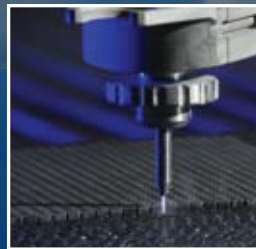
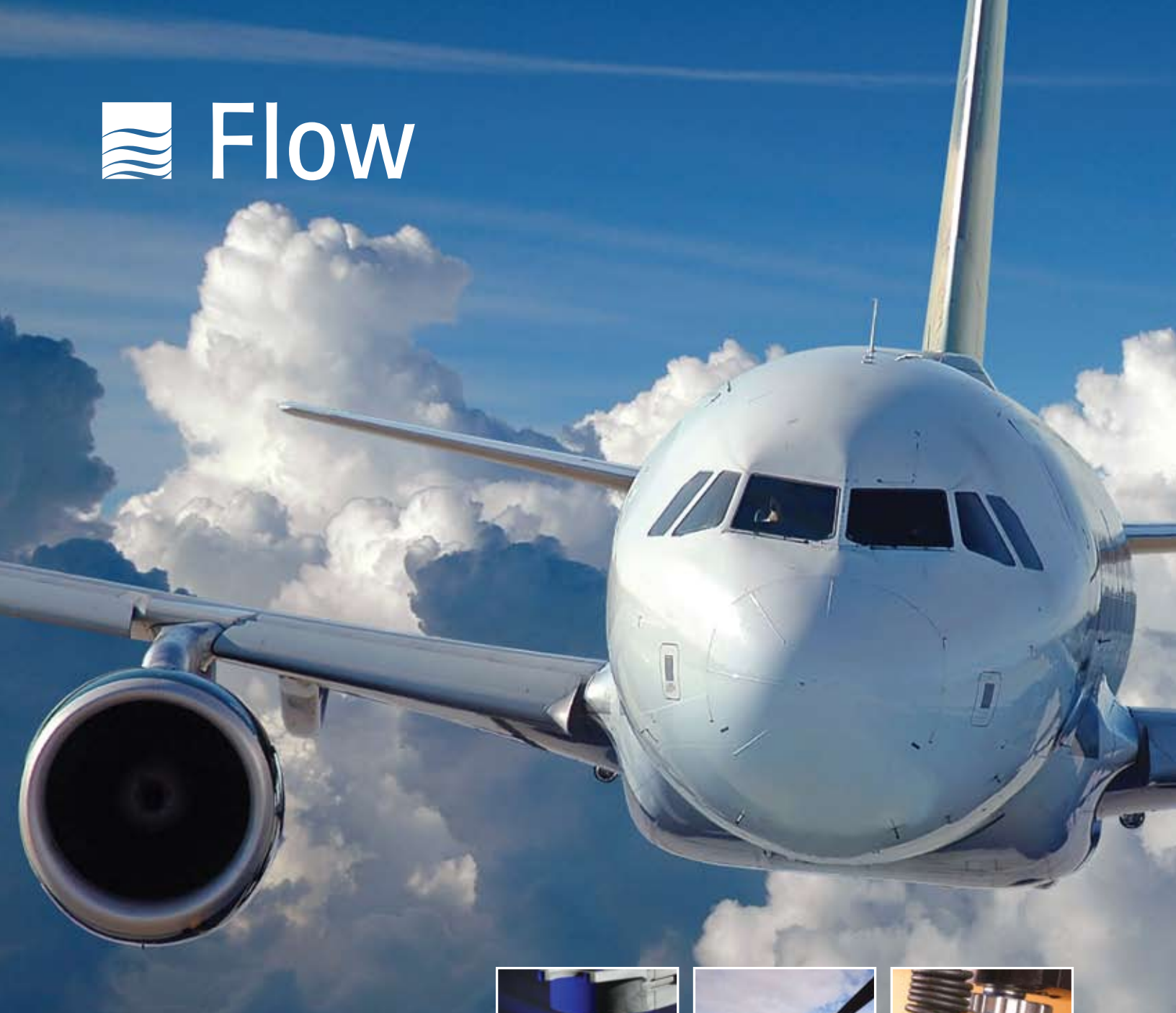




Flow



COMPOSITE MACHINING SOLUTIONS FOR AEROSPACE

INNOVATION | EXPERTISE | COMMITMENT **GLOBAL PRESENCE**

Flow's global presence means you get the attention you deserve, regardless of your location. We have facilities spanning the continents, with specialized training and technical services. With coverage like that, you can rest assured that your waterjet needs will be addressed, whenever you need it, wherever you are.

FLOW — YOUR GLOBAL WATERJET SOLUTION.



FLOW TECHNOLOGY: IDEAL FOR AEROSPACE

Composites Machining Center

Why is Flow technology so well suited for aerospace applications? We offer the most efficient and advanced turn-key composite machining solutions, and the expertise to back them up. Today, Flow provides the aerospace industry with multi-process machine tools that waterjet cut, drill, route, clean, and inspect. Since the introduction of Flow's Composites Machining Center (CMC) in 1991, we have continued to revolutionize the aerospace machining and tooling industry. Over the past two decades over 100,000 hours of research and development have been applied to the CMC machine structures, drives, software, and processes.

From "Autoclave to Assembly" you have complete part processing. The CMC handles trimming, drilling, routing, surface milling, marking and inspection — all in one set up — all on one machine. We offer flexible contouring capabilities using our patented focal point design with an abrasive waterjet catcher, automatic jet monitor, and vacuum assist for piercing composites. Flow's CMC can in most cases produce $\frac{1}{4}$ the cycle time machining composite aerostructures as compared to a conventional router with hard tooling, saving you valuable time and money. We offer the highest cut part quality, accuracy, and productivity of any large volume machine tool available for machining composites. This system can be equipped as a complete turn-key package with our Flexible Header System (FHS), cutting tools, FlowTrim and installation for a ready to use system. Let Flow provide you with the ultimate machine tool!

