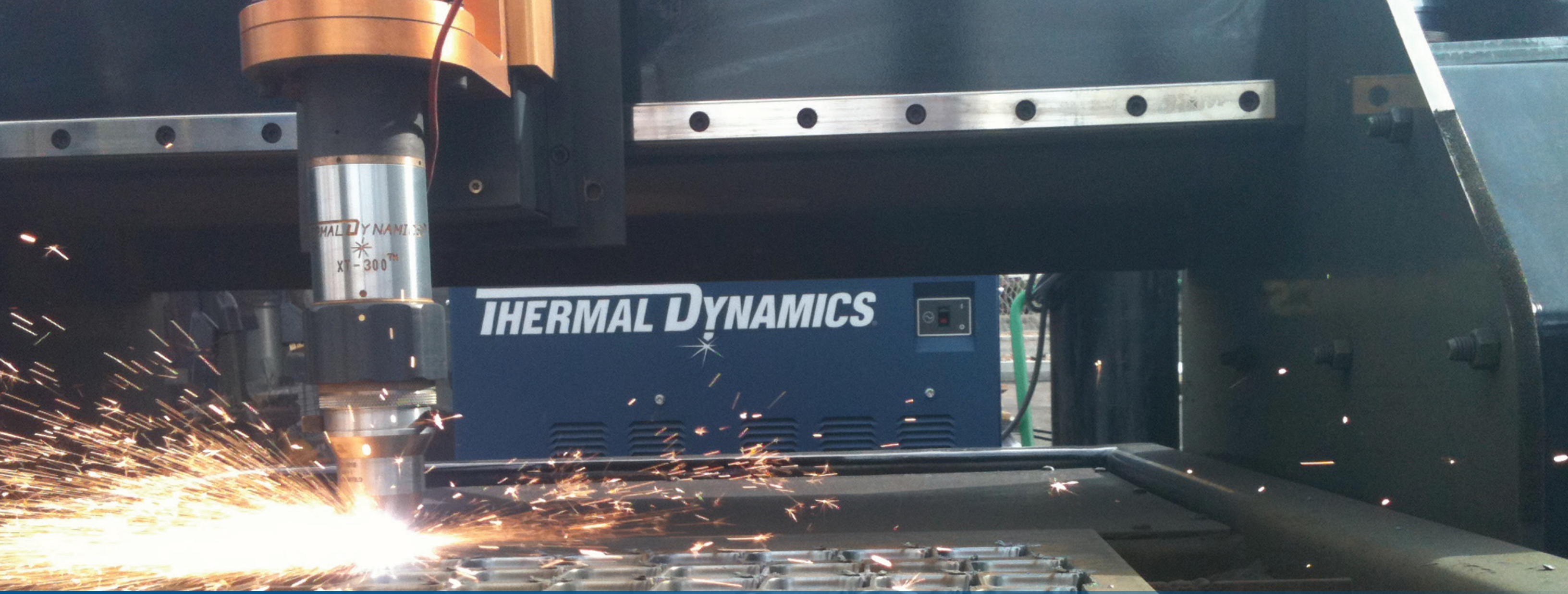

10 Signs You're Ready for an Automated Plasma Retrofit

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Automated plasma technology has progressed significantly in the last 7 to 10 years, the life span of an average system. This article provides guidelines to help fabricators assess the performance of their current automated plasma system. It reviews new automated plasma technologies and explores their potential benefits—notably "weld-ready" cuts and enhanced consumables life—so that fabricators can determine the payback of an automated plasma retrofit.

The Ten Signs

1. The system works intermittently. System controllers and power sources can experience glitches and unexplained shutdowns in the middle of a cut.
2. Less than optimal cut speed.
3. Poor cut quality. Parts require grinding or additional finishing.
4. Poor consumable life, typically measured in the number of arc starts.
5. System issues, such as downtime/availability rate and ongoing maintenance costs.
6. Difficulty meeting deadlines and other customer requirements.
7. Slow set-up or changeover times.
8. Limited materials flexibility.
9. Your cutting table has become a bottleneck, especially after implementing lean manufacturing techniques.
10. High cut cost per foot. This is often the bottom line in evaluating an automated plasma system.

Total costs for a new automated plasma system often range from $150,000 to $200,000 depending on size and complexity (including table, gantry, CNC and plasma).

However, costs for new, high-precision plasma cutting components for a retrofit are significantly less, typically ranging between $16,000 - $60,000. While a retrofit may include updating rails, bearings, fixtures and the like to ensure they can reliably and repeatedly hold required tolerances, a retrofit does allow preserving much of the investment in the existing table and/or robot.

Another benefit of retrofitting is that system components can be added over time, helping spread out capital expenses. Major components that can be added individually include the power source and associated torch and consumables cartridge(s), a torch height controller, a system controller/operator interface with associated productivity software and a gas flow controller.

Assessing Cut Quality

What constitutes a "quality" cut varies widely by application and end-user requirements. Further, quality and speed are interdependent, which is why programmable automated systems have options for "best cut" or "fastest cut."

