

# IFAR Young Researcher Presentation on Game Changing Technologies

Marlyn Andino-NASA (USA), Daniel Boehnke-DLR (Germany), Pervez Canteenwalla-NRC (Canada), Matthew Daigle-NASA (USA)  
Paul Dees-NASA (USA), Amin Fereidooni-NRC (Canada), Marcus Johnson-NASA (USA), Ryota Kikuchi-JAXA (Japan), Tim Lewis-NASA (USA), Ana-Maria Neculaescu-INCAS (Romania), Jeffrey Ouellette-NASA (USA), Donghun Park-KARI (Korea), Tiago Rebelo-CEIIA (Portugal), Shivanjli Sharma-NASA (USA), Roger Tokars-NASA (USA), Kai Wicke-DLR (Germany), Valerie Wiesner-NASA (USA), Tatsunori Yuhara-JAXA (Japan)

# Our Task

*“What one technology or process within the scope of IFAR’s focus areas are anticipated to be the “game-changers” in aviation?”*

*Why?*

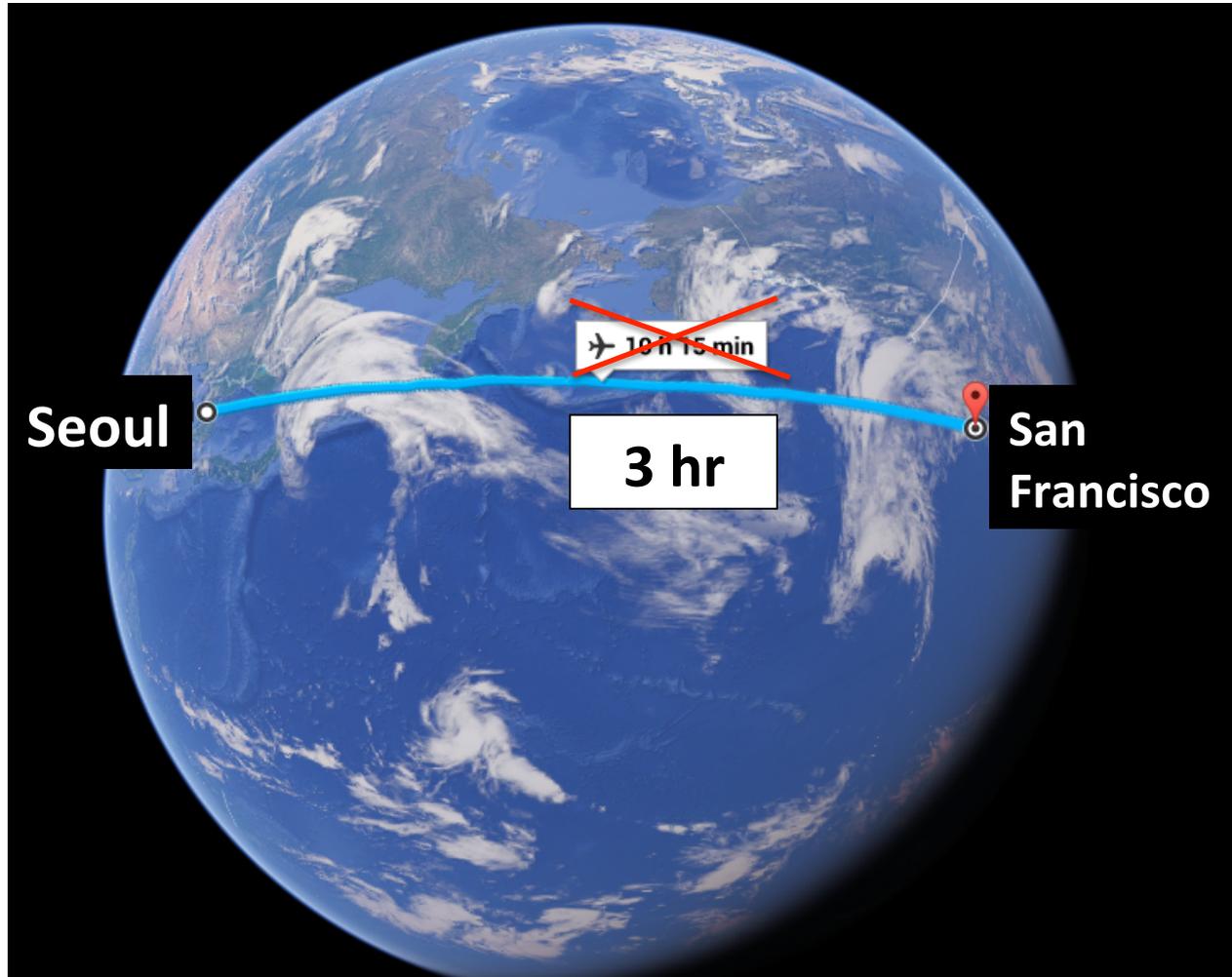
*Based upon your answer, how do we best address the future needs of aviation?”*

