenue of input data gathering and synthesis that engages the broader NASA community, focusing on a

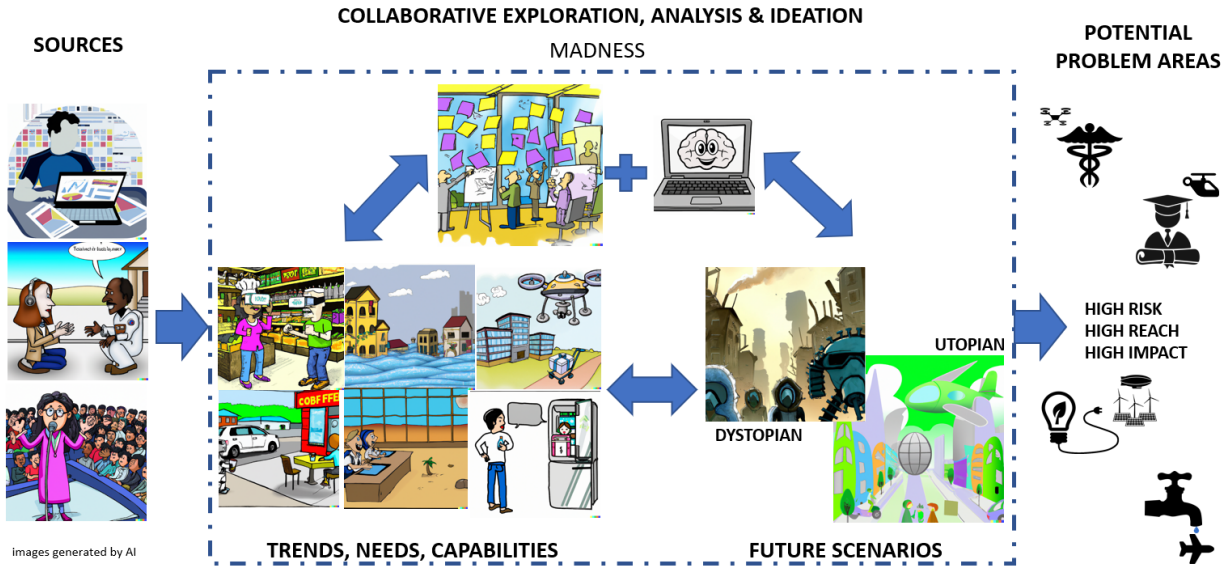


Figure 1.—MADNESS is a collaborative exploration and ideation session that engages the broader NASA community in the CAS Mapping process.

long-term horizon, and leveraging collective participant wisdom in evaluating threats and opportunities. MADNESS also serves as a mechanism to attract new NASA participants into the CAS process and to build awareness of and trust in the methods and tools used in the Mapping process.

## Methods

The entire MADNESS exercise consisted of four 2-h workshops starting May 11, 2022. Each workshop involved volunteer participants from NASA's Ames Research Center, Langley Research Center, Armstrong Flight Research Center, and Glenn Research Center. A summary of the distinct topics and approaches of each workshop session is shown in Table I (see Appendix A). The workshops were facilitated by the permanent members of CAS's Mapping Team.

After the four sessions, a smaller team of selected participants and facilitators synthesized the outputs in order to enrich several ongoing Mapping investigations and research threads in support of CAS's broader process and goals. This enrichment was predicated on many of the scenarios' threats and opportunities developed within the MADNESS workshops, suggesting that the workshops were a fruitful mechanism of innovation and ideation.

The notional concepts outlined in Table II and in Appendix B reflect a highly collaborative brainstorming effort intended to challenge assumptions and expand perspectives for participants—a diverse group of futurists, researchers, economists, and other domain experts. These concepts neither affirm nor disaffirm official positions of NASA, its affiliates, or collaborators.

## Workshop 1

In the first workshop, participants were asked to self-identify with various positions on a range of ideological issues. The questions and responses are shown in Figure 2.

This exercise served as an icebreaker and demonstrated to the participants that underlying differences in perceived futures and value systems will result in differences in choices in the present. Participants were able to identify shared frameworks or clusters of belief by visually clustering these perceived futures. Consequently, participants were also shown through their own discussions that there are no clear right or wrong answers and futures are necessarily complex.

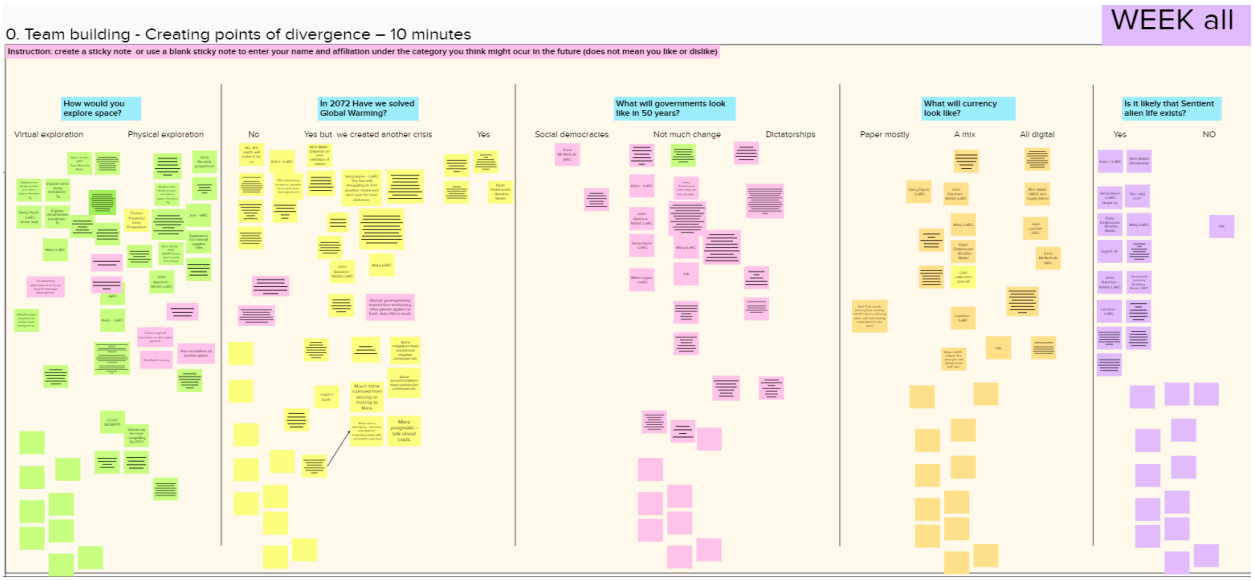


Figure 2.—Mural section showing variation in participant ideology and approach to futures.

The responses also showed a diversity in cognition amongst participants. Some participants focused on specifics (what and how) of certain future states, while others provided more philosophical responses (why). The differences in scale and the differences in value systems and perceived futures is beneficial in constructing rich future states, as each view challenges assumptions of the other. The notions of pooling and calibration are applicable to foresight, given that societies are inherently complex, and information is distributed (Refs. 3 and 4).

For example, one question posed to participants was "How would you explore space?" Two selections were provided: Virtual Exploration and Physical Exploration. Participants were asked to write their name under the category they most identified with and optionally to provide a rationale. Some participants chose to respond in both columns, showing divergent thinking. A few example responses are highlighted:

- Physical
  - Nuclear propulsion (How)
  - *Imagine* being on a planet where no one has stood (Why)
  - Demand for resources (Why)
  - Mars colonization (What)
- Virtual
  - [Better] Cost-benefit ratio; Another factor is that you can go places virtually that you cannot go in reality. At least not in 50 years. Venus is pretty inhospitable. (Why)
  - Explore the deep ocean (What)
  - Establish a network of platforms and ecosystems (How)
  - Mixed
- Virtual exploration for all; physical exploration for zones within reach. Roadmap to expand the physical exploration zone. Roadmap to develop commercial use cases for physical and virtual exploration zones.

After the ideological ranging exercise, the participants were then assigned to sub teams; each team was asked to collaborate in describing what societal structures might look like by 2072. This is shown in Figure 3.

The societal structures provided were education/learning, health and wellness, the environment, geopolitics, ethics and law, work and workforce, leisure, economy, and a general category. The participants were provided with roughly 50 headlines and links to news articles (top of Figure 3) across a range of societal, political, ethical, technological, environmental, legal, and economic issues and trends as input. They were allowed 10 min to pick a few headlines and quickly read excerpts from these news articles. Different types of inputs (trends, drivers) were consolidated to simplify the process for participants. One example headline provided to the team (Ref. 5) was:

> "Human brains could be connected to the internet in 'next few decades,' scientists predict."

