

 **Flow**



3D Waterjet Cutting: Adding a New Dimension of Opportunity

Tim Fabian & Jonathan Meas
Flow International Corporation



Agenda

- Challenges unique to multi-axis waterjet cutting
- Utilizing multi-axis waterjet technology to produce highly complex parts
- Examples of how the latest Dynamic Waterjet® XD technology can be used to grow and expand your business



Challenges with Waterjet Cutting

Common Challenges

All waterjet cutting (2D and 3D) shared common challenges:

- Waterjets have natural taper
- Occurrence of stream lag due to a non-rigid cutting tool
- Predicting the stream behavior which is fundamental when cutting accurate parts



2D Cutting Challenges

Waterjets have natural taper

- Taper was commonly .015”

Stream lag with a non-rigid cutting tool

- Striations/wash-out common

Predicting the stream behavior is fundamental to cutting accurate parts

- Difficult to get parts even within +/- .030”

Research and Development

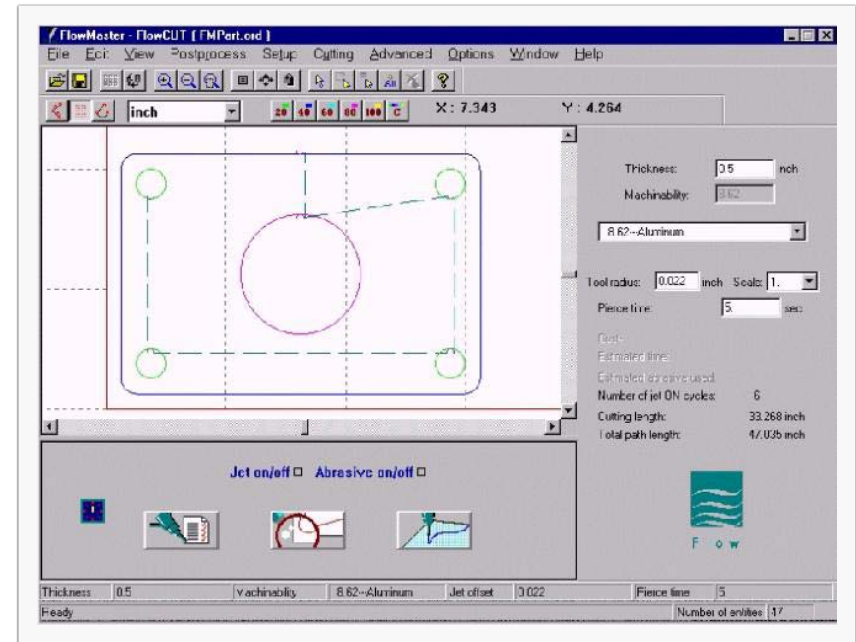
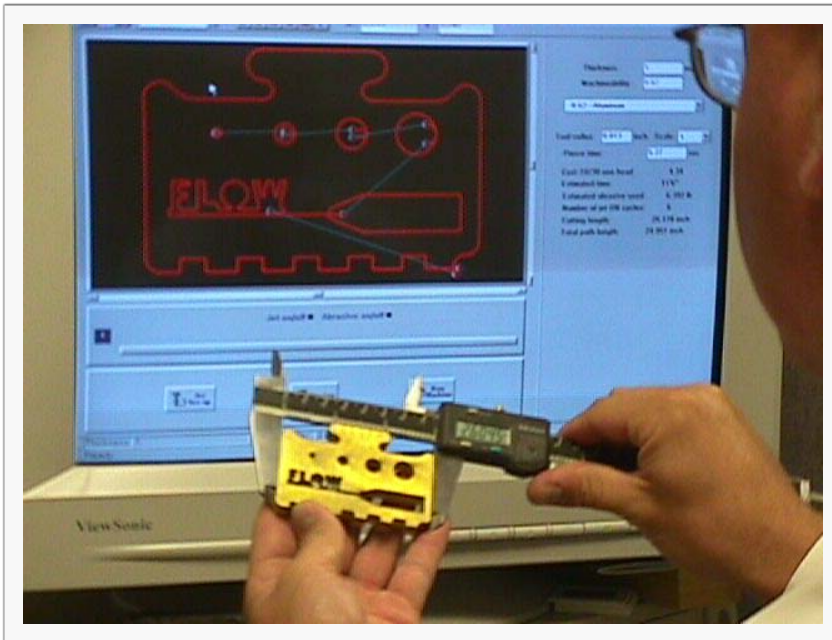
Through much R&D, 2 out of 3 of these issues were solved in 1995 for 2D:

- ✓ Stream lag with a non-rigid cutting tool
- ✓ Predicting the stream behavior is fundamental to cutting accurate parts

