

## Precision Machining

### CNC Milling Equipment



**Haas –VF-OE CNC Vertical-Mill**



**Haas -VF-6 CNC Vertical-Mill**

The Haas VF-OE has axis movements of X 30" x Y 16" x Z 15". The Haas VF-6 vertical machining center has 64" x 32" x 30" travels and is built utilizing vibration-damping cast-iron components. The Haas VF-6/40 is a rugged, medium-sized vertical machining center that yields reliability and accuracy in a moderately sized machine. The VF-6/40 has a 40-taper cartridge spindle driven by a 20 hp (14.9 kW) vector drive. The VF-6 produces either 75 ft-lb (102 Nm) of torque at a low 1400 rpm, or 250 ft-lb (339 Nm) at 450 rpm with the optional 2-speed gearbox -- and will also run up to 7500 rpm in 1.2 seconds for finishing aluminum. The Haas control features 15" color LCD monitor and a USB port.



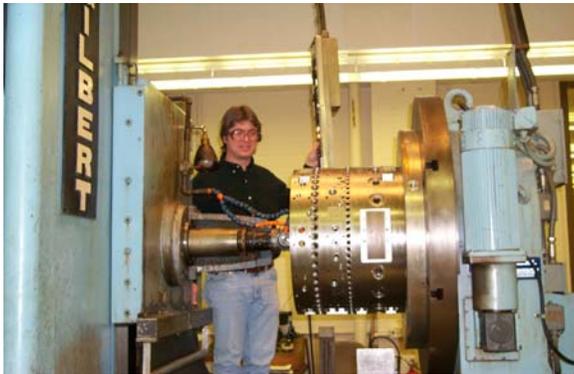
**Haas HS-4 CNC Horizontal Mill**

Horizontal Machining Center axis movements X 150" x Y 66" x Z 60" 50-taper geared-head, 30 hp (22.4 kW) vector drive, 5000 rpm, 38-tool side-mount tool changer, X-axis linear scales, 1 MB program memory, 15" color LCD monitor, USB port, rigid tapping and 95-gallon (360 liter) flood coolant system. The HS-4 features a 50-taper, geared-head spindle and a 10,000 lb (4536 kg) part capacity and offers fully supported X-axis travels to handle extremely heavy loads, and the high-torque 50-taper spindle allows serious metal removal.



**Monarch VMC 150B Vertical CNC Mill**

Combines big part capacity with precision performance. Table travel axis movements X 50" Y 36" Z 24" Table load 4000 lbs. 50-hp (peak) spindle drive 30 - 6000 spindle speed, 4.5 second tool change time. The VMC 150 has Accuracies as follows, Positioning, range $\pm$  0.0001", Repeatability, range $\pm$  0.00006" (up to 175b). It also has the following options: a high pressure/high flow coolant system, internal glass scales, and a full-function remote jog station. Computer Numeric Control: Traverse rate (X, Y, Z axis) - 600 ipm feed rate, maximum - 400 ipm (600 optional).



**Cincinnati Gilbert**

Five-Axis tool path and machining combines the movement of the machine head in the X-Y-Z axis directions with the ability of specialized machines to alter the angle and movement of the machining head and/or the rotary head. Five-axis Machine Capabilities: for the Cincinnati Gilbert is a 60" cube



**Makino A55E**

Makino's new Geometric Intelligence Software looks ahead in the part program for toolpath changes and compensates for machine dynamics to hold high machining accuracies at high cutting federates, and acceleration and deceleration in rapid traverse can now reach 1.0g with faster acceleration and deceleration, Makino's spindle can handle high rpm with low vibration for fast, accurate machining operations. As powerful as it is fast, the A55E provides unmatched start-to-finish processing efficiency. The A55E delivers a 12.8" wide trough positioned in the middle of the machining area and a double belt chip conveyor for maximum chip removal. The large 170.3 gallon (645 L) coolant tank capacity acts as heat sink, removing heat from the workpiece and tool. Core cooling of the ballscrew dissipates heat to increase accuracy during use. XYZ table travel X 28.7" Y 25.6" Z 28.7