After the brief reading period, the teams were assigned to four breakout rooms in Microsoft Teams. Participants were asked to cite current or past events that may support the given future state (shown in the top row of Figure 4). The bottom row (Figure 4) documents an example developed by a team. Table II (see Appendix A) summarizes the example.

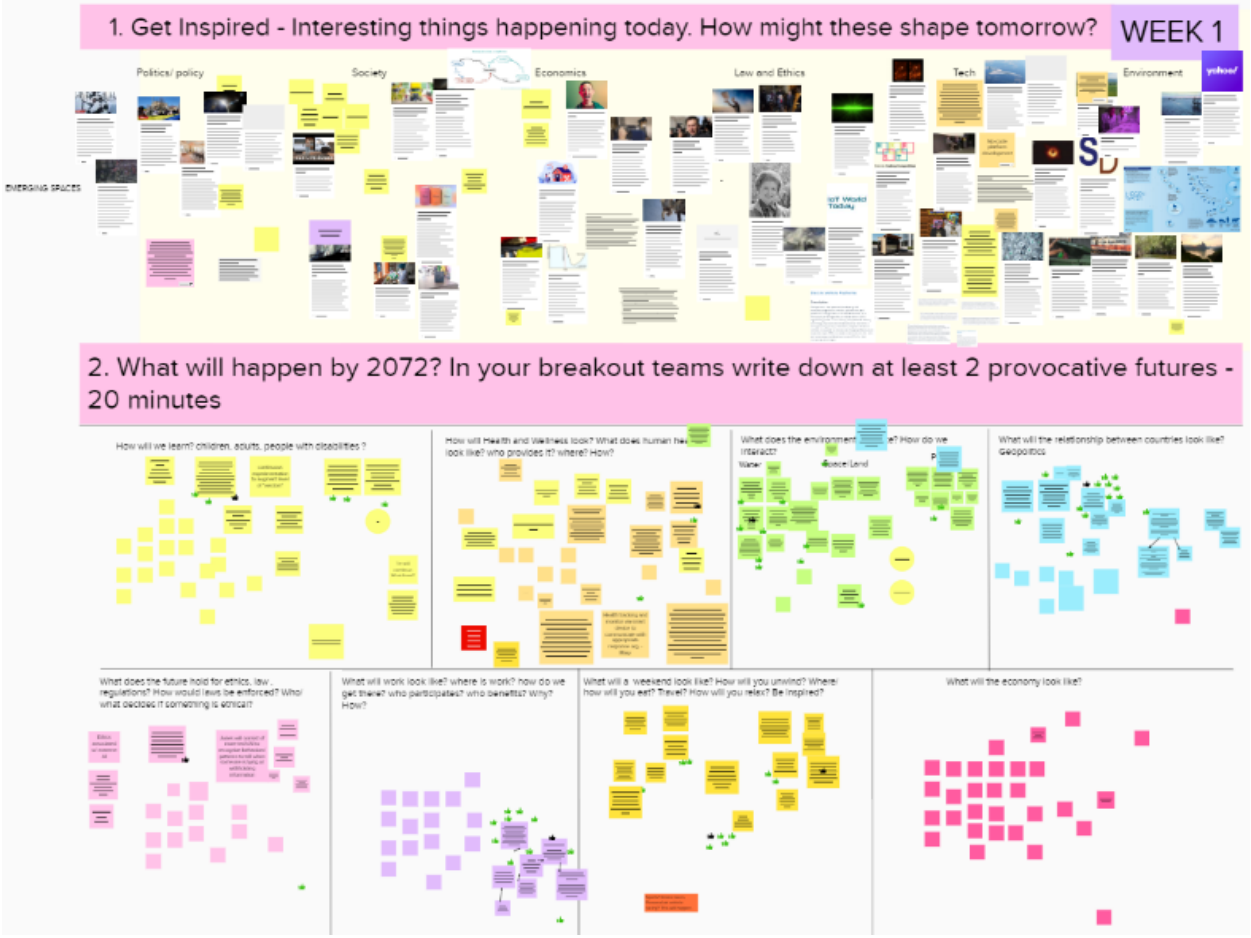


Figure 3.—Current events were used to imagine scenarios fifty years into the future.

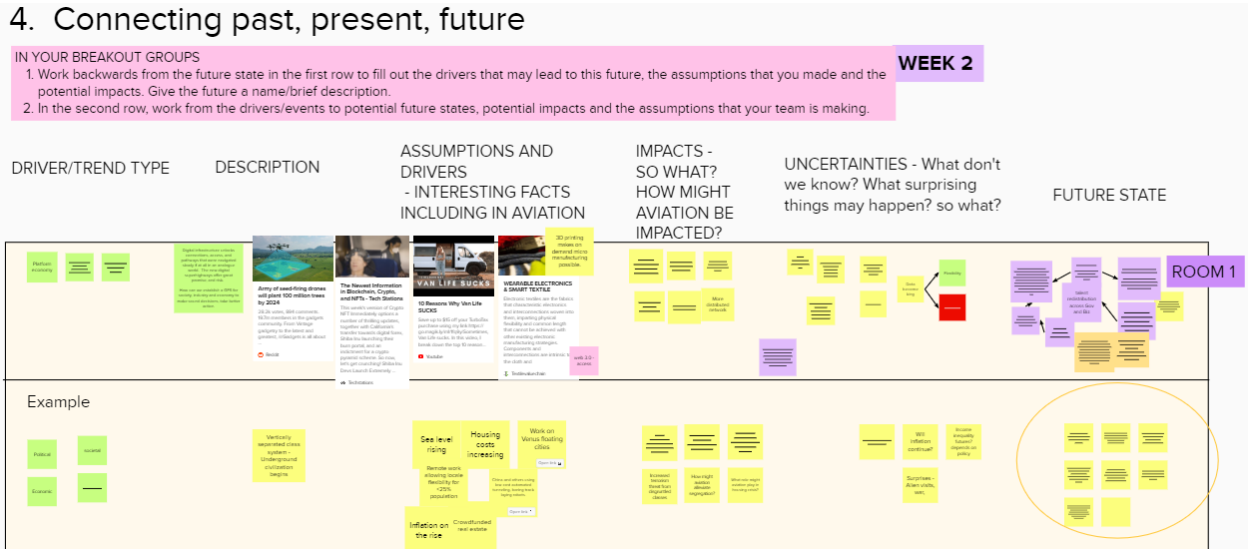


Figure 4.—Driver-impact laddering for high-impact drivers.

## Workshop 2

The open-ended nature of article sourcing in Workshop 1 created valuable inputs but allowed participants' prior interests to drive article selection. To push participants to challenge their preconceived ideas and biases, Workshop 3 attempted an alternative approach to driver-impact mapping by starting each team with a random set of drivers and potential future events. Participants were then asked to work on connecting drivers and impacts in two different approaches. First, they were asked to start from future states and ideate on ways that current and future events might support such a state. Second, they were asked to start with assumptions and drivers and postulate impacts and futures. This approach is similar to How-Why laddering in Interaction Design (Ref. 6).

## Workshop 3

To build on the success of Workshop 2, we gamified driver-impact mapping for Workshop 3. Workshop 3 was entitled "Cards Toward Insanity," modeled on the popular "Cards Against Humanity" game. Participants were split into three groups, with each group divided into two teams (totaling six teams). Each of the three groups was given a unique set of three random event cards, based on the articles from prior workshops, and asked to ideate on what the future will look like by 2072, no longer constrained by aviation.

Within each group, the two teams shared the same set of three event cards. One of the teams in each group was asked to envision dystopian futures (red team) and the other to envision utopian futures (blue team). The teams were incentivized through a Mad Hatter Award, to be awarded to the team producing the most creative future. To push participants to expand their creativity, we embedded a member of the facilitation team into each of the red and blue participant teams as "instigator" to encourage the generation of more provocative futures. Given the highly creative responses from all teams, we opted to award the Mad Hatter Award to each team for at least one of their ideas.

The outputs of Workshop 3 were captured by participants in the pink text boxes shown to the left of each wheel (Figure 5). Figure 6 shows an example of one of the team's Wheel of Futures. As displayed, each wheel encourages ideation within five sectors: Policy and legal, Environment, Society, Economy and Technology. The wheel is also designed to capture ideas as a function of time, with the center of the wheel representing the present day, increasing fifty years into the future at the edge of the wheel. For example, one Environment scenario was described as follows:

> "By 2050 a portion of the world will be so hot that aircraft will need to be redesigned to safely operate at lower altitudes."

Additional potential future events/impacts are listed in Appendix B.