Both solved in 1995 with introduction of a PC-based control and FlowMaster®



FlowMaster®

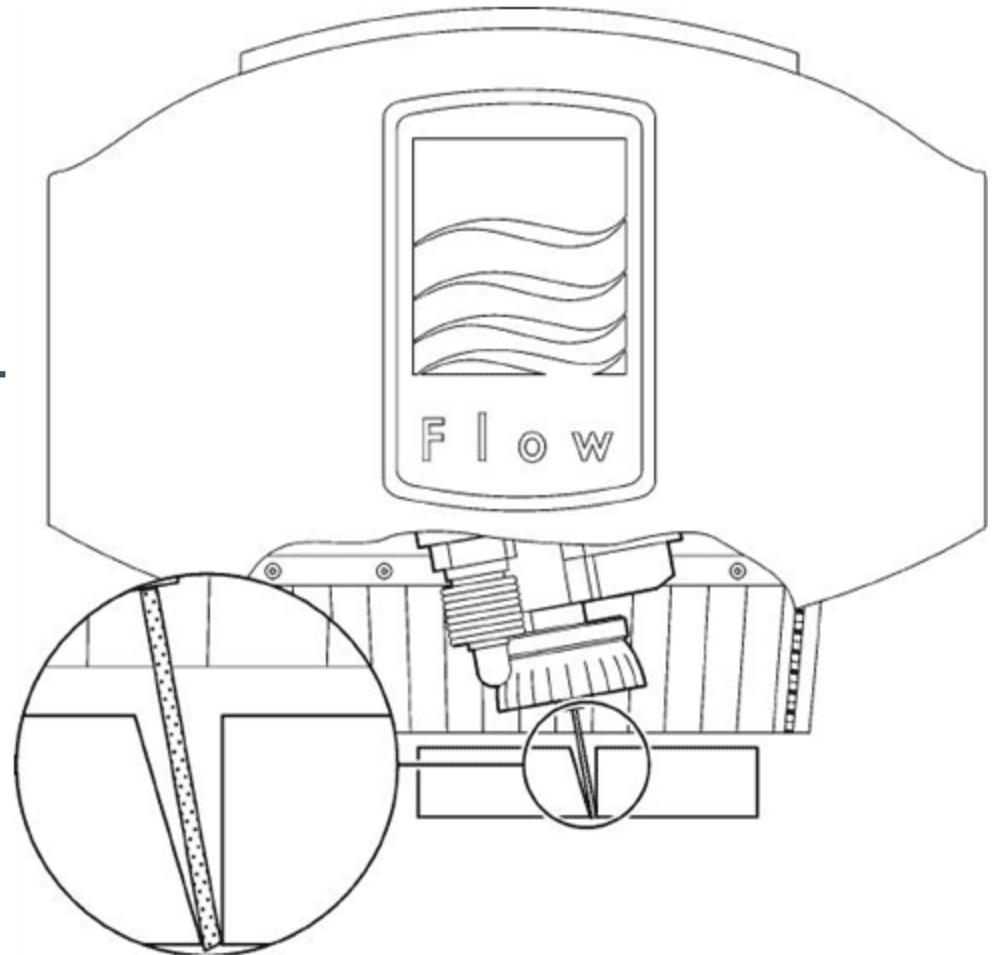


With the FlowMaster technology, tolerances went from +/- .030" to +/- .005"-.010"

Research and New Products

The final challenge was tremendously complex:

- ✓ Taper solved with **Dynamic Waterjet** in 2001



Dynamic Waterjet

With Dynamic Waterjet in 2001:

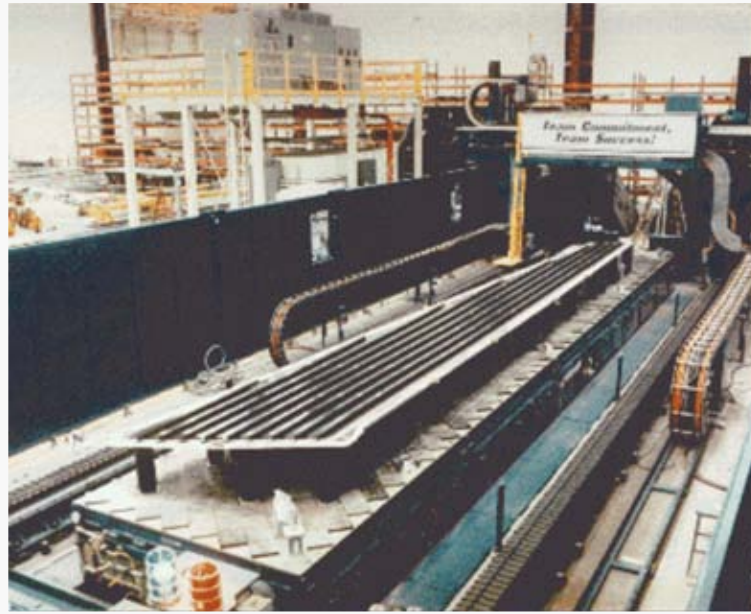
- ✓ Tolerances then went from .005" – .010" to approx. +/- .003"
- ✓ Speed increased up to 2–4 times
- ✓ Cutting accurate parts became much cheaper to produce



Multi-Axis Waterjet Technology

5-Axis Is Not New

- First commercial units produced in the early 1980's
- Have been restricted for use on repetitive parts
- Difficult to program
- Lacked sophisticated modeling
- Required a very knowledgeable operator
- Used primarily by aerospace or automotive OEM's



examples of older units

5-Axis Consumers

Aerospace industry has traditionally been the primary 5-axis consumer

Flow's Involvement in Major Composites Programs



Aerospace Industry



Since the introduction of PC-based controls that could predict stream behavior and **Dynamic Waterjet** that could eliminate taper, global demand for 2D waterjets has **increased nearly 400%**

Flat 3D Growth

These same facts
have persisted...

