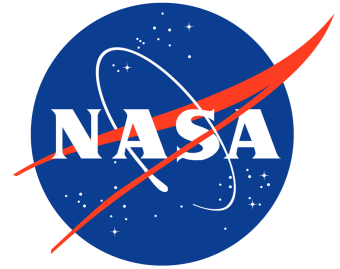


Operationalizing “Wickedness” as Analytical and Creative Tools to Transform Aviation



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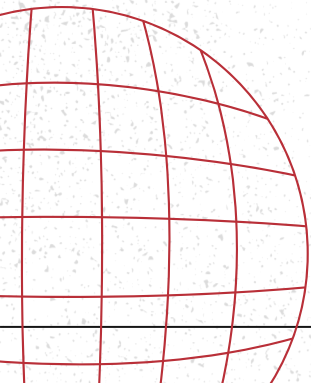


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01

Motivation & Background

“Wicked” problems and increasing complexity
in aviation



Growing Complexity and Aviation



COVID-19 Pandemic

The role of aviation in spreading pathogens worldwide



Climate Change

Innovation in aviation materials to mitigate environmental impacts



Healthcare Accessibility

Centralization of advanced care increasing demand for aviation transport



Sustainability

Development of sustainable aviation fuels to reduce industry emissions



Emergency Response

Leveraging aviation for high risk, high uncertainty, and high urgency situations



Digitization & AI

Increasing use of advanced tools in designing aviation solutions



Convergent Aeronautics Solutions (CAS) Project

The CAS project at NASA aims to transform aviation and the aviation workforce by:

- Identifying and advancing aviation concepts for transformative impact
- Investing in seemingly improbable ideas
- Facilitating cross-boundary collaboration and iterative experimentation to increase innovation capacity

CAS has used the concept of **wicked problems (WP)** as a strategy for achieving these goals.





NASA's Advanced Capabilities for Emergency Response Operations (ACERO) aims to manage complex responses to natural disasters.

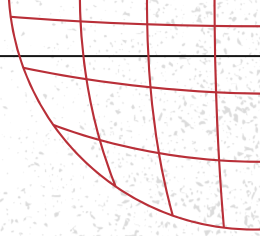


02

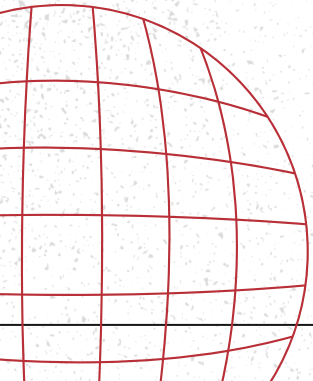
Framework for Analysis

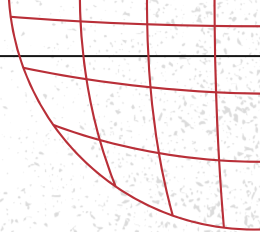
Our approach to operationalizing "wickedness"





Wicked Problems





Wicked Problems

A lack of definitive formulation.

No stopping rule that determines when a solution has been found.

Good or bad solutions rather than true or false solutions.

Lack of immediate and ultimate tests of solutions.

Solutions are “one-shot” operations rather than trial and error.

Lack of criteria that indicate all solutions have been identified.

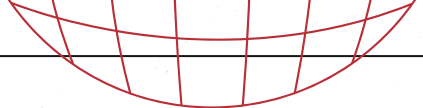
The uniqueness of every wicked problem.

Any wicked problem could be viewed as a symptom of another problem.

Any discrepancies in wicked problem can be explained in multiple ways.

Planners have no right to be wrong in that they are responsible for outcomes that result from the actions they take.





Framework for Analysis [1]



Analytical Tool for Evaluation

Use WP to evaluate the type of complexity and multi-dimensionality of a problem



Creative Tool for Generation

Use WP as a “point of reflection” to inform an approach or generate new solution paths



1. Adapted from Lönngren, J., & Van Poeck, K. (2020). Wicked problems: a mapping review of the literature. International Journal of Sustainable Development and World Ecology, 28(6), 481–502. doi.org/10.1080/13504509.2020.1859415



