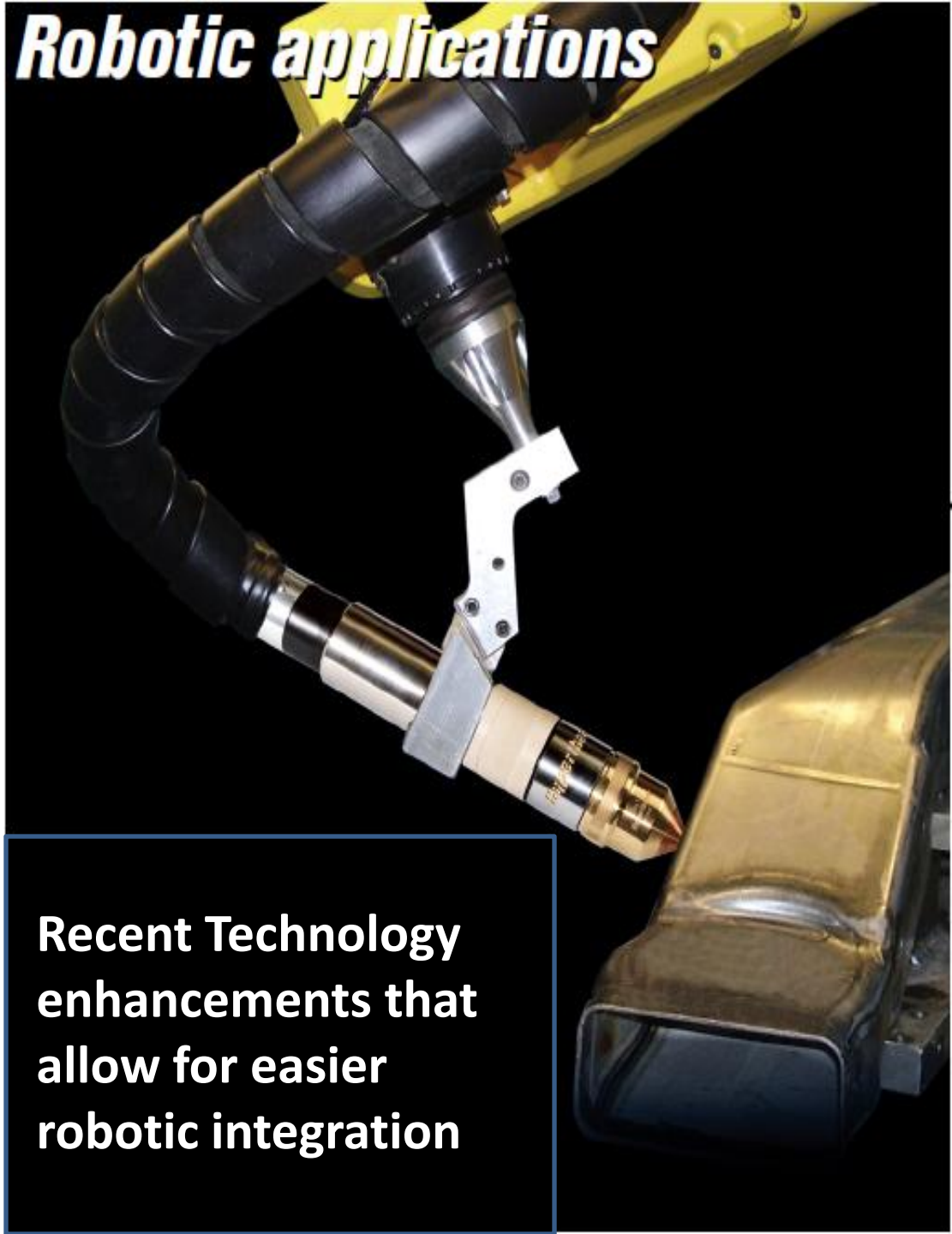
National Robotic Arc Welding Conference and Exhibition

AWS **FMA**



Recent Technology enhancements that allow for easier robotic integration

Jim Colt Applications Technology Manager

Hypertherm®

Copyright, 2003 Hypertherm, Inc.
These materials cannot be reproduced in any form without the permission of Hypertherm, Inc.

