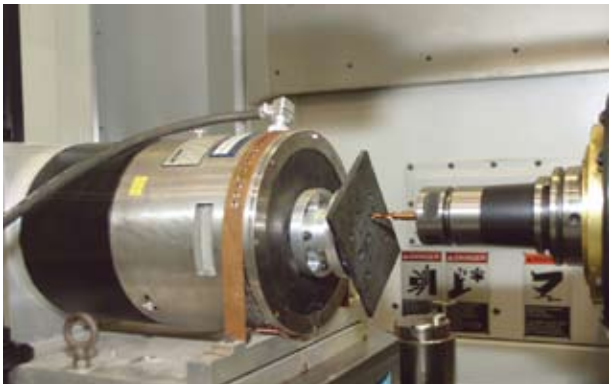
INFORMATION

AEROSPACE MANUFACTURING TECHNOLOGY

Advanced Materials Removal

Material removal experts at the NRC Institute for Aerospace Research (NRC Aerospace) develop high-performance, high-speed machining technologies to reduce costs and improve productivity in machining parts for the aerospace industry. Technologies currently under investigation include super-abrasive grinding, laser and vibration-assisted machining, dry machining, and machining under minimum quantity lubrication. Investigations are also carried out to enhance machine tool accuracy and cutting tool performance and to optimize machining processes using simulation and modeling tools.



Vibration-assisted drilling of composites

High-speed/high-performance machining

NRC Aerospace uses its high-speed Makino A88E machining centre to advance the machining of monolithic and thin- walled parts out of aluminum alloys, titanium and nickel-based alloys, stainless steels and composites. High-performance machining strategies are under development to reduce costs and speed up production of high quality parts.

The machining centre, which can mill, drill, bore and hone complex parts, is also used to develop Canadian expertise in super-abrasive grinding, a technology of interest to the aerospace industry because the high thermal conductivity of super-abrasives, such as diamond and cubic boron nitride, enables deeper grinding with less thermal damage. The grinding wheels, furthermore, have a longer life and can grind at a higher speed. Current studies are underway to integrate this grinding capability with the Makino's other machining processes.

High-performance turning

Aerospace materials such as nickel, titanium, inter-metallic alloys, and high-strength steels are difficult to cut because they retain their strength and hardness at elevated temperatures. Using its 6-axis, 2-spindle Boehringer NG200 turning centre, NRC Aerospace is developing high-performance turning strategies to more efficiently cut these materials. Investigations are also carried out on new technologies such as laser-assisted turning, which uses a laser beam to heat up and soften material prior to cutting, and dry machining.

Machining process dynamics and simulation

All machines and tool stack-ups exhibit dynamic characteristics that impact the cutting process. Machine tool performance, for instance, is often limited by chatter vibration, which reduces surface quality and decreases tool life. These characteristics vary significantly and are difficult to accurately predict by conventional means. NRC Aerospace is investigating the dynamics of machining processes to identify ways of effectively dealing with chatter through prediction and avoidance of onset.

State-of-the art modeling and simulation tools are used to optimize machining processes through correct selection of machining parameters and cutting tools, shortening machining time and reducing tool consumption. Finite element modeling of the machining process is used to predict residual stresses, burr formation, and other parameters that affect performance.

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Makino A88E Machining Centre

- Controller: FANUC 16i MA
- 5-axis, high-speed, high-power horizontal machining centre
- Spindle: maximum speed (18,000 rpm), power (50 kW), taper (HS-100A)
- Spindle vibration: 2 µm peak-to-peak at 12,000 rpm
- Tool magazine capacity: 40 tools
- Maximum work-piece size: 1000 mm dia. x 1300 mm
- Maximum work-piece weight: 1,200 kg
- Pallets: 2 pallets with a changing time of 17 sec
- Axes: 3 linear and 2 rotary axes
- Linear axis travel: X (900 mm), Y (800 mm), Z (970 mm)
- Rotary axes: 360 degrees, bi-directional
- Linear accuracy: positioning (±2 µm), repeatability (±1 µm)
- Maximum linear acceleration: 0.5 G
- Maximum rapid feed-rate: 50 m/min
- Maximum tool weight: 20 kg
- Maximum tool length: 690 mm
- Maximum tool diameter: 125 mm when adjacent pockets full; 300 mm when adjacent pockets empty
- Auxiliary tool measuring system and workpiece measuring device
- Coolant system: coolant pressure adjustable from 250 to 1000 psi
- Grinding capability
  - Retractable grinding nozzle unit
  - Table mounted rotary grinding wheel dresser
  - Permanent filtration system providing separation levels to 10 µm for grinding operation.

Boehringer NG200 Turning Centre

- Controller: Siemens SINUMERIK 840D
- 6-axis, two-spindle multi-tasking machine
- Working Area: maximum turning length (850 mm), maximum distance from main to sub-spindle nose (1,000 mm), swing diameter over bed (600 mm), maximum turning diameter with external tools (300 mm)
- Maximum rapid traverse: 25 m/min
- Main spindle: speed (4,000 rpm), power (40 kW), taper size (8)
- Sub-spindle: speed (4,500 rpm), power (36 kW), taper size (6)
- Linear axis travel: X (220 mm), Y (50 mm), Z (950 mm), sub-spindle (700 mm), steady rest (950 mm)
- Tool turret: storage capacity of 12 tools; 5 kW drive power; maximum 4,000 rpm.

Auxiliary equipment

- Shrink-fit machine for carbide, high-strength steel and cermet tools with automatic heating temperature control and up to 1” tool induction coil
- Balancing machine (two-plane balancing)
- Minimum quantity lubrication system
- Laser-assisted machining system
- Surface roughness, profile and topography measurement system (Form Talysurf Series S4C)
- Vacuum unit for collecting debris while machining composites.

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