①

Waterjets have
natural taper

②

Stream lags
with a non-rigid
cutting tool

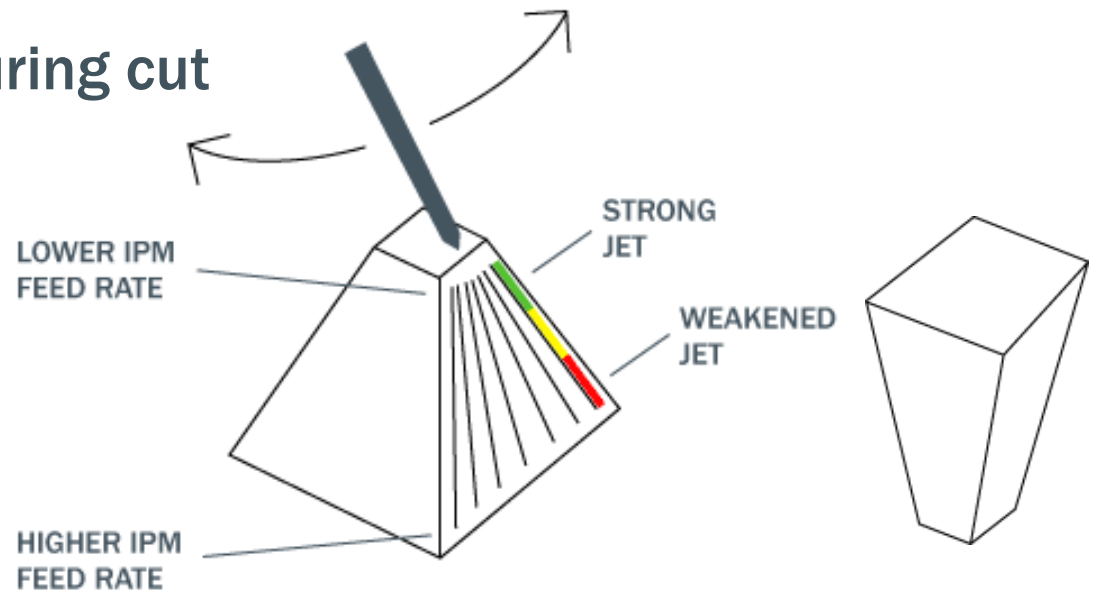
③

Predicting the
stream behavior
is fundamental
to cutting
accurate parts

Challenges With Accuracy

What makes cutting accurate 3D parts so difficult?

- Same part, completely different parameters
- Rotation of head changes feed rate
- Thickness can vary during cut



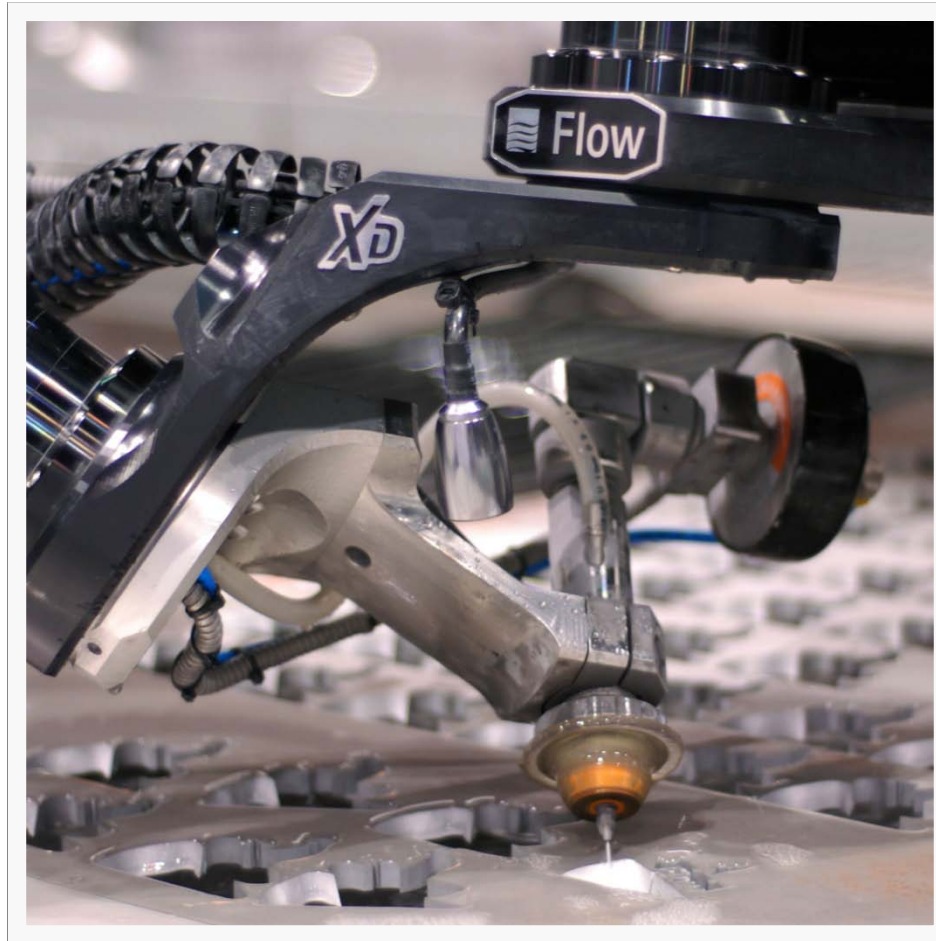
The Solution

Two new products have recently been introduced to overcome these hurdles:

Dynamic XD is a multi-axis cutting head that features 60 degrees of motion and full Dynamic taper compensation.