Relative Process Technology Levels

Plasma…. Technology has been in commercial use since 1960's

- High Definition Cutting to over 2" thickness
- Stainless and Aluminum to 6-1/4"
- Hole accuracy improvement in last 3 years
- Thin stainless quality improvements in last year
- Dramatic "ease of use" improvements in last 5 years
- Dramatic "cut to cut" productivity improvments in last 5 years
- Air Plasma (low cost) inverter systems mechanized use has grown dramatically for lower tolerance / duty cycle applications
- Beveling and structural shape cutting technology improvements in last 3 years

Plasma Technology is improving dramatically and rather quickly

Relative Process Technology Levels

Oxy-Fuel…. This technology, while it is not going away , has remained rather stagnant for over 50 years!

•Oxy-fuel is often mounted on the same cnc machine as plasma. Some improvements in automating te gas flow and cut gas processes has taken place.

•Some torch height control technology improvements have been developed

This process is necessary for productive steel plate processing on thicknesses over 2”.

Relative Process Technology Levels

Laser cutting….CO2 laser metal cutting technology has been well planted for around 25 years. Technology has continuously been evolving. We are in the midst of a major process change from C02 to Fiber Laser Technology.

•Faster speeds and thicker materials will continue to be developed
• Ease of use and process repeatability is continuously improving
• Reduction of long term maintenance costs should be a major factor in switch from CO2 to Fiber technology
• Ability to use Fiber Laser on more conventional machine designs….as well as for 3 dimensional structural shapes will be a major factor in change.
• Power levels of Fiber Laser will bring productive plate thickness levels up.

Major Engineering and Technology Improvements are ongoing…this process will continue to evolve

Relative Process Technology Levels

Abrasive Water Jet…. This technology will continue to evolve as well in the areas of:

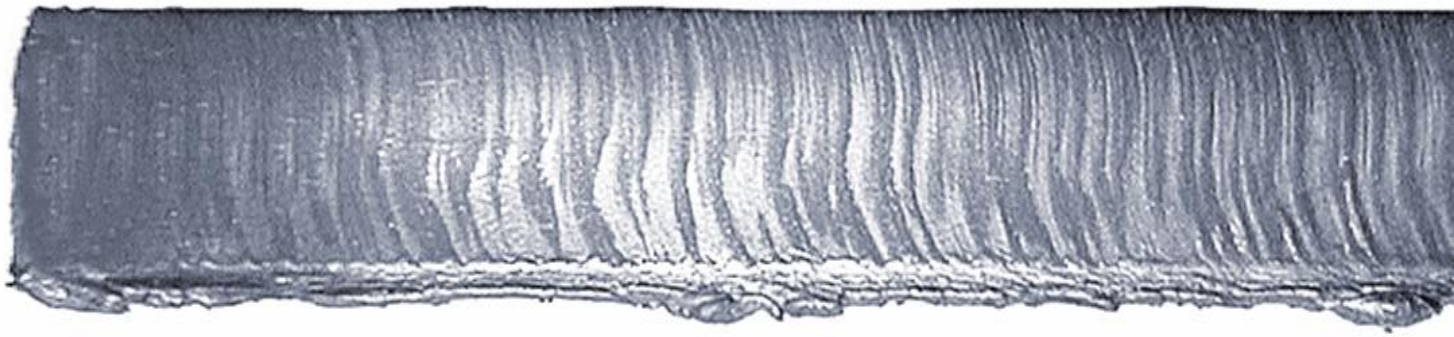
•Advancements in intensifier reliability (lower maintenance costs)
• Increased water pressures will go hand in hand with reliability improvements
• Improvement in water jet nozzle technology
• Cut quality improvements in terms of edge angularity
• Ease of use….expertise is transferring from the operator into the cnc and CAM software, similar to Plasma and Laser technologies

There will be some new emphasis on improvements in the automation and operation cost side of the abrasive water jet technology.

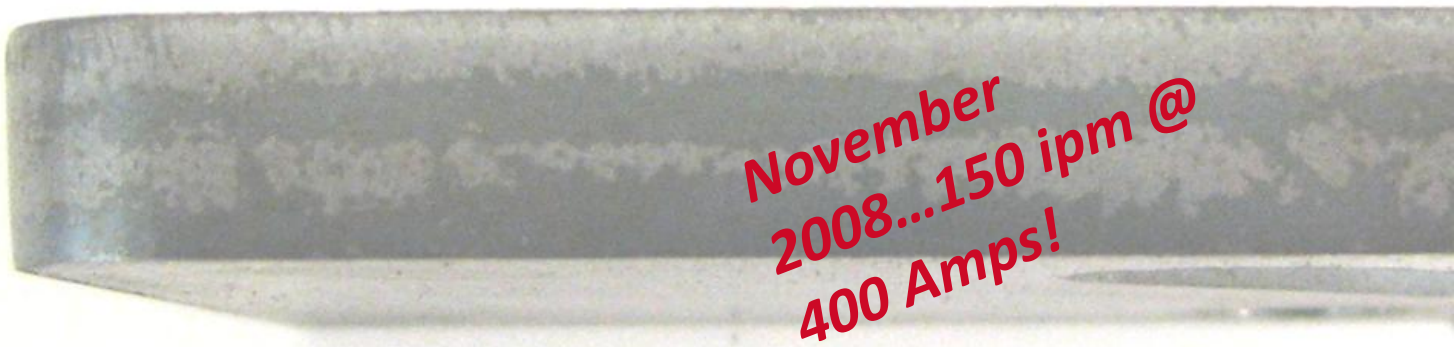
Plate cutting processes then……and now!