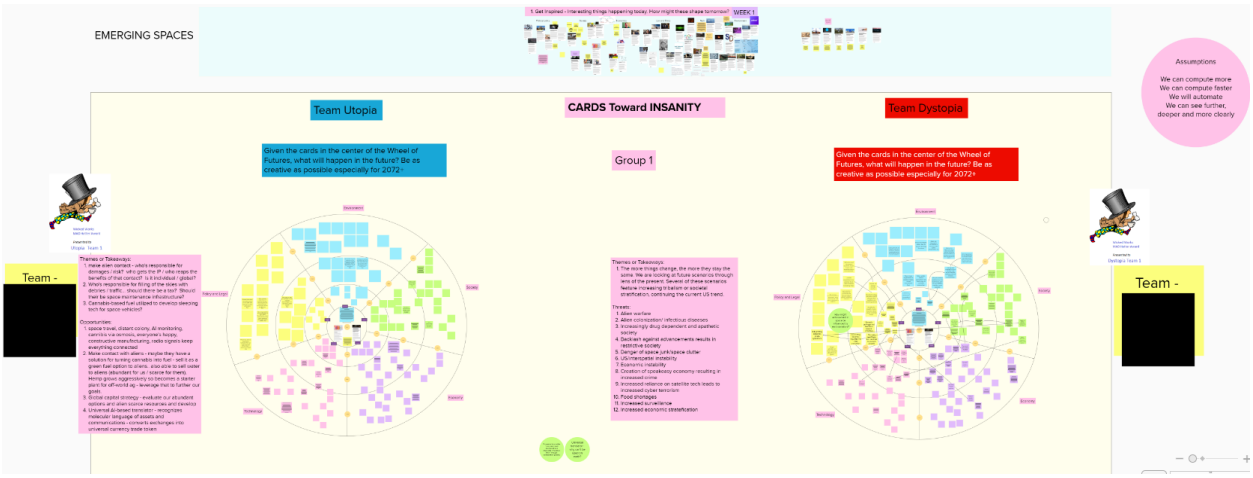


Figure 5.—Wheel of Futures—Overview.

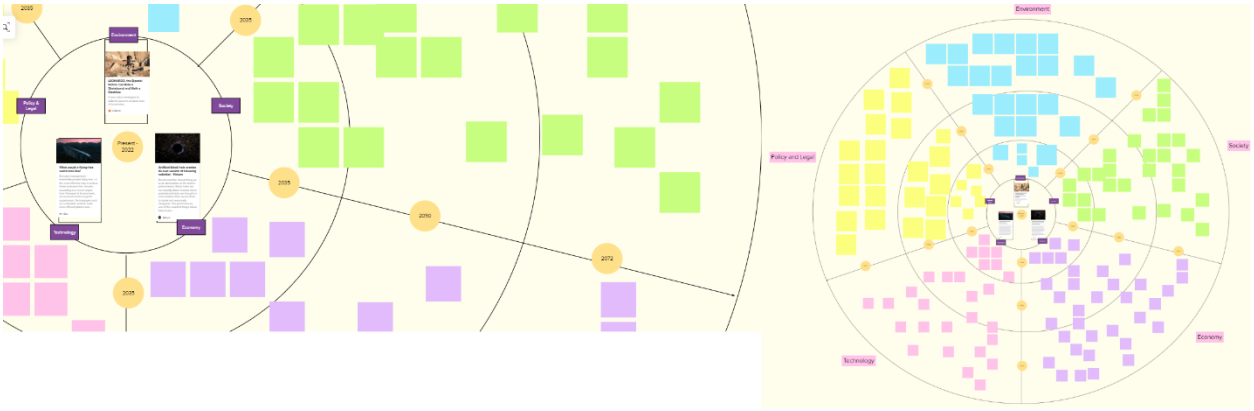

Figure 6.—Wheel of Futures. Sectors of the wheel representing society, policy and legal, technology, environment, economy, and technology (PESTLE) are seen on the right side of the figure.

## Workshop 4

After Workshop 3, we reviewed all the notional future events and drivers described by the teams. See Appendix B for future events, organized into PESTEL (politics, economics, society, technology, environment, law and ethics) categories. Across these impacts, two critical uncertainties or shared themes emerged.

- Transparency:
  - Security: Privacy and Security or Secrecy or Closed—Information, resources, access are held close to individuals or communities regardless of scarcity or abundance. The state may collect information without citizen awareness.
  - Openness: Flexibility or Access—Information is freely shared, geography is open to all, resources are equally accessible whether scarce or abundant. Transparency is key.
- Availability:
  - Scarcity: Lack of resources, lack of labor, technology without governance
  - Abundance: Abundance of resources due to changing behavior, changing technology, attention to ethics

After the critical uncertainties were identified, participants in Workshop 4 further developed the two critical uncertainties, explored as a two-dimensional mapping across openness and security (varying vertically), and scarcity and abundance (varying horizontally) (Figure 7). The Mapping team added resolution to the scenarios generated by the workshop participants. Table III in Appendix C shows the detailed scenarios constructed by the participant teams. For each scenario, participants were asked to identify threats and opportunities for aviation by 2072. Table IV in Appendix C outlines the major threats and opportunities emerging from these scenarios.

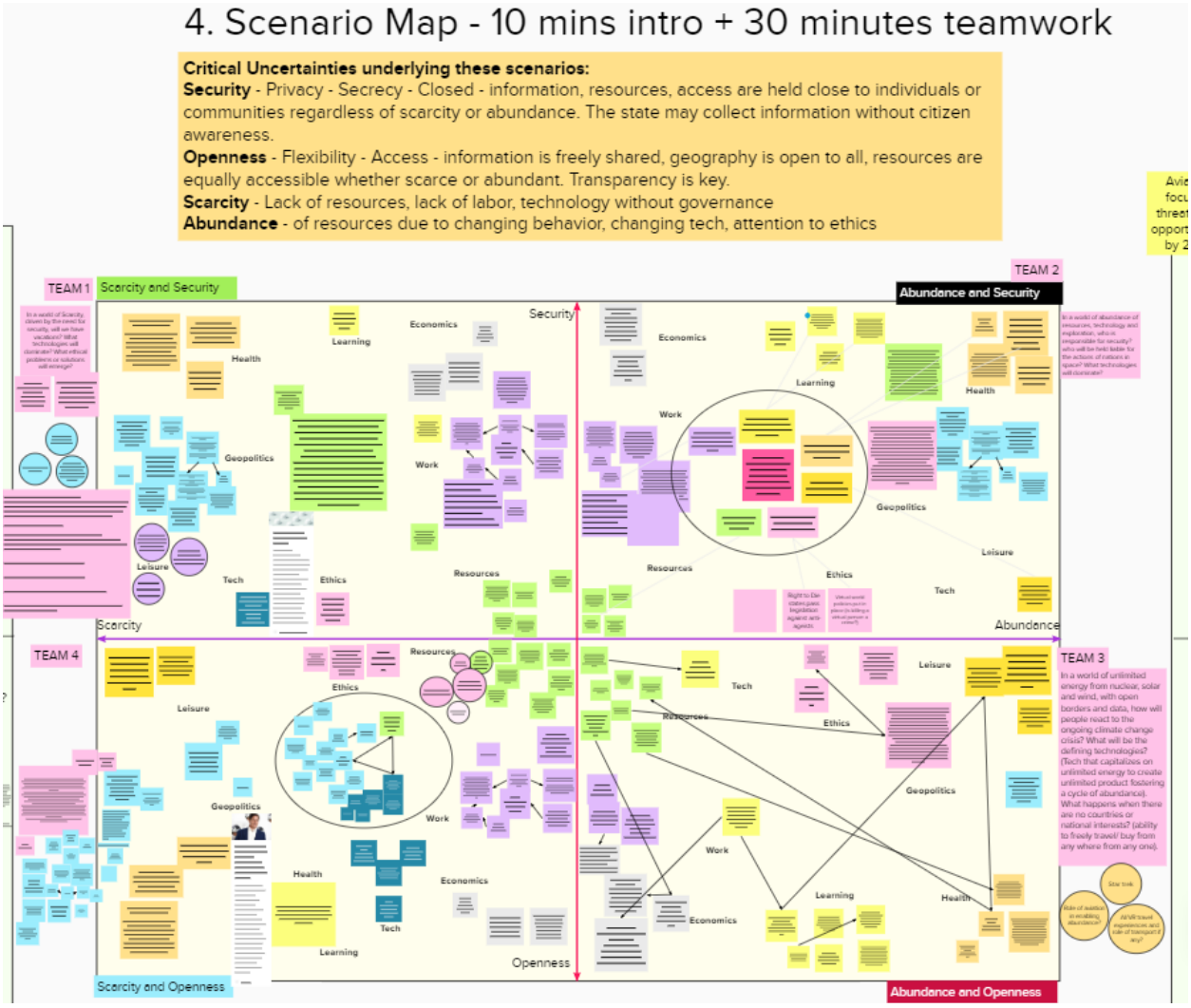


Figure 7.—Scenario map showing four futures with openness and security, and scarcity and abundance as critical uncertainties.