# Status Quo

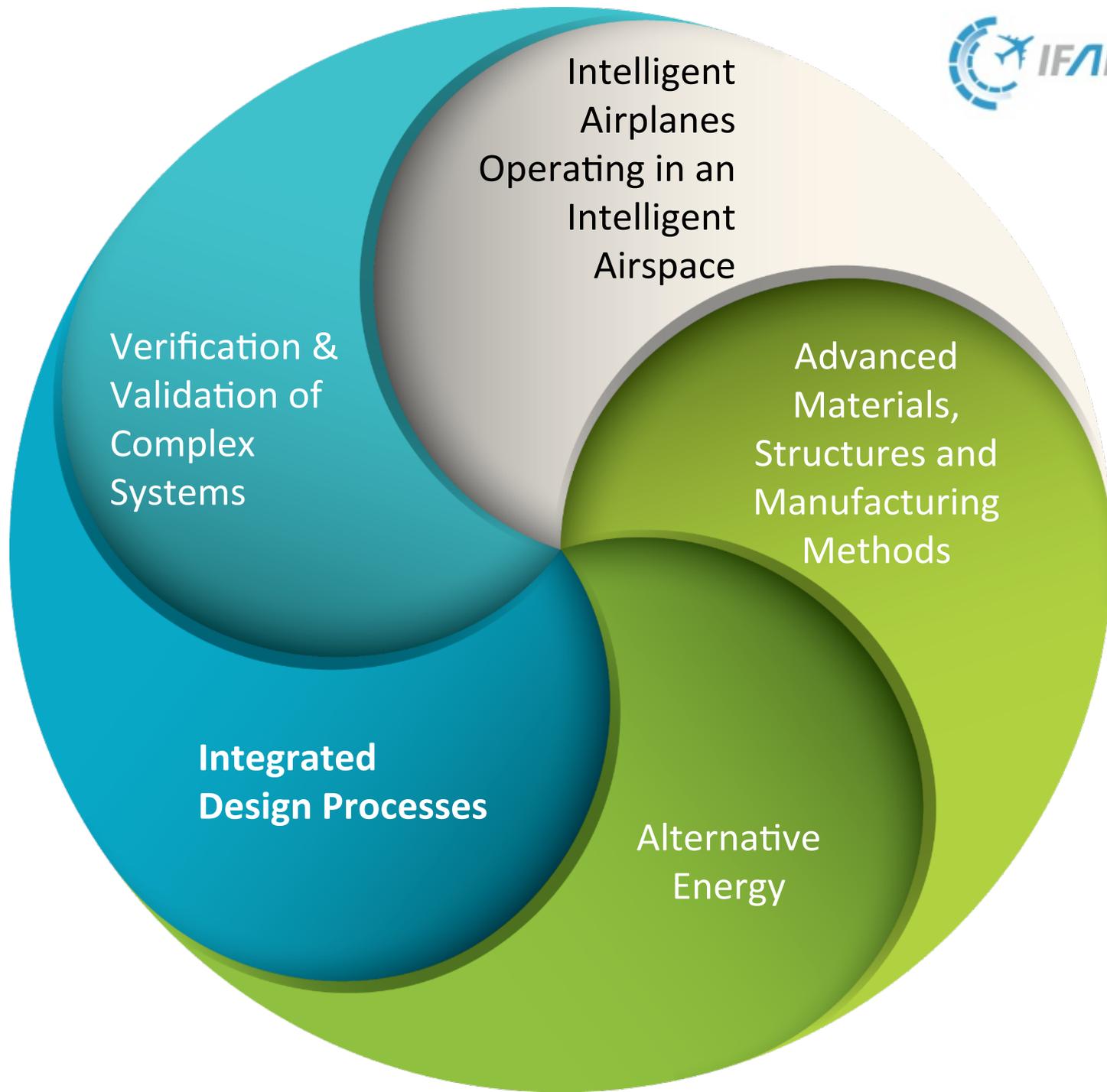


# Future of Aviation

# Why



Time	Eco-impact	Cost	Comfort
↓	↓	↓	😊



# Intelligent Airplanes Operating in an Intelligent Airspace

# Automation in our future ATM

- Sensing & Perception
  - Weather
  - Traffic
  - System health
  - Surface Operations
- Cognition
  - Self-diagnosis
  - Reasoning
- Decision Making
  - Prediction
  - Optimization



Self-diagnosing system with dynamic airspace configuration that can perform a mission in a robust and resilient manner

# Systems in our Future Integrated ATS

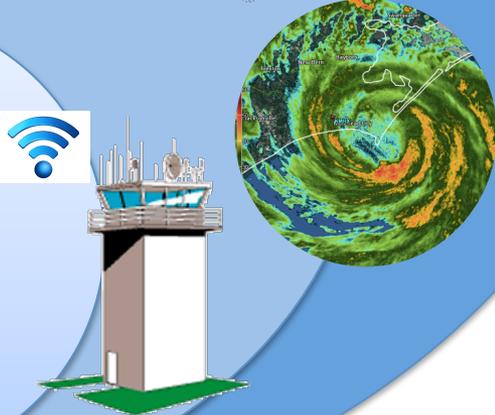
## Cyber Physical Airspace System



### Aircraft and Aircraft Subsystems



### Automated Ground System

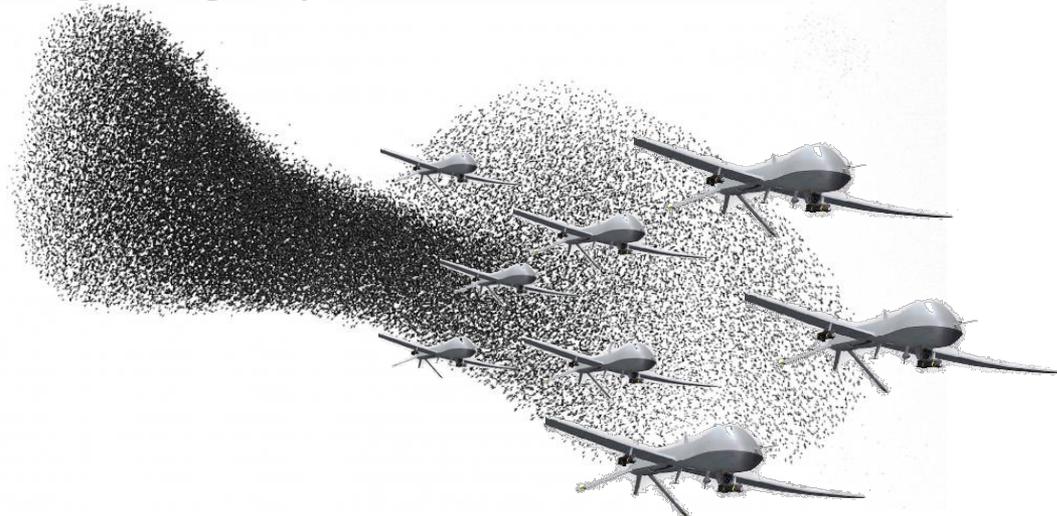


Enabling Safety, Efficiency, Resiliency and Reduction in Environmental Impacts

# Functions of an Intelligent ATM

## Management of a distributed network of targets in the ATM

- Capacity Gains
- Scalability
- Robustness to changing environments/conditions
- Eliminating single points of failure