Plasma could cut carbon steel at 6 times the speed of an oxy-fuel torch!

1980… 550 Amps, 85 ipm



Today…400 Amps, 150 ipm



Lower Power = Less smoke, less noise, less ultraviolet glare, less power cost

The Perfect Cut

All fabricators that cut metal are looking for essentially the same thing - THE PERFECT CUT. The perfect cut would have the following properties:

- ***Square cut edge angle***
- ***Excellent tolerance***
- ***No kerf lost***
- ***High speed***
- ***Low cost***
- ***No metallurgical changes***
- ***Repeatability***
- ***Easy to operate***

Metal Cutting Methods

Unfortunately, this is not a perfect world! All metal cutting methods have advantages and disadvantages. Fundamentally, all metal cutting processes on the market today fall into one of three categories:

- ***Mechanical*** ***(saw, shear, abrasive water jet, etc.)***
- ***Chemical*** ***(oxy-fuel)***
- ***Thermal*** ***(plasma or laser using non oxidizing gas)***
- ***Chemical/Thermal*** ***(plasma or laser using oxygen)***

Metal Cutting Methods

…Ultimately, the desire is that the best process is chosen to provide for the **Accuracy**, the **Throughput**, and the **Cost per Part**…..so the part will meet the required need!

Each of the plate cutting processes has it niche area where it will provide the best performance

Direct comparisons:

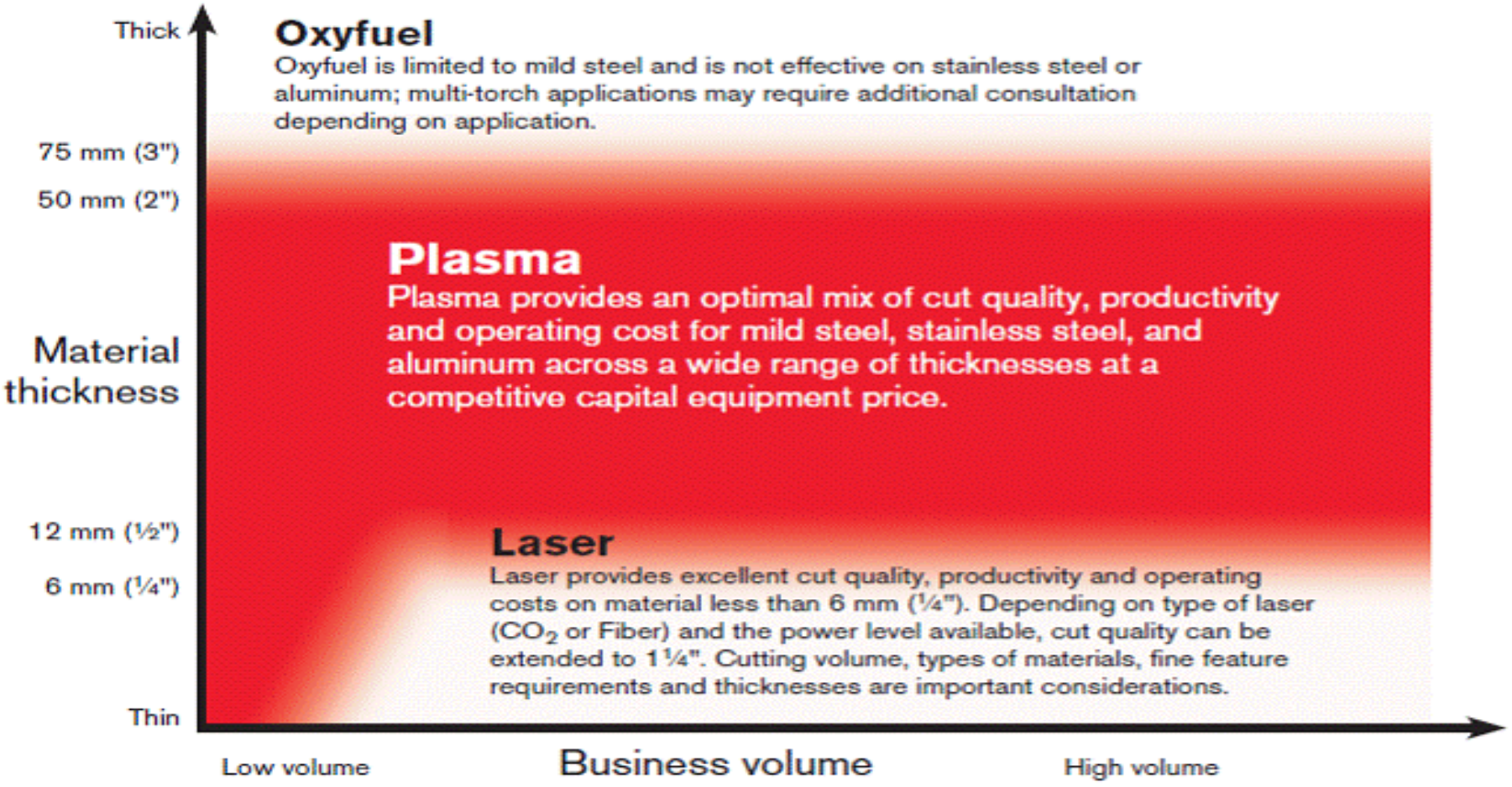
Plasma will cut all electrically conductive metals. The major strength is with carbon steels in the range of gauge to 2” thickness using a high definition oxygen based plasma system. Good quality on stainless and aluminum in the range from gauge to over 1” can be achieved, with maximum piercing on stainless and aluminum to 4” thick, and edge start cutting to 6-1/4” There are a variety of different plasma processes using different gases, power levels and levels of arc constriction….these process variations will provide different edge metallurgical effects based on the heat affected zone and chemical effects.