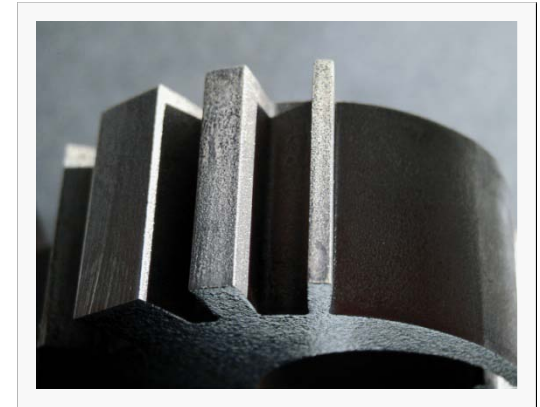
To predict stream behavior in a multi-axis environment, the **FlowXpert™** Software Suite featuring SmartStream™ Technology.

Dynamic XD



Taper Elimination

- Head automatically compensates via software to eliminate taper in 3D
- Amount of compensation varies greatly based on
 - Speed
 - Thickness
 - Geometry
 - Angle



with active tolerance control



without active tolerance control

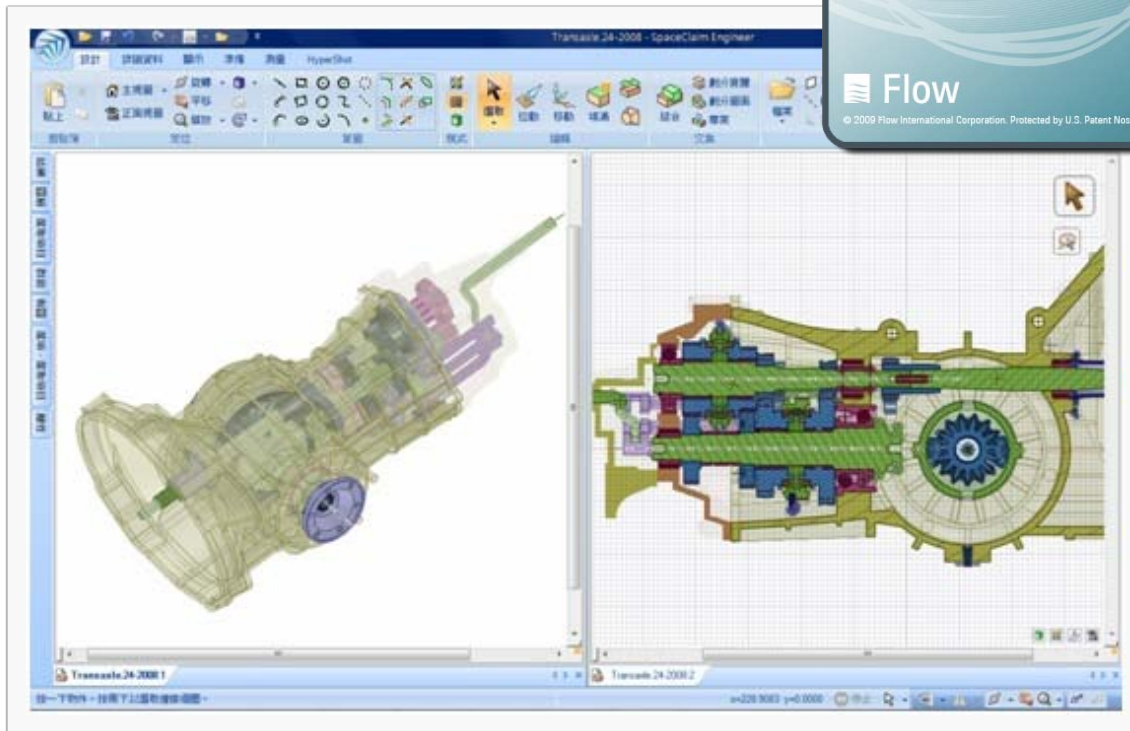
Stream Prediction

- By using similar cutting models that took years to develop for 2D
- 24,000 engineering hours to complete similar models for 3D
- Head automatically compensates via software to eliminate taper on an extensive material library
- Easy to program:
 - Take your solid model file
 - Input desired edge finish and material type
 - Software does the rest

What Makes Good 3D Software?

- Software should be able to create and import true 3D solid models
- Should allow a job shop to complete quick and accurate quotes
- Ability to program parts in a manner nearly as quick as 2D
- Ability for software and control to quickly locate material
- Easy to make changes and/or modify part

FlowXpert™



Traditional 5-Axis Challenges

- Proper head calibration
- Singularity
- Zero tool-length design
- Part flatness
- Environmental considerations

Proper Head Calibration

- Slight deviation can impact geometry tremendously
- Can be complicated and time consuming when done manually
- Laser method preferred



Singularity

- Also known as “dead point”
- When multiple motors are aligned at their zero positions
- Requires an “axis-flip” or “swing” at zero to continue cutting
- Can result in a part mark and/or increased cycle time
- Patent pending design eliminates most dead point situations