## Results and Key Themes

In addition to critical uncertainties, several additional themes or trends repeatedly emerged from participant scenarios and ideations. These themes provide insights into the most prominent threats and opportunities perceived by aviation and aeronautics, as represented by the participants in the MADNESS workshops.

1. Increased role of corporations and private entities in policy, geopolitics, and economics. There is a concern regarding the potential for conflicts that could arise in space, as initiated either by countries or corporations. How might NASA operate in a world where global corporations drive or significantly influence policy and society?
2. Increased role of nontraditional (bio, value-driven, digital, and decentralized) economies as part of a larger shift away from the conventional economy. How might value be defined?
3. Geoengineering is likely and many of the approaches may cause long-term harm.
4. Space and Earth economies will be linked. How might aviation integrate with the coming space migration and space economy?
5. The workforce will be decentralized, distributed, and dynamic. There is an increased use of platforms and AI. How might NASA pivot to leverage the new, more democratized workforce and economy?
6. Health and wellness will be more personalized and localized. How might aviation play a role in increased access and better outcomes?
7. Ethics around access, data, law, and the environment seem to gain importance. How might NASA play a role in ethical aviation?
8. There is a concern around waste, clutter, and debris (on Earth and in space) as a result of rapid technology proliferation and exploration. What role might aviation play in reducing these impacts and alleviating the concerns?
9. How might NASA react to militarization of all aviation?

## Conclusions and Future Work

The Convergent Aeronautics Solutions (CAS) Mapping team led a diverse group of NASA (civil servants and contractors) participants through a variety of scenario development exercises in each Mapping for Aviation Driven by Needs Emergence and Satiating Society (MADNESS) workshop. Each workshop was designed to build on the prior workshop and leverage the participants' increasing comfort with divergent thinking, including a gamified mad idea competition.

Participants constructed numerous scenarios spanning the 2022 to 2072 timeframe and focused on the future of aviation. These scenarios, themes, threats, and opportunities provide a basis for an in-depth exploration of aviation in each of the four scenarios outlined by MADNESS, including the role of aviation in avoiding potentially dystopian futures. This in-depth investigation is in progress.

Through the lens of these scenarios, we might better understand the robustness and suitability of existing aerospace strategy and investments. Further exploration might also help elucidate the overlap between, and transitional risks to, each proposed future. We understand that the selection of volunteer participants from NASA may have introduced bias in scenario development. By elevating and broadening participant engagement and diversity, we believe that future scenario development might highlight more intricate opportunities while also building a shared understanding of strategic risks across NASA leadership and stakeholders. The Mapping team is currently working on elaborating on each of the four scenarios developed through MADNESS and on exploring the nine themes identified.

# Appendix A.—Workshop Participants and Sessions Summary

## Participants List

Marco Annunziata (economist, Annunziata + Desai Advisors), Jeffrey Chin (Systems, NASA Glenn Research Center), Sang-Hyon Chu (Materials, NASA Langley Research Center), Thomas Cooke (workforce and space systems, Spacely), Dyan Finkhousen (platform ecosystems, Shoshin Works), Diana R. Fitzgerald (Communications, NASA Langley Research Center), Robert Fong (air traffic, NASA Ames Research Center), Terrence S. Garry (technology transfer, NASA Armstrong Flight Research Center), Trevor Grondin (Systems, NASA Langley Research Center), Ty Hoang (air traffic, NASA Ames Research Center), Gary Hunter (sensors, NASA Glenn Research Center), Cetin C. Kiris (computation, NASA Ames Research Center), Mary E. Koca (Configuration and Data Management, NASA Langley Research Center), Joel B. Lachter (human systems integration, NASA Ames Research Center), Michael J. Logan (aviation systems, NASA Langley Research Center), LeeAnn Maryeski (analyst, Sonalysts Inc.), Rabindra D. Mehta (experimental physics, NASA Ames Research Center), John E. Melton (aerospace systems, NASA Ames Research Center), G. Edward Powell (business intelligence, TensorX), Jon Rask (life sciences, NASA Ames Research Center), Michael M. Rogers (project manager, NASA Ames Research Center), Vikram Shyam (futurist, NASA Glenn Research Center), Kelci J. Skaggs (project coordinator, NASA Langley Research Center), Cecelia S. Town (budget analyst, NASA Ames Research Center), Jeffrey J. Trudell (structures, NASA Glenn Research Center), Jeremy Conescu (illustrator and science fiction, NASA contractor), James A. Villarrubia (policy, NASA Headquarters), David F. Voracek (technologist, NASA Armstrong Flight Research Center), David Wagner (intrapreneur, NASA Langley Research Center), Richard Walsh (blockchain, NASA Aeronautics Research Institute)

TABLE I.—SUMMARY OF MAPPING FOR AVIATION DRIVEN BY NEEDS EMERGENCE AND SATIATING SOCIETY (MADNESS) WORKSHOP SESSIONS

| Session | Input and Approach | Objectives and Learnings |
|---|---|---|
| 2022 | **Exercises**:<br>● Four 2-h facilitated sessions using Mural collaboration boards<br>● Collaborations focused on futures and foresight-related brainstorming and ideation exercises with randomized, non-persistent teams<br>**Tools**:<br>● Mural board with reference articles and prompting questions<br>● Microsoft Teams for virtual teaming and breakout rooms<br>● Microsoft Word for capture of workshop output<br>**Participants**:<br>● A diverse group of civil servants and contractors drawn from NASA's Ames, Armstrong, Glenn, and Langley research centers | **What we intended**:<br>● To identify potential threats and opportunities for aviation through long-term scenario planning<br>● Test effectiveness of workshop model for scenario building<br>● Test effectiveness of gamified approaches to ideation<br>**What we learned**:<br>● Asynchronous contributions were rare even though encouraged<br>● Participants were engaged<br>● Diversity of input and ideology helped drive cognitive processes<br>● Debate and discussion were plentiful<br>● Some exercises need modifications to drive to the valued output<br>● Professional facilitation may aid with speed and planning |
| Workshop 1: May 11 2022 | **Exercises**:<br>● Points of Divergence<br>● Provocative Futures<br>**Inputs**:<br>● Mural board with prompting questions<br>● Interesting recent events from the news or from reports | **What we intended**:<br>● To demonstrate the ideological diversity of our participant cohort<br>● To provide a baseline for ideation (minimal input from facilitators)<br>● To generate provocative futures as starting points for driver-impact mapping |

| | | |
|---|---|---|
| | **Method**:<br>● Points of Divergence: Participants share their names and background on Mural board by responding to opinions on desired future states<br>● Provocative Futures: Participants were assigned into subteams and tasked to select a question related to societal structures of the future, with the objective of producing the most provocative futures imaginable<br>**Group Size**: 31 | ● To test the effectiveness of using superficial news headlines as inspiration for ideation<br>**What we learned**:<br>● Points of Divergence: Participants were engaged and output showed not just diversity of ideology but diversity in interpretation of the questions and in cognitive processes<br>● Provocative Futures: Exercise was useful to identify themes, but output lacked depth and diversity (most of the responses did not draw from the headlines)<br>● Teams of five or more found it difficult to ideate and resulted in low output volume |
| Workshop 2: May 18, 2022 | **Exercises**:<br>● Driver-impact mapping: Connecting past, present, and future<br>**Inputs**:<br>● Curated but random interesting recent events from the news or from reports<br>● Provocative Futures from Workshop 1<br>**Method**:<br>● Participants were segmented into four teams.<br>● Approach 1: Each team was given a set of futures states. Teams were asked to ideate on drivers for those futures and impacts on aviation.<br>● Approach 2: Each team starts with a random set of drivers/events and asked to ideate on what futures.<br>**Group Size**: 22 | **What we intended**:<br>● To generate sufficient diversity in drivers and impacts to see common themes, uncover critical uncertainties that drive futures according to the participants<br>● To test which approach is more amenable to scenario generation in a limited time with a diverse group of people.<br>● To obtain feedback from participants on ease/comfort of each approach<br>**What we learned**:<br>● Participants found it easier to move from events to futures.<br>● Participants found smaller groups (three to five) to be easier to ideate in.<br>● Some underlying themes and uncertainties emerged and were useful in scenario framing.<br>● Teams tended to focus on dystopian or utopian futures exclusively. It was proposed to separate teams into red and blue teams working on the same set of initial drivers. |
| Workshop 3: May 25, 2022 | **Exercises**:<br>● Timelining and driver-impact mapping<br>**Inputs**:<br>● Multiple sets of three random but significant events in the present<br>**Method**:<br>● Session broken into three groups with each group divided into two teams<br>● Each group is given a unique set of three random event cards and asked to ideate on what the future will look like by 2072<br>● The teams within a group share the same set of three event cards, with one team tasked to envision dystopian futures (red team) and the other to envision utopian futures (blue team)<br>● Teams were told they would be rewarded with a Mad Hatter Award for most creative futures.<br>● An “instigator” was embedded in each team to push the team toward provocative futures.<br>**Group Size**: 26 | **What we intended**:<br>● Develop ingredients for scenarios<br>● Uncover critical uncertainties<br>● Test effectiveness of gamification approach for scenario development<br>**What we learned**:<br>● Some underlying themes and uncertainties emerged and were useful in scenario framing.<br>● Teams found gamified approach appealing.<br>● Teams enjoyed smaller groups (three people).<br>● Debate between red team and blue team produced robust uncertainty framing for scenarios. |