The CMC is available in either a Mid-Rail Gantry or a Dual Traveling Column type configuration with FANUC 30i or Siemens 840D controllers.

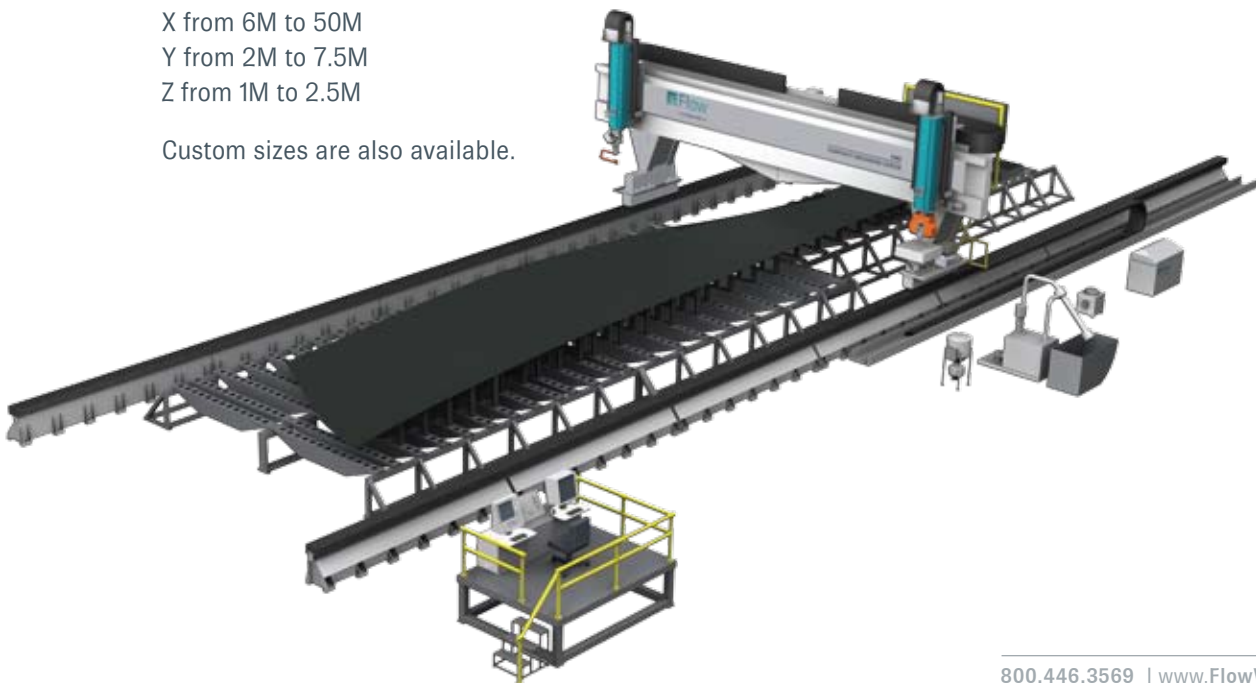
STANDARD SIZES:

X from 6M to 50M

Y from 2M to 7.5M

Z from 1M to 2.5M

Custom sizes are also available.





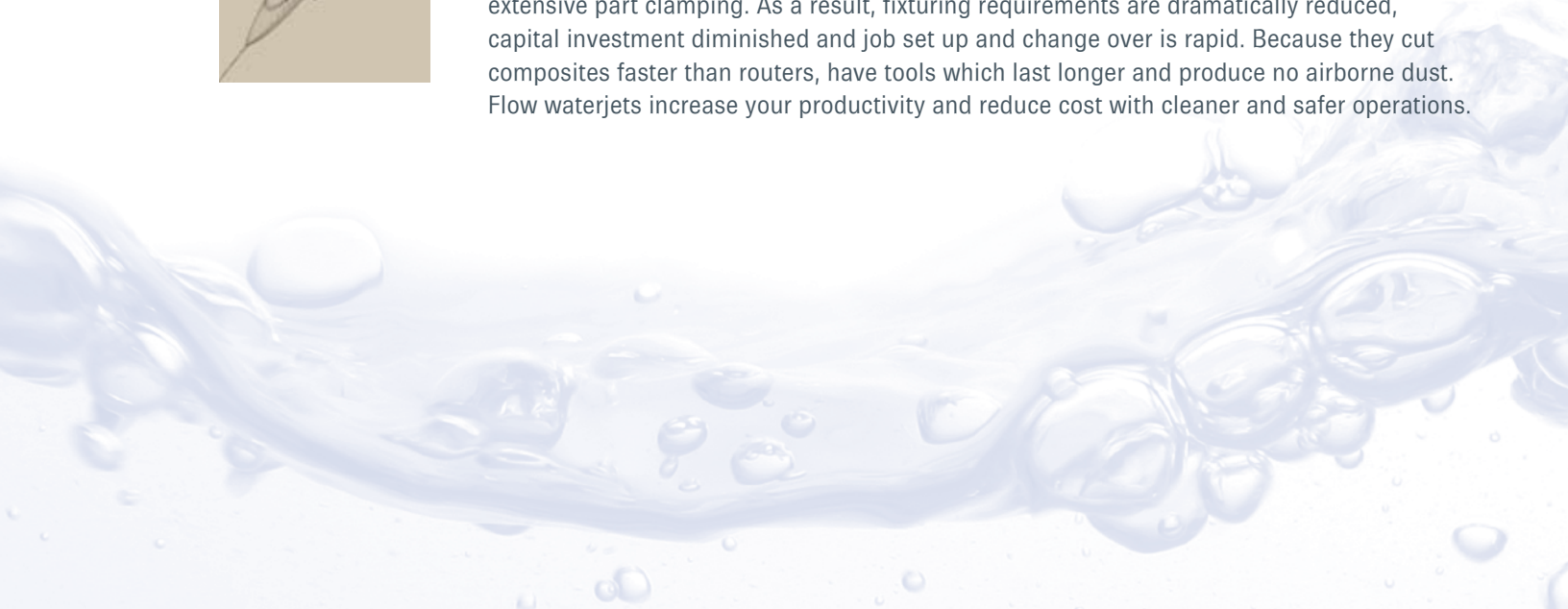
WATERJET UNMATCHED SPEED AND VERSATILITY



