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2025 Forecast

Commercial aircraft backlog remains strong as manufacturers tackle supply chain, production obstacles.

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JANUARY/FEBRUARY 2025
Volume 19 Issue 1

COVER STORY

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DEPARTMENTS

FEATURES

COVER STORY

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DESIGN & AUTOMATION

Eric Brothers // Senior Editor // ebrothers@gie.net

A roadmap for aerospace M&A

Mergers and acquisitions (M&A) in the aerospace industry are in a transformative phase, with trends indicating a shift toward streamlined portfolios and strategic partnerships, according to PwC's Aerospace & Defense US Deals 2025 Outlook. Emphasis now is on sustainable growth, resilience, aerospace growth trends, and supplier consolidation. Since this is our 2025 Forecast issue, let's examine some report findings in greater detail.

I asked Michelle Ritchie, PwC's global industrial manufacturing deals expert, to help explain some key trends.

Portfolio reshaping: Demand for emerging technology, along with increased competition from new entrants, has prompted major players to consider divesting non-core assets to streamline operations, pooling capital to modernize core competencies, and pursuing innovation by acquiring venture capital-backed startups.

Companies are reevaluating what's core to their business in the next three to five years and what's non-core. "For a couple of years, CEOs and teams have been looking at their portfolio, so I think we're going to find in 2025 people are now ready to take action and divest," Ritchie says. "We're going to see other strategic buyers look at them for acquisitions as well as private equity looking at them for stable cash flows and to do a roll up strategy, putting five or six smaller businesses together to maximize scale and cost savings."

Commercial consolidation: Intensifying competition and operational inefficiencies are prompting small- and mid-sized aerospace firms to pursue strategic consolidation. Larger players are leveraging M&A to secure critical supply chain capabilities, mitigate production bottlenecks, and achieve economies of scale, particularly in high-demand segments such as narrow-body aircraft and aftermarket services.

As smaller businesses grow, their working capital requirements can become challenging. They're looking for a partnership or investment to cover their working capital growth requirements to get them through the next growth phase.

"Companies are also looking to fill gaps in basic technologies or abilities, and they're looking for efficiency," Ritchie explains. They're looking for technologies to put into their offerings to get them on desirable commercial or defense contracts. "We're seeing increased M&A activity, strategic from a technology perspective, but also assets able to provide stable cash flows for the long term."

Read the PwC Aerospace & Defense US Deals 2025 Outlook:

Partnerships and joint ventures (JVs): The sector increasingly favors JVs over traditional acquisitions. This shift is due to JVs being less complex, having fewer regulatory hurdles, and offering increased protection against risks. JVs also support the development of advanced capabilities through innovation achieved via acquisition.

"A JV has a lot less risk than an acquisition, and it lets companies investigate certain technologies or markets of interest," Ritchie says. "I'm seeing in the JVs more digitization or artificial intelligence (AI). If companies do a JV, it limits the risk." If it works, the major partner buys the smaller one. If it doesn't work, they'll dissolve the JV and move on. – *Eric*

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Hypertherm Associates partners with BLM GROUP

BLM GROUP and Hypertherm Associates are partnering to offer solutions through BLM GROUP's laser cutting and tube bending systems and Hypertherm Associates' plasma and waterjet cutting products and software.

The partnership includes an agreement to expand demand for BLM GROUP's tube cutting and bending systems, pipe and plate cutting systems, and 3D robotics systems in North America and Europe.

The partnership allows each company to maintain its current leadership structure, operations, and other strategic priorities. BLM GROUP has headquarters and manufacturing facilities in Italy. Hypertherm Associates is a U.S.-based employee-owned company offering Hypertherm plasma and OMAX waterjet systems. **https://www.blmgroup.com; https://www.hyperthermassociates.com**

Left to right: Taylor and Huggett

APPOINTMENTS

INDEX Corp. announced **Michael Huggett** will succeed **Cris Taylor** as the company's president and CEO by the end of April 2025, when Taylor retires.

Huggett brings more than 30 years of industry experience, starting as a machinist, followed by roles of increasing responsibility at multiple machine tool builders. He's served as INDEX Corp. director of sales since early 2017.

Taylor took the helm of INDEX in January 2021. His 40-year career began as a machine-building apprentice and culminated in serving as CEO of multiple machine tool organizations during the past two decades. **https://www.index-group.com**

Henry

Sandvik Coromant appointed **Thomas Henry** vice president of marketing for the Americas. He brings more than 25 years' experience in metal cutting and industrial distribution. **https://www.sandvik.coromant.com**

PHOTOS COURTESY RESPECTIVE COMPANIES

Bukowski

Mastercam, a business area segment of Sandvik Manufacturing Solutions, named **Russ Bukowski** as interim president. With more than 20 years' expertise in strategy, Bukowski will guide Mastercam through the transition. **https://www.mastercam.com**

Obras

While continuing in his role as general manager for Latin America, **REGO-FIX USA** General Manager **William (Bill) Obras** will spearhead strategic relationships as director of partnerships for the Center for Machining Excellence (CME), which he was a driving force in developing. Obras has been with the company for nearly 30 years.

Schemel

Jeff Schemel is being promoted from North American sales manager to general manager USA.

Schemel has more than two decades' experience with REGO-FIX customers and will oversee all business activities in the U.S. and Canada. **https://regousa.com**

Lyndex-Nikken promoted **Matt Mowell** to regional sales manager for the Southeast Region; **Jacob Franco** as regional sales manager for Texas, Oklahoma, and Louisiana; and **Rafael Isaias** as national sales manager for Mexico.

Mowell's experience spans sales, machine operation, service engineering, applications engineering, and machine tool apprenticeship. **Franco** brings 22 years' experience in machine operation and cutting tool sales focusing on machining complex bulkheads for commercial and military aircraft. **Isaias** has more than 25 years of industrial expertise in cutting tools, distribution, and electrical plus sales, marketing, business operations, and strategic planning. **https://www.lyndexnikken.com**

7 strategies to streamline machine setup and boost productivity in CNC GRINDING

BY ERIC SCHWARZENBACH

About the author: Eric Schwarzenbach, founder of MyGrinding Inc., retired as president from Rollomatic Inc. – global builder of CNC grinding and laser cutting machines.

Minimizing the time and frequency of setups on CNC grinding machines is key to enhancing productivity. The strategies are applicable across various CNC grinding machines, but the annual savings estimates below are specific to CNC tool grinding.

A standardized approach also aligns with lean manufacturing principles. Process discipline, daily accountability, and visual management can be integrated into production, supporting continuous improvement.

1 Maintain precise machine calibration, including onboard in-process gaging and measuring devices. An inaccurately calibrated machine wastes time and materials, requiring more blanks to produce the first acceptable part.

2 Use precision wheel arbors and wheel bodies, with grinding wheels featuring a hole tolerance of H5 (-0/+0.0004"). It's equally important to dress and preset the grinding wheel on the designated wheel arbor for the machine, without switching between arbors.

3 Ensure precision wheel dressing, as any run-out means only one-third of the wheel's periphery is effectively grinding. Many operators opt to dress a small, predefined, and programmable corner radius to increase corner durability, minimizing the need for frequent adjustments until the wear naturally stabilizes.

4 Maintain precise wheel balancing, with a typical balance class of G2.5, which corresponds to a residual imbalance of approximately 2.5g.mm/kg at 10,000rpm.

5 Accurate wheel pre-setting (measurement) is crucial, ensuring the presetter precisely captures the corner radius and any other dimensions on the wheels.

6 Use precision grinding software with robust tool design capabilities. The software should accurately integrate the corner radius into calculations and support detailed 3D simulations and machine animations for enhanced precision.

7 Ensure thermo-stable, high-precision coolant oil delivery. All grinding spindle motors should feature internal oil cooling, and a high-accuracy coolant chiller is recommended to maintain a consistent temperature, even as oil volume fluctuates when other machines on the line are powered on or off.

Here are examples of potential annual savings per CNC tool grinding machine, based on a setup time reduction from 52 minutes to 45 minutes and a reduction of blank waste by 2 pieces per setup:

Lot size	Annual savings, 7 minute cycle time	Annual savings, 15 minute cycle time
150	$6,090	$3,890
50	$15,330	$10,440
15	$38,990	$29,970

Estimated annual savings are based on assumptions regarding the number of operators, machine up time, hourly shop rate, and wheel costs.

Implementing these strategies can greatly reduce the required number of setups, boosting efficiency and throughput while elevating overall grinding quality.

MyGrinding Inc.
https://www.mygrinding.com

Do you have any manufacturing challenges? Email me so I can address them in a future column: eschwarzenbach@mygrinding.com.

10 STEPS TO ACHIEVING PERFECT PHYSICAL INVENTORY

Global Shop Solutions' Senior Consultant Brady Stevens offers tips on improving manufacturers' inventory counting process.

1 PREPARE AHEAD: Having all hands on deck will ensure enough people are available to count. With two-person inventory teams, one scans and inputs the counts as the second counts parts.

2 IDENTIFY YOUR INVENTORY: Software-generated labels ensure employees can identify the correct inventory when consuming into jobs or shipping to customers.

3 FREEZE TRANSACTIONS AND INVENTORY MOVEMENT DURING COUNTING: No exceptions.

4 MINIMIZE DOWNTIME: Wirelessly scanning barcode labels and recording electronic counts directly into inventory software reduces count time and improves accuracy.

5 ACCURACY IS IMPORTANT: Scanning barcode labels ensures the right counts are recorded and similar parts correctly identified.

6 MONITOR COUNTS: Ensure count integrity with spot checks on how teams are counting. Spot checks are normal for company audits.

7 IDENTIFY WHAT'S BEEN COUNTED: Mark off or flag an area that's been counted. There's no right or wrong way to do this.

8 REVIEW COUNT VARIANCES CLOSELY: Material variances should be identified and discrepancies double-checked using a physical inventory variance report generated from system software.

9 COMMIT COUNTS: Once the count is verified and confirmed accurate, commit the count changes to the inventory system.

10 OPEN FOR BUSINESS: Now everyone can get back to making and shipping parts with accurate inventory numbers.

ICONS: ADOBE STOCK

Learn more about achieving perfect physical inventory in 10 steps at https://www.globalshopsolutions.com.