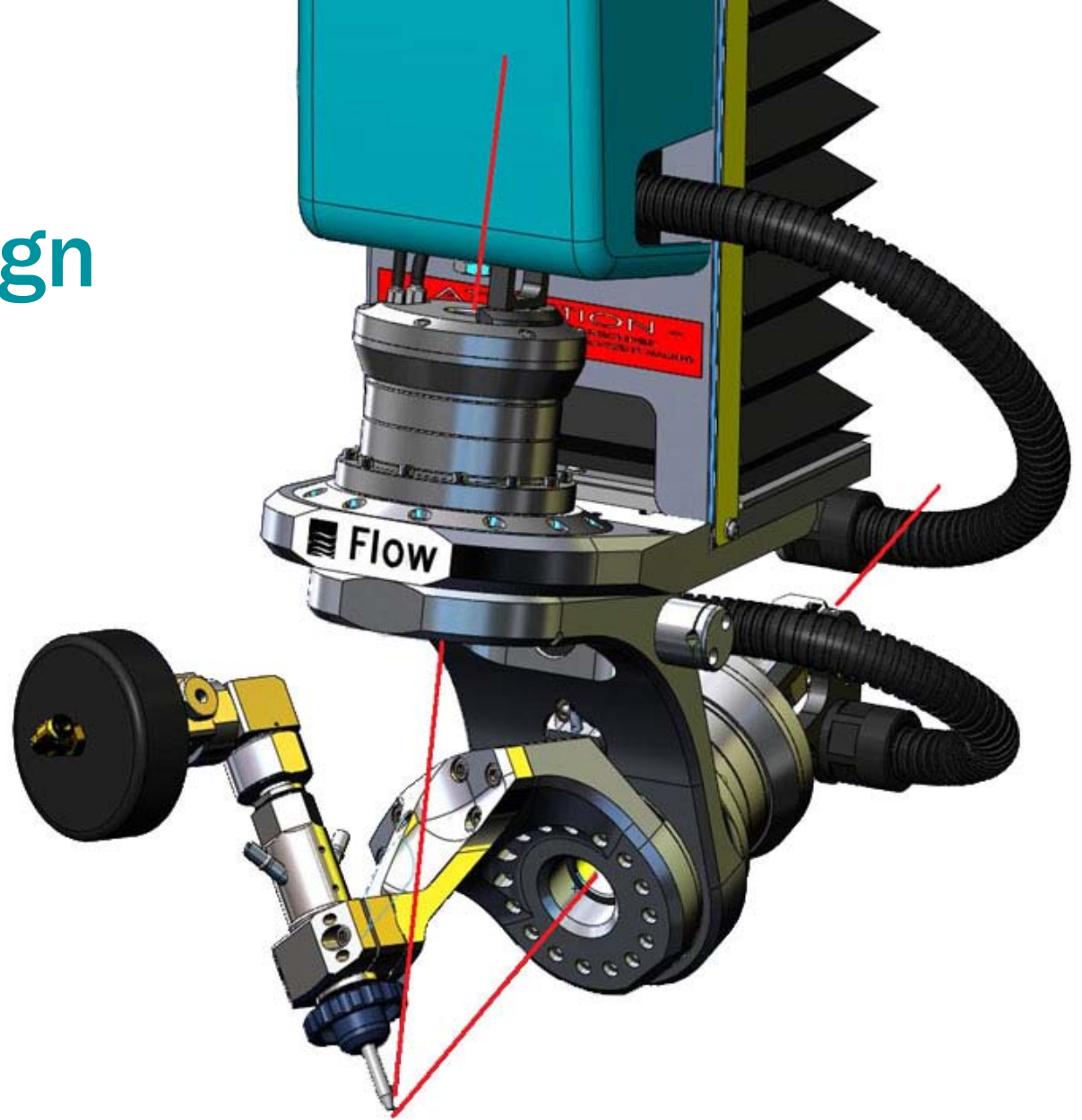
Singularity



Zero Tool Length Design

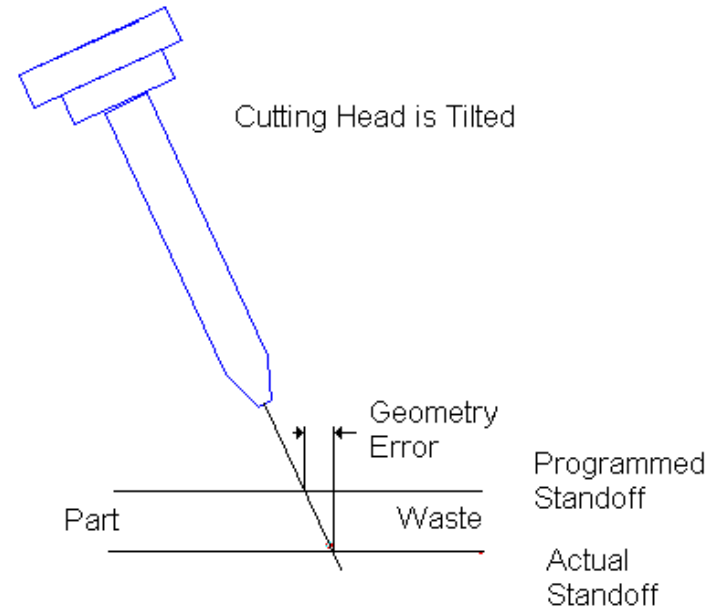
- Necessary in order to provide optimal control of jet focal point
- Without it, small XY movements become necessary
- XY “Backfeeding” results in speed loss and diminished edge quality