Laser cutting technologies are available with a wide array of power ranges. The most common lasers are C02 based, with new technology in the form of Diode Pumped Fiber lasers rapidly entering the marketplace. Lasers will cut a variety of different materials, with the major strength in cutting metals thinner than ¼”. Some C02 laser have reflectivity issues on highly reflective materials such as some grades of aluminum and copper, while the newer technology fiber lasers can cut reflective materials quite well. Lasers are particularly strong on materials ¼” and thinner, yet the higher powered C02 systems can cut up to 1” steel, and ¾” stainless materials with respectable tolerances

Abrasive Water Jet will cut almost anything…however for this comparison we will talk about the cutting of metals. Abrasive water jet can cut any metal, and almost any thickness. The process is rather slow on hard materials and on thicknesses above about 1/8”, and uses garnet as the abrasive cutting medium which adds some cost. Cut part accuracies will rival laser on thinner materials and will be the best of all of the processes on thicker materials. The main advantages are the ability to cut anything, and the ability to cut without a heat affected zone. The clear disadvantages are the slow cutting speeds (low productivity) as well as the associated high operating costs.

Oxy-Fuel technology is limited primarily to cutting steel. Advantages are that the process is relatively simple, low cost from a capital equipment point of view, and it is relatively common to have multiple oxy-fuel torches cutting simultaneously on a common cnc cutting machine….making heavy plate cutting quite productive. Best material thickness range is from about ¾” to over 15” . Oxy-Fuel torches are often mounted on the same cnc machine as plasma systems….dramatically expanding the thickness capability of these cutting machines.

Thickness range and productivity



Note: Abrasive water jet fits in here as well! Discuss!

Choices for Plasma Cutting

State of the Art with Today's Industrial CNC plasma systems:

CAM Nesting Software controls all aspects of part drawing conversion…as well as virtually all plasma and machine motion related settings

Industrial CNC control is the brains of the system…controls motion, height, plasma gas flows, on/off functions, and is the operator interface. Windows based….easy to learn, operate.

Torch height control..the key to consumable life, faster cut to cut cycle time, as well as cut quality. Fully automated, no operator intervention required

High Definition class plasma….high speed, high accuracy, low cost per part. Fully automated….highly reliable.

Industrial cnc plasma machines are heavily constructed for rough industrial duty, yet use the latest motion and drive technologies to insure excellent mechanical accuracy and shift to shift reliability and accuracy. The open design allows for easy material handling.