5 THINGS YOU NEED TO KNOW ABOUT CHIRON GROUP

When Simon Knecht, VP of Sales and Marketing at CHIRON America, talks about CHIRON in the aerospace industry, he starts with one simple truth: first part good part.

1 Global expertise, local focus

With over 100 years of German engineering excellence, CHIRON has developed a full range of 5-axis machining centers designed to tackle the unique challenges of aerospace manufacturing. Guided by our commitment to Performance Meets Precision, we deliver cutting-edge solutions that provide real value to our customers in the North American market. From our state-of-the-art facility in Charlotte, North Carolina, we collaborate closely with our customers to define optimal solutions, optimize processes and workflows, reduce costs, and build the path to success at every stage of their journey. For over 30 years, CHIRON America has been local in North America delivering more than 2,500 machines.

2 Turnkey solutions: We've been doing this for a while!

We've built machining centers solving the most demanding requirements in the industry. Throughout the years, we've developed machining centers capable of producing critical components with tight tolerances and intricate designs pushing the boundaries of precision and innovation. From turbine components, fuselages, stringers, rails and structural components, and other highly complex aerospace parts, we've worked on remarkable applications. With hundreds of aerospace projects successfully completed worldwide, we've demonstrated our expertise in delivering turnkey solutions. On customer projects, we currently have about 30% of value added locally, such as automation, fixtures, tooling, and all process-related developments.

3 Advanced manufacturing with automation

Automation plays a crucial role in our solutions. Automation isn't just about adding robots – it's about making everything work together smoothly, minimizing downtime and errors as well as creating a workflow resulting in increased output per footprint and process stability. CHIRON designs these solutions in-house to maximize the performance of our machines. From loading and unloading workpieces, measuring, deburring, washing, digital workflows, cut-to-length raw parts, and secondary process steps, we bring it all together. For each customer, we assign a project manager who ensures each step aligns with the requirements.

4 Trusted by aerospace pioneers

Aerospace has been in our portfolio for the past 30 years, and we have a dedicated team developing processes, customizing machines, and designing automation cells to meet delivery. With CHIRON's solutions, our customers gain a partner for the life cycle of each machining solution.

5 We are always advancing – FZ 19 S 5-axis, our newest machine

We answered the industry's increasing demand for precision and speed with the 19 Series fast, 5-axis machine. Able to load workpieces up to 1.2t and having a turning diameter of 800mm, the FZ 19 S 5-axis has become essential for machining large aerospace safety-critical parts. Two configurations – HSK-A63 and HSK-100 – let manufacturers tailor the machine to their needs.

Customers can combine the machine with a palletizer system, available in the market, or a customer-specific load and unload solution. The smart tool handling was developed in partnership with Zoller.

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Edited by Clare Scott

BOOSTING EFFICIENCY

Nidec Drives tackles challenges by implementing advanced manufacturing automation.

Invar implemented an automated tote conveyor system for Nidec Drives.

During the past five decades, Nidec Drives' UK manufacturing facilities have undergone significant expansion and transformation and a new solution was required to tackle a critical challenge.

Movement of raw materials from the warehouse to the module assembly plant was handled manually. Operators transported materials between buildings via forklifts and internally across three separate levels. This process was time-consuming and resource intensive. Given the complexity of interlinking different levels within the facility, a custom solution was essential.

"We conducted value stream mapping, and by taking an overview of production, preparation, and process, were able to formulate the plan for a conveyor and lift system which would move raw materials around the factory, where they needed to be, and when they needed to be," says

PHOTOS COURTESY OF NIDEC DRIVES

CLOCKWISE FROM TOP:
The conveyor system in use.

Nidec used Control Techniques drives for the automated conveyor and lift system.

The installation of the new conveyor and lift system was completed in just four months.

An overhead view of the conveyer system.

Jamie Evans, warehouse and distribution manager at Nidec Drives.

Identifying the right partner

Evans embarked on a mission to find the ideal vendor for implementing the latest advancements in automated warehouse solutions.

"We invested significant time in researching the right supplier to collaborate with us on achieving the optimal solution. Through extensive dialogue and interaction with Invar, they emerged as the clear frontrunner," Evans says.

Invar are intralogistics engineering experts who provide turnkey automation solutions specific to individual clients and proposed a solution fully tailored to Nidec Drives' needs and values.

Variable speed drives for conveyor system

One unique feature of Nidec Drives' UK manufacturing site is that, where possible, the automated machinery in use – from component store cranes to production equipment – runs on the Control Techniques variable speed drives Nidec Drives manufactures. The new conveyor and lift system would be no exception.

By combining teamwork and top-quality components and incorporating Control Techniques variable speed drives, Invar successfully completed the project ahead of schedule and within budget.

Providing a sustainable solution

Invar's solution involved implementing a tote transportation system comprising approximately 300m of Interroll-powered tote conveyor and three Nerak lifts, spread across three buildings. The conveyor system features two tiers for goods in/out and the main assembly area. Operators use screens at the infeed stations to select the tote's destination.

In any building on the manufacturing site, the tote license plate number (LPN) is scanned, and the operator places the carton onto the powered conveyor, selecting the tote's destination using the human machine interface (HMI) screen. The tote is then transported to the first lift and directed to the operator station. Once the operator has completed their tasks, the process of scanning the LPN, choosing the destination, and dispatching the materials is repeated. Additionally, in the store area of the facility, the lift allows for infeed or outfeed from both sides, depending on where the materials need to go next.

However, the true efficiency lies in the system's ability to operate on demand, halting completely between tote loads. This energy and cost-saving feature significantly reduces unnecessary consumption of resources and is expected to achieve a return on investment (ROI) in less than a year.

Leveraging Control Techniques products

Integral to the efficient stop/start nature of this system are the Control Techniques drives. For this project, two types of drives were used: three Unidrives and 11 Digitax HD M750.

The Control Techniques Unidrive was selected for the lifts within the system. Unidrive offers exceptional control stability and bandwidth for all industrial motor types, with the M702 variant featuring onboard Ethernet and dual STO inputs.

Several option modules were fitted to the Unidrive. The SI-I/O Interface Module provided additional input and output connections. The SI-Universal Encoder Module, which ensures positional accuracy by connecting to a rotary encoder on the motor, was also added. This module checks if the encoder's value matches that of a second encoder measuring position with a laser; if the values align, the programmable logic controller (PLC) allows the drive to run; if not, the system's brakes are applied.

Nidec engineers also used the PTi210 Easy Motion Controller with no need for software development – it plugs into the drive and is connected through PowerTools Studio software for creation of quick, simple, repeatable routines which the Unidrives in the conveyor execute repeatedly. The PTi210 is compatible with both Unidrive and Digitax HD M750 drives.

For single-axis motion with complex controls such as the conveyor, the PTi210 and PowerTools software package is a cost-effective way to provide simple, fast, and effective motion control. Users of all skill levels can configure, program, select functions, and set up parameters, expediting configuration, management, and long-term maintenance of the conveyor.

Finally, the KI-keypad was installed, allowing users to adjust drive parameters while displaying key information such as current draw, RPM, or faults.

The Control Techniques Digitax HD M750 servo drive series complements the Unidrive range by maximizing servo performance in a compact package. Digitax HD M750 is optimized for high-dynamic applications, offering flexibility in standalone and modular configurations. This drive delivers full servo control, plus open-loop permanent magnet motor and induction motor control, across four functionality levels: EtherCAT, MCI machine control, Ethernet, and the flexible Base servo drive.

The Digitax HD M750 drives chosen in this project were used for controlling the drum motors along the powered roller conveyors, and on the conveyor belt's incline and decline. This drive was selected for its compact size, while offering high power density, dual STO, and ability to communicate on the PROFINET network.

As a full machine control solution, the Unidrive works with three Leroy-Somer IMfinity 3-phase induction motors, one on each lift of the conveyor. Provided by Nidec

ACIM, IMfinity motors reach premium efficiency up to IE4 to maximize energy savings, enhance performance, and optimize lift productivity. Design of the IMfinity range of Leroy-Somer motors ensures performance and reduced cost of maintenance. To work with the Unidrive, the IMfinity motors have winding protection as standard, thermal reserve for maintaining the rated torque over an extended speed range, and adaption of the metal support plate to reduce electromagnetic noise.

The application of various Nidec components within the Invar conveyor provides an efficient, modern, and functional conveyor and lift system.

Impact and future developments

Installation of the new conveyor and lift system was completed in just four months. Since implementation in April 2024, impact on productivity and staff morale has been significant. The team can now retrieve parts without physically moving and accessing bulk materials, production bottlenecks have been eliminated, and individual efficiencies have markedly increased.

"The conveyor is just the latest step in our ongoing efforts to enhance our manufacturing facilities," Evans says. "We are always exploring the next steps we can take to improve efficiency and quality, and we look forward to further growth."

"At Invar, we install a legacy for our clients," says Sham Jama, project manager at Invar. "We work hard to meticulously maintain every element of our solution through custom maintenance, communication, and strong connections with our customers. This project ran so smoothly with the help of Jamie and his team, I believe this marks the beginning of a long and fruitful relationship."

Looking ahead, Nidec Drives is considering the implementation of autonomous mobile robots (AMRs) at the UK manufacturing site. AMRs address many challenges in high-specification manufacturing by independently navigating their environment picking, sorting, and transporting components.

Nidec Drives will collaborate with Nidec Automation, which produces motors, motor control solutions, integrated drive solutions, and battery management systems for AMRs, to explore how these robots can further improve efficiency and quality at the Nidec Drives manufacturing site. D&A

Invar
https://www.invargroup.com

Nidec Drives
https://acim.nidec.com/en-US/drives/control-techniques

5-axis machining center

Designed for high precision and efficiency, the MF700 5-axis machining center features a robust column-moving C-frame structure to minimize errors and protect key components from contamination.

By separating the linear and rotary axes, the machine minimizes following errors, ensuring machining accuracy. Additionally, the transmission components are strategically placed away from the working area, reducing the risk of coolant and chip contamination and improving machine longevity.

