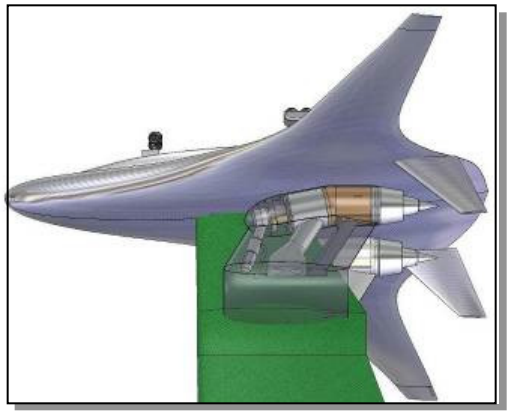
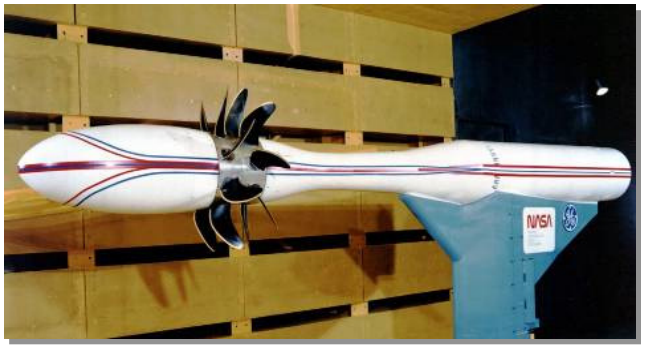
Environmentally Responsible Aviation (ERA) Project,
Integrated Systems Research Program





Dr. Tony Strazisar
Director (Acting), Fundamental Aeronautics Program
NRC Meeting of Experts, May 14-15, 2009