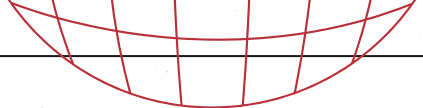


03

Analytical & Creative Tools in Practice

Methods and outcomes from using wicked problems to transform aviation

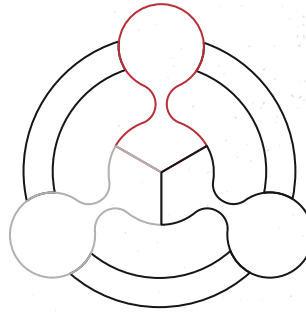




CAS Dimensions of WP

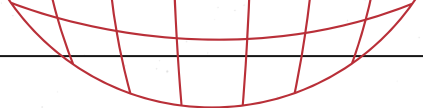
Substantial effort needed to
understand the problem

Uniqueness and scale of
impact for NASA, the USA,
and humanity



Irreducible dependencies
amongst social, economic,
technical, other factors





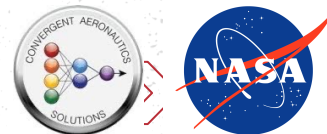
Project-Specific Analytical Tools

Pugh Chart Criteria

The Zero-Impact Aviation – Human Health project used characteristics of WP for project selection to align with the long-term goals of the project.

Scoping Action Items

The Capabilities, Communities, and Connectivity (3C) project used characteristics of WP as criteria to identify specific goals in exploring rural revitalization.



Zero-Impact Aviation - Human Health

PROJECT TOPICS	PATHOGENS Aviation as a vector of pathogens (datum)	AMR Aviation as a contributor of pathogen growth / antimicrobial resistance	ADV. CARE ACCESS Access to healthcare as distance to advanced care increases	AAM STIMULI Negative mental & physical health impacts of future AAM noise	DRUG EFFICACY Drug efficacy due to lack of clinical trial representation for which aviation could be a catalyst for change
<i>Criteria</i>					
<i>Reach</i>	0	0/-	-	-	0
<i>Impact</i>	0	++	+	0	+
<i>Multi-stakeholder/domain conflict & convergence</i>	0	+	0	0	0
<i>Gap in whitespace</i>	0	++	0/+	-	-
<i>Fit with NASA's resources & role as a federal agency</i>	0	0	-	+	-
<i>Fit with NASA SME expertise</i>	0	-	0	+	-
<i>Sum</i>	0	3.5	-0.5	0	-2

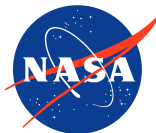
Pugh Chart Criteria

The Zero-Impact Aviation – Human Health project used characteristics of WP for project selection to align with the long-term goals of the project.



Capabilities, Communities, and Connectivity

Characteristic	Action Items
There is no definitive formulation of a WP.	Define 'edges' or boundaries Have specific research questions Let the problem statement evolve
WP have no stopping rule.	Predict and share good future paths Scope project timeline and push ahead with solution area Identify first- and second-order interdependencies
Solutions are not right or wrong.	Weighted argumentation, pros, cons, counters to increase confidence in micro-decisions
There is no immediate and no ultimate test of a solution to a wicked problem.	First-degree stakeholder network feedback as litmus test Continuous iteration & progress-based criteria to assess impact Light / agile prototypes that we can easily pivot



Capabilities, Communities, and Connectivity

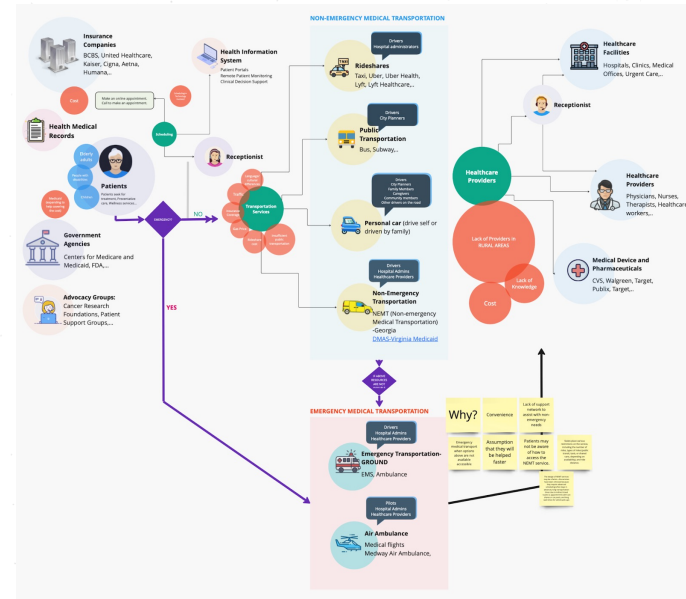
Characteristic	Action Items
There are no throwaway rounds,	Embrace inherent error as learning Practice knowing our own bias and listening for it Continue to learn about possible consequences
Every wicked problem can be considered to be a symptom of another problem.	Know there are many problems; scope to a pain point Iteratively make decisions about our slice and update Clearly track steps to communicate system changes
Stakeholders will have different explanations	Illuminate latent needs through data collection Identify causes, evaluate, integrate, map Proactively identify and document other perspectives
No right to be wrong.	Ongoing stakeholder engagements Identify ecosystem and prioritize the desirability, viability, and feasibility interdependencies Use tools and outside expertise to understand first-order ecosystem impacts