The MF700's linear axes feature a cross-frame design that, along with the wide-span column and large-size linear way blocks, provides stability during high-speed cutting operations. The rotary table, integrated with a bridge-type column, combines a compact design with a smaller footprint, maximizing the working envelope.

The rotary table is designed with tailstock support, increasing its load capacity to 500kg and allowing it to handle larger workpieces, with a maximum swing of 700mm and a height capacity to 500mm. The standard worm gear/wheel and encircling brake design ensure high rigidity and lock-force, while the system can be upgraded with dual direct drive motors for higher speed requirements.

Two wide-opening doors make it easier for operators to access the work area and facilitate automation upgrades. The MF700 offers three types of top guards – telescopic, solid, and open top – tailored for different working environments. The base allows chips to fall directly onto the conveyor, cutting chip cleaning time by 50%.

Quaser America Inc.
https://www.quaseramerica.com

MF700 at-a-glance

- Table size: 650mm dia.
- Table load: 500kg (1,102 lb)
- Travel X / Y / Z: 820mm (-460mm, +360mm) / 570mm (-285mm, +285mm) / 530mm
- Travel B / C: +110°, -90° / 360° continuous
- Max. spindle speed 12C / 15C / 20C: 12,000rpm / 15,000rpm / 20,000rpm
- Floor space W x D: 3,720mm x 4,475mm (147" x 176")
- Machine weight: 10,500kg to 11,570kg (23,149 lb to 25,507 lb)
- Position accuracy (repeatability): 0.010mm (0.007mm)

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2025 Forecast

Commercial aircraft backlog remains strong as manufacturers tackle supply chain, production obstacles. By Eric Brothers

Companies throughout the aerospace supply chain are struggling to overcome parts shortages and workforce challenges to produce the commercial aircraft the market wants. The demand is strong: global passenger traffic is projected to surpass 10 billion passengers in 2025, according to electronic payments company ACI World. That figure is up 6% from 2024 and up more than 16% from 2019.

Aircraft leasing company Avolon predicts the global airline industry will reach $1 trillion in revenue for the first time during 2025. According to its analysis, the main driver behind this growth is the Asia-Pacific region, which will be adding more capacity than all other regions of the world combined.

At the same time, the aircraft manufacturing industry strains to supply airlines and leasing companies with modern, fuel-efficient jetliners. Avolon expects aircraft deliveries to be ramped up by 20% in 2025. However, Airbus and Boeing order books will remain full for years to come. Avolon predicts this year may even see new delivery slots for narrowbody aircraft stretching from the 2030s into the 2040s. With production rates lower than anticipated, the backlog that was expected to last a decade may now last 14 years if current production rates don't increase.

As a result of new aircraft scarcity, carriers are forced

PHOTO © SUPAPICH | ADOBE STOCK

to extend the lifespan of their current fleets, increasing demand for maintenance, repair, and overhaul (MRO) and services. Increased MRO demand creates a shortage of used serviceable parts and engines.

Long term, predictions remain consistent with estimates from recent years. Boeing's 2024 Commercial Market Outlook (CMO) predicts strong air travel demand will drive demand for nearly 44,000 new airplanes from 2024 to 2043. The global commercial fleet is projected to grow 3.2% annually. Single-aisle airplanes are expected to make up 71% of the 2043 fleet. Boeing forecasts the support and services market to be worth $4.4 trillion in the same 20-year period.

Airbus' 2024 Global Market Forecast for the same timespan is for 42,430 jets, with 80% being narrowbody. Annual growth will be approximately 3.6% from 2027 onward. Airbus' Global Services Forecast puts the commercial aircraft services market at $290 billion in 2043, up from $150 billion in 2024.

Supply chain issues encompass many shortages, with workforce needs a persistent pain point. Attracting and retaining a quality workforce was cited by more than two-thirds of the respondents in a National Association of Manufacturers (NAM) mid-2024 survey. While artificial intelligence (AI) and digital technologies offer recruitment solutions, traditional approaches are gaining momentum. Deloitte analysis shows the number of apprentices in advanced manufacturing occupations increased to 59,500 in fiscal year 2023, nearly 3x that of fiscal year 2021. **https://avolon.aero; https://www.deloitte.com; https://nam.org**

AIRBUS delivered 766 commercial aircraft to 86 customers globally in 2024 – up 4% from 2023, but shy of its 770 target, revised down from 800. Delivery milestones included the first A321XLR to Spanish airline Iberia, and A330neo and A350 deliveries to several customers. Sixty percent of single-aisle deliveries were the A321neo. The commercial aircraft business had a 2024 year-end backlog of 8,658 aircraft – up from 2023's 8,598.

Airbus CEO of commercial aircraft Christian Scherer says, "2024 confirmed sustained demand for new aircraft. We won key customer decisions and saw phenomenal momentum for our widebody orderbook, complementing our leading position in the single-aisle market." Of the 878 gross new orders (826 net), a quarter are widebodies: 82 A330s and 142 A350s.

Scheer adds, "Given the complex and fast-changing environment we continue to operate in, we consider 2024 a good year."

Airbus produced an average of 44 A320s per month last year, according to Forecast Int'l, and it's working with its supply chain to increase A320 production to 75 aircraft per month by 2027 – a year later than planned. Airbus pushed back the target as its suppliers – especially engine manufacturers – can't keep up with demand. **https://www.airbus.com; https://www.forecastinternational.com**

Airbus commercial aircraft deliveries 2024 vs. 2023

Program	2024	2023
A220 family	75	68
A320 family	602	571
A330 family	32	32
A350 family	57	64
Total	**766**	**735**

Left to right: Airbus A350-1000, A321XLR, A330-900, and A220-300. CREDIT: AIRBUS SAS

BOEING's 2024 deliveries were reduced by a nearly two-month strike by the International Association of Machinists and Aerospace Workers (IAM) in the Pacific Northwest and ongoing scrutiny of its 737 MAX safety and quality program in the wake of a mid-exit door (MED) plug blowing out of the left side of a 737-9 while in flight last January. Boeing management is focusing on four areas in its safety and quality plan: investing in workforce training, simplifying plans and processes, eliminating defects, and elevating its safety and quality culture. The plan also sets forth measures to continuously monitor and manage the health of its production system. Progress highlights:

- Added hundreds of hours of new curriculum to training programs, including quality proficiency
- Instituted new random quality audits of documented removals in high frequency areas to ensure compliance to process
- Reduced defects in 737 fuselage assembly at subcontractor Spirit AeroSystems by increasing inspection points at build locations
- Implemented a new work in process (WIP) procedure in 737 and 787 final assembly to track and secure parts for manufacturing work not yet completed
- Addressed more than 70% of action items in commercial airplanes production based on employee feedback
- Implemented criteria across airframe final assembly to manage traveled work, mitigate risk

The largest model in the 737 MAX family, the 737-10. CREDIT: BOEING

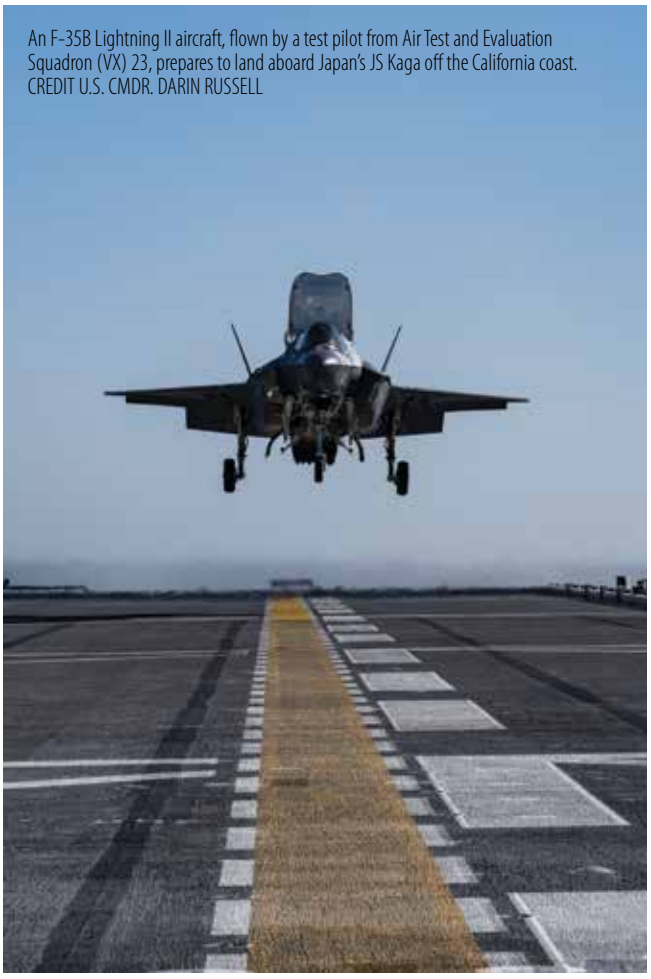
The company has developed detailed plans and deliverables for each recommendation from the FAA's Expert Review Panel, convened per the Aircraft Certification, Safety, and Accountability Act (ACSAA) of 2020. This includes safety and quality training to more than 160,000 employees focused on their role in identifying and reporting potential product hazards; improving the Speak Up reporting channel to increase transparency, strengthen confidentiality, and create a better user experience for those who report; and creating the new position of human factors functional chief engineer. These and more actions are detailed on the Boeing Strengthening Safety & Quality webpage.

The company reports 569 gross orders for 2024 with 6,245 total unfilled orders and an Accounting Standards Codification (ASC) 606-adjusted 5,595 aircraft backlog. The order book was boosted notably in December by Pegasus Airlines' order for 100 737-10s with options for 100 more.