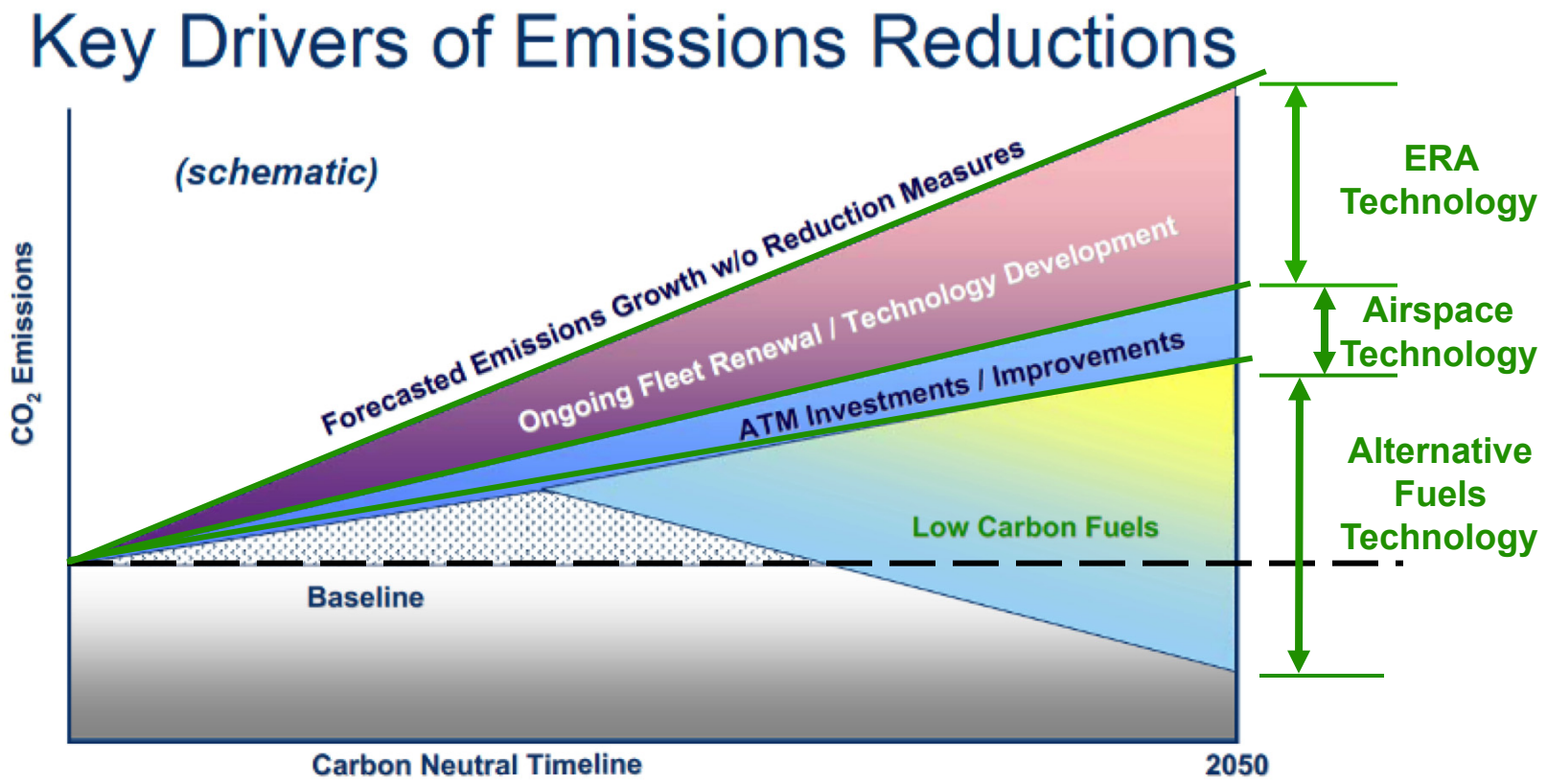
NASA Fundamental Aeronautics Program

- ***Hypersonics***
  - Conduct fundamental and multidisciplinary research to **enable airbreathing access to space** and **high mass entry into planetary atmospheres**
- ***Supersonics***
  - **Eliminate environmental and performance barriers** that prevent **practical supersonic vehicles** (cruise efficiency, noise and emissions, performance)
  - Develop supersonic deceleration technology for **Entry, Descent, and Landing** into Mars
- ***Subsonic Fixed Wing (SFW)***
  - Develop concepts/technologies for enabling dramatic improvements in ***noise, emissions and performance*** **(fuel burn and reduced field length)** characteristics of subsonic/transonic aircraft
- ***Subsonic Rotary Wing (SRW)***
  - Radically **Improve capabilities and civil benefits of rotary wing vehicles** (vs fixed wing) while maintaining their unique benefits

Common for all projects: Develop **prediction and analysis tools** for reduced uncertainty in design process and advanced **multidisciplinary design and analysis capability** to guide our research and technology investments and realize integrated technology advances in future aircraft

Environmentally Responsible Aircraft Planning Activity

Technology Impact on Environmental Footprint



Thomas Roetger , IATA
ICAO Fuel Burn Technology Workshop
London, 25 March 2009

Subsonic Fixed Wing System Level Metrics

…. technology for improving noise, emissions, & performance

CORNERS OF THE TRADE SPACE	N+1 (2015)*** Generation Conventional Configurations relative to 1998 reference	N+2 (2020)*** Generation Unconventional Configurations relative to 1998 reference	N+3 (2025)*** Generation Advanced Aircraft Concepts relative to user-defined reference
Noise	-32 dB (cum below Stage 4)	-42 dB (cum below Stage 4)	-71dB (cum below Stage 4)
LTO NOx Emissions (below CAEP 6)	-60%	-75%	better than -75%
Performance: Aircraft Fuel Burn	-33%**	-40%**	better than -70%
Performance: Field Length	-33%	-50%	exploit metro-plex* concepts

***Technology Readiness Level for key technologies = 4-6
** Additional gains may be possible through operational improvements
* Concepts that enable optimal use of runways at multiple airports within the metropolitan area