Coupled with the above industrial systems…todays cnc Industrial machines are designed and built for many years of extremely accurate, high productivity cutting.

Purchase price of a turnkey industrial plasma is substantially less than the Laser and WaterJet machines.

Choices for Plasma Cutting

Advancements in recent years in plasma cutting technology:

-Dramatically lower operating costs
-High Definition cut quality
-Full automation / ease of use
-Faster cut to cut cycle times
-Advanced CAM software capabilities
-Beveling capability
-Improved thin steel and stainless quality
-True Hole technology
- More energy efficiency…industrial plasma systems can transfer as much as 85% of the input electrical energy directly to the cutting process (Torch)

Choices for Plasma Cutting

-Entry level Air plasma systems, while less productive, can produce nice cut quality on low cost cnc machines.
-Entry level machines as small as 2’ x 2’ can be purchased for less than $3k!

-Industrial, high definition plasma cutting systems can be configured in virtually any size, with multiple torch heads and beveling capability. On materials thicker than 3/16”…..and up to 2” on steel and 6” on aluminum and stainless….are by far the most productive plate cutting processes available.

Choices for Plasma Cutting

The plasma cutting process has a very wide cut thickness capability range…..coupled with its productivity, it is a very popular plate cutting process today.

So…..which process?

Key points regarding process choices

-Laser is most productive on materials thinner than ¼”. Tolerances are excellent on most materials and thicknesses. Extremely productive on sheet metal. Medium to high operating cost, high capital equipment cost.

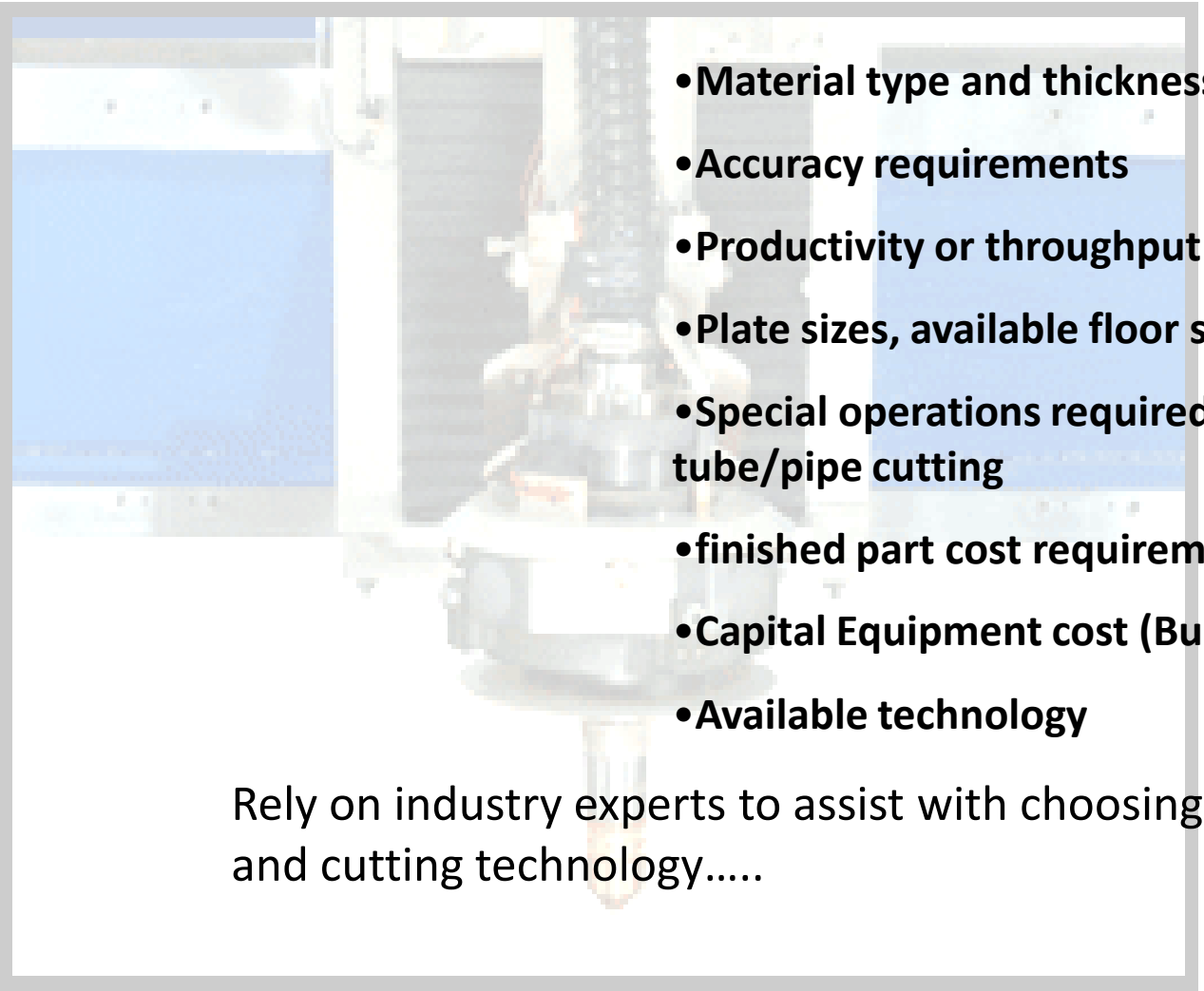
-Oxy-Fuel is necessary for carbon steel thicker than 2”, does a good job down to about 3/8”. Is comfortable on the same cnc machine with plasma, is relatively inexpensive from a capital equipment view, higher than plasma in terms of operating cost.