### **Micro Machining**



**CNC Lathe**



**CNC Willimin Mill**

The lathe capacity was 8" diameter swing, with 6" X and 10" Z movement. The design and the placement in a temperature controlled, shock free environment, allowed minimal vibration to the vacuum chuck and part. The Willimin CNC 3 axis Swiss made milling machine, with a capacity of approximately 18" in the X axis, 6" in the Y and 5" in the Z axis, and a resolution and repeatability of .00004"

**CNC lathes**



**Haas SL-30 Slant Bed CNC lathe**

**Haas SL-20 Slant Bed CNC lathe**

The SL-30, with a max turning capacity of 17" x 34" and a 10" chuck, a bar capacity of up to 3.0". The SL-20, with a max turning capacity of 10.3" x 20" and an 8.3" chuck, has a bar capacity of up to 2.0". Haas high-performance turning centers also feature headstock castings with symmetric ribs for rigidity and thermal stability; on-the-fly wye-delta switching for peak performance throughout the rpm range. The Haas control features a 15" color LCD monitor and USB port.

**Manual Grinding**



**Surface Grinder Brown and Sharpe**

8" x 24" BROWN & SHARPE "Super-Precision"  
Hydraulic Surface grinder  
w/automatic incremental downfeed  
Model: #824 Micromaster  
worktable size..... 8" x 24"  
Grinds work to heights of.. 18" (W/14" wheel)  
Wheel sizes..... 14" x 1- 1/2" x 5"



**Kellenberger Universal OD/ID Grinder**

Distance between centers 23.6"  
Swing Diameter 13.77"  
Table swivel 11 deg  
The universal wheelhead U has been designed for OD-face- and ID-grinding in a single set up.  
The workhead is designed for a working capacity of up to max. 150kg (330lbs) between centres.

## Inspection Equipment



**FARO Arm**



**LEICA Laser Tracker**



**Sheffield Cordax**

Inspection Tool	Faro Arm	Leica Tracker	Sheffield Cordax	Zeiss Contura
software	Faro	Axyz	QC5000	Calypso
capacity	4ft. rad.	130ft. rad.	2ft.x2ft.x1.5ft.	2ft.x3ft.x2ft.
manual	x	x	x	x
automated				x
portability	x	x		
multi-axis (vectoring)	unlimited	line of sight or multi stations	only w/ star stylus	only w/ star stylus
GD&T	yes	no	yes	no
data record type	data points, scans	data points, scans	data points	data points, scans
evaluation of data	best fit	best fit	best fit	best fit, MaxIC, MinCC
laser scanner capable	x (\$20K)	x (\$20K)		
CAD translators	IGES std., STEP xtra	extra \$	none	IGES, STEP
level of difficulty	medium	high	medium	high
Report Format	very good	good	poor	needs work

## EDM Equipment



**Wire EDM**

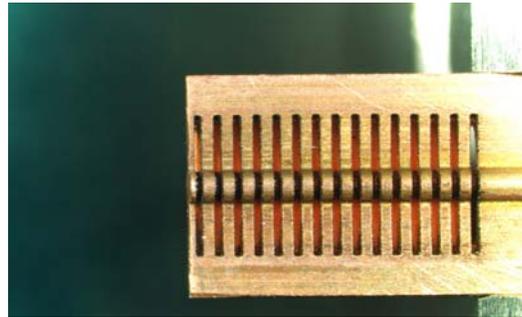
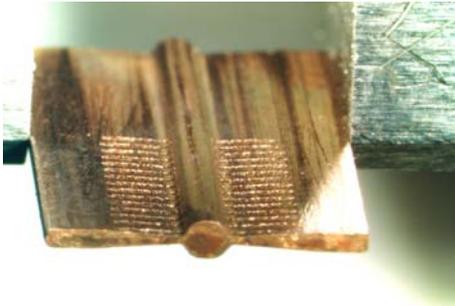
Wire Machine Capacities: De Ionized Water  
A280 (3) X 11.8" Y 7.8" Z 7" (Submersible)  
Charmille 440 CC X 21.6" Y 13.8" Z 15.7"  
Charmille 240 CC X 13.7" Y 8.6" Z 8.6  
Taper angle/height  $\pm 30^\circ/8.66$   
Repeatability  $\pm .0002$



**Sinker EDM**

Die Sinking Capacities: Oil  
A6R (1) X18" Y12" Z 12" (Submersible)  
A65R (1) X18" Y12" Z12"  
Both have programmable rotary axis's

Widely seen as a reliable and precise machining technology, EDM provides burr-free, multi-axis machining of parts that, because of hardness or shape, may be difficult or impossible to machine by other methods and although the process is slower than laser machining—its speeds are described in inches per hour (Wire Only) as opposed to the inches per second that characterize laser cutting—it is capable of holding tighter tolerances than laser.