Approach

-Enable Major Changes in Engine Cycle/Airframe Configurations

- Reduce Uncertainty in Multi-Disciplinary Design and Analysis Tools and Processes

- Develop/Test/ Analyze Advanced Multi-Discipline Based Concepts and Technologies

Goals are Challenging

Current Noise Rule
(Stage 4)

Current Best Aircraft
Stage 4 – 11 dB CUM

N+1 Goal
Stage 4 – 32 dB CUM

Relative ground noise contours for notional N+1 and N+2 aircraft

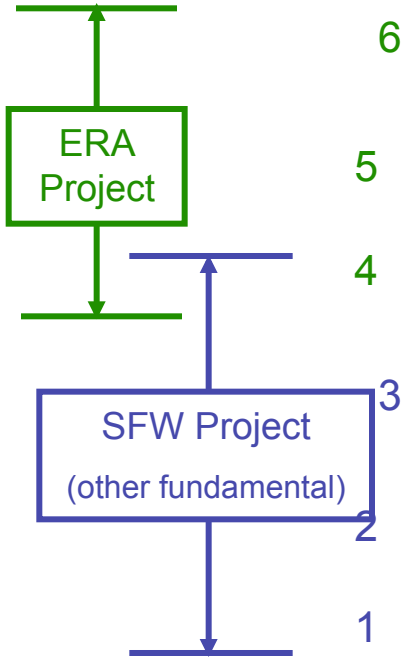
N+2 Goal
Stage 4 – 42 dB CUM

Airport Boundary

Ultimate goal: Aircraft noise is completely contained within the airport boundaries

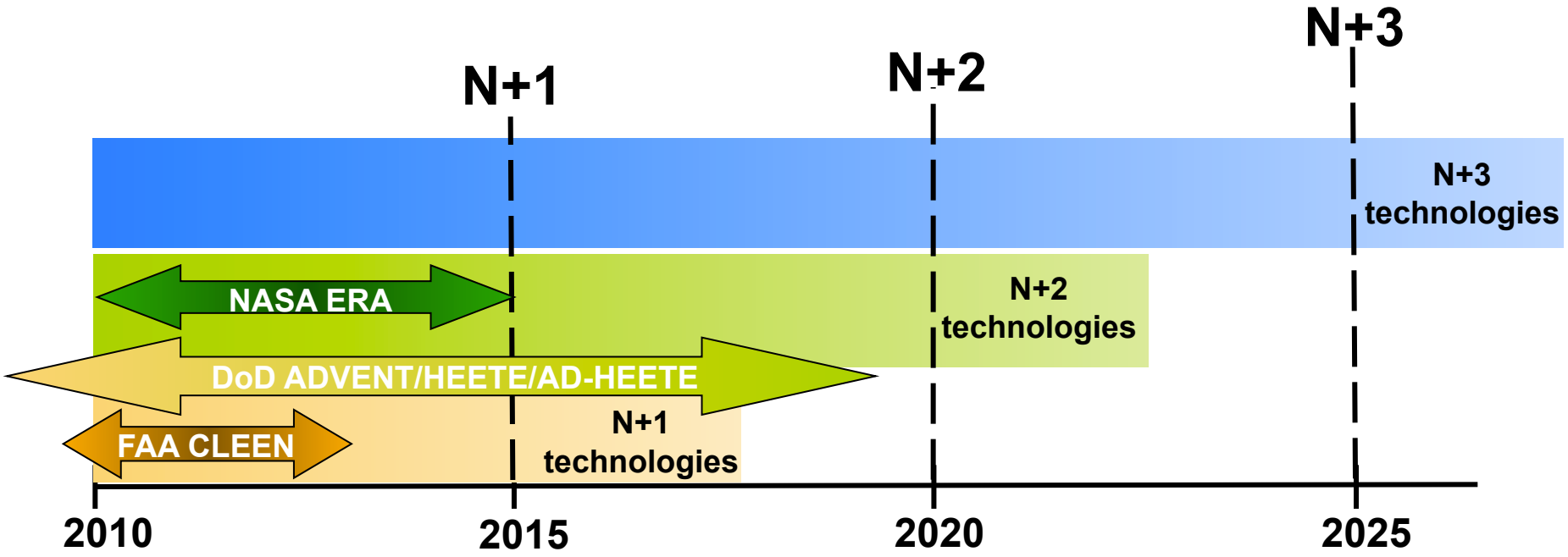
Technology Maturation Perspective on SFW and ERA Projects