| | | |
|---|---|---|
| Workshop 4: June 8, 2022 | **Exercises**:<br>● Scenario building<br>● Threats and opportunities identification<br>**Inputs**:<br>● Input from the three previous sessions<br>**Method**:<br>● Based on critical uncertainties identified from the first three workshops, a scenario map was created with four quadrants.<br>● The participants were divided into four teams; each team was tasked to work on developing narratives for a quadrant they were assigned.<br>● Prompting questions were provided to guide the discussion.<br>● **Group Size**: 16 | **What we intended**:<br>● Create a coherent narrative of the future, including all aspects of society<br>**What we learned**:<br>● Three of the four scenario quadrants were completed (ideas captured on Mural and reported out to the larger group) during the 2-h working session. The incomplete quadrant was later completed with a small group that included two of the original members of the team assigned to that quadrant and the Mapping team.<br>● Threats and opportunities were extracted from the scenarios through four 2-h sessions involving a smaller group of volunteers and the Mapping team.<br>● More time allocated to the threats, opportunities and scenario discussions may yield a richer future state<br>● The output generated provided the needed seed scenarios for the Mapping team to create a more detailed vision of the future in 2072. |

TABLE II.—DRIVER-IMPACT MAPPING EXAMPLE

| Description | Assumptions and Drivers | Impacts | Uncertainties | Future State |
|---|---|---|---|---|
| Vertically separated class system—Underground civilization begins | ● Sea level rising<br>● Housing costs increasing<br>● Development of Venus floating cities<br>● Remote work allowing locale flexibility for < 25 percent of the population<br>● China and others using low-cost automated tunneling, boring track laying robots.<br>● Crowdfunded real estate<br>● Inflation on the rise<br>● Many countries already establishing underground labs, malls, and cities<br>● Ancient humans lived underground to protect from enemies and weather<br>● Mammalian ancestors lived underground and survived extinction events | ● Floating power generation stations to supply floating cities<br>● Drones and floating cities may beam power to surface as needed<br>● Cheap underground transport needed for rapid transport of “minions”<br>● How might aviation alleviate segregation?<br>● What role might aviation play in the housing crisis?<br>● Increased terrorism threat from disgruntled classes | ● Feasibility/viability of floating cities<br>● Will inflation continue?<br>● Income inequality futures? Depends on policy<br>● Surprises—Alien visits, war | ● Wealthy people move inland, driving up housing prices further<br>● Venus tech transferred to wealthy population above ground to provide floating cities that are solar powered and cool<br>● Poor people paid in crypto to plug into a virtual metaverse as computing nodes<br>● Underground transport moves lower-income people through tunnels using vacuum tech or air taxis/air buses.<br>● Labs and industry moved underground so any negative effects are confined to lower-income settlements<br>● Underground servers and humans facilitate above-ground (normal) lifestyle<br>● Crowdfunding platforms allow lower-income people to buy into a few floating cities, but regulations and minimum investment guidelines soon exclude them from participation |

# Appendix B.—List of PESTEL (politics, economics, society, technology, environment, law) futures contributed by participants

List of

- Politics/Geopolitics
  - Nation states will naturally select components of the Earth system (and space exploration sphere) to control, lead, and manage
  - “The Expanse” (SyFy/Amazon television series rebroadcast on Netflix)
  - Political situation framed in the asteroid belt, Mars, and Earth
  - “Idiocracy”/”Don’t Look Up” (movies) inspired
    - Anarcho-capitalism of multiplanetary countries (The Google–Walmart Wars) or (Moon Miners vs. Asteroid Belters vs. Martians)
  - Extraplanetary citizens will shift the resources in ways way beyond the current semi-stable border structures.
  - Information Balkanization—the borders are informational and not geopolitical.
  - Like Starlink, will unilateral tech involvement in war create technology Balkanization along borders?
  - Social stealth and technological obscurity
    - Major driver for off-world migration
    - Affront to “We hold these truths to be self-evident”
    - “Techno-garch” rule by special interest groups.
    - (Oligarch roll forward from industrial age to industrial age)
    - High-performing technologies that pose existential threats that are high function and undetected until providing agency for a minority group.
    - Methods include hysteria, fear, and restriction of human rights
  - Attempts to avoid surprise leads to a 100 percent pattern of life surveillance. Rising pressure on privacy leads to increased investments in detection-evasion technology.
  - Some people get good at hiding. Others get really good at getting people to tell stories.
  - By 2040, the Earth will have experienced its first conflict with remote-controlled systems (ground, sea, air, space)
  - Technology and communication advancements will lead to a new style of war, possibly affecting areas and pushing them back into a third-world status
  - War of the Worlds (conflict between Earth and other colonized planets over resources)
  - By 2040, the world will have had its first space-based conflict between states
  - Resources become more scare, which leads to governing bodies trying to control their use (water)
- Economics
  - Traditional economy decays while the bio-based economy thrives.
  - Personal information becomes increasingly commodified, with upper class being able to buy their privacy or restrict their image; i.e., “This person is behind a paywall.”
  - There may be parallel economies
  - Decentralized economics
  - Crypto to become essential to participate in society
  - No paper/physical currency driven by pandemic worries, need for stability and fighting crime

  - All digital economy, but a bigger question is whether it will still be mostly government managed or totally privatized through evolution of crypto
  - Rate of market change and dynamic talent allocation models necessitate lifelong learning models, shift burden of upskilling/reskilling to talent. Need for digital thread to connect socio/economic futures more effectively to academic lifecycles (Kindergarten to advanced education providers)
  - Government functions fail:
    - Basic talent to execute fundamental government functions is no longer viable
    - Talent redistribution across government and business
    - Work flexibility breaks the social norm of weekends of leisure time
    - Dissolution of existing global stabilizing political structures
  - Basic functions executed by new pop-up authorities that are not federated and poorly meet growing challenges.
  - Level of effort to conduct in terms of weekly hours is now detached from cultural norms.
  - Ability to aggregate perspectives
  - Hemp grows aggressively so becomes a starter plant for off-world agriculture—leverage that to further our goals.
  - The accessibility of additive manufacturing inspires a massive shift in capital expenditures (CAPEX)—additive manufacturing equipment is recharacterized as infrastructure and funded by the government, enabling industry to focus their investment on (1) innovation, (2) advanced materials, and (3) commercialization. This shift unlocks a massive surge in economic growth, vibrant innovation, and entrepreneurship.
- Society
  - Cities and enclaves without cameras/sensors
  - Leisure
    - Space tourism will keep increasing; people will have their own flying hotel pods or even large-scale flying hotels. We may need to rethink this business of closing airspace for launches.
    - People of any ability can experience travel to anywhere in person (with robotic help) or virtually.
    - Visit places you're curious about but don’t physically want to be there: middle of the Atlantic during hurricane; top of Everest; during the movement of herds of animals in faraway places
    - High-speed travel to get to anywhere in the world in a small fraction of the time needed today
    - Vacation with the “masters” as avatars, tour guides, artist guides, etc.
    - VR will transform the vacation industry = can get a “vacation hit” with a full sensorial experience
    - Painless travel that is fast opens up new places to go
    - “Visiting” with each of the members of your family tree
    - People with severe physical limitations can experience the joys of vacationing and refreshment via enhanced VR
    - Groups (families and friends) can travel in a seamless pod anywhere they can travel, and their pod has sleeping quarters
    - “Weekends” will cease to exist for many occupations. Flexible work areas will become common.