# Functions of an Intelligent Aircraft

Fully autonomous, self healing, aircraft capable of performing a mission in all environments and is robust in changes in configuration and health

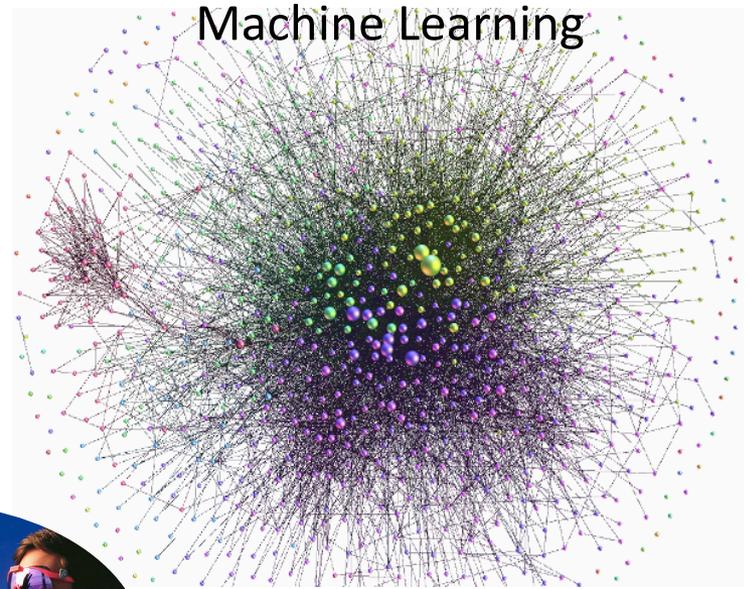
- Accessibility
- Safety
- Efficiency
- Resilience



# Fundamental Research Areas



Automated ground tools for ATM



Machine Learning



Human System Teaming



Cyber Physical Security

# Fundamental Research Areas



Dynamic airspace and aircraft reconfiguration



# Advanced Materials, Structures, and Manufacturing Methods

# Intelligent Aircraft



# Smart Structures

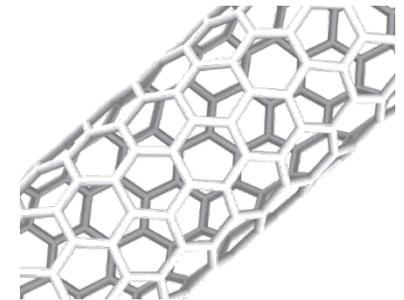
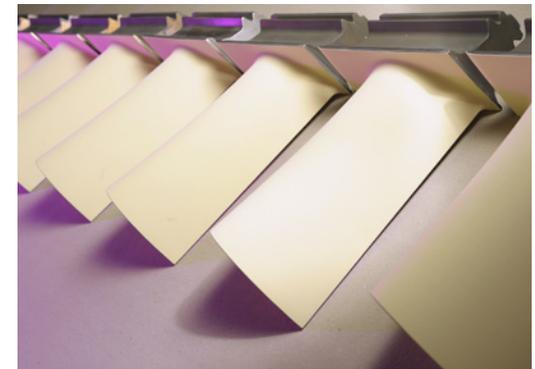
- Smart wing
  - Improved aeroelastic behavior
- Smart seats
  - Vibration mitigation
- Self-healing structures
  - Fly whenever, wherever



Safer, more reliable and enjoyable flight experience in any condition

# Advanced Materials

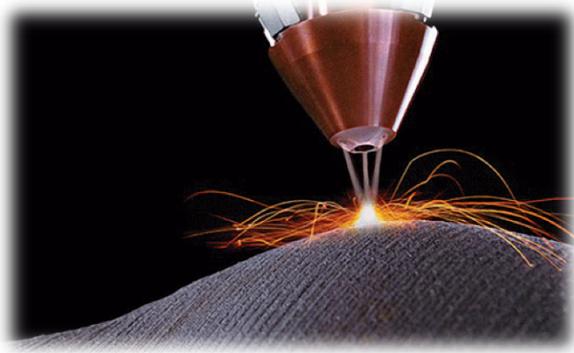
- Shape memory alloys
  - Adaptive Chevron
  