Zero Tool Length Design



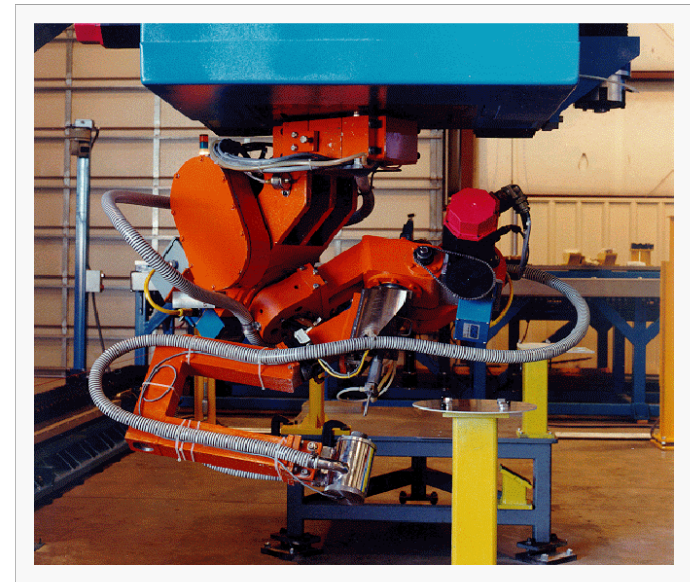
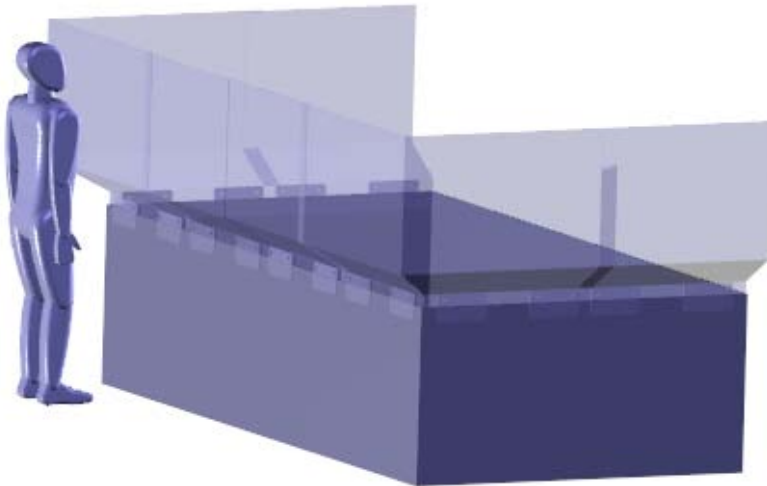
Part Flatness

- Any small error on flatness can be amplified during 3D cutting
- Flat plate is important
- Height sensing optimal
- Laser “Pre-Map” solution



Environmental Considerations

- Spray and splash is increased
- Light curtains are often used to maintain a safety zone
- Machines are provided with additional shields, sometimes fully enclosed



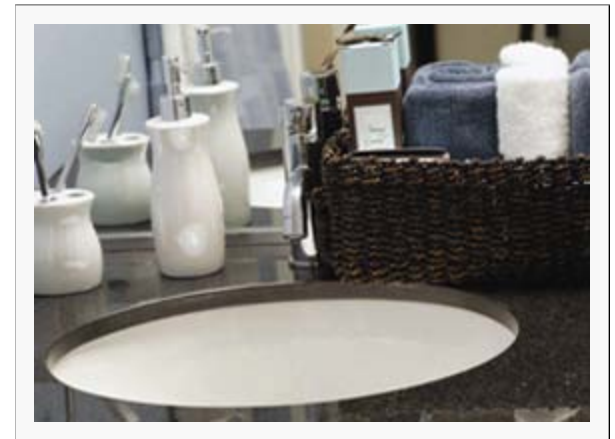
Bevel Cutting vs. 3D Cutting

- Much simpler because 5-axis variables stay constant
- Entire edge will have constant thickness
- Wrist will set position and hold throughout entity
- Stream behaves like 2D, just on an angle
- A bevel machine can't cut 3D, but a 3D machine can cut bevels!

Grow And Expand Your Business

Ceramics, Tile & Stone

- Bevels can now be created on counter top edges
- New profiles can enhance edges of material
- Custom signage
- Great for artwork