    - Tasty food that is good for me and fun for the experience
    - Helping vacations where the world helps each other are easier due to seamless and rapid travel
    - Make remote wilderness vacations safe and available to anyone of any ability
    - Micro-vacations during the day or week via VR
    - Sports? Drone races, personal air vehicle racing? This will happen.
- Learning/Education
    - Continuous experimentation to augment level of “wisdom”
    - Basic knowledge requirement. Afterward, self-learning. No need to learn any theory any more as humans (based upon their age/class/permissions) will be able to connect via a network to the collective brain that allows us to speak all languages, be a genius in mathematics/astrology/and know how to reanimate a person who got into an accident.
    - Hybrid, in person and virtual, say VR glasses, allowing disabled people equal accessibility, equality.
    - Learn by experiencing other’s experience, not just reading text. Maybe using an experience suite to get tactile/smell experience.
    - Small “many to many” communities on specialized topics. One to many learning will continue but in what form?
    - Richer methods of information dissemination than conventional paper publications. What might these be?
    - On-Demand Learning for everyone. Ability to learn what we want whenever we want.
    - Simulators will be of sufficiently high quality and so affordable that anyone can log time that counts as true flight hours.
- Health and Wellness
    - Mass starvation amid economic collapse while the wealthy are too stoned to notice.
    - Increase in car accidents due to stoned drivers
    - Air quality becomes so bad that humans will only be able to live in air-controlled environments and go out in specific (astronaut-like) suits wearing air masks/helmets.
    - Increased individual responsibility supported by the government system.
    - Service is random, depending on what/when/if help is needed.
    - Basic health care services are available to all.
    - Health tracked/monitored via cell phone.
    - Embedded machines (aka The Borg) that monitor our health 24/7.
    - Wearable to monitor health and networked to our health providers and others per our permission
    - Transportation restriction to manage global stability
    - Human rights in the medical field fall to an all-time low value. Exploitation reaches a breaking point where desperation leads to organized disruption of world order. Restricting/controlling transport becomes the leading method to manage the imbalance.
    - Growing food at work sites
    - Health is a right. We own and get to sell our data, not brokers.
    - Basic health is available and provided to everyone at low or no cost. Not linked to employment status, for example. Additional options will be at cost, if desired.
    - Scavenger hunt with groceries/farms via mobile app. Users can earn credits via app for additional healthy purchases/deals.
    - Processed foods are reduced.

    - Full health scan to help prevent health issues (at low cost)
    - Body tracking vitals—suggesting behavior.
    - Making health and wellness fun.
    - EPIC (European Prospective Investigation into Cancer) and other data collection systems in use today will rely more on artificial intelligence (AI) and machine learning (ML) to enhance human roles such as physicians and nurses by the late 2020. By 2030, these systems will be partially responsible for diagnosis; by 2040, physicians will rely heavily on automated systems for most of the diagnosis, and by 2050, nearly all diagnosis will be in the hands of automated systems.
    - Apps to do meal plans and exercise with a reward system. Integration of healthcare provider, insurance, farmers' market for reward system. Apps help with meal planning and vendors to shop at the market. Walking, exercise, and healthy food consumption contribute to healthy living.
    - Google solves human aging.
    - High-speed travel to get to anywhere in the world in a small fraction of the time today.
    - In-pocket doctor. Personal and always active.
    - People with severe physical limitations can experience the joys of vacationing and refreshment via enhanced VR.
    - Aliens visit and colonize us, bringing about a set of infectious diseases we have no immunity to. This is similar to permafrost thawing and releasing viruses that we are unable to respond to.
- Technology
  - All useful orbital positions are too cluttered to use—no more GPS or satellite comm available
    - The sky is so cluttered it forms a Faraday cage around the earth, cutting us off from all space communication.
    - Aliens responding to our now-dark beacon accidentally sterilize the surface of the Earth in an attempt to clear the sky to see what is down here
  - Real-time data from rocket launches into flight patterns and will only shut down the airspace for brief periods of time for each flight.
  - Backyard launches and balloon launches will escalate (e.g., Australian universities)
  - Social currency—2035—exchanges where people's social value is traded, tracked. YouTubers, TikTokers are not special anymore while algorithms weight contributions to society.
  - Incentives for human–machine integration and human computing for greater good.
  - Custom skins—gene editing, human–machine integration
  - Supercapacitor bricks: A new version of a building power supply. If broadly applicable and coupled with solar/piezoelectric power generation, vast aspects of the infrastructure/building /structural systems become power storage systems. In effect, one does not need an outlet, one needs a wall.
  - Nuclear rocket use by the US military: A new stage of warfare where weapons attacks on spacecraft yield a different type of nuclear fallout.
  - Space Data Integrator or SDI. It's a software system that will gather data about launches and reentries, based on radar and sensor measurements. That information will then be sent to computers, which can calculate the amount of airspace that needs to be closed to make sure airplanes are safe.
  - Climate modeling as a service

  - Universal AI-based translator(s) developed
  - What are the long-term implications on Earth's environment of placing satellites in space (emissions, debris, aesthetics)?
  - Pirate 3-D printing becomes a speakeasy economy.
  - A continual worldwide rain of space junk makes aviation impossible.
- Environment
  - By 2050, a portion of the world will be so hot that aircraft will need to be redesigned to safely operate at lower altitudes.
  - Climate change drives changes to water distribution.
  - Conservation and land access due to population growth and agricultural needs will drive food production technology research and development needs.
  - Popular natural tourist locations will become only accessible to a small part of population; virtual and augmented reality (AR/VR) will replace in-person tourism to physical locations (beaches/canyons/mountains)
  - Space tourism and the "space environment" will become a "thing" to manage.
  - Easy field trips to investigate habitat and ecology changes
  - By 2050, all cargo traveling via aircraft will use pilotless aircraft.
  - Personal travel is increasingly accessible across multiple layers (air corridors, surface travel, and increased use of underground tunnels for transport), potentially reducing need for surface roads.
  - Large amounts of population living under water (submerged and or floating islands) to keep up with high temperature
  - Zero sunlight on Earth due to large amounts of free-floating space debris
  - Global access to 100 percent renewable energy (solar/wind)
  - We exploit agri-photovoltaics to grow produce with less water requirements yet higher yield. The PV plant shelters double as energy sources for communities.
  - Geoengineering
    - Technology to control the weather—next-generation cloud seeding
    - Homogenization of flora and fauna across the globe
    - Desalination and freshwater management will become areas of urgent research
    - Better ways to grow food without large amounts of water
    - Is there a better way to control the environment?
    - Air quality becomes so bad that humans will only be able to live in air-controlled environments and go out in specific (astronaut-like) suits wearing air masks/helmets
    - Earth observation will allow predicting and mitigating natural/climate disaster, reducing number of casualties
    - Water rights and resources will cause costs/access to become like oil.
    - Increasing number of floods/storms across the globe
    - Environmental engineering: Attempts to counteract or mitigate climate change may result in new issues. Reflecting sunlight?
    - Greater awareness, walk softly very low impact, environment expands to other solar bodies, but we continue humanity's drive to terraform its surroundings
  - Companies/nonprofits/governments have programs where you earn points when doing things that help the environment.
- Law and Ethics
  - How might enforcement in space be influenced by Earth (aviation)?

- What does present hold? What are some antecedents? I see this the same in the future as it is now. Even if war or natural disaster disrupts life on earth, people will work to get back to what we have now.
- Juries will consist of more tech/AI to recognize behaviors/patterns to tell when someone is lying or withholding information
- Ethics associated with extreme AI
- Is information from the Internet of Things (IoT)/wearables admissible in court? If people are required to provide information to fly (personal air vehicles, air taxis, air hospitals or air medical services) can that information be used in court? How might it be different from the present?
- Distorted perception through amplification through social media
- By 2030, space-based UN agreements will be in the process of being negotiated
- Subjective truths inform [regulations]