### High Speed Dynamic Balancing



The capacities of the machines allow us to balance parts weighing ½ lb up to 5000 lbs. Rotors from 1” in diameter to 5’ in diameter can be balanced in our machines. Typically, a requestor specifies balancing accuracy in inch displacement of the minimum principal inertia axis from the axis of rotation. They will also specify whether they wish the balance to be achieved through weight removal or additional weight added, depending on application.

### Rapid Prototyping Equipment



### Selective Laser Sintering and Stereo lithography

The term rapid prototyping (RP) refers to a class of technologies that can automatically construct physical models from Computer-Aided Design (CAD) data. These "three dimensional printers" allow designers to quickly create tangible prototypes of their designs, rather than just two-dimensional pictures. Such models have numerous uses. They make excellent visual aids for communicating ideas with co-workers or customers. In addition, prototypes can be used for design testing. Part dimensions are moved directly from a CAD file to a functional plastic or metal part with a build envelope of 12x11x16 inches. A fraction of the time is required from traditional machining and tooling processes. The systems can build parts with a smooth, transparent surface finish and high dimensional accuracy. It's ideal for rapid modeling and prototyping of test hardware. Models can also be used for injection molding and investment casting

## Fabrication Technologies

The Fabrication Technologies area creates aeronautic structures that are riveted and fastened to common aero standards. They also can build and assemble flight hardware and space experiments. The technician in the fabrication area can precision form a variety of material from small intricate designs to large 20 foot diameters. They also have a full array of welding capabilities, which include most industry recognized welding applications.

The GRC Manufacturing Division processes rolling capacities from .015 thru 1.5” material thickness and small dia to more than 20’ diameter roll ups.



### DAVI Roll

The Davi four roll bending machine has the ability to roll up to 1 1/2" thick steel plate. The finished product can be up to 10 feet wide and over 20 feet in diameter. The machine can be programmed to produce conical, ovals, and ob-round shapes with accurate repeatability.



### Bertch 8" Roll

The Bertch 8" roll is a three roll rolling machine that can roll up to 4 foot lengths of material 1/2 " thick.



### Americol Roll

This CNC 4' three roll pinch bending roll has a capacity to roll diameters in excess of 3' using up to 14 gage material



### **Accu-Shear**

The Accu-shear has the capacity to cut a 10 ft long sheet, up to 3/8" s/s, 1/2" mild steel and 1/2" aluminum.

The Pexto precision hand shear has the capacity to cut a variety of thin material such as shim stock as thin as .0005.



### **Wysong Press**

The Wysong press brake is CNC controlled with the ability to create accurate and repeatable shapes in sheet metal up to 8 feet long and 4 ft wide. Steel, stainless, and aluminum up to 1/4" thick can be bent using a variety of dies To give a variety of radii from 1/32 to 2" using dies. It can also bump thicker metals to infinitely larger radii and can develop large conical bump shapes.



### **DI-CO Bending Brake**

This CNC controlled hyd. Brake has the ability to create accurate and repeatable shapes in sheet metal up to 4 feet long. Steel, stainless, and aluminum up to 3/16" thick can be bent using a variety of dies



### **Chicago Leaf Brake**

This manual Leaf Brake's has the capacity to bend 8' wide by 12 gage thick material. This brake is designed for accurate and economical bending of standard and special design forms.



### **Chicago Box Brake**

This manual Box Brake's has the capacity to bend 4' wide by 12 gage thick material. This brake has removable, sectioned fingers that can bend any length of metal from 3 inches long to the full length of the machine. Boxes and pans can be up to 6 inches deep.