-Plasma is a universal process with the most metal applications, a wide capability and price range. Is by far the most productive process on carbon steel from ¼” through 2”, medium capital equipment cost, low operating cost.

-Abrasive Water Jet can be considered a universal cutting product for all materials…including non-metals. It’s tolerances rival Laser. It is necessary where heat affected zones cannot be tolerated. Medium ot high capital cost, high operating cost.

So…..which process?

Your metal cutting technology should be selected based on the following criteria:



- **Material type and thickness range**
- **Accuracy requirements**
- **Productivity or throughput needs**
- **Plate sizes, available floor space**
- **Special operations required such as beveling or tube/pipe cutting**
- **finished part cost requirements**
- **Capital Equipment cost (Budget)**
- **Available technology**

Rely on industry experts to assist with choosing the correct equipment and cutting technology…..

Structural Shapes, 3D cutting applications

Since most robotic cutting applications are with repetitive 3 dimensional applications…..what has changed with the plasma cutting processes over the years in regards to robotic integration?

X – Y Plate Beveling

Plasma beveling of plate has been successfully done for over 20 years……which lead to advancements in torch, cnc and software design that allows for high quality 3 dimensional cutting, as well as high quality tube and pipe cutting capability.

Based on newer technology with machine designs that has simplified use, bevelling on flat plate has grown dramatically in the last 5 years!

X-Y Plate beveling enhancements that affect 3 dimensional cutting

Bevel plasma enhancements:

- Better torch lead reliability and robustness
- Better control of electrical noise / high frequency torch start technology
- Front end of torch has better geometry for bevelling and 3 d cutting (more pointed)
- Better real time control of cut parameters
- purpose built torches for beveling and robotic applications.

More iterations of plasma torch designs!

Many robotic applications used a 70 degree or 90 degree modified hand torch….

These air torches worked well for many applications…..and have a variety of process power levels and consumables choices to fit many needs.

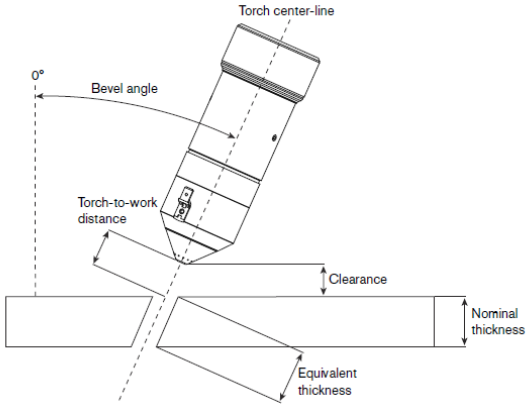
Unfortunately these torches were a little difficult to mount to a typical tool mount!