# Appendix C.—Potential Scenarios for 2072

TABLE III.—SCENARIOS BASED ON UNCERTAINTIES IN ECONOMIC AND CULTURAL TRENDS

| Scarcity and Security<br>In a world of scarcity, driven by the need for security, will we have vacations? What technologies will dominate? What ethical problems or solutions will emerge? | Abundance and Security<br>In a world of abundance of resources, technology, and exploration, who is responsible for security? Who will be held liable for the actions of nations in space? What technologies will dominate? |
|---|---|
| Geopolitical: greater polarization of have and have not<br>Health: becomes paramount; life spans decrease among the have-nots—fewer resources invested to sustaining life for these individuals; medical and pharma R&D becomes more limited—expenditure for have-nots is more focused on the economization of end of life for have-nots.<br>Learning: big emphasis on survival.<br>Economics: crypto underpins, strong have/have not split<br>Work: monitoring systems, manual labor replaced by robotics, would only sustain critical workforce members who could contribute directly to sustaining the human experience.<br>Leisure: becomes the provenance of the haves<br>Tech: more focused on survival of infrastructure<br>Ethics: backseat to survival, heavy controllership from haves<br>Resources: clear/creative allocation to the haves; have-nots have to struggle for the sparse remains | Abundance leads to artificial scarcity (laws, taxes, etc.) because the haves regulate against the have-nots.<br>Access to specialized medicine in the palm of your hand.<br>Learn through others' experience (AR/VR/data upload/communal shared knowledge).<br>Ever decreasing nuclear generator sizes get down to device-scale. (drone or even jewelry-sized). The advent of this technology erodes the energy economy and introduces a massive shift in high-energy technical development. (What if energy is persistent, local to the device, and cheap?) That energy powers swarms of versatile drones that can distribute or monitor chemical composition of the atmosphere or space (like the winged balls in the movie "Twister"). People then can bid on the atmosphere or weather for their area. Impoverished areas then become the dumping ground for all the ill-weather patterns that are the externalities of controlled patterns. Bidding wars continue to impact how droughts are managed. Rich people get water; poor people get floods or droughts. |
| **Scarcity and Openness**<br>In a world ravaged by scarcity, people embrace openness to solve global issues and yield to technology to identify value and give direction. How will we learn in this scenario? Who will get resources? How? What technologies will play a significant role in this world? | **Abundance and Openness**<br>In a world of unlimited energy from nuclear, solar and wind, with open borders and data, how will people react to the ongoing climate change crisis? What will be the defining technologies? |
| Democratization of information. Government or private entity (google model) provides citizens with a chip in the brain and digital infrastructure. Databases interface with each other. The highest level must orchestrate the infrastructure. There is a rebirth, resurgence of economic value. General AI may be used for governance. What defines community? Geographically oriented in history—in the digital era different definitions. Biases of human intellect—how to exclude?<br>Limited by self-imposed constraints. Why do we self-limit? Robert Hazen—mineralogist—relationship between tech and environment.<br>Digital infrastructure—Information could be part of wellness/economy. Access to information/restriction becomes a gating feature. Pathways/choices hidden. In order to participate—need awareness and access via "device." Human rights in medicine fall to all-time low value. Exploitation reaches a breaking point where desperation leads to organized disruption of world order. Restricting/controlling transport becomes the leading method to manage the imbalance. Nano-sized surveillance devices (like smart dust) are spread over cities to monitor and prevent crime. But the same minification of devices makes crime easier. This ladders up to a near-perfect surveillance state. But perfect knowledge of everything happening everywhere cheapens the information arbitrage value in the economy, so the economy reverts to physical control of physical assets. (i.e., modern colonialism—might makes right). The use of nearly invisible devices to commit murder also spawns a new realm of the supernatural—pray that the Death Flies don't get you. | Tech that capitalizes on unlimited energy to create unlimited products fostering a cycle of abundance. What happens when there are no countries or national interests? The ability to freely travel/buy from anywhere from anyone. Less 9 to 5 schedules, more people can own businesses and sell across mass markets instead of having geographic market saturation associated with brick-and-mortar business. Waste product fuel reduces the justification for wars based on protecting natural resources, removing economic and legal barriers to global travel. The waste product fuel market becomes so competitive that fuel is essentially free. Planetary and interplanetary services focusing on enablement and commerce replace government-based agencies and services. Learn by experiencing other's experience, not just reading text. Maybe using an experience suite to get tactile/smell experience. No need to learn any theory any more as humans (based upon their age/class/permissions) will be able to connect via xG to the collective brain that allows us to speak all languages, be a genius in mathematics/astrology/and know how to reanimate a person who got into an accident. Juries will consist of more tech/AI to recognize behaviors/patterns to tell when someone is lying or withholding information. |

TABLE IV.—THREATS AND OPPORTUNITIES PRESENTED BY CULTURAL AND ECONOMIC UNCERTAINTIES

| Scenario | Threats | Opportunities |
|---|---|---|
| Scarcity and Security | Water scarcity—alternatives to water for aviation? How might aviation tackle water scarcity? space economy-aviation—water production? desalination—processes that use non-H2O for fuel, materials. Solar desalination? | Moving people and goods to and from regions of scarcity. Aviation becomes a critical resource. |
| | Rise in hacking, cyberthreats | Mobility may become a currency and, as such, get regulated, stolen, used on the digital black market. |
| | Limited aviation for wealthy | Advancement in nanobot security allows for better security monitoring/spy work to take place to avoid terrorist attacks or other threats. |
| | Limited flying corridors due to climate change. We lack resources for weather control. | Greater connectivity may mean reduced usage of aviation, lowering the impact on the environment. |
| | Aviation becomes like present-day metro/bus—shuttles to take underprivileged to work—limited safety and infrastructure | Connectivity may increase cross-border, non-geographic community building, prompting more international travel and fostering that business ecosystem. |
| | Fuel shortages reduce flights | Drone prospecting may grow. |
| | Travel for leisure decreases, leading to loss of revenue for airlines and negative impacts to economies globally. | Lack of leisure time and corresponding economic impact to aviation sees the rise of VR, as well as alternative means of transportation. Robotic taxis for long distances? Hyperloop? |
| | Greater exploitation reduces the use of aviation by lower socio-economic groups | Advancements in surveillance aviation result in quieter planes and drones/also low flying (bigger growth in aviation tech). |
| | Nudged nationalism may reduce the interest in flying | With a scarcity of supplies and resources, aviation could be key in getting essential needs into hard-to-reach areas or getting resources out of those areas. |
| | Increased scrutiny of passengers, security measures to enforce regulations puts people off flying | Replicator technology enables people to live with less. |
| | Reduction in cross border (states and countries) results in fewer regional flights and international flights—depresses travel, tourism, culture, economy | Solar enforcement drones may proliferate, seeing boom for niche aero industry |
| | Supreme Court rulings today will have decades-long impacts—already seeing states start to divide along ideological lines. | Push to space economy for prospecting and mining leads to boom in aviation as part of space economy (workers shuttled to space docks, cargo from space and to space). |
| | Flying may become militarized | May induce users to go full urban, seeking out resources and advantageous living conditions. |
| | Stricter flying laws eliminate a lot of drone delivery, rural areas cannot get goods and medicine | May induce new technologies that are beneficial in a world lacking sufficient resources. |
| | Increased poverty increases the likelihood of pandemics, further damaging the aviation industry. | May enable the rise of ocean communities (accessibility). |
| | Less tourism could result in an economic crash in certain areas dependent on tourism dollars | AI—enables alternative resource utilization for building vehicles that serve the people. People with enough social currency can buy access. |
| | Bomb drones take out undesirable parts of society for the greater good | Drones used for on-demand assistance (i.e., 911) |
| | AAM future may be used to enforce health, resource distribution with militarized crews | Renewable drones replace humans in the health and wellness industry and other areas with labor shortages and the need to reduce human error. |
| | Create solar domes for haves using limited resources while blocking out have-nots in deserts | People move from homes, offices to living in airship colonies—Venus on earth. solar energy, water from the atmosphere, airships as leisure platforms. colonies segregated by ideology. Reduces strain on surface but poor still live there and fight for conventional resources |
| | Civilians develop counter-tracking jammers that have potential to bring down aircraft and infrastructure in a certain radius. | Aviation used increasingly as a shuttle service from rural to urban areas of commerce |
| | People forced to serve as human computers for air traffic management and human cloud. | Faster, cheaper aviation reduces the felt distance between rural and urban areas, increasing intra and international empathy. |
| | Aviation used for weather modification that can start geopolitical conflicts. China creates more tornadoes and floods for the US while isolating itself in a normal earth weather zone. | Better geospatial monitoring will decrease market inefficiencies. |
| | On-board accidents may occur. | Increased aviation usage may homogenize market access, reducing national disparities in basic needs and thus reduce conflict. |
| | Air pollution and traffic congestion create the same issues faced with traffic now. | |
| | Constant watching from all eyes (maybe government, maybe creepy neighbor?) | |
| | Can be used as a weapon; if production cost is cheap enough, can be crashed. | |
| | Aviation/drones may be used as a cheaply deployed surveillance system as the price drops for such devices. | |
| | Drones as police force to “manage the herd” | |
| | Cheaper UAVs may lower the barrier to foreign low-life-risk, short-term actions. That will increase the velocity of conflict as a balance against long-term retaliation. | |