### **Strippit Sheet Metal Punch**

This Precision hydraulic metal punching machine has the capacity to accurately and repeatedly punch 1/8" material up to 6" dia.



### **GEKA Metal Worker**

This metal working machine has the capacity to cut flat and round steel as well as various structural steel shapes. The GEKA is equipped to punch holes up to 2" and a notching attachment.

## Water Jet Technologies



**Omax WaterJet Machining Center**

The Omax Waterjet can cut a variety of material up to 2" thick. Such as Aluminum, Steels, Titanium, Glass, Ceramics, natural stone materials and carbon fiber to name a few of many. The Omax uses CNC programming to cut intricate shapes in the afore mentioned materials. The machine XY travel is 168" x 80", Work table size 178" x 89", Machined part Repeatability is  $\pm 0.001$ ", Squareness 0.002" per foot Straightness 0.003" per foot



**MG Water Jet**

The MG Water Jet has a cutting capacity of 72"x 120"x6" (WxLxH) and can cut a variety of material up to 6" thick. Such as Aluminum, Steels, Titanium, Glass, Ceramics, natural stone materials and carbon fiber.

## Welding Technologies

The following welding processes are used in the Manufacturing Technologies areas:

- Gas Tungsten Arc Welding (GTAW),
- Flux Core Arc Welding (FCAW)
- Shielded Metal Arc Welding (SMAW)
- Gas Metal Arc Welding (GMAW)
- Electron Beam Welding (EBW)
- Laser Welding
- Torch Brazing
- Soldering



A wide variety of materials can be welded by our certified technicians such as:

- Carbon Steel
- Stainless Steel
- Aluminum
- Copper (brazing)
- Haynes
- Hastelloy
- and similar metals heat resistant materials



Thicknesses from 0.0002" to 2" plate

### EB Welding



Electron beam welding is not only applicable to the same kinds of fabrication as the more conventional fusion processes, but the unique performance capabilities permit it to be used for a wide range of joining processes that cannot be handled by any other method. Some of the principal process capabilities of electron beam welding are given. It permits the narrowest known fusion zones and the highest known depth-to-width ratios. The depth-to-width ratios can exceed a ratio of 20 to 1 in some metals. The heat affected zones of the materials welded by this method possess better metallurgical properties when compared to other welding processes. Electron beam welding has made possible the joining of dissimilar metals, and repair welds previously deemed impossible. At present our capacities are limited to a 12" cube.

## Plasma Spray Technologies



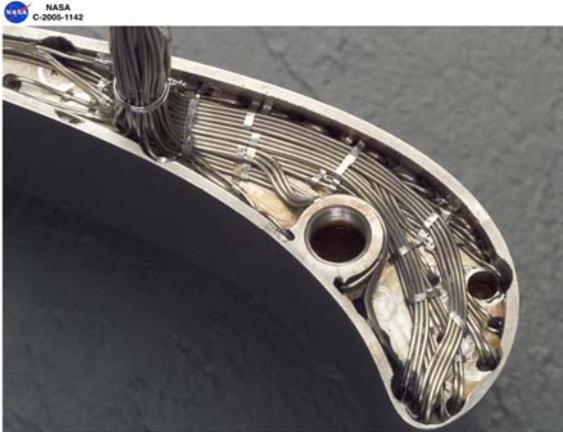
Coatings can be applied in a variety of thicknesses and hardness's. Further, the coatings can be softer than parent metal so that in a compressor test environment, where rotor and blade growth, during operation, are unpredictable, wear rings can be sprayed, preventing damage to expensive blades

