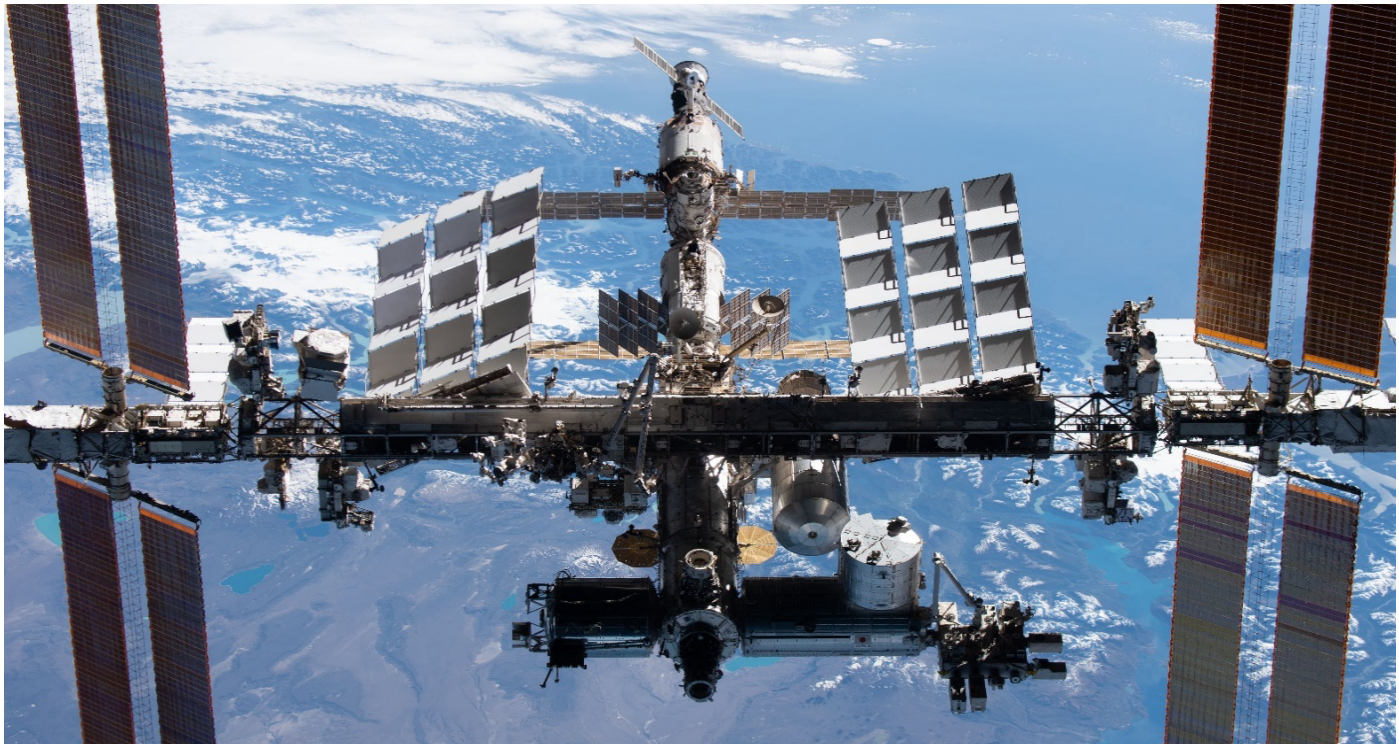
# Aurora Intelligent Scheduling For Aerospace Operations

Expensive, limited resources. Complex constraints. Demanding requirements. Routine customization.

Aerospace manufacturing and flight operations scheduling problems are among the most demanding.

Aurora™ is the world's leading planning and scheduling software solution that combines expert knowledge with artificial intelligence. Aurora helps many of the world's most demanding organizations manage their mission-critical space and aviation manufacturing, maintenance, and flight operations more flexibly and efficiently. For example, Boeing uses Aurora to help manage their Boeing 787 Dreamliner™ airliner assembly operations and 60 other commercial and defense applications. Axiom Space uses Aurora to schedule crew time on board the International Space Station.



## Expensive, Limited Resources

Aerospace equipment and personnel are expensive, limited, and difficult to replace, so effective selection and usage are critical.

## Complex Constraints

Aerospace manufacturing and flight operations schedules must satisfy unique, complex scheduling and resource constraints, such as when/which activities can share a resource, how conditional requirements depend on the situation, and limits on work per-day.

## Demanding Requirements

Aerospace manufacturing requires the highest precision and quality assurance, and errors require costly rework. So, activity schedules must satisfy rigorous constraints and quality assurance.

## Customization is Routine

Aerospace manufacturing and operations are anything but standardized. One-off builds and crew schedules are routine, so activities must be scheduled, analyzed, and refined quickly and robustly.

## Introducing Aurora

Aurora was developed to help tackle difficult, mission-critical scheduling problems—by using artificial intelligence technologies to encode and apply extensive domain knowledge and decision rules to generate more efficient schedules.

Today, Aurora manages the most demanding operations for organizations like The Boeing Company, Mitsubishi Heavy Industries, Bombardier Learjet, Spirit AeroSystems, Korea Aerospace Industries, US Air Force, and US Space Force.