| | | |
|---|---|---|
| Abundance and Security | With great abundance comes a greater and harder task of security.<br>Personal electric solar aircraft take the place of personal ground vehicles, resulting in an energy surplus.<br>If no regulation on abundant materials, resources, potential to proliferate unchecked private aviation growth—could lead to conflicting routes, applications, and unintended consequences.<br>Abundance of tech, learning through may lead to increased hacking, cybercrime that can lead to terrorism (localized and global).<br>Aesthetics may be compromised due to crowded airspace.<br>Aviation sports and special events will proliferate—could lead to noise, deaths, security issues.<br>Bio waste would need to be transported and if it crashed what would be the protocol for handling possible large contamination areas? (Difference spilling biohazard in a hospital room vs. it is raining from the air).<br>Learning through AR/VR makes things possibly more affordable but does not cover real-time situations that could pop up.<br>Abundance breeds lethargy, a good portion of the population chooses to disengage from society, stratification between workers/nonworkers.<br>System can't pace operational demand.<br>Access to specialized medicine leads to a larger black-market trading of different medicines otherwise given in a hospital/controlled environment; now the average person has access and can sell.<br>More air pollution, resulting in lower quality of life in certain areas, which then leads to the real estate in areas crashing, people leaving and ghost towns.<br>Possible cold war with different countries having different abilities to infiltrate across borders almost undetectable and gather sensitive information or extractions.<br>Illegal smuggling of intergalactic goods.<br>Drone delivery eliminates delivery platforms with a person-to-person system and people lose jobs (no more DoorDash drivers, just drones).<br>On-board accidents may occur.<br>With abundance of aviation choices driving the cost down, things like drones can be used as weapons and carry out attacks (crashing into things/carrying weaponized aerosol/dropping bombs).<br>Increased travel access for the wealthy will decouple all major tax systems from the people making money.<br>Enforcement of travel and import laws will diminish as the separation between haves and have-nots widens. | Safer and more frequent travel means more people traveling and it is becoming more affordable.<br>Aggregation of wealth will yield more investment in fancier, smaller aircraft<br>Faster and more technological advancements in aviation; like an iPhone, there's a new aviation update every 1 to 1.5 years.<br>Aviation as part of the space economy will increase economic benefits to participating nations. However, this increases inequities. countries with older assets in the airspace lead to accidents.<br>If built, aviation may begin to extend to upper atmospheric destinations (space ports).<br>Aviation sports and special events will proliferate; increased revenue, sponsored aviation—robot wars in the air.<br>The NAS has become the GAS (Global Airspace System) pun intended! As such, the system is beyond borders, facilitating the advancement of civilization via the mixing of cultures.<br>Increased educational attainment will increase workforce for aviation.<br>Allows for greater human-scale initiatives like exploration, leisure, knowledge<br>SpaceX style model—drive down cost—similar with UAM.<br>ushers in on-demand aviation, driving cost down and access up. Flying becomes commonplace.<br>Uber apps for wealthy<br>transportation of goods and resources to otherwise isolated areas allow for growth and economic growth in new areas.<br>Intentional themed aviation to bring cultural awareness to people.<br>Aviation sports play a similar role to ground sports in bringing people together.<br>Aviation could be used to monitor and detect potential tensions that arise from closed societies.<br>Ideology airlines to promote empathy<br>Provides way for people to escape or move to countries/states that are in line with their values<br>Larger ecommerce market<br>Goods and resources delivered to students across the world<br>Highways in the sky replace those on the ground; those are being reverted back to natural settings...less pavement less heat.<br>Increase access to aviation to all—how might we do this? Standardization, open access, enable easier certification, entry into the market...<br>AR/VR tech integrated with aviation allows passengers to have their own experiences on same flight<br>Tech to increase security in airspace operations shared openly with other countries—reduce mistrust |
| Scarcity and Openness | Minimum size for readability<br>Only essential personnel are authorized to travel via plane.<br>Aviation is nationalized, growth stalls.<br>Increased data transparency allows for society to vote people off.<br>Reduced aviation—lower demand, lower fuel availability<br>Scarcity of resources, opportunities and experiences establishes greater motivation for bad actors to self-optimize by exploiting soft spots in open systems—data, digital operations, physical locations when governed for open access.<br>The security state is dominant (e.g., social credit score, individual "state" status) | Wealthy will still travel<br>Drives research into alternative resources<br>Aviation industry might experience more competition, furthering growth<br>What is prosperity<br>Aviation and mental health<br>Binging entertainment to people.<br>How to get to post-scarcity?<br>How might aviation reduce homelessness<br>Help develop wellness infrastructure<br>Aviation for information access<br>Digital layers and aviation<br>Aspirations, inspiration<br>Good dictator?<br>Operation + aspiration => innovation => self-actualization |

| | | |
|---|---|---|
| | Technological advancement slows, old tech resurfaces e.g., burning of coal for heat<br>What is prosperity<br>Drones as riot control—nameless, faceless actors diminish accountability<br>International wealth disparities heighten VISA restrictions—enforced through aviation (See Russia).<br>On-board "accidents" may be more frequent as everyone has access to information.<br>"Flights to nowhere" to control population—enjoyable last ride<br>Travel becomes highly monitored, reducing political freedom of activists.<br>Transportation restriction to manage global stability<br>Human rights in medicine fall to all-time-low value. Exploitation reaches a breaking point where desperation leads to organized disruption of world order. Restricting/controlling transport becomes the leading method to manage the imbalance. | Relocation of scarcity-stricken populations using automated air conveyor belt<br>Alternative fuel research provides energy for terrestrial applications<br>Space economy support leads to benefits on earth<br>Because of scarcity, a lot of good could be done by a singular entity with resources (shipping of meds, etc.)<br>Drone farming converts poor land into modest food sources.<br>Role of aviation? Workforce development? Ecosystem building?<br>Incentive structures for small businesses and startups that lead to prosperity for disadvantaged<br>Aviation becomes a currency symbolic of freedom. People connected to the cloud and allowed their bodies to be used for computing power and storage given air miles.<br>Incentive structures put in place to ensure access to resources and locations.<br>Aviation creates cloud electrical corridors.<br>Global welfare support |
| Abundance and Openness | Security becomes paramount. Abundance can desensitize actors to the value of life, autonomy, independence. Combined with openness—could introduce a heightened landscape of soft targets.<br>increase in air traffic could cause congestion and pollution.<br>Bad actors have access to everyone's data and tech. Could result in terrorism, kidnapping<br>Minimum size for readability<br>With everything in abundance, it could cause other issues over resources<br>Is everyone able to fly to 'desirable' locations—congestion—how to balance freedom of travel with safety, congestion, noise?<br>Currently road infrastructure limits what areas people have access to. If people can get to anywhere/fly over anything there will be privacy issues.<br>More affordable drone options make it easier to fall into the wrong hands<br>Black market industry emerges in aviation for the consumer<br>Too much air traffic causes airline issues or possible crashes<br>More aviation may increase air traffic pollution.<br>Easy access to aircraft means import laws fall to the lowest denominator.<br>Currently road infrastructure limits what areas people have access to. You might find people flying to the bottom of the Grand Canyon or other sensitive sites if they had access.<br>Might want to look at how these issues have been handled in other areas where there has been high demand for helicopter tourism like the Grand Canyon,<br>Transportation of illicit cargo becomes easier. | Not really a threat or opportunity, but a world with abundant clean energy makes ubiquitous air transport possible. In particular, flying cars.<br>Education and openness reduce ethnic or nationalist conflict.<br>Faster advancement in aviation technology<br>Food and resource delivery to isolated areas<br>Possible reduction in carbon footprint (eliminating cars)<br>Cheaper deliveries (i.e., high fees associated with shipping food from far locations)<br>New business/market ideas emerge (DoorDash/Uber for drones or tele travel)<br>Opportunity for the Post Office to get into the drone business.<br>Miniaturization + aircraft shipping reduces road traffic and opens up significantly more urban and small business manufacturing.<br>Currently road infrastructure limits what people have access to for recreation. This would be less so with ubiquitous aviation.<br>Possible to clean the air as it flies, reducing pollution impact<br>Redesign flights according to an individual's preferences—from planning to destination—do you want to interact with another human? Do you want to sleep or stay awake? How long should your flight be?<br>Deliveries to previously undeliverable areas<br>Ubiquitous aviation would reduce the need for road infrastructure.<br>Freer movement will empower workers to get better wages.<br>Consumer market and economic growth due to lower cost of delivery<br>Weather control for water redistribution<br>Aviation as a health service—medical check while you fly. Genetic update while you fly.<br>Currently roads constrain where people live. This is less so with ubiquitous aviation and offsite construction.<br>Eliminating or down cycling roads into bike paths would open up space for other uses, beautify wherever you are eliminating the roads and freeing animal migration paths |

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