Modeling the Future of High-Speed C

Transportation Business Processes

Problem:

NASA and SpaceWorks faced the challenge of understanding how high-speed future aircraft would perform as commercial systems, especially as costs, operations, and demand evolve over decades.

Solution:

- Validated performance results against existing cost models.
- Increased confidence when testing scenarios and assumptions.

Introduction: aviation economics of high-speed aircraft

NASA is best known for space exploration, but a large part of its work focuses on aviation. One of NASA's goals is to understand what future aircraft might look like and whether they can work in the real world, technically and economically.

As part of a NASA SBIR research program led by NASA Langley Research Center, SpaceWorks analyzed the long-term economics of high-speed commercial aircraft. To support this work, SpaceWorks aimed to better understand how fleets, routes, and markets change over time.

What are high-speed aircraft?

High-speed aircraft are future commercial airplanes designed to fly much faster than today's passenger jets. By operating at **supersonic cruise speeds**, they could cut long-haul travel times dramatically.

While the idea is exciting, these aircraft also raise major questions around cost, operations, and demand. That's why high-speed aircraft research focuses as much on interconnected factors, such as demand growth, operating costs, maintenance, and aircraft lifespan. These factors play out over decades, not just a few years, making long-term planning for future aircraft especially challenging.

SpaceWorks already had an Excel-based life cycle cost model called *ROSETTA*. It worked well for early studies, but as the project grew, its limits became clear. The model relied heavily on averages and fixed assumptions, which made it hard to capture how real fleets behave and how changes over time affect aviation economics.

ROSETTA model created in Excel

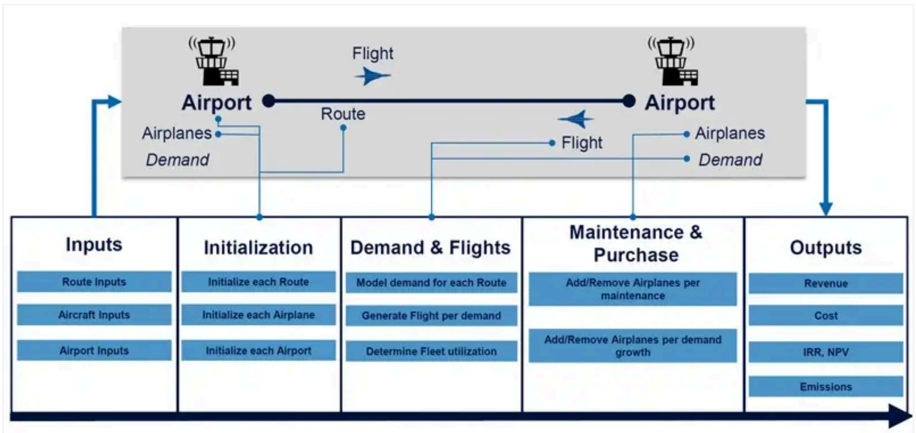
Some of the main challenges were:

- Aircraft could not be tracked individually over their lifetimes.
- Maintenance and retirement were based on fixed schedules.
- Routes were fixed at the start and could not grow with demand.

NASA needed a more flexible way to explore long-term

approach

SpaceWorks addressed these challenges by moving the economic modeling into a simulation environment, called *MIDAS (Multi-market Integrated Dynamic Aerospace Simulation)*, built in the AnyLogic software platform. Aircraft sizing and performance were still handled separately, but AnyLogic was used to model how operations and aviation economics unfold over time.



Road map of the project using AnyLogic simulation software (click to enlarge)

Instead of relying on averages, the model represents individual parts of the system. Aircraft, routes, airports, operators, and manufacturers are all modeled separately and interact with each other as the simulation runs. This approach makes it possible to see how small operational changes accumulate and affect both system behavior and aviation economics at scale.

enlarge)

With this approach, the model could:

- Track individual aircraft from delivery through retirement.
- Base maintenance and retirement on actual flight hours.
- Allow routes to enter service as markets grow.
- Adjust fleet size as demand changes.

Inputs were kept simple by using Excel files, while AnyLogic dashboards made it easy to see what was happening inside the model, from daily operations to long-term outcomes relevant to future aircraft programs.

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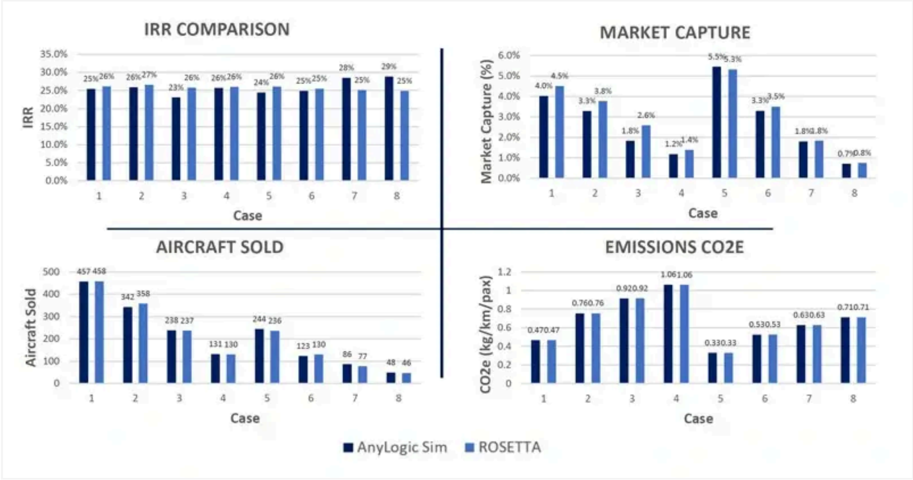
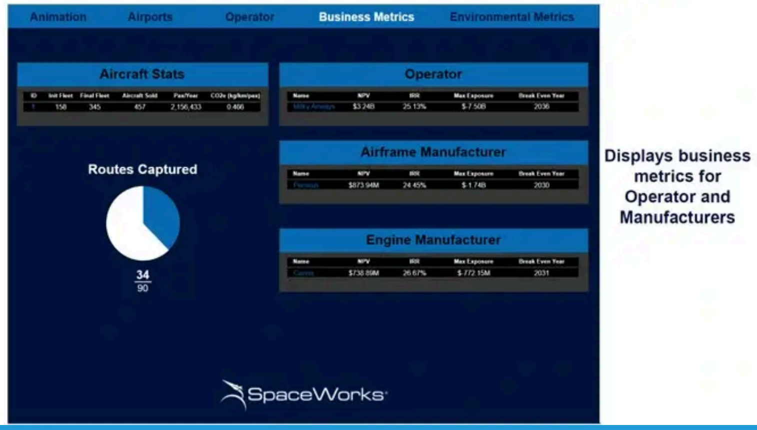
consistent. While the numbers were not expected to match exactly, the overall trends aligned well across key measures such as aircraft sales, market capture, emissions, and financial performance.



Consistency check between AnyLogic and ROSETTA models (click to enlarge)

More importantly, the new model made the **results easier to understand**. Analysts could see why certain outcomes occurred, not just what the final numbers were. This helped teams explore risks, test assumptions, and compare scenarios when evaluating future aircraft over long time horizons.



economics and supporting ongoing research into future aircraft and high-speed commercial aviation.

The case study is based on research conducted by SpaceWorks Enterprises, Inc. under a NASA SBIR contract with NASA Langley Research Center. For more details on the modeling approach, assumptions, and results, please refer to the NASA contractor report and the SpaceWorks final review presentation.

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