- Ceramics
  - Engines
  - Leading edges for hypersonics
  
- Nanomaterials
  - Improving strength of composites



Faster, greener, quieter, cheaper flight in any condition

# Innovative Manufacturing

- Additive manufacturing



- Out-of-Autoclave processes

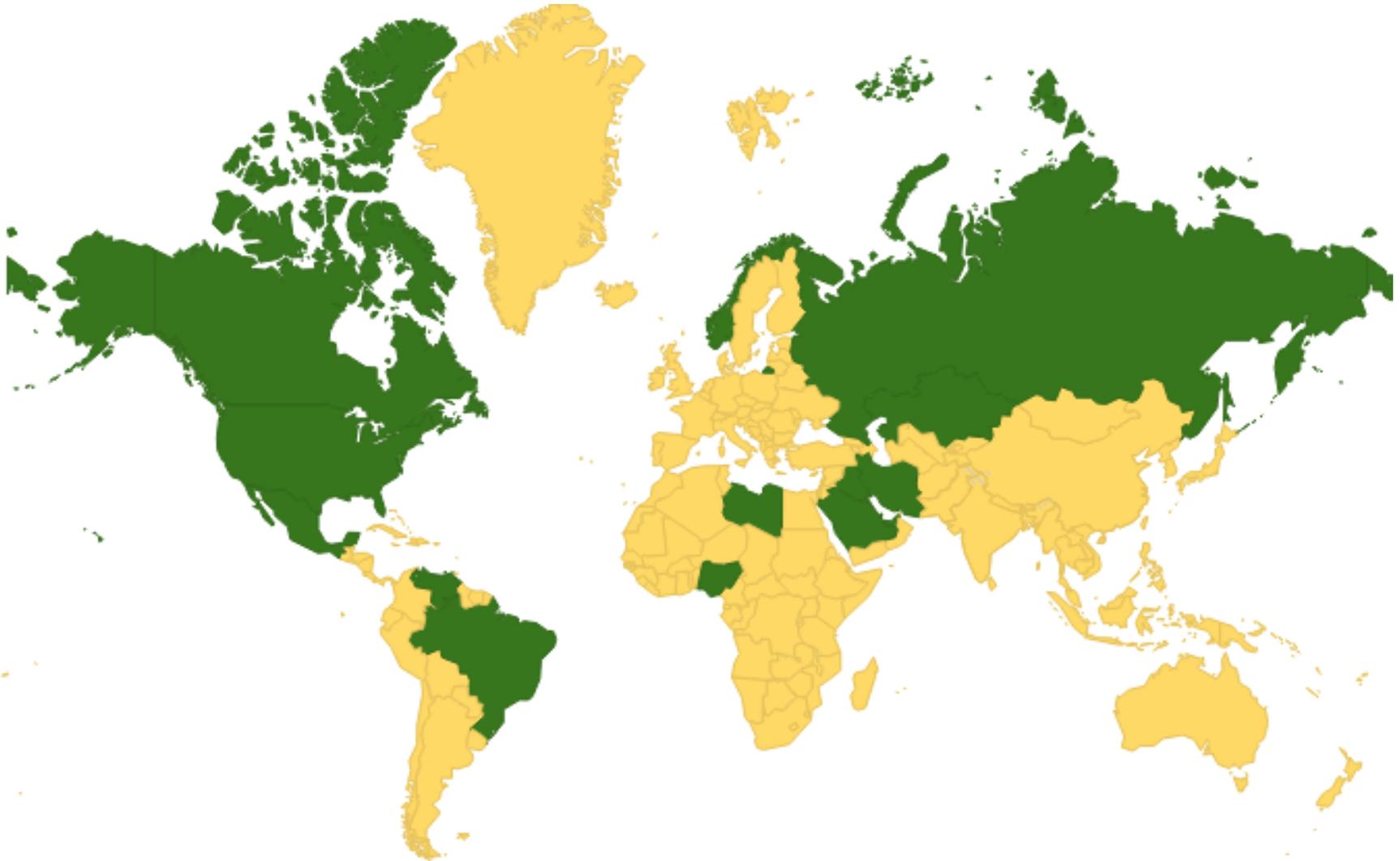


Access to cheaper, more frequent flights



# Alternative Energy

# Alternative Energy



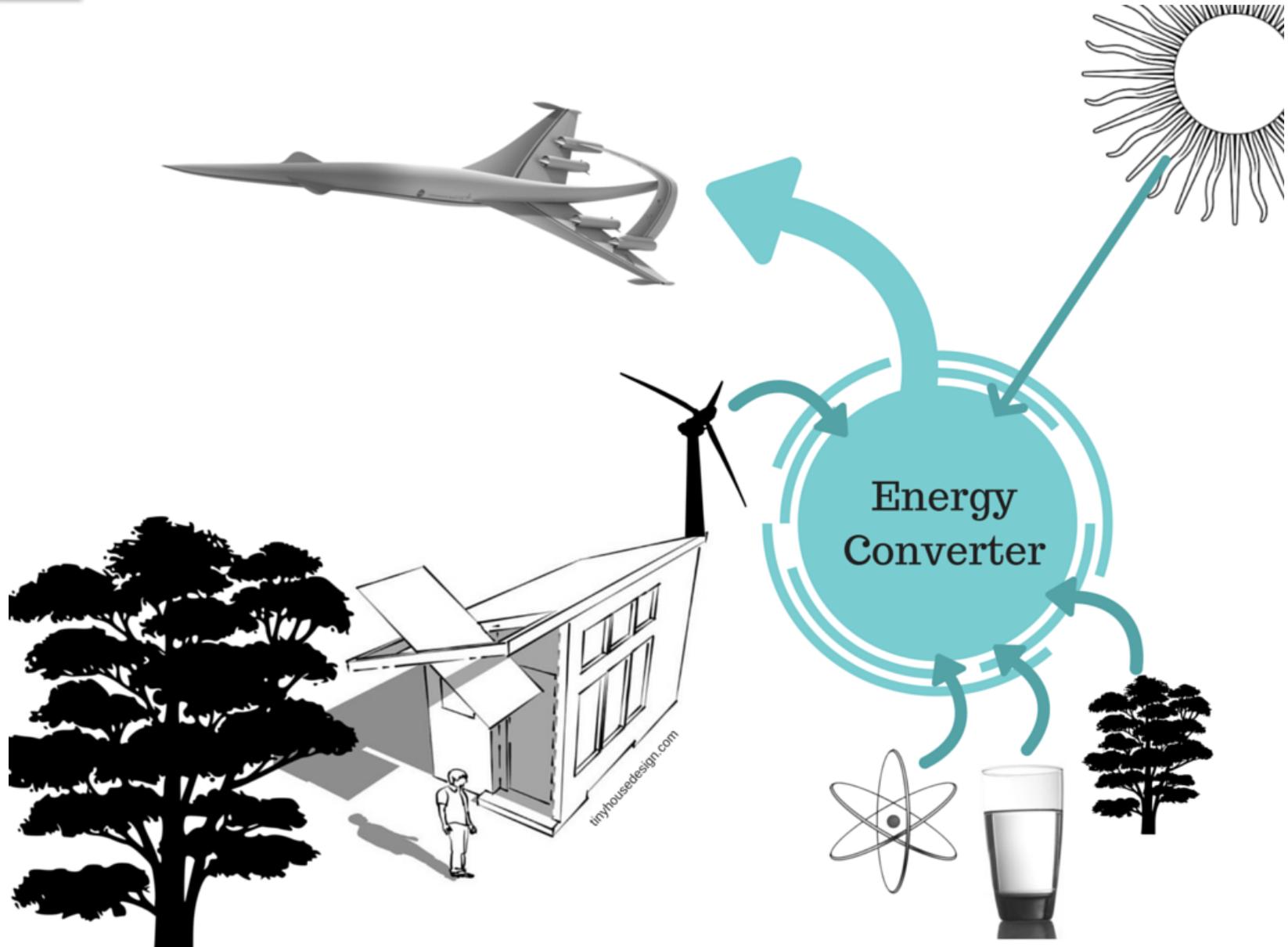
**Current Major Oil Reserves**

# Alternative Energy



**Potential Bio-Oil Reserves**

# Alternative Energy



# Alternative Energy

How to achieve this:

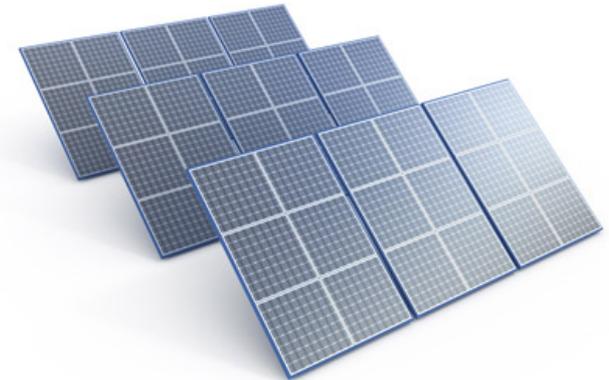
Improved feedstocks

- Increased energy density
- Designed for conditions



Improved conversion efficiency

- Solar
- Biomass



# Alternative Energy

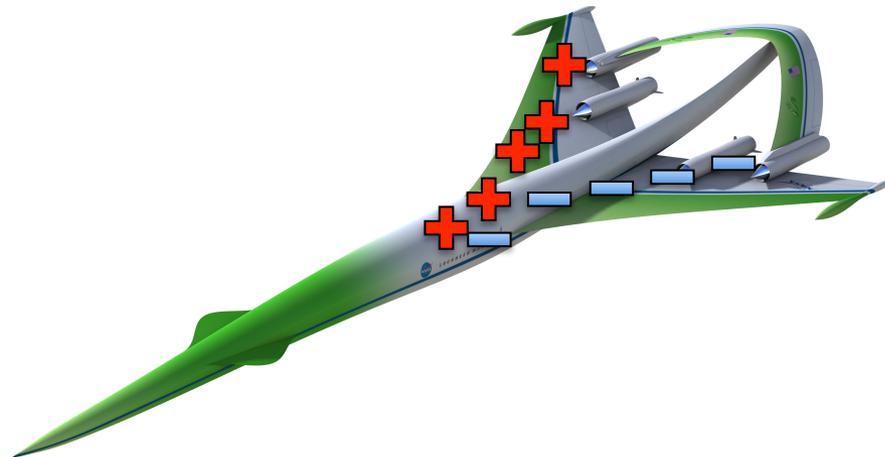
How to achieve this:

Better batteries



**1 kg jet fuel  $\approx$  40 kg Li-ion Batteries**

Batteries in structures



# Alternative Energy

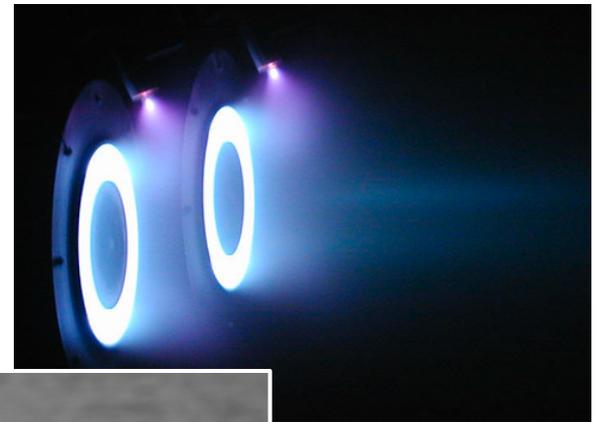
How to achieve this:

Improved liquid (H<sub>2</sub>/NG) storage



© Pragma Industries

Alternative propulsion methods



[www.quora.com](http://www.quora.com)