Citing supply chain delays as the reason for scaling back production earlier in 2024, Boeing plans to produce 737 MAX aircraft at a rate of 38 per month by May 2025. That's the limit the FAA now allows, but observers say Boeing may not be able to reach that rate until 2026. The 787 build rate is targeted at five per month, again constrained by the supply chain. The 777 program is currently delivering three aircraft per month with a company goal of four 777s per month by 2026.
https://www.boeing.com

Boeing commercial aircraft deliveries 2024 vs. 2023

Program	2024	2023
737	265	396
747	-	1
767	18	32
777	14	26
787	51	73
Total	**348**	**528**


An F-35B Lightning II aircraft, flown by a test pilot from Air Test and Evaluation Squadron (VX) 23, prepares to land aboard Japan's JS Kaga off the California coast. CREDIT U.S. CMDR. DARIN RUSSELL

EMBRAER delivered 206 aircraft in 2024 – a number 14% higher than the 181 recorded in 2023. With 31 deliveries in the last three months of the year, the commercial aviation division reached 73 new aircraft for 2024 (inside guidance of 72 to 80), up 14% from 2023. The company's executive aviation unit made 130 deliveries in the year (the midpoint of the original guidance), up 13% year-over-year. In the third quarter of 2024, Embraer's backlog reached $22.7 billion, a 25% increase year-on-year and a nine-year high.
https://embraer.com

LOCKHEED MARTIN delivered 110 F-35 Lightning II joint strike fighter aircraft to the United States and its allies in 2024, topping the 75 to 110 CEO Jim Taiclet indicated in a summer earnings call and up from 97 delivered in 2023. Deliveries were paused that year for an electronic warfare software upgrade and Technology Refresh 3. **https://www.lockheedmartin.com**

THE GLOBAL SPACE ECONOMY presents an opportunity worth $1.8 trillion by 2035, up from $630 billion in 2023,

according to a report by the World Economic Forum and McKinsey & Co. The figure counts satellites, launchers, services, and applications for which space technology helps companies across industries generate revenues (Uber, for example). Expected annual growth rate is 2x the projected rate of gross domestic product (GDP) growth during the next decade.

Growth drivers for the space economy include the need for greater connectivity via satellites, higher demand for positioning and navigation services on mobile phones, and increased demand for insights powered by artificial intelligence (AI) and machine learning (ML).

A mid-2024 Space Foundation report stated the global space economy totaled $570 billion in 2023, 7.4% higher than 2022's $531 billion. Commercial space products and services accounted for $321.4 billion, commercial infrastructure and support industries $123.8 billion, U.S. government space budgets $74 billion, and non-U.S. government space budgets $51.2 billion. This growth is consistent with the industry's five-year compound annual growth rate (CAGR) of 7.3% and is nearly 2x the size of the space economy a decade ago.

https://www.mckinsey.com; https://www.spacefoundation.org; https://www.weforum.org

Embraer E195-E2 Tech Eagle. PHOTO: EMBRAER

INDUSTRY INSIDERS

Richard Aboulafia, FRAeS Managing Director, AeroDynamic Advisory

The aviation industry continues to be a strange mix of very good and very bad. Demand in all segments – jetliners, military systems, business aircraft, rotorcraft, etc. – continues to be quite strong, with backlogs at or near record highs. Global conflict is fueling demand for defense equipment, while a strong post-COVID travel recovery and undersupplied airlines are fueling demand for civil transports.

Unfortunately, supply chain delays and production problems are greatly slowing output. 2024 saw very little progress with the production ramp, despite the continued strength in markets. For a market wanting equipment, deliveries were actually down. However, if it weren't for the Boeing strike and a Lockheed Martin F-35 systems upgrade delay, deliveries would have slightly risen relative to 2023.

There are hopes for improvement in 2025, but given past disappointments many in the industry are skeptical of more than single-digit percentage year-over-year output increases. Unfortunately, lower inflation doesn't seem to be an indicator of an improving supply picture.

It's also notable that this time – compared with previous civil market upturns – all segments of the industry are also demanding production resources, particularly labor. Defense is very strong right now, with record U.S. defense budgets and record world levels of spending. (Read sister publication *Defense and Munitions'* Jan/Feb 2025 cover story for more details.)

But returning to the positive side of things, comparing today's very sluggish recovery with the fast growth seen previously points to a possible silver lining. In most civil segments, market booms have tended to end with market busts. This is because for manufacturers, it's tough to know when to stop increasing production. They tend to keep the good times rolling and ignore warning signals to reduce output. The result tends to be overcapacity, followed, inevitably, by a production drop.

Today's recovery, while slow, holds no serious risk of overcapacity. Despite healthy backlogs, supply chain problems will almost certainly keep the industry from building too many aircraft for years to come.

https://aerodynamicadvisory.com

Dan Janka, President, Mazak Corp.

Commercial aircraft and defense spending will remain robust in 2025, and several other industry sectors will also experience upswings as policies favoring manufacturing materialize. Those industries include the oil & gas, mining, construction/infrastructure, and agriculture sectors along with medical and semiconductor industries.

While production demand surges in the aerospace and defense industries, skilled labor in manufacturing is going to remain a problem, and the cost of raw materials will continue to rise. This will, in turn, drive the need for investment in automation, advanced machine tools, and the use of digital manufacturing solutions to improve quality, output, and more effective use of existing assets.

Multi-tasking and full 5-axis machining along with gantry profiling and high-torque/high-speed milling will continue to dominate the aerospace, satellite, and private space exploration industry sectors. To maintain profitability, suppliers of aircraft structural parts, engine components, landing gear, rockets, and satellites as well as any other flight or mission-critical components will look to machine technologies that produce the highest quality parts, delivered quickly and at the lowest possible price.

Along with automation and advanced machines, artificial intelligence (AI) is going to be a game changer during the next five years in the aerospace industry. It'll make smart machines and systems even smarter, eventually giving manufacturers the ability to go from a 3D model to an optimum part program quicker.
https://www.mazak.com

Raman Ram, Defense & Mobility Leader, EY Americas Aerospace

The aerospace and defense (A&D) industry is currently experiencing a period of sustained growth, across sectors – commercial air transport, business aviation, defense, and space – benefiting from favorable market conditions. Air traffic demand has returned to long-term growth trends, and commercial aircraft production rates are on the rise. Additionally, heightened global security concerns are contributing to a gradual increase in defense budgets. Despite the growing demand and rising investor expectations, the industry continues to face supply-side challenges.

The A&D supply chain is inherently less resilient due to variables such as single sourced, low-rate production, poor visibility into sub-tier suppliers, inflexible production systems, and outdated technology. These vulnerabilities are exacerbated by macroeconomic challenges such as inflation, talent shortages, and tariff uncertainties, leading to delivery delays and quality issues that hinder program performance. Addressing these requires proactive risk management using advanced monitoring and predictive tools to build resilience.

Supply risk monitoring and prediction is no longer nice to have, it's essential for the operational and financial success of A&D companies. Advances in digital technologies have dramatically reduced the time and investment needed to integrate these capabilities into existing processes and systems. However, technology alone isn't enough; successful organizational adoption requires a strong change-management strategy. The return on investment in these capabilities is transformative and can drive long-term competitive advantage.
https://www.ey.com/en_us

Sherman D'Souza, Global Aerospace and Defense Specialist, REGO-FIX

All indicators point to a strong 2025 for aerospace, defense, and space industry manufacturers. Though supply chain and workforce challenges must be addressed, overall demand for commercial, defense, and space technology will take off.

Aircraft inventories suggest a current 15,000-plane order backlog with some 42,000 additional planes needed between 2024 and 2043. There's also a huge demand growing for narrow-body aircraft in South Asia.

The private sector's entry into space has driven launch costs down from NASA's typical $2 billion to between $60 million and $90 million. That reduction will spur increased demand for and production of satellites, launch vehicles, and infrastructure.

With ongoing global tensions, defense spending is up, and in 2025, solid rocket motor inventories will need to be replenished. Defense planners are also focusing on R&D and next-generation systems while spending to modernize legacy programs.

On the downside, labor shortages continue to cramp production. Additionally, ongoing raw material supply chain issues – especially those around the acquisition and shipment of titanium – will affect downstream part delivery and, indirectly, aircraft final cost if not addressed. Manufacturers are actively countering the lack of skilled operators with education and apprenticeship programs, but government and original equipment manufacturers (OEMs) must spotlight supply bottlenecks before small delays become bigger problems.

The economy, interest rates, and political uncertainty were troublesome for aerospace in the past year. But demand is there for 2025, and manufacturers are poised for a resurgence with budgets and justifications in place.
https://regousa.com

Jason Roberson, Industry Value Expert – Aerospace & Defense, Dassault Systèmes
In the past year, we witnessed an accelerating trend of companies – from startups to established tech giants – venturing into Earth orbit. In 2025, as the democratization of space continues, a new wave of innovation will fuel a modern-day space race that transcends national borders. This dynamic shift is set to revolutionize the space economy, transforming how we approach exploration, communication, and commerce in the years ahead. Central to this transformation is the rapid pace of digitalization, which is already driving the next generation of space technologies.

As we move into 2025, the role of virtual twins coupled with advanced simulations will accelerate product development, operational efficiency, and the evolution of space technologies. The ability to simulate, test, and refine space products virtually will dramatically shorten development timelines, creating a competitive edge for those who leverage these cutting-edge tools. In this high-stakes race, speed will be the defining factor for success, and companies who harness the power of virtual twins and simulation technologies will emerge as industry leaders. This will also allow for more competition in this next-gen space race, where industry juggernauts are not the only ones with the ability to break into space. Lower barriers to entry for new entrants will be a game changer for the space industry, and the result of the competition it creates will be faster and dynamic innovation.
https://www.3ds.com/industries/aerospace-defense/space

John Giraldo, Americas Engineering Projects Manager – Aerospace, Space, and Defense, Sandvik Coromant
Digital transformation through artificial intelligence (AI) will continue to play a key role as we move into 2025 and will be implemented in many parts of manufacturing to automate manual processes and eliminate human errors.