In addition to being the largest manufacturer of ultrahigh-pressure (UHP) waterjet systems in the world, Flow has engineered the most innovative breakthroughs in waterjet technology. This began with the invention of the abrasive waterjet system in 1979. With the proliferation of composites in new industries, particularly in aerospace, the abrasive waterjet has become the preferred and standard method for trimming composites.

Flow waterjets cut in any direction — around tight corners — producing the final part with no hand finishing, saving you valuable time and expense. Flow's patented Flow Focal Point wrist provides unparalleled access to highly contoured aerospace components. Because waterjet technology is a cold cutting process, there is no thermal damage to heat sensitive materials. Aerospace composites can be drilled and cut with ease, without material delamination, even at a microscopic level. Our integral programmable catcher arm, cleanly and efficiently collects the water, abrasive, and kerf material, and deposits the material in a convenient drum for disposal.

Also, Flow waterjets integrate easily with new or existing robots and gantries, are quickly reprogrammed for short runs, and replace or eliminate dies, templates, routers and hand trimming. Because they exert little or no vertical force, waterjets do not require extensive part clamping. As a result, fixturing requirements are dramatically reduced, capital investment diminished and job set up and change over is rapid. Because they cut composites faster than routers, have tools which last longer and produce no airborne dust. Flow waterjets increase your productivity and reduce cost with cleaner and safer operations.



WITH FLOW WATERJETS
AEROSPACE COMPOSITES
CAN BE DRILLED AND CUT
WITH EASE, WITHOUT
MATERIAL DELAMINATION.



BENEFITS OF THE ABRASIVE WATERJET

COMPOSITE CUTTING ADVANTAGES VS. HIGH SPEED ROUTING

- Preferred part finish over routers
- Much longer tool life — up to 100 times
- No secondary operations required
- No material delamination
- No heat generation, so no heat affected zones (HAZ)
- No airborne dust
- Little or no cutting forces or vibrations
- Simple fixturing
- Higher feed rates/faster machining
- High speed
- High accuracy
- Robust construction
- Very few moving parts
- Ease of alignment
- Kinematic coupling for Side Fire



MHI Proprietary

DRILLING, ROUTING, AND MILLING



The Flow milling "C" and "B" axis and spindle are designed with over 20 years experience in drilling, milling and routing composites. Each of the rotary axes incorporates precision certified direct coupled feedback to ensure extremely accurate positioning for drilling of fastener holes ready for assembly, or for precise surface milling and routing.

With maximum speed, torques, and forces considered, and a very generous design safety factor applied, you can expect exceptional part quality. Flow routers are proven design with some of the stiffest structures in the business.

FEATURES

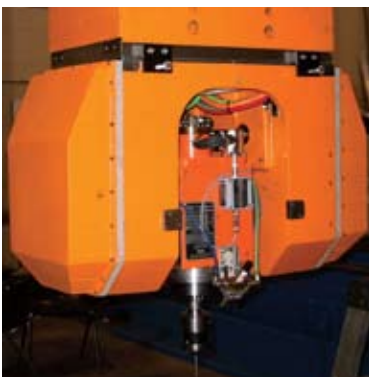
- High stiffness "CB" (230,000 kgcm)
- Direct feedback on rotaries
- Zero backlash design
- 22 to 40 hp
- Up to 30,000 rpm
- HSK40 or 63 taper
- Coolant — mist, flood or both
- Liquid-cooled spindle
- Auto tool changer
- Probe ready



Our precision drilling and routing systems have spindles up to 40 hp and 30,000 rpm, dust extraction systems, direct feedback on rotaries, zero backlash design, "W" axis for drill assembly, auto tool changes, and are probe ready.

PERFDRILL

Flow's PerfDrill systems are designed to produce millions of holes in composites for acoustic attenuation in engine components. The PerfDrill is available in either a column or gantry style in 5 or 6 axis with 3 or 4 spindle arrays. Our machines are designed with high stiffness, acceleration and spindles with up to 120,000 rpm for fast throughput.





With maximum speed, torques, and forces considered, and a very generous design safety factor applied, you can expect exceptional part quality with our optimal machining solution.





FLOW PROVIDES THE
AEROSPACE INDUSTRY
WITH MULTI-PROCESS
MACHINE TOOLS

FLOW PRECISION ACTUATOR CYLINDER (FlowPac)