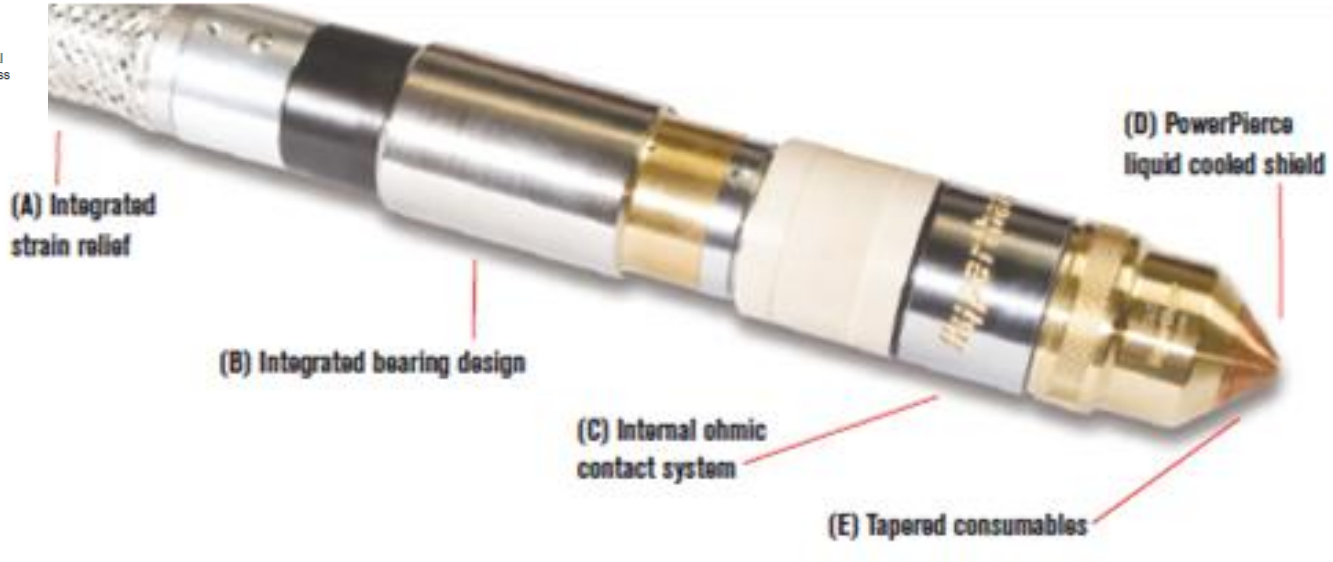
More iterations of plasma torch designs!

Handheld	Mechanized	Robotic
Handheld torch handles are designed to be five times more impact resistant and 20% more heat resistant.	The mechanized torch can be converted to a mini-machine torch.	Robotic torches have been designed for precise positioning. Flats, grooves and dowel sockets on the torch body prevent rotational or horizontal slip.
 75° hand torch	 180° full-length machine torch	 90° robotic torch
 15° hand torch	 180° mini machine torch	 45° robotic torch
		 180° robotic torch

More iterations of plasma torch designs!

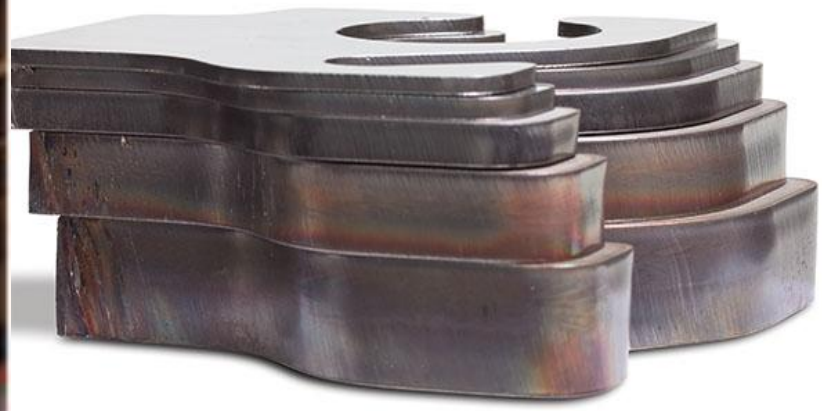
100% duty cycle…..30 Amps to 800 Amps. Features for better robotic integration.





High Definition class plasma HPRxd

More iterations of plasma torch designs!



Stainless

Mild steel,
Carbon steel

Cutting applications for tube, pipe and structural shapes

Purpose built tube / pipe cutting machine with an air plasma system.