TRL	NASA Definition (NPR 7120.8)
9	Actual system flight proven through successful mission operations
8	Actual system completed and "flight qualified" through test and demonstration
7	System prototype demonstrated in operational environment
6	System/sub-system model or prototype demonstration in relevant environment
5	Component and/or breadboard validation in relevant environment
4	Component and/or breadboard test in laboratory environment
3	Analytical and experimental critical function, and/or characteristic proof-of-concept
2	Technology concept and/or application formulated
1	Basic principles observed and reported



Foundational Research Time Horizons

Systems Programs that Augment Foundational Research



We simultaneously work on foundational technologies that are at different levels of maturity, targeted for technology readiness for different generations of aircraft. Systems experimentation efforts augment this foundational approach.

ERA Planning Framework

- ERA Technology Suite

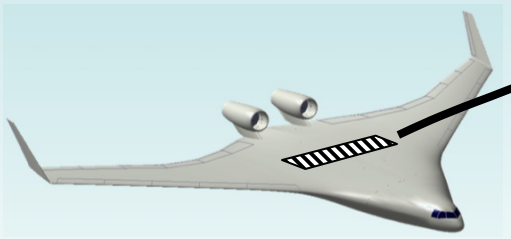
  Technologies selected for systems experimentation are those

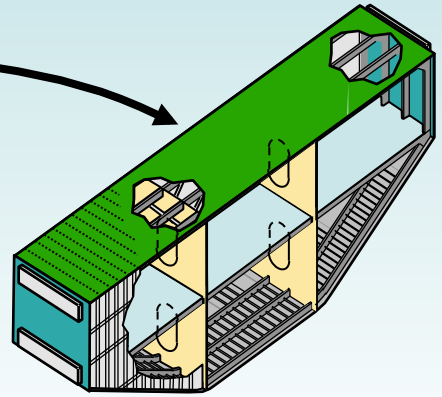
  – that have attained enough maturity in the foundational research program that they merit more in-depth evaluation at a system level in a relevant environment

  – which systems analysis indicates have the most potential for contributing to the simultaneous attainment of N+2 goals

  – identified through stakeholder input as having potential for simultaneous attainment of N+2 goals

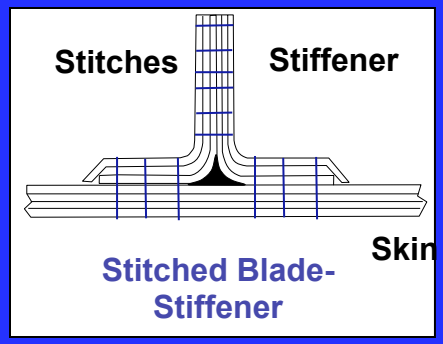
Fundamental vs Systems Research





Systems Research validates feasibility of game-changers in relevant environments

Fundamental Research



ERA Planning Framework

- ERA Project Goals
  - Explore/assess the feasibility and benefits of vehicle concepts and enabling technologies identified to have potential to mitigate the impact of aviation on the environment
  - Explore and document the interdependencies
  - Identify and mitigate issues related to safety
  - Expand the well-informed trade space
  - Retire technical risk
  - Transfer knowledge outward to the aeronautics community so that new technologies can be confidently incorporated into design of new aircraft and propulsion systems
  - Transfer knowledge inward to NASA fundamental aeronautics projects for further fundamental work where required