## **Welded spool piece**

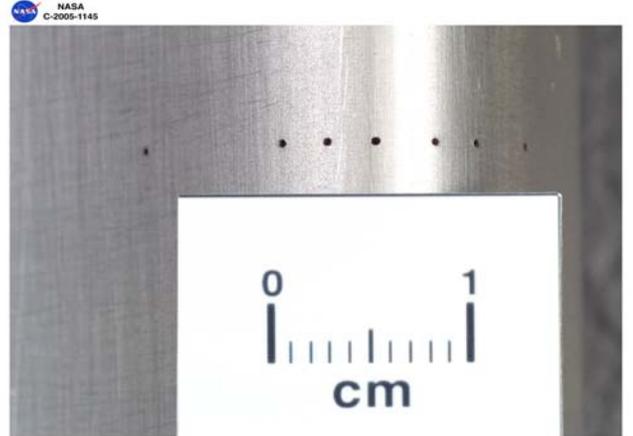


## Instrumentation Technologies

The Instrumentation technician fabricates, installs, modifies, repairs and tests pressure and temperature sensing instrumentation in single and multiple arrangements, such as probes, rakes, orifices, millivolt output and resistance-sensing devices and related component. Our technicians use an array of traditional and nontraditional machinery including welders, lasers, mills and lathes. Our technicians specializes in instrumentation manufacturing of custom temperature and pressure probes, Strain gage services, Research test cell services and Thermoelectric trouble shooting.



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John H. Glenn Research Center at Lewis Field



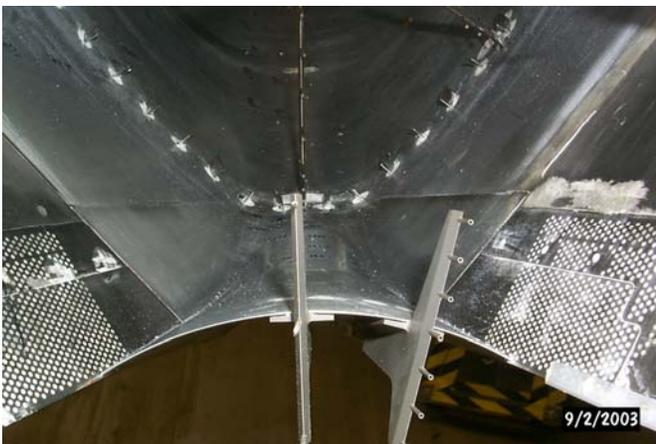
National Aeronautics and Space Administration  
John H. Glenn Research Center at Lewis Field



Gulfstream Proprietary



9/2/2003



9/2/2003

## Laser Technologies



Lasag 350 Watt Laser

We have 2 Nd:YAG pulse lasers in the Instrumentation group. Between the two of them, we possess a good deal of capability. This includes cutting and welding of 5-4700 microns, (.0002-.185 inch), thick material as well as laser scribing. Our lasers are capable of working with materials such as most metals, ceramics, carbon and silicon based materials, and some polymers. Substrate shape is not an issue since we can setup any configuration and have X, Y, Z, and C, (rotational) axis with servo accuracy of 5 microns. Laser capacity: is X 22" Y 14" and Z 14"



Laser Star 50 Watt Laser work station

This Class 4 LaserStar Workstation offers a significant competitive advantage for today's operators looking for pin-point accuracy, increased the range of assembly and repair applications and minimize potential hazards of heat damage. The resulting weld is considerably stronger than a traditional bonded joint.

Wavelength	1,064 $\mu$ m
Output Pulse Energy	0,5 - 150 Joules
Maximum Peak Power	10.0kW
Pulse Length	0,5 - 50 Milli-seconds
Pulse Frequency	0,5 - 20 Hz
Burst (Count) Mode	1 - 25 pulses
Beam Diameter <sup>1</sup>	0,005mm - 2,00mm

## Instrumentation



A variety of different Magnifiers, Microscopes, Cameras and Comparators, to use when working on miniature and small assemblies.