- Robotics and automation will be more accessible to smaller companies as continued advancements drive affordability and ease-of-use, resulting in fewer bottlenecks and fewer challenges with skilled labor shortages.
- Autonomous systems will continue to play a larger role in the transportation and delivery of components and equipment, both on the factory floor and across the supply chain.
- Integrating advanced AI into robotics

will enable adaptive smart manufacturing systems and enhance overall robot decision-making.
- Using AI to analyze large pools of tool wear data will assist with predicting wear on cutting tools.
- AI will be used by CAD and CAM companies to help users program and design their components more quickly. AI software can analyze component features to predict and recommend the optimal machining operations and parameters, dramatically simplifying the programming process.
- AI-powered digital twins will enable real-time data analysis to optimize manufacturing processes. They'll have the potential to simulate various changes in the manufacturing cycle such as design changes or expedited timelines.

Sustainability
- There will be continued investments in alternative energy sources such as electric flight technology and all-electric aircraft that run on batteries to curb emissions. There will also be continued investments in alternative forms of air transportation, such as drone technology for package deliveries.
- Manufacturers will continue to adopt and invest in renewable energy sources such as solar, wind, and geothermal power to reduce greenhouse gas emissions and meet ambitious climate goals.
- Greater adoption of 3D printing will power more sustainable manufacturing, reducing material waste.
- Manufacturers will increasingly turn to lightweight materials and optimize aircraft and engine designs to reduce emissions and fuel costs. **https://www.sandvik.coromant.com A**

About the author: Eric Brothers is editor of GIE Media's Manufacturing Group. He can be reached at 216.393.2228 or EBrothers@gie.net.

For more forecast insights from industry insiders, visit https://www.aerospacemanufacturinganddesign.com/magazine/january-february-2025

ASK THE EXPERT

QUESTIONS WITH ATLAS TECHNOLOGIES' JED BOTHELL

Identifying why aluminum vacuum chambers and bimetal fittings and flanges are the winning choice for aerospace testing and performance.

1 How are UHV and XHV chambers applied in the aerospace industry today?

Vacuum chambers are often used for testing satellites, space vehicles, and related components prior to launch. Because vacuum in deep space reaches 1×10^{-17} torr or higher, on-earth testing to ultra-high vacuum (UHV / 10^{-7} torr to 10^{-11} torr) or extreme high vacuum (XHV / 10^{-12+} torr) levels provides the most accurate simulation currently possible. Chambers are also used for telescopes and gravitational wave detectors.

2 What makes aluminum a better vacuum chamber material?

Aluminum contains about 10 million times less hydrogen than stainless steel. It also has little carbon and absorbs far less gas from the atmosphere when a chamber is opened. The result is greatly reduced vessel contamination.

Aluminum conducts heat 10x better than stainless steel, so a chamber can be heated and cooled quickly, allowing better simulation of the rapid temperature changes experienced by orbiting spacecraft. In addition, the process of baking out impurities to improve vacuum is faster and more complete.

Aluminum is non-magnetic and has low residual radioactivity, both desirable features for testing and use in space. It also offers significant vibration dampening, making it ideal for precision applications where excess vibration can have disastrous consequences.

Aluminum is less expensive than stainless steel for large vacuum vessels. It machines 10x faster, costs less per unit strength, and is lighter weight, resulting in lower manufacturing, shipping, and installation costs.

Finally, the light weight of aluminum makes it an obvious choice for vacuum chambers that are launched into space.

3 What are the key applications for bimetallic and multi metal components in aerospace?

It's all in the critical transitions. In fuel lines, stainless tubes can transition to aluminum tubes with a single bonded stainless steel/aluminum fitting. In rocket engines, where high temperatures melt most metals, a small fitting capable of withstanding the extreme heat can be bonded to other metals. And bimetal flanges provide rugged, demountable, industry-standard ConFlat (CF) sealing for UHV and XHV vessels.

4 What makes bimetal a better option for aerospace?

Solid state, explosion bonded bimetals can combine metals with wildly different properties to address weight constraints, radiation shielding, extreme temperatures, and chemically corrosive environments.

For example, niobium alloy thruster nozzles maintain mechanical integrity and corrosion resistance at temperatures more than 2,000°F. However, niobium is heavy and expensive for use in the entire fuel delivery system. A niobium/stainless transition combines the advantages of heat and chemical resistance with lighter weight and lower cost – resulting in a more resilient, less costly, and longer-lived system.

NASA atmospheric simulation chamber

These bimetallic joints offer long-term reliability with no servicing, unlike joints using adhesives, bolts, and elastomeric seals. This is especially beneficial in space where it isn't practical to replace a component.

Atlas Technologies is a fully integrated U.S.-based facility with onsite engineering, testing, and manufacturing capabilities, specializing in aluminum vacuum and bimetal components.

FOR MORE INFORMATION
https://www.AtlasUHV.com

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Moya Aero eVTOL UAV. PHOTO COURTESY ALTAIR

Altair, Moya Aero to develop UAVs

Brazilian aerospace start-up Moya Aero is collaborating with computational intelligence provider Altair as part of the latter's Aerospace Startup Acceleration Program (ASAP).

Moya Aero will leverage Altair's HyperWorks design and simulation platform to accelerate product development and reduce prototyping costs of electric vertical take-off and landing (eVTOL) and uncrewed aerial vehicles (UAVs).

Moya Aero, founded in 2020 as a spin-off from ACS-Aviation, seeks to provide high-capacity autonomous UAVs for sustainable and efficient cargo transportation in untapped markets. **https://altair.com; https://moyaaero.com**


BlueBear mobile command and control system with UAVs on the ground. PHOTO COURTESY SAAB GROUP

Autonomous Swarm technology used in AUKUS trial

Saab's Autonomous Swarm technology was recently featured in the AUKUS Project Convergence 2024. AUKUS, a trilateral security partnership between Australia, the United Kingdom, and the United States, held trials demonstrating Saab-owned BlueBear's artificial intelligence (AI)-enabled Centurion mission system which allowed a single operator to command a diverse swarm of uncrewed aircraft systems (UAS).

The AUKUS trial was the culmination of autonomy and open architecture work funded by the Defence Science and Technology Laboratory (Dstl) of the UK Ministry of Defence during the past two decades. **https://bbsr.co.uk; https://www.gov.uk/government/organisations/defence-science-and-technology-laboratory; https://www.saab.com**

NORTHERN PLAINS UAS TEST SITE

PHOTO COURTESY NPUASTS

NPUASTS, TDOT partner on BVLOS system

North Dakota's Northern Plains UAS Test Site (NPUASTS) and the Tennessee Department of Transportation (TDOT) are partnering to develop a system like NPUASTS' Vantis beyond-visual-line-of-sight (BVLOS) system in Tennessee, aimed at enhancing its uncrewed aircraft system (UAS) program throughout the next five years.

NPUASTS provided a comprehensive proposal to assist in the planning, development, implementation, and operation of a system to support UAS and other autonomous technologies as directed by Tennessee leadership. The Test Site will collaborate with TDOT to assess current assets and infrastructure to devise a strategic plan for deploying the necessary infrastructure to meet their objectives.

"This collaboration represents a significant step forward in creating a more interconnected and sustainable UAS ecosystem in the United States," says Trevor Woods, executive director of NPUASTS. "By working together across state lines, we can achieve greater collaboration and support the development of robust infrastructure."

"We're eager to leverage NPUASTS as Tennessee continues to grow and demands on the transportation system increase," says TDOT Aeronautics Director JP Saalwaechter.

As one of seven FAA-designated UAS Test Sites, NPUASTS is committed to leading the nation in autonomous technology solutions and is at the forefront of integrating UAS into the National Airspace System. **https://www.npuasts.com; https://www.tn.gov/tdot.html; https://www.vantisuas.com**

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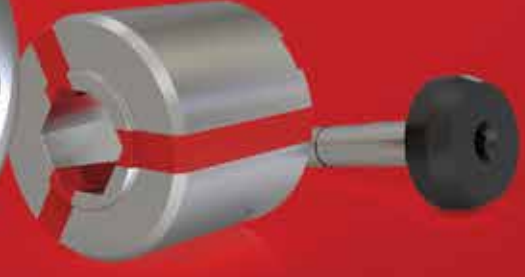

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Bayonet-connection milling head

The BFS bayonet-type connection for replaceable-head milling systems achieves high rigidity and symmetrical insertion and force distribution from the large cylindrical face connection. The replaceable head is inserted and turned 90° to lock. In previous systems, the threaded replaceable head required several turns to be screwed in.

In keeping with the trend toward more sustainability, the bayonet connection uses 70% less material compared to the previous connection.

The BFS is offered in seven different sizes with head diameters from 11.8mm to 22.5mm and head lengths up to 1xD. Extended cooling channels allow for more efficient cooling directly at the cutting edges and greater stability. The manufacturer can also custom design the tool holder to optimize coolant supply.

MAPAL
https://mapal.com

Tool measurement, inspection system

The VT 122 measuring camera system automatically creates images for efficient tool inspection, acting as a tool presetter, tool microscope, and visual tool inspector all in one system. It allows for comprehensive tool analysis within the machine envelope, reducing downtime.

Non-contact measurement of tool length, radius, and corner radius accommodates sensitive edges. End mills, ball nose cutters, and drill bits at least 1mm in diameter are supported. In-process inspection can be performed on preset tools.

The camera can take close-up images of each tooth, or detailed panoramic images of the entire tool circumference. The lighting angle can be adjusted for optimal illumination of individual teeth. Tools can also be imaged from below.

HEIDENHAIN
https://www.heidenhain.com

VT 122 vision system

- Two cameras with ring light, lateral illumination
- Compressed-air inlet for tool, vision system cleaning
- System control, tool evaluation through VTC software
- Gigabit Ethernet interface
- IP66/IP68 protection rating

Automatic pallet changer with trunnion

The automatic 4-pallet changer with trunnion system for CNC machining integrates with vertical machining centers (VMCs) via M-codes, allowing operators to control the system directly from the VMC's control panel.

The 4-pallet changer features durable cast aluminum or cast-iron pallets in X-Y sizes from 28" x 15" (711mm x 381mm) to 50" x 24" (1270mm x 609mm). Each pallet is automatically transferred with ± 0.0001" (0.0025mm) repeatability onto a cast-iron receiver mounted directly on the machine table that supports up to 500 lb (226kg) for smaller models and up to 2,000 lb (908kg) on larger models with weight evenly distributed. The system is powered by a servo drive and equipped with a rotary shuttle, automatic door, and CE light curtain for safety.