At NASA's Kennedy Space Center, Aurora scheduled MRO activities for the Space Shuttle as well as for spacecraft components prepared for flight or refurbished for return to the International Space Station (ISS).


The Boeing Company uses Aurora to prioritize production of the Boeing 787 Dreamliner commercial airliner, in addition to other commercial and defense aircraft in Boeing's product line. Aurora's dynamic assembly schedule adapts to real-time production variations, so Boeing can produce aircraft as efficiently as possible.

## Aurora Outperforms Traditional Schedulers

In a study conducted by The Boeing Company, Aurora managed resources more efficiently than any other software Boeing could identify, including software that Boeing had developed and maintained specifically for managing its own operations over almost two decades.

When compared to Primavera, Aurora reduces turnaround time by 20%. When compared to Microsoft Project, Aurora's schedules are 30% shorter.

Comprising more than a dozen ground-based antennas, the Satellite Control Network (SCN) is critically important for commanding, controlling, and maintaining the health of more than 170 government and commercial satellites.

The U.S. Space Force uses Aurora, embedded in the MARS command and control system, to schedule communications between antennas and satellites which ensure that the satellites maintain their orbits and operate correctly.

## How Aurora Works

Most other scheduling systems use simple rules to select and schedule tasks and assign resources to carry them out. These rules usually consider only limited information about the required tasks, resources, and constraints, so the generated schedules are far from optimal.

Many systems rely on mathematical optimization to search systematically for the best scheduling solution. However, as the number of scheduled tasks and constraints grows, the computer time needed to solve the problem increases exponentially, making this approach impractical for managing large, complex operations.

Aurora solves complex scheduling problems effectively by encoding and applying sophisticated scheduling knowledge and decision-making rules, along with complex constraints and resource requirements.

Aurora encodes attributes of data objects representing individual tasks, groups of tasks, resources, resource sets, and constraints.

Aurora's built-in and user-supplied decision rules produce better schedules by considering the values of these attributes at key scheduling decision points such as:

- Determining which task to schedule next,
- Assigning the best time and resources to each task to optimize the overall schedule, and
- Handling situations in which some resources are unavailable when the task is scheduled.

Aurora's knowledge-rich approach enables it to combine human expertise with intelligent algorithms to generate superior schedules.

Aurora technology addresses aerospace operations planning challenges by:

- Generating near-optimal schedules for highly customized and resource-constrained aerospace schedules.
- Generating and revising schedules rapidly, so organizations can quickly adapt to changing conditions.
- Providing complex constraint support beyond what is found in other scheduling tools.
- Explaining why Aurora selected the scheduled time and resources for each task.
- Exploiting domain-specific scheduling knowledge and requirements, entered quickly and easily via graphical user interface.
- Detecting and highlighting scheduling problems such as unresolved conflicts.

Aurora accelerates airplane assembly operations, enabling Bombardier Learjet to adjust smoothly to changes in production rate and component delivery dates.

Mitsubishi Heavy Industries selected Aurora to accelerate its production of composite wings for the Boeing 787 Dreamliner.

## Complex Constraint Modeling

Conventional scheduling systems often support only basic constraints such as finish-to-start, start-to-start, finish-to-finish, and start-to-finish. Without a complete and accurate model of the constraints that schedules must satisfy, simpler systems cannot even determine whether a candidate schedule is valid.

By contrast, Aurora enables specification and enforcement of complex constraints, so it can schedule projects that other tools cannot even model. Examples of these constraints include:

- Resource requirements for each task (e.g., labor, equipment, space, materials),
- Exclusivities (incompatible tasks that cannot run concurrently),
- Preferred resources,
- Ergonomic constraints,
- Shift-based constraints, and
- Same-resource constraints for related tasks.

## Advanced Algorithms

Aurora uses advanced techniques such as bottleneck avoidance, which pre-analyzes the resources required by all the tasks, prior to scheduling them, to ensure that the most constrained resources are assigned to the tasks that have the greatest need for them, resulting in better schedules.

## Recognition and Awards

- Aurora has been featured in *MDA Tech Update*, *Defense Tech Briefs*, *NASA Tech Briefs*, *Air Force Launch Stories,* and *Spinoff*, NASA's premier publication featuring successful spinoff technologies.
- NASA designated Aurora a Small Business Innovation Research Success Story and showcased Aurora technology in a *Hallmarks of Success* video.

In service for 18 years at NASA's Kennedy Space Center (KSC), Aurora/AMP generated short- and long-term (10 year) schedules of ground-based activities that prepared and refurbished Space Shuttles before and after each flight. Rapid scheduling enabled the analysis of numerous what-if scenarios.

## About Stottler Henke

Stottler Henke (www.stottlerhenke.com) creates and applies artificial intelligence and other technologies to deliver solutions for planning and scheduling, autonomy, knowledge management and retrieval, education and training, and machine learning and data analytics.

By combining cognitive modeling and knowledge engineering with symbolic reasoning and machine learning, Stottler Henke solves problems that defy traditional approaches.

## Learn More

We invite you to discover how Aurora can help you manage your operations more efficiently, possibly in ways you did not think were possible.

To find out how Aurora can help you obtain an unfair competitive advantage, call Rob Richards, Director of Aurora Strategic Solutions at (650) 931-2700, or send email to aurora@stottlerhenke.com.


## Stottler Henke

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