ORIONICS  
Fiber Optic Fusion Welder

## Ovens



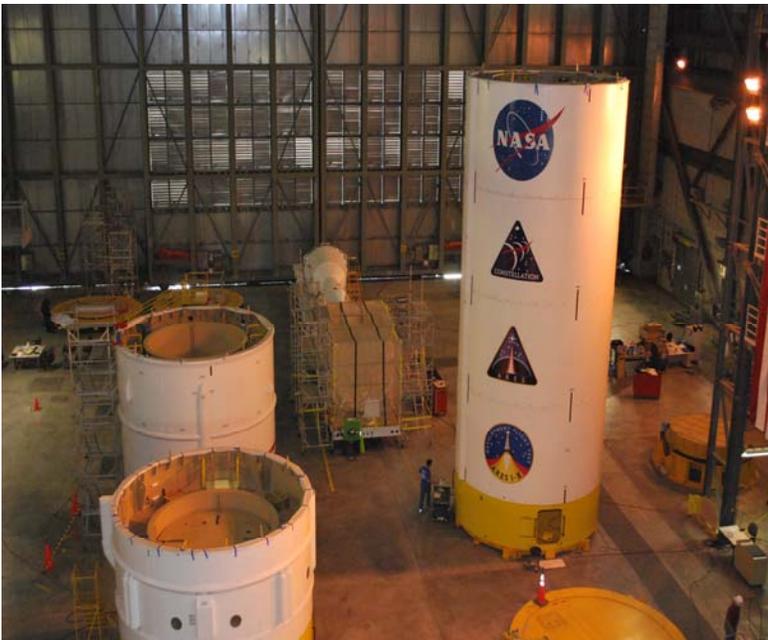
Ashing Furnace



Big Blue Oven

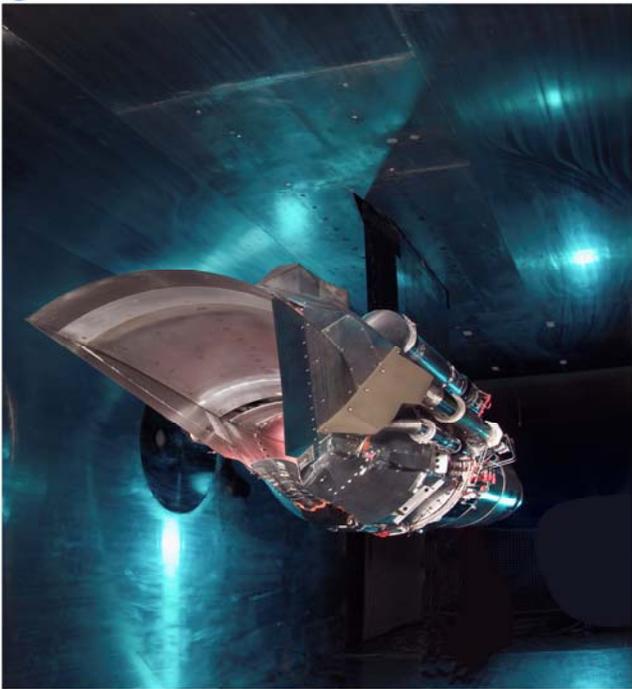
The Manufacturing group possesses a variety of ovens and furnaces in many sizes and temperatures ranges.

# ARES-I-X



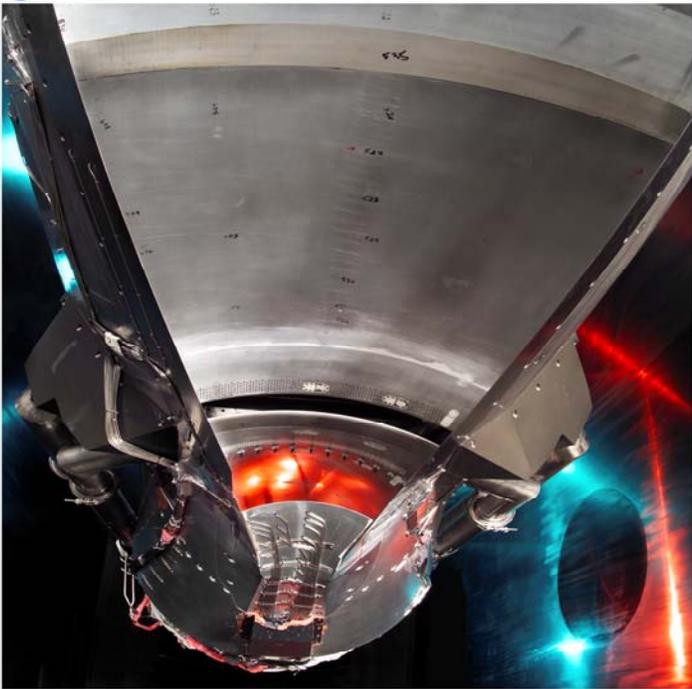
Parametric Inlet

NASA 45544282



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