The shuttle system's two loading stations allow clear access to all four pallets with no overhead obstruction for workflows requiring heavy part handling or crane loading.

The trunnion system enables 4th-axis operations on a 3-axis VMC, handling parts with complex geometries, angled surfaces, or multi-sided components to perform intricate work in a single setup. The included actuator assembly provides smooth, reliable trunnion movement and straightforward operation.

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4 TOOLING STRATEGIES to reduce vibration in boring operations

Advances in modular, digital, and anti-vibration tooling help cut the chatter.

By Matt Tegelman

Vibration is a slippery slope. You could have the ideal tooling setup for a given application and still encounter unforeseen issues. In precision boring operations, vibration can slow you down, cause excessive tool wear, and even result in scrapped parts. The specific factors that can contribute to vibration are myriad – but we have the best four ways to minimize them.

Modular CK precision tool system components use a cylindrical connection with a radial locking screw.

1 ***Choose the best anti-vibration tech*** – The fight against vibration starts at the machine, but what if your machine tool isn't new? For older machines and applications requiring extremely tight tolerances, tooling tech can go a long way. The EWN Smart Damper combats vibrations and reduces chatter in deep-hole finish boring via a passive damping mechanism that counters vibration with high-resonance friction action. Smart Damper components are designed to be modular, enabling longer tool assemblies that address vibration as close to the cut as possible. It's not just for a better finish – the Smart Damper system enables higher speeds and feeds to improve cycle times up to 10x.

2 ***Think smart with modular solutions*** – Common logic tells us modular tooling can cause problems with rigidity. It's true that when using modular tooling systems to achieve extension, fewer connections are better. But in complex and deep-hole boring operations, longer tools may be inevitable. Several approaches to modular tooling can reduce vibrations:

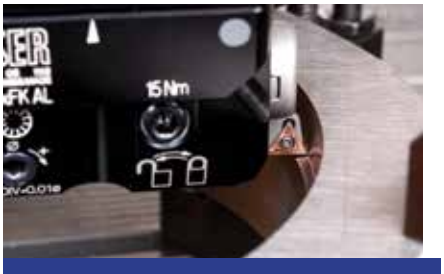
- Lighter, higher-precision modular parts combat issues with tool assembly weight, reducing vibration and tool-change issues. Modular tooling allows greater flexibility with modular connections without compromising precision.
- In specialized cases, a different type of modular assembly can help: adding a guide bushing around the tool to guide the tool in the hole in a more rigid way. This solution calls for slower

ALL PHOTOS COURTESY BIG DAISHOWA INC.

The EWE 2-152 digital fine boring heads connect to BIG KAISER's user-friendly smartphone and tablet app. This integration simplifies monitoring and configuring the boring head during assembly and operation of boring tools. The app enables users to track changes in cutting diameter and helps operators determine optimal cutting parameters for tool assemblies. Additionally, the heads feature variable length adjustments for tool holders, ensuring the shortest and most rigid tool assembly possible.

The modular CK system is fully compatible with all machine tool interfaces, allowing the user to create tool assemblies tailored to specific requirements. Optional features, such as anti-vibration technology, balance compensation, and digital readouts, are available from stock.

The EWN Smart Damper is designed for precision deep-hole machining, allowing for high cutting parameters that result in extremely short cycle times, improved surface finishes, and enhanced metal removal rates.



BIG DAISHOWA offers a range of boring inserts, including pressed and ground-geometry, available in coated and uncoated grades, to optimize performance and extend tool life.

cutting and careful observation, so seek application support from a trusted tooling partner.

- Each piece of a modular system must be higher quality and more rigid than single-tool solutions to make up for the incremental loss in rigidity as connections are added.

3 ***Compensate with digital boring heads*** – For boring applications requiring tight tolerances or where challenges increase the risk of oversized or undersized holes, digital boring heads can offer a bit of insurance and significantly speed production. Digital boring heads allow operators to make high-precision adjustments faster and easier.

4 ***Select the right insert*** – The right tooling insert to reduce vibration in boring is a high-quality, ground insert with a sharp cutting edge to reduce tool pressure. Beyond that, longer lead angles may allow you to increase speeds and feeds, but lead angles closer to 90° apply the least amount of radial pressure against the tool. Less pressure means less vibration – and better productivity and tool life.

Minimizing vibration to achieve optimal results and productivity is a team effort, from the many physical components at play to application experts who can help guide your team to the best solution.**A**

BIG DAISHOWA Inc.
https://www.bigdaishowa.com

About the author: Matt Tegelman is senior product specialist for BIG DAISHOWA Inc. He can be reached at matt.tegelman@us.bigdaishowa.com.

AvAir is certified climate neutral

Aviation aftermarket inventory solutions provider AvAir has been Climate Neutral Certified by the Change Climate Project. AvAir is the first aviation aftermarket company to achieve the standard by measuring 12 months of greenhouse gas emissions, acting on reduction plans, and compensating their footprint with eligible-verified credits.

Climate Neutral Certified is earned by organizations choosing to be accountable for greenhouse gas emissions generated in the production, operations, and shipping of goods and services.

"We're extremely proud to receive this certificate and be Climate Neutral Certified," says Tyler Botthof, vice president of operations at AvAir. "As a company, we've committed to removing nearly 7,000 tons of carbon dioxide emissions which is equal to driving 1,500 gas-powered cars for one year and taking steps to continue to reduce carbon dioxide emissions that are a result of the company's and team's actions."

"Climate Neutral Certified companies are demonstrating immediate action on climate change is possible and essential," says Austin Whitman, CEO of Change Climate.

Brands must measure cradle-to-customer greenhouse gas emissions each year to maintain certification, then commit to cutting future emissions within 12-to-24-months and invest in verified carbon credits to compensate for their emissions.

AvAir is also working with Waste Management (WM) to invest, improve, and build upon its sustainability strategy and endeavor. AvAir is assessing its processes and data to benchmark procurement, waste, water, energy, fuel, transportation, and other potential contributors to greenhouse gas emissions.

"AvAir is modeling what companies can do when they lean into environmental commitments," says Eric Dixon, vice president, sustainability & environmental solutions, WM. "For more than two years, we've helped AvAir better understand its environmental footprint, from procurement and waste generation to transportation and utilities."

AvAir is headquartered in Chandler, Arizona, with operations in Dublin, Ireland. **https://www.changeclimate.org; https://avair.aero; https://www.wm.com**

CommuteAir, Embraer sign inventory management, repair services contract

United Express partner CommuteAir and Embraer are expanding their partnership with an Exchange Plus Program to support CommuteAir's E-Jet fleet. Through the program, CommuteAir will be able to access tailored inventory management and repair services from Embraer's worldwide supply chain.

"CommuteAir is excited to build on its existing partnership with Embraer for our ERJ145 aircraft to now include parts inventory and repair support for our E-Jet aircraft," says Lon Ziegler, CommuteAir's technical operations vice president. "Embraer will help ensure we have a ready supply of parts to support our charter operations using the 76-seat E170 aircraft."

CommuteAir and Embraer are already partners on rotable and expendable parts support for the ERJ145 fleet through the Pool and Inventory Planning programs.

CommuteAir operates 57 Embraer ERJ145s for United Airlines. Additionally, CommuteAir offers charter services with an Embraer E170 under its own brand. Headquartered in suburban Cleveland, CommuteAir has major hubs at Houston Intercontinental and Washington Dulles airports and operates maintenance hangars in Houston, Texas; Albany, New York; and Lincoln, Nebraska. **https://www.commuteair.com; https://embraer.com**

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- Maximum Bar Capacity: 2.5 inches.
- Rapid Traverse (X/Y/Z): 1,181/472/1,181 ipm.
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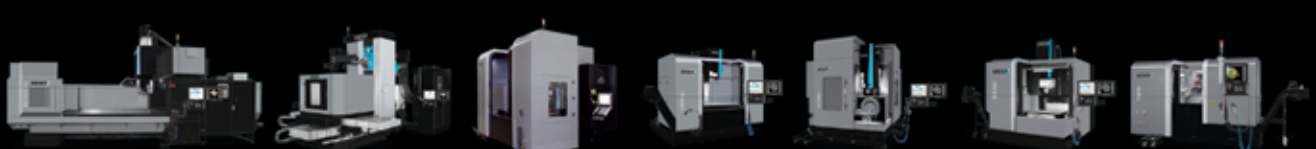
  - Speed: 4,000 rpm.
  - Power (continuous): 15.5 hp
  - Torque (continuous): 72.4 ft. lbs.
- Direct-drive linear axes.



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NAME THAT PLANE

Brought to you by AEROSPACE MANUFACTURING and DESIGN

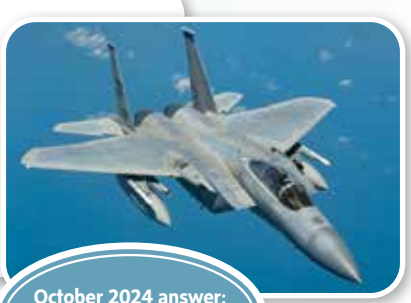
Aerospace Manufacturing and Design welcomes all aircraft enthusiasts to join the fun and NAME THAT PLANE! Each issue, a new aircraft will be featured. Given a photo and a clue box, readers are encouraged to guess what plane is being described and submit their answers to **www.AerospaceManufacturingAndDesign.com/Form/NameThatPlane.**

RAPID-FIRE FACTS

- Role: Air superiority fighter
- First flight: July 27, 1972
- Status: In service
- Primary users: U.S. Air Force, Japan Air Self-Defense Force, Royal Saudi Air Force, Israeli Air Force

SPECIFICATIONS

- Wingspan: 42ft 10" (13.1m)
- Length: 63ft 9" (19.4m)
- Height: 18ft 6" (5.6m)
- Max. speed: 1,617mph (2,602km/h)
- Engines: Pratt & Whitney F100-PW-220 afterburning turbofans



October 2024 answer:
Laird-Turner RT-14 Meteor

OCTOBER 2024 WINNER:

Luis Suarez, Manufacturing Engineer,
C&S Propeller, Fort Worth, Texas

How long have you been in the aerospace business?
3 years.