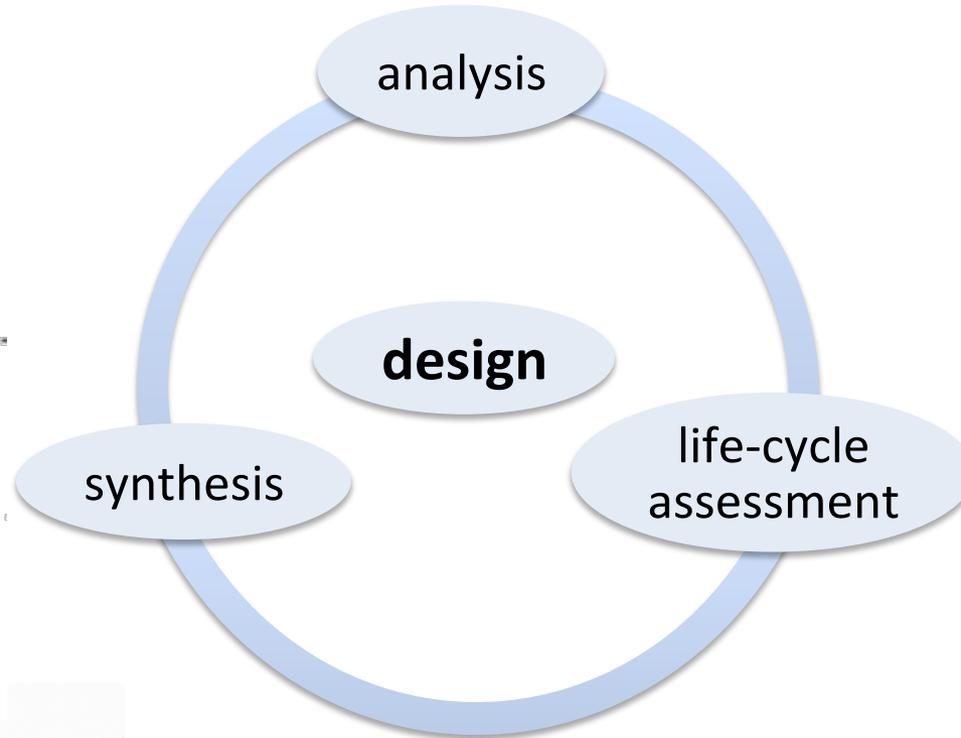
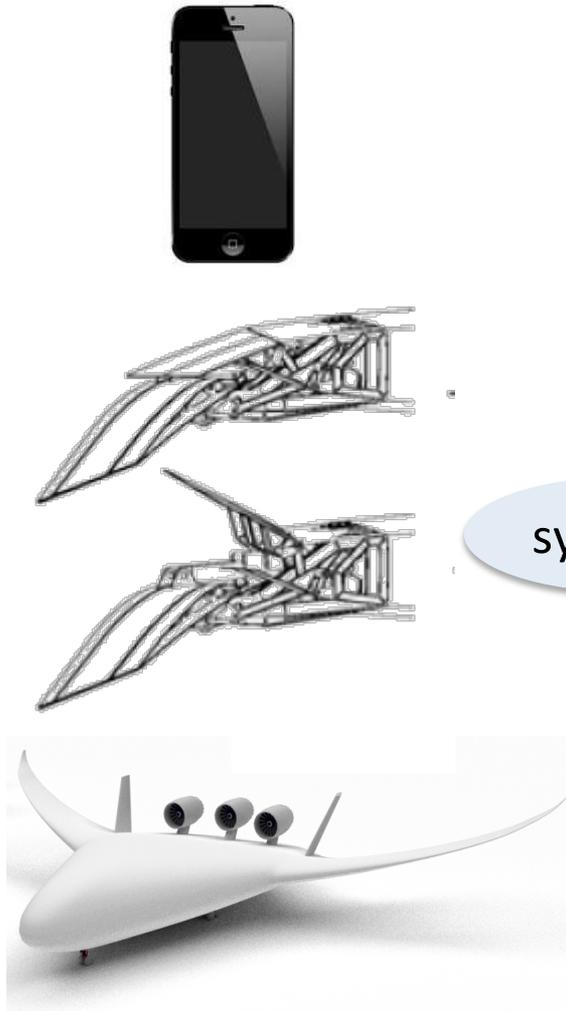


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# Integrated Design Processes