Cutting applications for tube, pipe and structural shapes

Custom designed robotic tube trimming cell

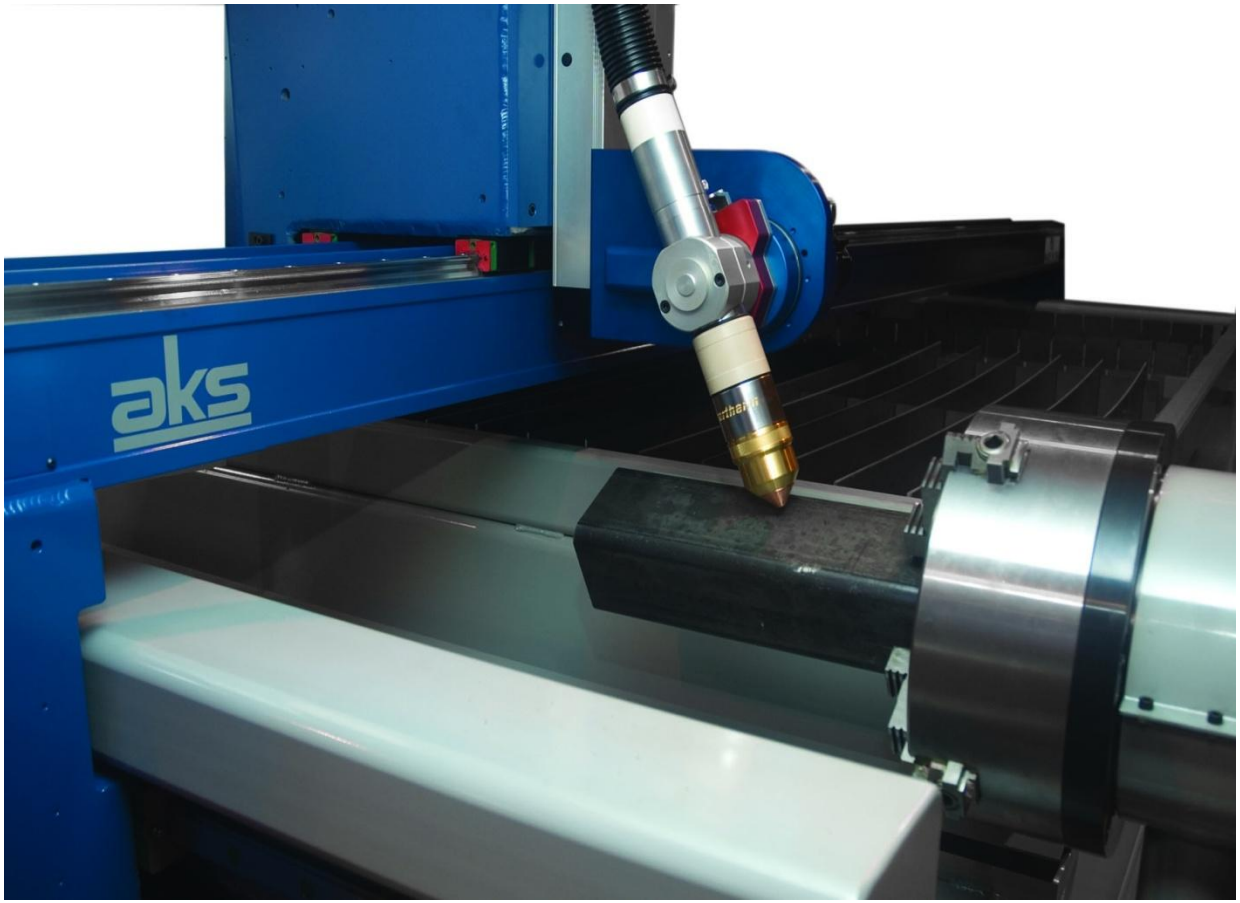
Cutting applications for tube, pipe and structural shapes

Structural shape coping / cutting machine . Holes exceed AISC standards.

Cutting applications for tube, pipe and structural shapes

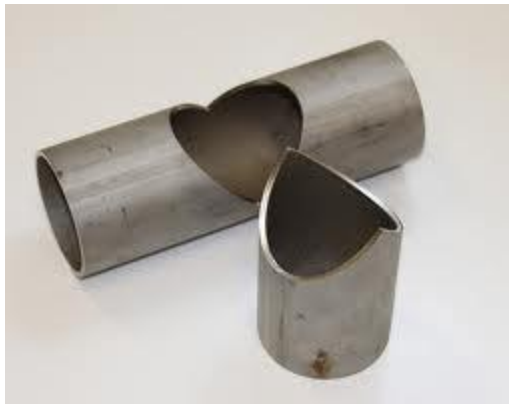
Entry level cnc with air plasma and tube cutting attachment…less than $20k.

Cutting applications for tube, pipe and structural shapes



Industrial combination cnc plasma plate cutting machine with beveling and tube cutting capability. Can contour cut round and rectangular with beveled cut edges.

Cutting applications for tube, pipe and structural shapes



Cutting applications for tube, pipe and structural shapes

Thanks for listening!

Metal cutting questions?

Hypertherm®

Copyright, 2003 Hypertherm, Inc.
These materials cannot be reproduced in any form without the permission of Hypertherm, Inc.