How did you become interested in aircraft?
Since I was a kid and would see aircraft taking off from a nearby military base during recess.

What is your favorite aircraft and why?
My favorite aircraft is the Lockheed C-130 just because it's a plane I grew up watching it fly and now I get to work on its propellers.

RUNNERS-UP:

Josh Hill
Mechanical Engineer
ATI Forged Products
Cudahy, Wisconsin

Bob Bialkowski
President
Great Lakes Aviation Services LLC
Kimball, Michigan

SUBMISSION PROCEDURE

To enter the contest, visit http://www.AerospaceManufacturingAndDesign.com/Form/NameThatPlane and fill out the provided entry form. Only completed forms will qualify. A full set of rules is provided.

The entry deadline for this issue's contest is March 7, 2025. Winners will be announced in the April 2025 issue.

Have fun, and good luck!

Look what Luis won!

Enter today to win your own high-quality desktop aircraft replica!

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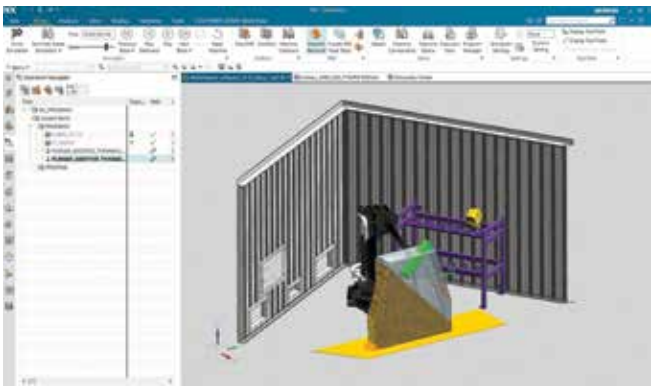
Digital thread allows users to simulate machine builds, part production



Siemens has developed a fully integrated digital thread between its NX software suite of CAD and CAM products and SINUMERIK control technology for additive and subtractive manufacturing. Using Create MyVirtual Machine and Run MyVirtual Machine digital twin technology, the system allows additive machine builders and users to fully digitalize the machine build (including software systems, post-processors, part programs, HMIs, and Edge devices), as well as machine commissioning and manufacturing process in a virtual world, long before the actual machine build or first part production begins.

As industrial additive manufacturing (AM) shifts toward more final part production, Siemens saw the need to create a full digital thread allowing CAM toolpaths, generated by NX, to interface with the virtual controller and run time code, complete with 3D machine kinematics, code execution, machine parameterization, visualization of material deposition and removal, and other real world characteristics.

The flexibility of NX to simulate hybrid scenarios combines with the SINUMERIK virtual controller to provide a comprehensive look at the machine's characteristics and the production process.

Siemens
https://www.siemens.com

3D printer offers temperature control for multimaterial printing

The CORE One is the latest addition to Prusa's line of 3D printers, featuring a fully enclosed frame with active chamber temperature control up to 55°C. It uses a CoreXY kinematic system and offers increased speed and more compact design compared to previous releases, while maintaining a large print volume of 250mm x 220mm x 270mm.

The printer's temperature control feature allows users to print with materials from standard PLA and PETG to more advanced polymers. Its robust, stable design is intended to last for years, yet in line with Prusa's open source philosophy users can modify their printers with only a screwdriver. The CORE One can be operated fully offline, and the open source firmware updated offline as well for added security. Prusa will offer a Conversion Kit allowing users to transform their Original Prusa MK4S 3D printers into CORE One models.

Prusa Research
https://www.prusa3d.com

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BUILD MACHINING CELLS FROM THE GROUND UP

Precision manufacturer Machine Sciences partners with Fastems to automate six work cells.

Edited by Elizabeth Engler Modic

For nearly a quarter of a century, Machine Sciences has been on the move. Since its start in 2001 by Founder & CEO Brian McCabe (who remains its majority owner), the company has grown more than 20% annually, changing locations as it expanded shop floor space, eventually settling in Tualatin, Oregon in 2020. The space is unique in that McCabe and his team partnered with a developer to determine how the building would be designed, maximizing shop layout and workflow. This forward-thinking approach mirrors Machine Science's commitment to working with emerging technologies in satellites, rockets, drones, and advanced air mobility vehicles.

Planning the work space

Machine Science's 72,00ft^2 CNC machine shop houses a robust Fastems automation system and 34 CNC machines – 10 of which are 5-axis mills and 6 are lathes – and the shop's laid out in six work cells.

According to McCabe, "The idea is there's redundancy in equipment in each cell, so if one piece of equipment has a maintenance issue or is over-scheduled because of increased demand for a part, we have the same or comparable equipment next to it to which we can transfer the job."

The lathe cell contains three mill/turns, two lathes with live tooling, and a Swiss screw machine. A vertical cell contains 11 machines (10 Haas mills and one FANUC Robodrill). Four DMG MORI DMU 50 machines are in the 5-axis prototyping cell.

"In the first three work cells our operator interfaces with the machine," McCabe says. "The last three cells are all linear-pallet cells connecting multiple machines with automation."

PHOTOS COURTESY FASTEMS AND MACHINE SCIENCES

Teams from Machine Sciences and Fastems worked together to draw out the entire automated system to determine how many machines would fit in the designated area for 5-axis cells. Every millimeter mattered.

The final cell features three GROB 552's – two standard and a 552T 2+1 turning center – with two more machines on order. "We designed this last cell along with Fastems to accommodate five matching machines," McCabe adds. The first three machines operate 24/7 with two pre-installed pallet systems ready and waiting for the final two machines.

Often, machining centers are available with the manufacturer's optional pallet loading stations. Machine Sciences' needs were more complicated, requiring the team to look elsewhere for an automation solutions partner. "We had one cell system with two load stations and one with four," says Process Engineer Chris Luis. "We found we really liked having the extra load stations and when the GROB cell system is fully up and running, it will have four load stations, 108 pallets, and five machines. This was the maximum that could be installed in the 110ft clear span of the building. We wanted to have four load stations so operators can keep the machines fed and parts moving through."

Fastems designed a pallet changing system consisting of a single pallet for the GROBs resembling a lazy Susan with a pallet waiting at each machine. A robot replaces each pallet as it's taken, significantly reducing machine waiting time.

"Another big draw for me as an operator who runs it all is having the data the Fastems system collects," Luis adds. "I keep live tooling inventories for all the machines in the system. Even the tool holders appear on the screen, and it makes it easy for me to see where my empty tool holders are."

Having tool holder inventory at hand and viewing the pallets and scheduling has been invaluable. The team can see when material stock is running low and plan for big jobs without keeping a large material inventory. The machines each contain 140 tools with an additional 200 tools in an external magazine on each machine.

Designing the work cell

Machine Sciences' growth played a part in their decision to go with a Fastems modular pallet loading system. It provided the flexibility needed within the cell system. Early in planning, Luis suggested Fastems, and the company worked with distributor Machine Tools Northwest's Vince Selway and Fastems' International Sales Manager Robert Humphreys to determine which system was best. Ultimately, they decided on the modular Fastems Flexible Manufacturing System (FMS) comprising a rail-guided transportation vehicle, a setup station and material station, buffer storage, a control system, and integrated machine tools.

"A big thing for us was Fastems drew out the entire system and helped figure out exactly how many machines we could fit in the area planned for a 5-axis cell system,

TOP: Brian McCabe and his team partnered with a developer to determine how the building would be designed, tailoring it to an ideal machine shop layout and workflow.

BELOW: Machine Sciences has received an increase in demand for critical defense components. The ability to set up and load multiple pallets, get the materials lined up on the machines, and schedule unmanned production time has made a significant difference in meeting these new deadlines.

PHOTOS COURTESY FASTEMS AND MACHINE SCIENCES

how we could fit all five GROB machines on the 18" steel reinforced concrete slabs poured with the original building foundation, and locating exactly where in the shop everything needed to go," Luis explains. "We went through several iterations with Fastems lining up all the machines and Fastems equipment. We also had CAD drawings of our shop showing all the machines and including all our slab-lines." Eventually, every individual machine foot of the cell system was aligned to ensure everything was falling on the concrete slabs and the machines weren't too close to any slab seams. "Planning it out with the Fastems team really took the majority of the work of getting the cell system designed and planned out," Luis recalls.

McCabe adds, "We were working in such a tight space that every edge mattered. We had to make sure we were going to get in and out with chip bins and whatnot. We had guys from Fastems mark on the floor exactly where components of the Fastems system would fit, down to the millimeter."

One pressing need was fitting as many spindles into the space as possible. According to Humphreys, they eventually ended up with five machine locations with four load stations – in addition to the existing systems. They had to figure out how to build the cell without complicating the current setup. "The machines are landlocked after installation," Humphreys recalls, "so we installed them back to front. Machines five, four, and three were installed and the open slots are currently open for machines one and two arriving soon. It was a tricky process, and it took a lot of patience to make sure everything fit. It's quite a work of art."

Luis and McCabe found the cell was the most important factor to consider when designing the space, and then everything else, from the type of machines to other equipment, was decided after the cell layout was finalized.

McCabe says, "Most shops will say 'these are the machines we want, what cell can you provide for these machines?' We asked, 'this is the cell we want, what size machine and what else can we put in the cell to best use our space?' Fastems was great at working on different iterations so we could make better use of the larger machines we needed the most."

Success

The GROB cell helps Machine Sciences meet some of its biggest challenges, especially machining complex satellite and drone parts with very short lead times. One customer has asked that Machine Sciences

Teams from Machine Sciences and Fastems worked together to draw out the entire automated system to determine how many machines would fit in the designated area for 5-axis cells.

with dashboard and reporting software modules. Luis appreciates the ability to view data on spindle run time to measure machine performance and how much run time they can expect to get from a particular spindle. The software goes one step further, though, and shows how much time a particular job took to complete and which program was used, so he can estimate run time for more accurate scheduling.