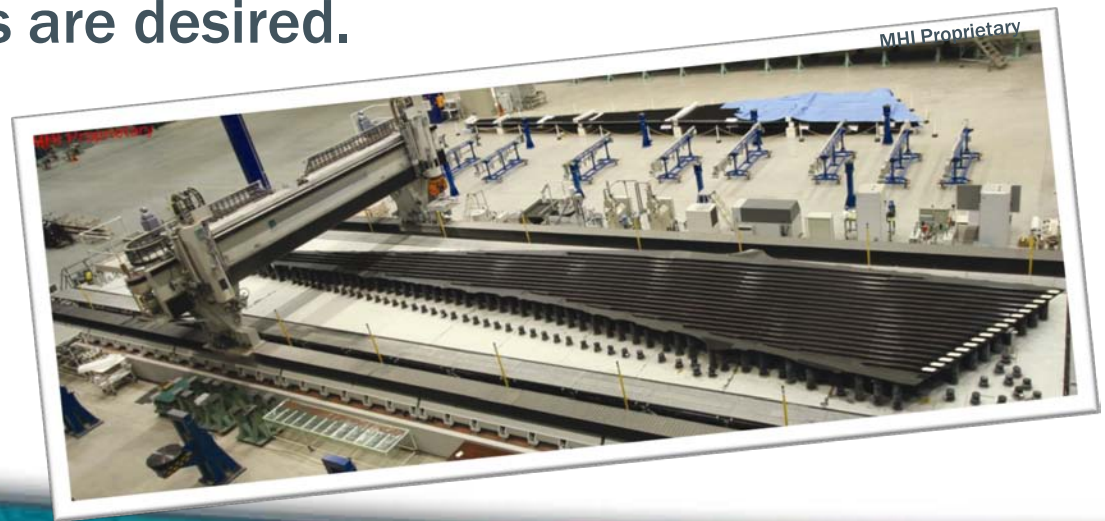
Metals

- Angular edges are highly desired in military armor plate
- Cut parts traditionally processed with milling or EDM machines
- Countersinking holes
- Providing reliefs and tapered clearances in precision die making applications



Laminates & Composites

- Ability to profile out a complex structure
- Examples of these are already common in aerospace industry
- Examples: carbon-fiber racing seats, bulletproof composite helmets for the military, assembled structures where profiles edges are desired.



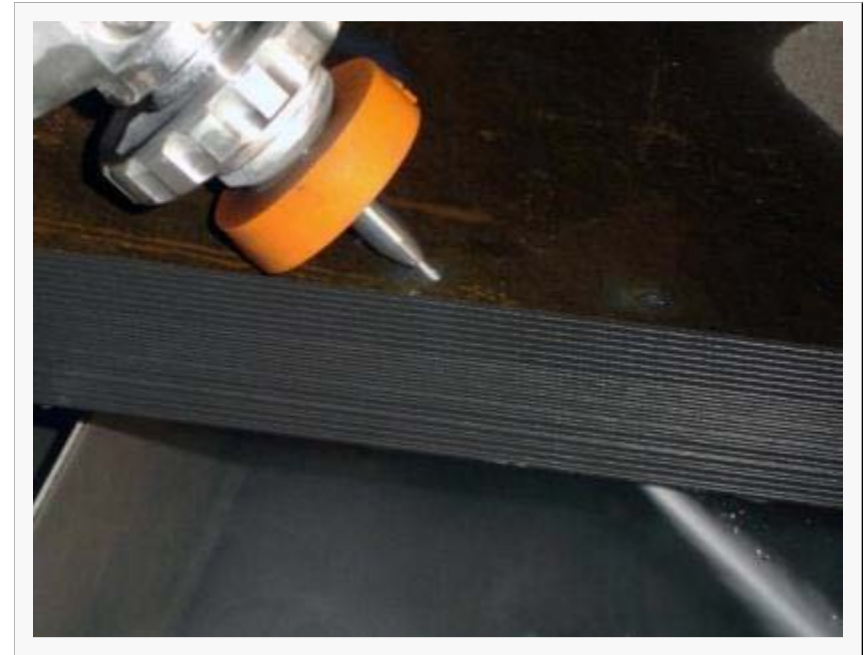
Prototyping

- The ability to cut out shapes in any material
- “Art to Part” in 1 minute
- Quickly and easily try out different designs
- Materials testing
- Prototyping companies like OCC, used Flow Waterjets to cut out their formed fenders



Angular Hole Drilling

- When many small holes are needed
- Often used in aerospace applications
- Most common with ceramics and advanced alloys
- Up to 3 holes per second using new technology



“Green” Opportunities

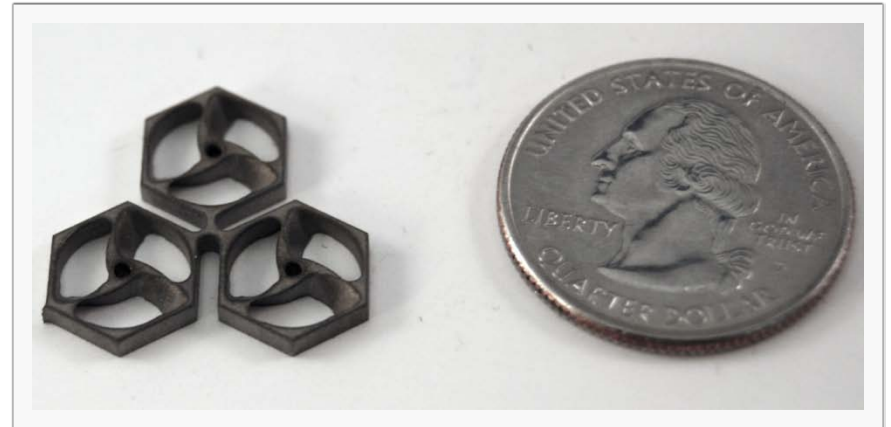
- Wind turbine blades
- Angular solar glass
- Energy efficient composite siding
- Waterjet is a green process!



3D Success Stories

Sensor Components

- Prior Process (EDM) took 56 minutes per part
- Dynamic XD time to complete: 2 min. 47 sec.



Specifications

- .030" 304 stainless
- .002" tolerance
- Angles up to 56 degrees
- Excellent surface finish

3D Success Stories

Mail Sorting Machine Bracket

- Prior Process (Mill) took 2 setups and 14 minutes of cycle time
- Dynamic XD time to complete: 3 min. 56 sec.



Specifications

- .500" mild steel
- .005" tolerance
- Angles up to 45 degrees
- Very good surface finish

3D Success Stories

Custom Gauge Bezel

- Prior Process (Mill) took 3 setups and 19 minutes of cycle time
- Dynamic XD time to complete: 5 min. 11 sec.