# Integrated Products & Integrated Design



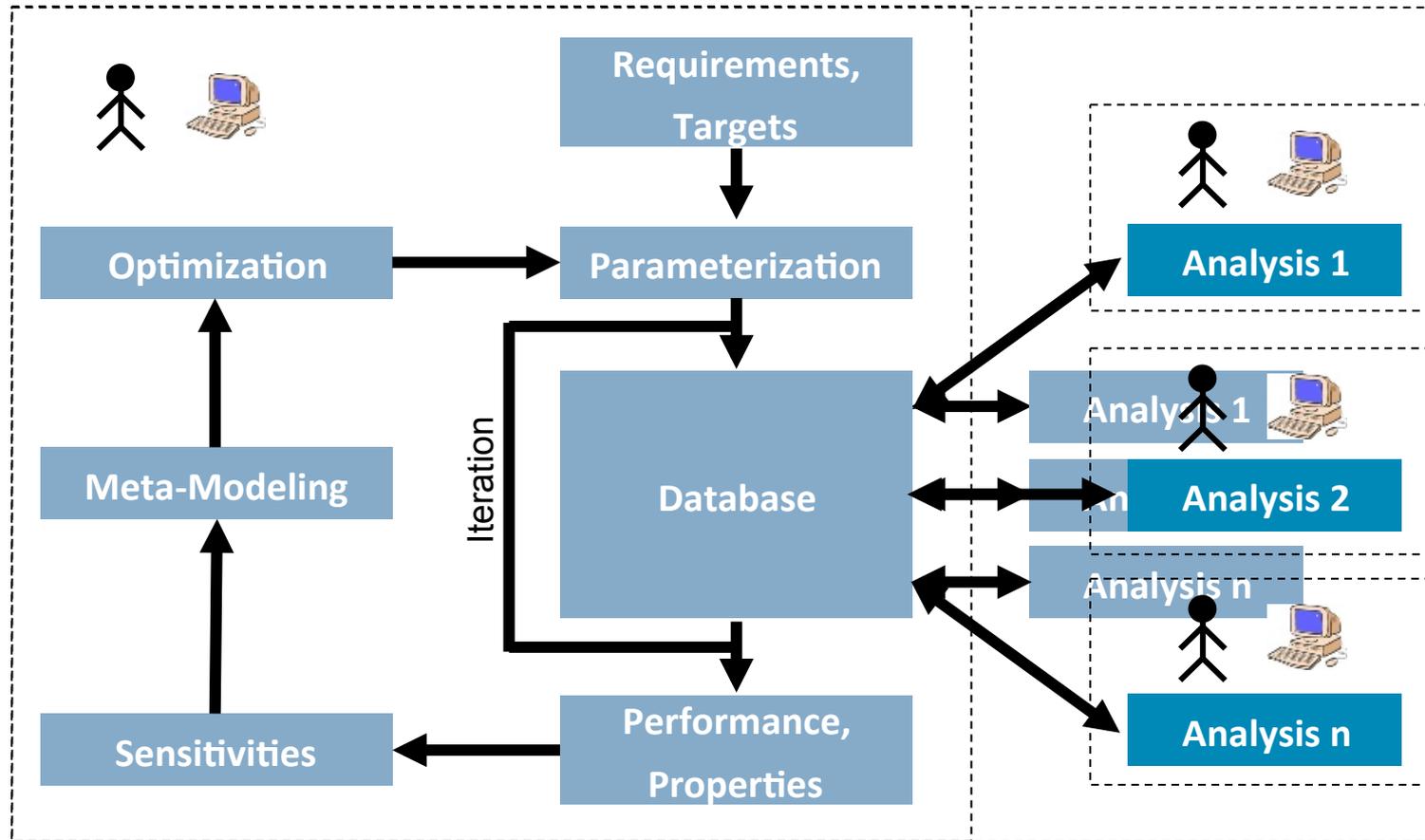
Time
↓

Eco-impact
↓

Cost
↓

Comfort
😊

# Intensified Collaboration



# Information Exchange

- Concurrent engineering
- Cloud / grid computing
- Web-conferencing
- Collaborative facilities

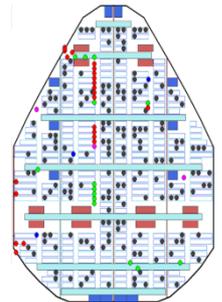
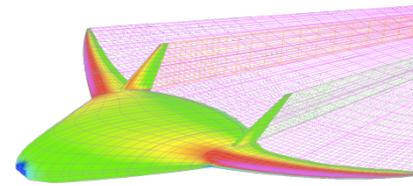
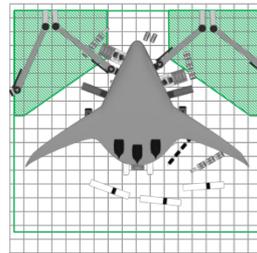
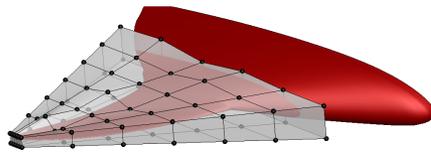
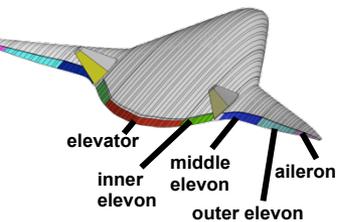


**IFARlink**



# Upcoming Challenges

- Collaboration in iterative processes
- Multi-disciplinary, -scale, -fidelity
- Post-processing
- Implicit knowledge

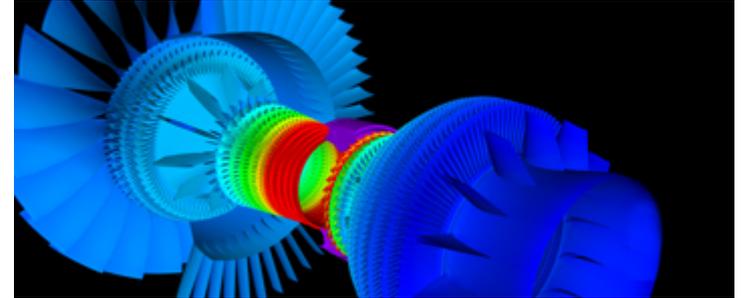




# Verification and Validation of Complex Systems

# Why Verification and Validation?

- Need to show systems behave as expected
- Increasing Complexity
- Greater integrations
  - Cannot separate into smaller pieces
- New approaches needed



## How is it a game changer?

- Enabling Technology
  - Indirect Benefit
- Public Acceptance
  - Both Technologies and Methods
- Improved technology maturation
  - Earlier identification of difficulties
  - Without sacrificing safety