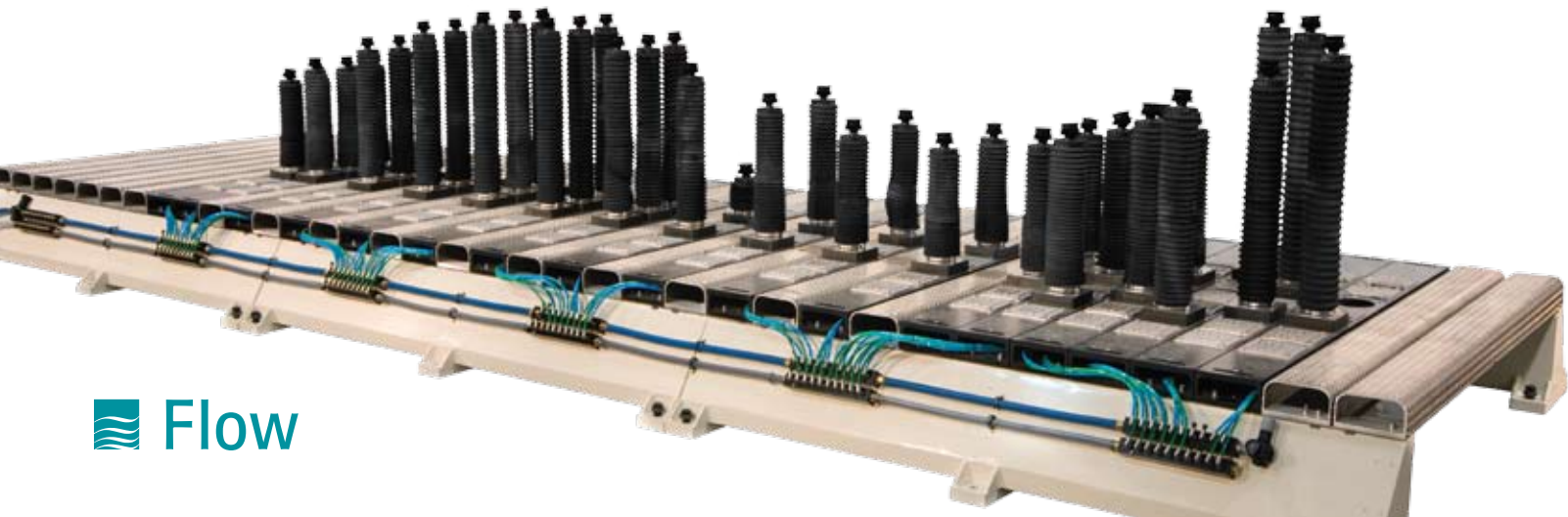
Flow's Precision Actuator Cylinders (FlowPac) are a direct result of our product development, based on 20 years of experience in integrating configurable tooling systems. FlowPacs are simply constructed, corrosion resistant and IP65 rated for complete protection and wash down capabilities. The FlowPac serves as a complimentary benefit to the Flexible Header System. It utilizes new "Smart Motor" technology to greatly simplify wiring and eliminate your maintenance troubles. The FlowPac is equipped with an air blow off to float the parts to position and vacuum to pull the parts to location.

Cup sizes are available from 75mm to 150mm in diameter. Accuracies are $< .075\text{mm}$ and repeatability $< .025\text{mm}$. Standard stroke is 915mm with special strokes available.



FLOW FLEXIBLE HEADER SYSTEM (FHS)

Flow's Flexible Header System provides a highly rigid, highly accurate platform for mounting our FlowPac actuators. This set-up gives you a reconfigurable fixture system for aerospace components. The headers may be located in one half pitch increments in the "X" axis, and rotated 180 degrees for a one half pitch in the "Y" axis. Our FlowPacs are eccentric and may be clocked in 90 degree increments for further location adjustments. Flow's FHS, coupled with FlowPac's, efficiently and easily allows changes in the FHS for part engineering changes, or new parts added to the FHS. A simple "daisy chain" wiring and plumbing scheme facilitates ease of addition, subtraction, or relocation of Flow's Precision Actuator Cylinders.



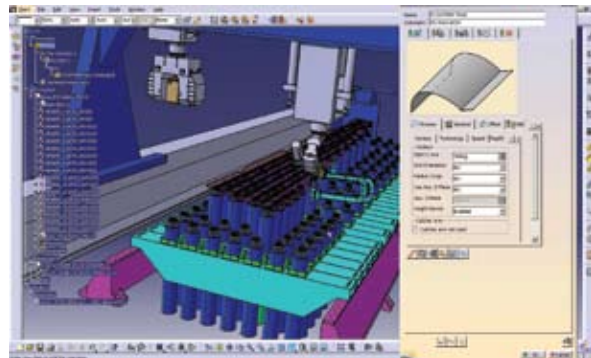
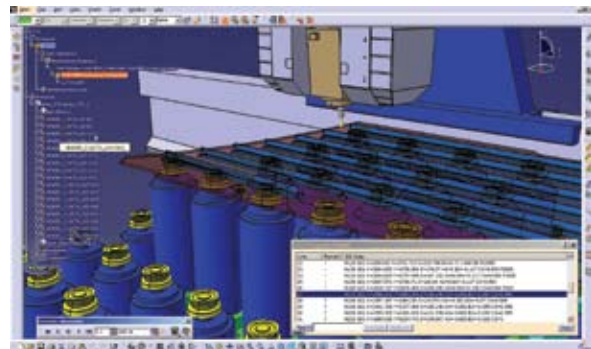
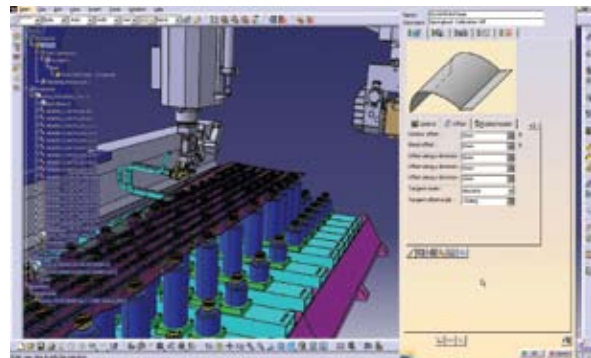
OPTIMAL PART PROGRAMMING — FlowTrim

Flow is pleased to provide the only seamless CATIA V5 off-line programming system in the industry. Parts designed on CATIA are programmed along with the FHS, post processed, real time simulated and collision detected. You are able to complete your programming in a single step, easier than you ever have before.