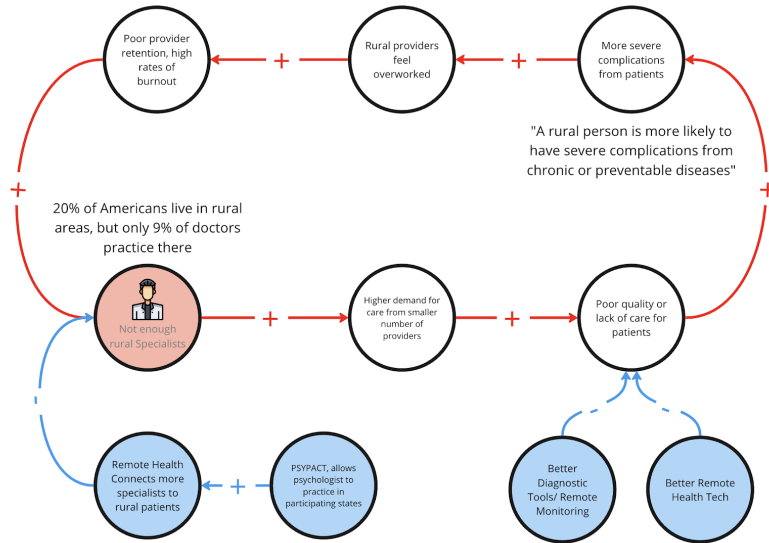
Creative Tools for Mapping WP

Stakeholder Mapping

During a design sprint for Zero-Impact Aviation - Human Health, participants mapped the relationships between stakeholders involved in non-emergency medical transportation



Creative Tools for Mapping WP



Causal Loop Diagrams

Also during Zero-Impact Aviation – Human Health, participants mapped the system of medical diagnostics in terms of relationships between problems to Identify opportunities for impact



04

Recommendations

Conclusions from our experiences and future
work with wicked problems



Lessons Learned – Analytical Tool

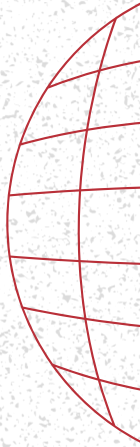
Lönngren & Van Poeck suggest that successful usage of WP as an analytical tool requires precise definition and instruction for operationalizing.

Key Learnings

- **Organizational Level:** It was difficult to agree on the definition and dimensions of WP at the organizational level, which created challenges for CAS in operationalizing WP for evaluation.
- **Project-Specific Activities:** In specific project activities, participants aligned on the definition and how the concept would be used in that particular exercise, which streamlined operations.
- **Setting Expectations:** Even though the team can create a clear definition of WP for analysis, using WP as an analytical tool does not result in a fully-defined problem or clear direction.



Lessons Learned – Creative Tool



» For Exploration

Ill-definition of WP enables researchers to remain open to surprises while guiding the exploration process [1], illustrated through CAS stakeholder mapping and causal loop diagramming

» For Reflection

Exploring WP enables reflection [1] on the conventional technical design process and experimentation with new methods of exploring the problem and engaging with stakeholders

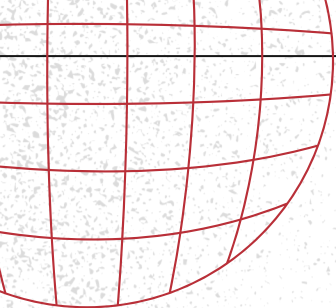
» For Developing a Generative Mindset

Collaboratively exploring and formulating WP requires creativity and iteration [2], which enables development of a flexible, generative mindset in aviation professionals



1. Lönngren, J., & Van Poeck, K. (2020). Wicked problems: a mapping review of the literature. International Journal of Sustainable Development and World Ecology, 28(6), 481–502. doi.org/10.1080/13504509.2020.1859415
2. Dorst, Kees. Frame Innovation : Create New Thinking by Design. Cambridge, Massachusetts: The MIT Press, 2015. Print.





Thanks!



CAS Project Page
tinyurl.com/CAS-AIAA-2024

Do you have any questions?

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