Specifications

- .625" 6061 aluminum
- .005" tolerance
- Angles up to 45 degrees
- Excellent surface finish

3D Success Stories

Sear Ring

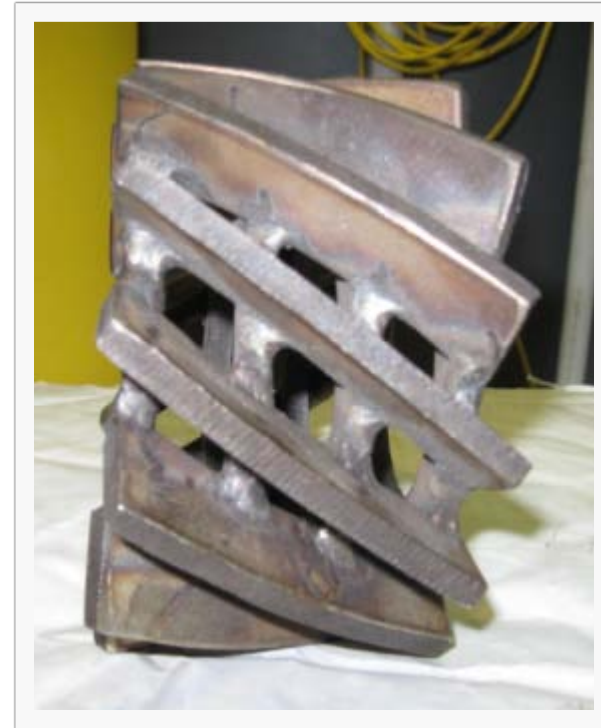
Existing waterjet user “EMS” would like to:

- Expand their capabilities
- Replace 5-axis plasma and other equipment
- Multi-axis part accuracy of $\pm .001$ ”
- Eliminate man hours needed for secondary operations
- True 3D 5-axis solution, not just a bevel cutter



3D Success Stories

- Used multi-axis plasma
- Multiple part set takes 120 man hours
- Low tolerance required large gaps to be left for welds
- Elaborate fixturing needed for welding



Sear Ring: before

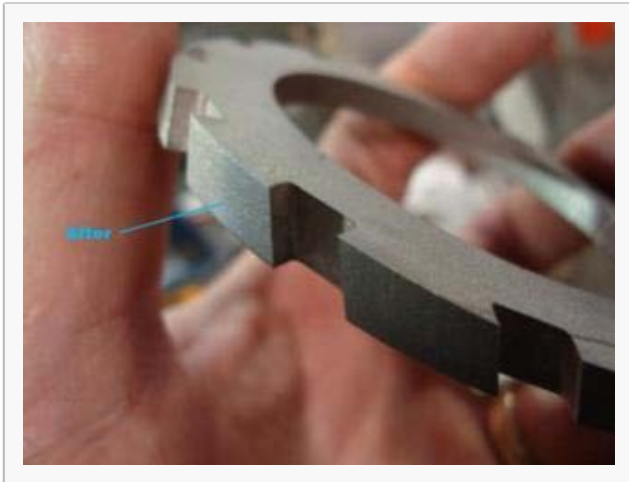
3D Success Stories

- 50% less time for finished part
- Fits tight together
- No fixturing required for welding operation
- Much more attractive part to end user



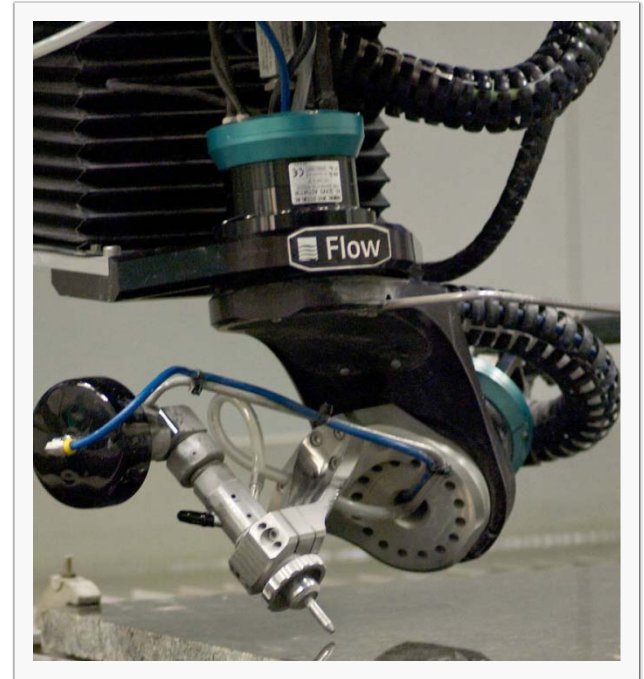
Sear Ring: After

Proven Results



Conclusion

- Multi-axis waterjet technology compares favorably among other processes
- A user of virtually any level can now program in 3D
- Obstacles to 3D cutting have been solved by Flow. We see the same rapid growth in Waterjet technology
- Users everyday are discovering how the latest in 3D waterjet technology helps them expand their business



Questions?

Thank you for you attending.

For a complimentary needs analysis or a product demonstration contact us at info@flowcorp.com or visit us at FlowWaterjet.com.





Flow

INNOVATION | EXPERTISE | COMMITMENT