The programming process with FlowTrim is totally bidirectional, and completed without changing from program to program. If a change is made to the program, that change does not need to be reposted, resimulated or recompiled. All of your changes are accomplished real time and on the very same screen. All standard machines, robot systems, FHS, and special machines are supported in FlowTrim.

Our expertise makes your software programming straightforward, and undemanding.

AEROSPACE PART DESIGN AND MACHINING HAS NEVER BEEN EASIER.



SPECIALTY MACHINING SYSTEMS

At Flow, we specialize in the manufacture of specialty or custom machining systems, particularly for the aerospace industry. Specialty configurations include bridge types, various gantry arrangements, traveling columns, cylindrical, cantilever and more!

All of our custom machine configurations are designed, analyzed, assembled, and tested on the latest CAD design tools prior to build to ensure your new system is a state of the art machine tool. Custom systems have been built to enhance the processes of waterjet, milling, drilling, and inspection. Whatever your aerospace production requirements, Flow has a system that can help you manufacture more efficiently.

STRINGERTRIM

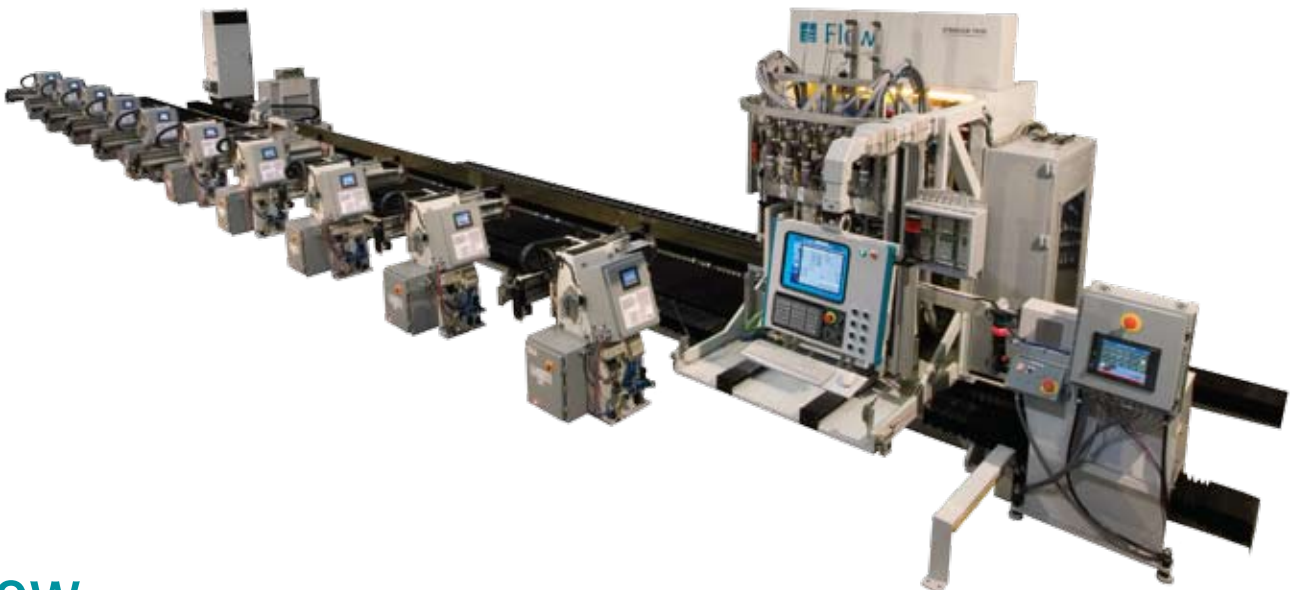
For machining of complicated aerospace elements such as wing skins, Flow offers an ideal solution. The StringerTrim offers 6 heads with our exclusive Side Fire nozzle mounted on a moving head assembly. It easily trims cured carbon fiber stringers which are used on wing skins.

SIDE FIRE NOZZLE CUTTING SYSTEM



The unique Flow Side Fire nozzle dramatically reduces the size of the cutting head to gain access in hard to reach places. The side fire is currently being used to machine parts such as stringers, ribs, leading edges and engine components.

The Side Fire Nozzle cutting head accelerates the abrasive with a high-velocity waterjet to generate a stream capable of cutting any material. The cutting head assembly includes the nozzle body, orifice, mixing chamber, and mixing tube assembly and is integrated into the focal point "C" "B" or applied in special purpose build machines.



5 AXIS WATERJET SYSTEMS

Flow's abrasive waterjet systems excel at three-dimensional cutting, and we manufacture a complete line of turnkey systems for cutting complex shapes. The AF-Series cuts with precision accuracy, at speeds up to 10 meters per minute.

SPECIFICATIONS

- **Size/Work Envelope:**
Base: 6 ft, 12 ft, 16 ft, 20 ft (2M, 4M, 5M, and 6M)
Bridge: 8 ft (2.5 M)
- Custom sizes also available
- **Control System:** Siemens 840D CNC or FANUC 30i controllers
- Patent Focal Point "C" "B"
- Custom cutting tanks and fixtures available



ROBOTIC MACHINING SOLUTIONS

At Flow, we pride ourselves on being the world leader in the integration of robots and waterjet systems. We have teamed with the robotic accuracy experts at Kuka Robotics. The partnership between Flow and Kuka provides you with the highest level of expertise in each of their respective fields to give you the finest waterjet robotic solutions. Together we offer complete trim and drill cells for the machining of small to medium sized aerostructures.