"One feature I really like is when I'm looking at spindle run times, I can have the operators specify why a machine is taken offline when it's taken out of automatic mode," Luis says. "I can take a look at the notes and see it was switched from auto to manual mode for a new part setup and the spindle hours were still captured."

PHOTOS COURTESY FASTEMS AND MACHINE SCIENCES

be the sole provider for all the parts on their drone bill of materials – 111 complex parts that need spot drops on all of them.

"The Fastems cell helps us because we'll just need to set the pallets and indicate it's a high-production job," Luis says.

They anticipate making 200 of these parts in different batches throughout the year. The pallets can be set up in storage according to the job specifications and Luis can upload the schedule to the Fastems Manufacturing Management Software (MMS) system according to customer deadlines. The entire job is then ready to go.

Luis says some orders have quadrupled over the years and the ability to set up and load multiple pallets, get the materials lined up on the machines, and schedule unattended production time has made a significant difference in meeting these new deadlines. The MMS software also helps keep things humming thanks to Machine Sciences' investment in the Ultimate software package including a DNC program and tool magazine management along

Summing up

For a shop focused on precision manufacturing for space, aerospace, and military customers, the ability to meet changing specifications on short notice is paramount to keeping the machines running. The ability to provide accurate and traceable data during every step of the manufacturing process helps with the reporting required of an AS9100-certified and ITAR-compliant operation. By partnering with their automation supplier Fastems, Machine Sciences tailored their space and processes to their customers' needs and, therefore, their own needs as well, starting from the smallest inch to the massive final space. **A**

DMG MORI USA
https://us.dmgmori.com

FANUC America
https://www.fanucamerica.com

Fastems Manufacturing Management Software (MMS) software allows operators to view data on spindle run time to measure machine performance for more accurate scheduling.

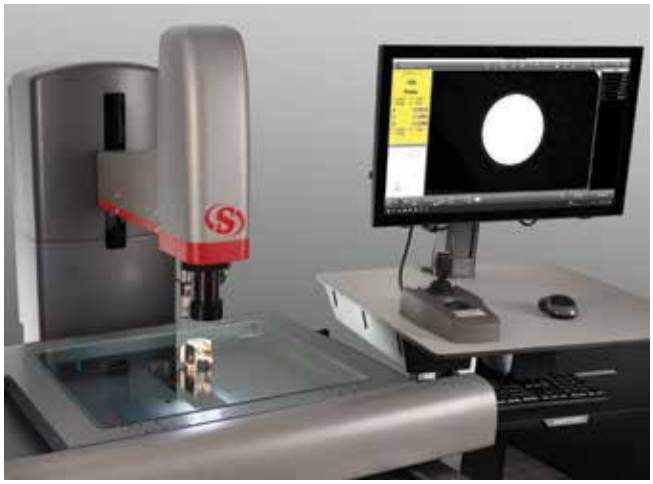
Fastems LLC
https://www.fastems.com

GROB Systems Inc.
https://www.grobgroup.com

Haas Automation Inc.
https://www.haascnc.com

Machine Sciences Corp.
https://www.machinesciences.com

Benchtop CNC vision system



The AVR400 CNC vision system is a benchtop platform with stage travel of 15.8" x 11.8" x 7.9" (400mm x 300mm x 200mm) in the X, Y, and Z axes with a speed up to 120mm/sec. It offers full CNC capabilities including X-Y-Z positioning and several zoom and telecentric lens options. Users can also choose motorized manual positioning via a pendant with a joystick and trackball.

The system features automatic part recognition, enabling creation of a part management program from the desired features of a part for inspection. Programmable light output options can be built into the program as defined steps, including being called up as the part recognition program initiates. Once the program is created, placing that part within the camera's field of view allows the saved program to initiate and run. A Renishaw touch probe can also be used for quick acquisition of discrete points along a part's profile and Z-axis measurements.

The AVR400 is equipped with the M3 software package from MetLogix and includes both a touchscreen and a traditional mouse. The system's built with a granite base for high stability and offers a line of accessories including a modular system workstation on rolling caster wheels.

The L.S. Starrett Co.
https://www.starrett.com

Cut-off system for small parts machining

The KGZ series cut-off system is made for small parts machining, featuring a body and clamp design for stable machining and to minimize chatter, improving surface finish and delivering more consistent tool life. Designed to boost efficiency, the KGZ series offers fast and secure insert installation, making it easier for operators to manage tooling without extensive downtime.

The inserts feature PR20 series coating technology for grooving and cut-off applications and are engineered to be more resistant to wear in a variety of materials, reducing the frequency of tool changes for a smoother, uninterrupted machining process. Users can select from four chipbreaker options for low- to high-feed machining or the sharp edge style for low cutting forces. The KGZ series comes in a variety of holder sizes with direct-to-turret, jet coolant-through styles available.

Kyocera SGS Precision Tools Inc.
https://www.kyocera-sgstool.com

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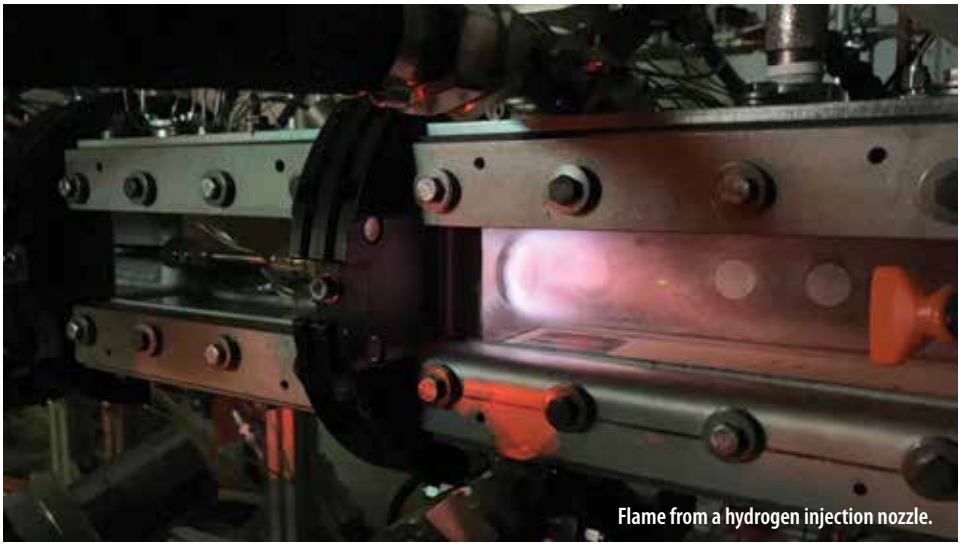
ad index

Edited by Eric Brothers

Readying jet engines **for hydrogen**



Flame from a hydrogen injection nozzle.

To make hydrogen-powered planes possible, engineers must develop the jet engines that will power them. Experiments by researchers at ETH Zurich are now providing the necessary basis for making these engines powerful and durable.

Europe is preparing for climate-neutral flight powered by sustainably produced hydrogen. In 2023, the EU launched a project to support industry and universities in developing a hydrogen-powered medium-haul aircraft. Among other things, jet engines will have to be adapted to run on the new fuel. Today's engines are optimized for burning kerosene.

"Hydrogen burns much faster than kerosene, resulting in more compact flames, which must be taken into account when designing hydrogen engines," explains Nicolas Noiray, professor in the Department of Mechanical and Process Engineering at ETH Zurich. Experiments by Noiray's team now provide an important basis for this difference. The team's results are published in the journal *Combustion and Flame.*

One problem is vibration, which engineers try to minimize. In typical jet engines, about 20 fuel injection nozzles are arranged around the annular combustion chamber of the engine. The turbulent combustion of the fuel there generates sound waves. These waves reflect from the chamber walls and have a feedback action on the flames. This coupling between the sound waves and flames can cause vibrations that induce a heavy load on the engine combustion chamber.

"These vibrations can fatigue the material, which in the worst case could lead to cracks and damage," says Abel Faure-Beaulieu, a former postdoctoral researcher in Noiray's group. "This is why, when new engines are being developed, care is taken to ensure that these vibrations don't occur under operating conditions."

An elaborate test and measurement facility at ETH Zurich allows Noiray to measure the acoustics of hydrogen flames and predict potential vibrations. As part of the EU HYdrogen DEmonstrator for Aviation (HYDEA) project in which he is involved, Noiray tests hydrogen injection nozzles produced by GE Aerospace.

"Our facility allows us to replicate the temperature and pressure conditions of an engine at cruising altitude," Noiray explains. The ETH researchers can also recreate the acoustics of various combustion chambers, enabling a wide range of measurements. "Our study is the first of its kind to measure the acoustic behavior of hydrogen flames under real flight conditions."

The researchers used a single nozzle and then modeled the acoustic behavior of the collection of nozzles as it would be arranged in a future hydrogen engine. The study is helping GE Aerospace engineers optimize the injection nozzles and pave the way for a high-performance hydrogen engine. In a few years, the engine should be ready for initial tests on the ground, and in the future, it could propel hydrogen fueled aircraft.

ETH Zurich
https://ethz.ch/en

Journal
Combustion and Flame

DOI
https://doi.org/10.1016/j.combustflame.2024.113776

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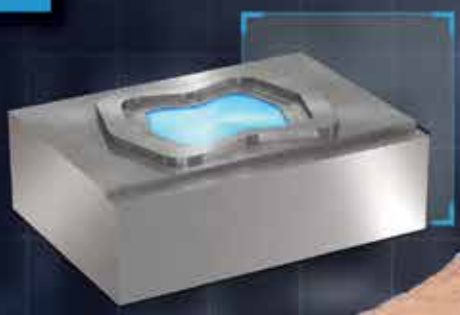

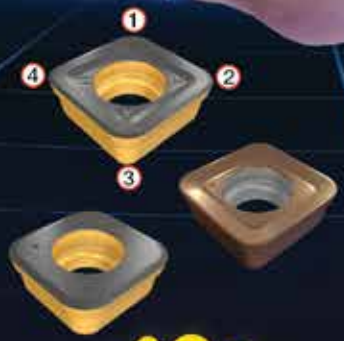

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