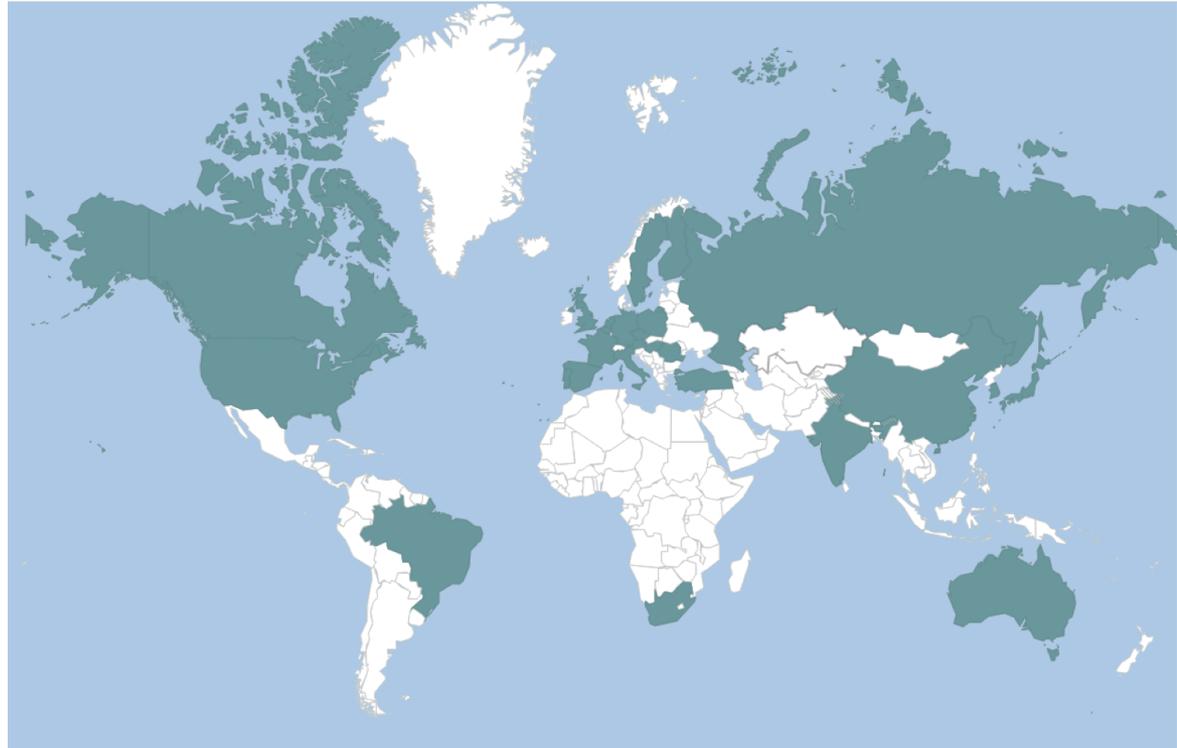
## How can it be done?

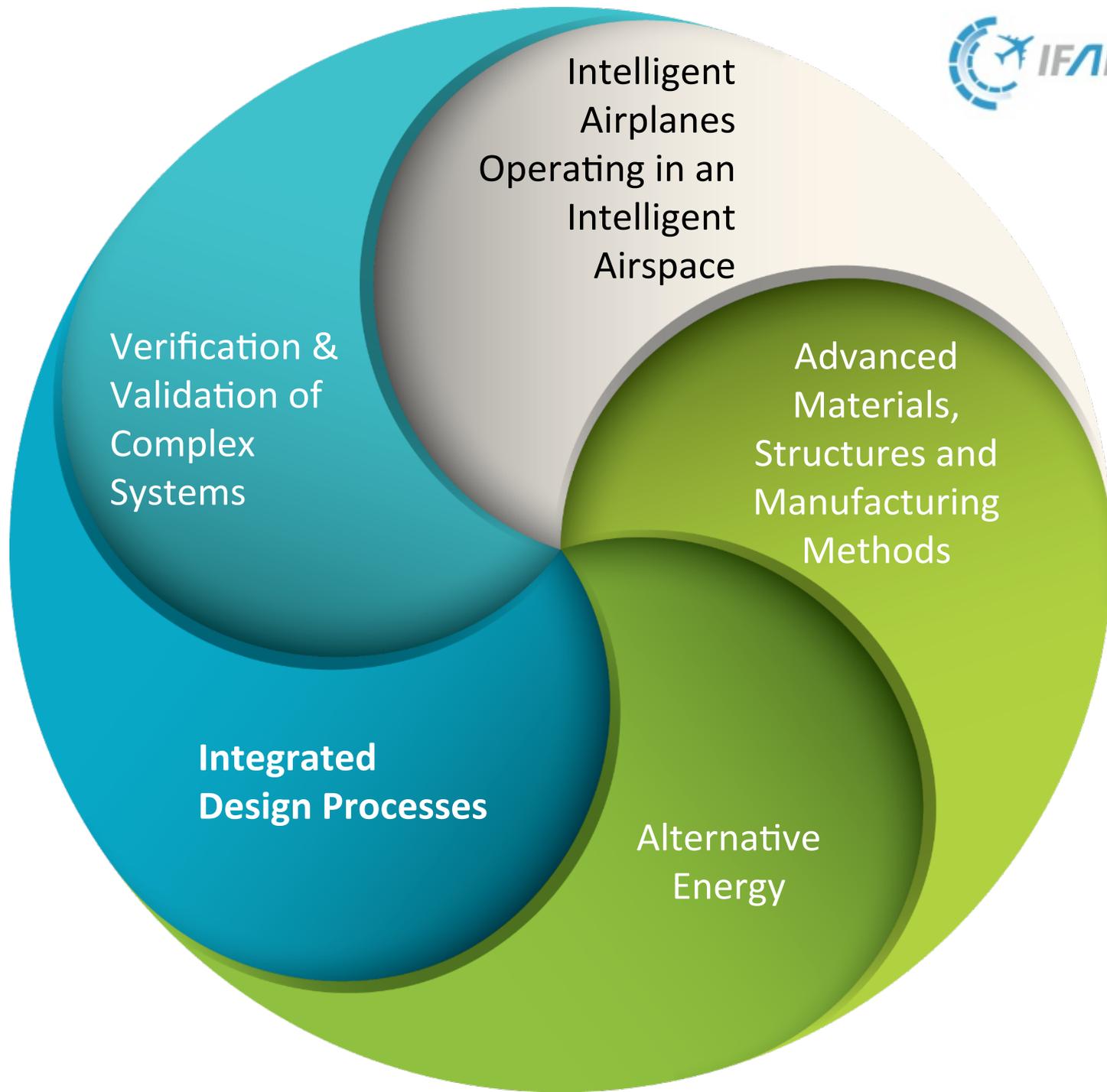
- Formal Methods
  - Integration with Design Methods
- Runtime Assurance
  - Testing in operation



# Why we need collaboration

- Global Market
- International Acceptance
  - Requirements vary around the world
  - Both cultural and legal
  - Certification





## Conclusion

This is the direction we would like to  
make Aviation go.

This is the difference we can help  
make.

The Young Researcher Network  
wants a voice in shaping the future  
direction of Aviation.