Our 6 Axis robotic waterjet systems offer three-dimensional cutting capability without the obstructions of a traditional box gantry design. The work envelope of an articulate arm robot is much more flexible than a box frame gantry while occupying a reduced footprint.

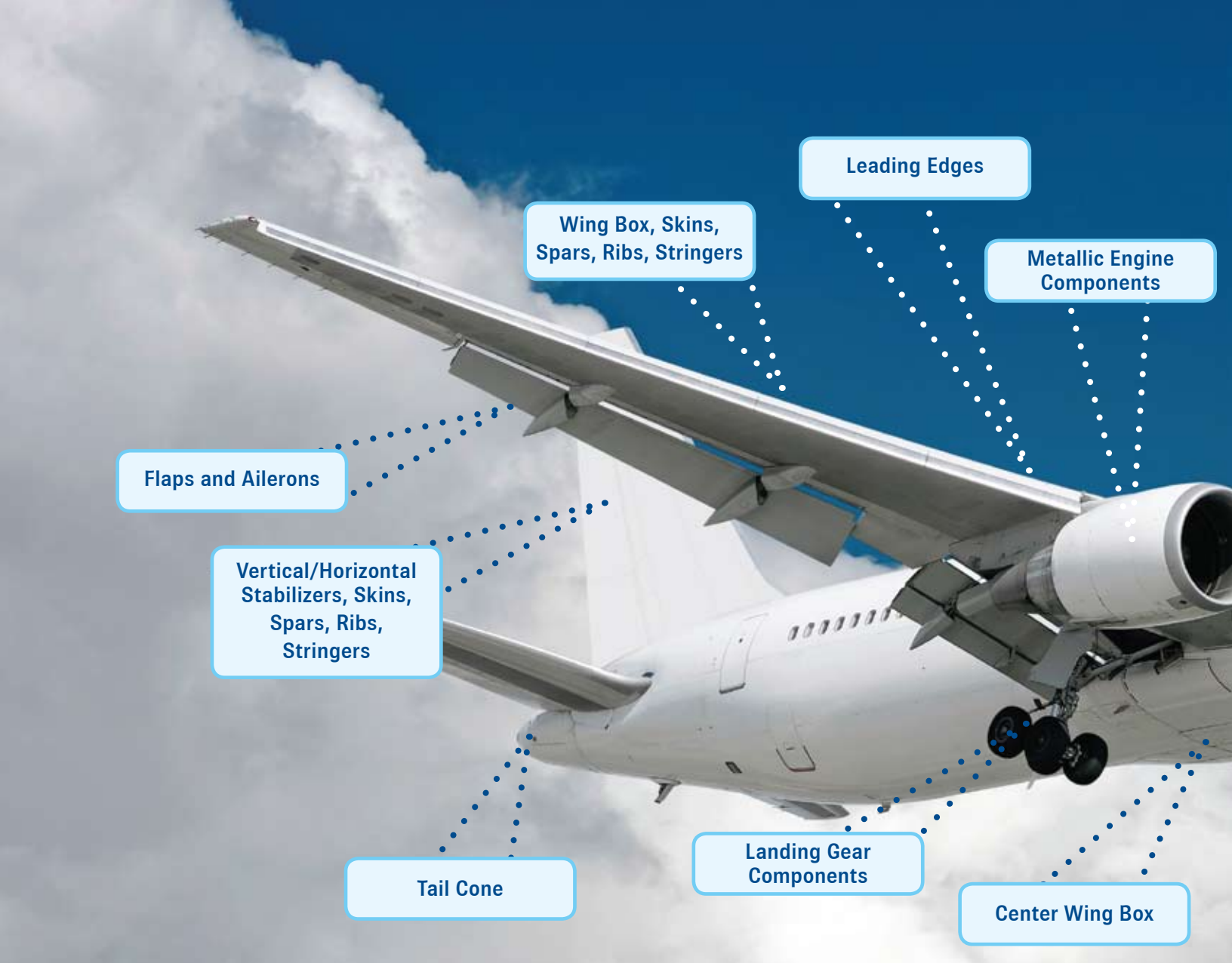


6 AXIS ABRASIVE WATERJET ROBOT WORKCELL

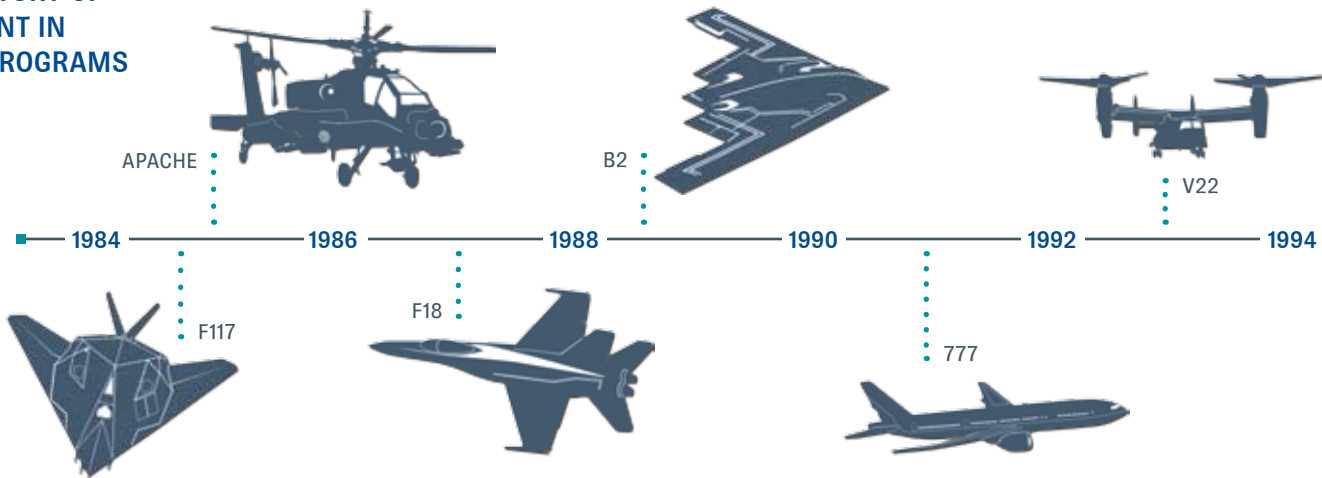
Our 6 Axis robots are an economical solution for multi-axis machining. Increased application flexibility with highly repeatable three-dimensional cutting capabilities.

SPECIFICATIONS

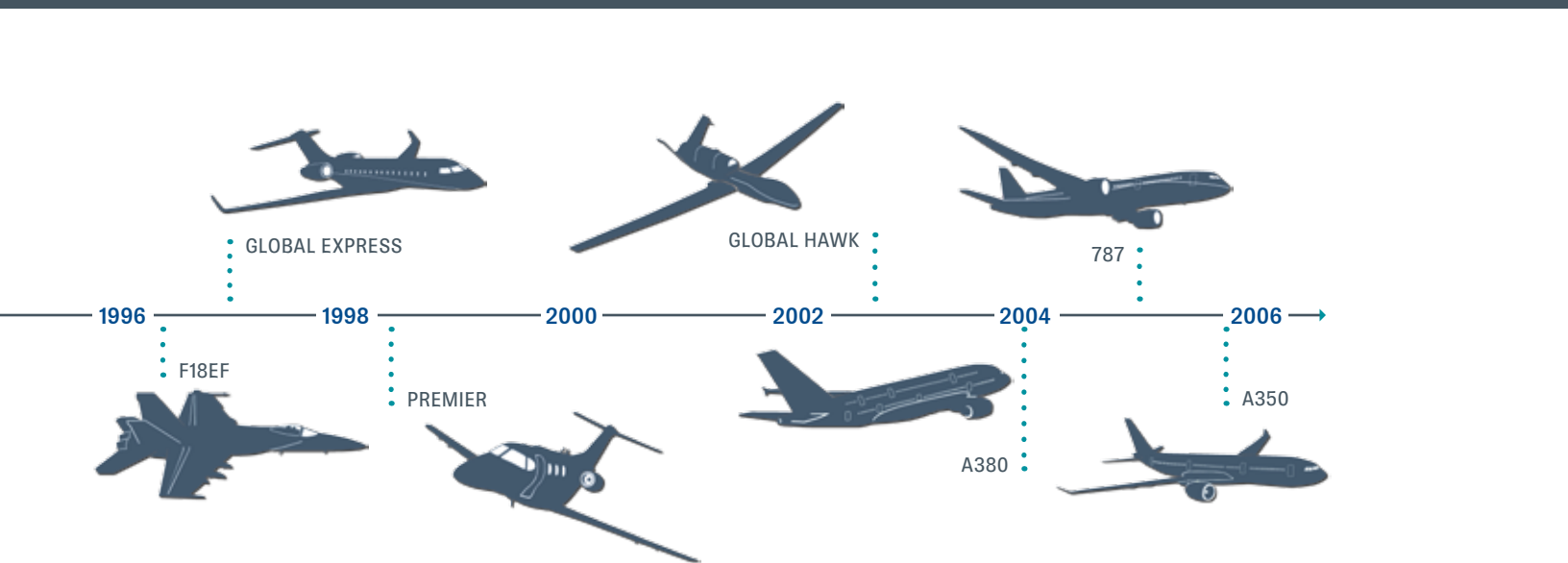
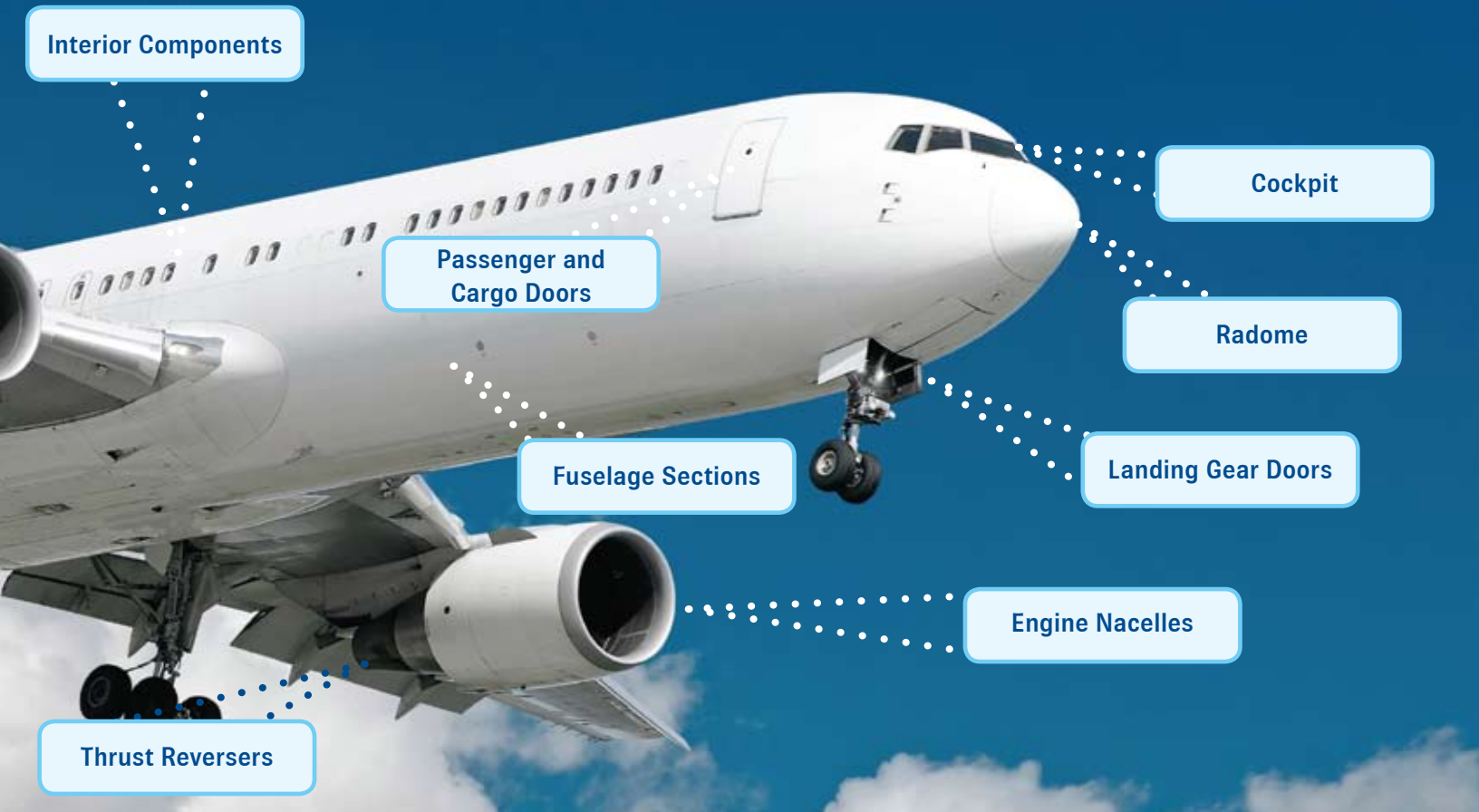
- Reaches up to 3 M
- High accuracy models available
- Available with full 6 Axis and catcher arm with waste removal system
- Optional work cells with rotary or shuttle tables and enclosures



FLOW'S HISTORY OF INVOLVEMENT IN AIRCRAFT PROGRAMS



UTILIZING ABRASIVE WATERJET TO MACHINE COMPOSITES



ENGINEERING FOCUS AND EXPERTISE

No other company in the world offers the comprehensive machine tool solutions that Flow provides. We even have dedicated resources in research and development specifically devoted to the precision machining of aerostructures. From simple three-axis waterjets and routers to the large multi-process, fourteen-axis trim and drill cells, you can feel confident in Flow's expertise to back up your purchase with industry proven technology. Particularly since we have provided more composite machining systems than any other machine tool manufacturer, and many of our systems offer multi-process capability.

In our Mechanical Engineering Department we utilize solid modeling, real time kinematic simulation, and dynamic finite element analysis in the design of our machines. Our Electrical Engineering department designs our own PC based controls and also integrates commercial CNC and robot controls. In electrical design, the newest, high level language compilers and computers are used for software development. And, all of our servo systems are designed utilizing servo sizing and analysis software. Any new design is thoroughly tested and simulated for range/interference, stiffness/deflections, fatigue, servo performance, and software functionally, before being built. This method of engineering has been proven hundreds of times by the performance and reliability of the many different machines we have supplied. What does this mean to you? It means unsurpassed performance and reliability with the operation of your Flow waterjet.



CUSTOMER SERVICE YOU CAN COUNT ON.

OUR CUSTOMER SUPPORT NETWORK INCLUDES:

- **COMPLIMENTARY NEEDS ANALYSIS.** At Flow, we don't rush a sale. We take the time to understand your application so we can identify the best waterjet system to meet your needs. With the most extensive product offerings in the business, we're confident we can deliver exactly the right products and services to achieve your success.
- **DEDICATED PROJECT MANAGER.** You will be assigned a dedicated Project Manager who will walk you through facility set-up, system delivery, installation, and training.
- **HANDS-ON TRAINING.** Our courses train you on part programming, system maintenance, and application techniques — everything you need to know to obtain the very highest return from your investment.
- **LARGEST, BEST-TRAINED SUPPORT TEAM IN THE INDUSTRY.** We are dedicated to your success and here for you 24 hours a day, 7 days a week.
- **QUALITY FLOW SPARE PARTS.** Flow maintains the largest selection of spare parts built to our exacting quality standards to ensure optimal performance of your system.



INNOVATION | EXPERTISE | COMMITMENT

■ GET IT ALL WITH FLOW

For over three decades, Flow has set the standard for excellence in waterjet technology. We are the only waterjet company in the world that offers total solutions and support from a single source, both before and after your waterjet system is installed. We learn your business requirements. We help you select and implement the right solution. We train your staff and are there for you for the entire lifecycle of our products.

■ WHEN YOU PARTNER WITH FLOW, YOU GET MORE THAN A PRODUCT:

- Our **INNOVATION** ensures that you will always have the latest and highest quality technology.
- Our **EXPERTISE** ensures that you will always have the right technology for your individual business needs.
- Our **COMMITMENT** to customer service ensures that you will always receive the support you need to stay productive.

For your complimentary needs analysis or a product demonstration, please call one of our waterjet experts at **1-800-446-3569**.

- **WE LOOK FORWARD TO PARTNERING WITH YOU IN YOUR SUCCESS.**

THE ADVANCED SYSTEMS TECHNOLOGY CENTER

Jeffersonville, Indiana, USA



The Advanced Systems Technology Center located in Jeffersonville, Indiana includes engineering, production, research and development, and an interactive customer demonstration and training center.

"By concentrating our advanced systems development expertise in a single location, Flow is able to service our customers more efficiently and drive the technology forward faster."

ADVANCED SYSTEMS TECHNOLOGY CENTER

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