To gauge potential productivity improvements, consider the cut speeds possible from a new high precision plasma cutter, as shown in Chart 1 (200-amp system) and Chart 2 (400-amp system). Note that every automated plasma system is optimized to cut specific range of

Chart 1: Cutting Speed - 200-amp System

Torch Model	XT™ Torch
Production Piercing & Cutting Capacity (Mild Steel)	1" (25mm)
Maximum Piercing & Cutting Capacity (Mild Steel)	1-1/2" (40mm)
Maximum Edge Start (Mild Steel)	2-1/2" (65mm)

Thickness Inch	Speed IPM	Amps	Plasma/ Shield	Thickness mm	Speed mm/min.
Material: Mild Steel					
20 ga.	130	30	O2/O2	1	3060
10 ga.	30			3	910
10 ga.	210	70	O2/Air	3	6820
1/4	120			6	3100
1/4	150	100	O2/Air	6	4030
3/8	95			10	2300
1/2	64			12	1800
5/8	50			15	1370
1/2	100	150	O2/Air	12	2850
3/4	50			20	1120
1	25			25	650
3/4	65	200	O2/Air	20	1590
1	48			25	1260

Chart 2: Cutting Speed - 400-amp System

Torch Model	XT™ Torch
Production Piercing & Cutting Capacity (Mild Steel)	2" (50mm)
Maximum Piercing & Cutting Capacity (Mild Steel)	2-1/4" (60mm)
Maximum Edge Start (Mild Steel)	3-1/2" (90mm)(MS) 4" (100mm)(SS)

Thickness Inch	Speed IPM	Amps	Plasma/ Shield	Thickness mm	Speed mm/min.
Material: Mild Steel Precision					
10 ga.	30	30	O2/O2	3	910
1/4	120	70	O2/Air	6	3100
1/4	150	100	O2/Air	6	4030
3/8	95			10	2300
1	48	200	O2/Air	25	1250
1-1/4	30			35	750
3/4	100	300	O2/Air	20	2540
1	70			25	1780
1-1/4	50			35	900
1	80	400	O2/Air	25	2100
1-1/2	45			40	1330
2	30			50	790

thicknesses. Just because a system has the power to cut 2" material doesn't mean it's also the best system for cutting 3/16 to 1/2 inch material.

Cut quality has several components:

- **Cut surface.** A quality cut means the part is ready for the next fabrication step. Characteristics include a smooth surface free of dross and nitride contamination. Cutting technology (more on this shortly) and motion device precision especially influence quality.
- **Top edge rounding.** This is caused by the heat of the plasma arc at the top surface of the cut. Proper torch height control minimizes top edge rounding.
- **Top spatter.** Cutting too quickly or using too high of a torch setting causes top spatter, which is easy to remove.
- **Bottom dross.** Easy-to-remove dross indicates cutting too slowly. Hard-to-remove dross indicates cutting too quickly.
- **Kerf width.** The kerf (or cut) width is related to tip orifice size, current setting and torch height.
- **Cut surface bevel angle.** High precision processes produce a bevel angle of 0 to 3 degrees, while conventional plasma will produce larger bevel angles. Proper torch height control produces the smallest bevel angle (as well as kerf width and top edge rounding).

One of the best ways to assess quality and speed is to ask the prospective plasma system supplier for cut samples. Suppliers typically offer standard shapes in mild steel, 304 stainless and 6061 aluminum that demonstrate cut speed, cut surface, outside radius, inside radius, squareness, top rounding, kerf width and bevel angle. Custom cut samples may be obtained by providing a DXF file (preferred) or an engineering drawing. Fabricators wishing samples cut on exotic alloys (titanium, P91, Inconel®, etc.) usually need to supply the sample material. To ensure accurate shipment of cut samples, be sure to provide a specific contact person's name, phone number and street address (no P.O. Box) to facilitate shipping by UPS or Fed-X.

New Processes

One major reason for considering a retrofit is the advent of new plasma and shielding gas combinations that enable high precision cutting on non-ferrous materials (see Chart 3). One such process is the water mist secondary (WMS®) process, which uses nitrogen as a plasma gas and water as the shield. The water in the shield stream is divided into its principal components during the cutting process (hydrogen and oxygen). The hydrogen creates a reduced atmosphere in the cut zone, isolating it from contaminants. Most of the water used in the cut process is evaporated. The result is a clean, dross-free and oxide-free cut surface that is ready to weld.

Compare WMS and other high precision processes to conventional air/air plasma cutting. Air/air cutting produces nitride contamination on the cut surface. The depth of contamination will be about 0.005" to 0.010". A cut surface with nitride contamination requires grinding before welding to eliminate porosity in the weld.

Conversely, high precision processes enable parts to go straight to welding or the next fabrication step. On steel, they cut up to three times faster than oxy-fuel, so one high precision plasma system may be able to replace three oxy-fuel systems. On non-ferrous materials, WMS cuts up to three times as quickly as conventional plasma technology.

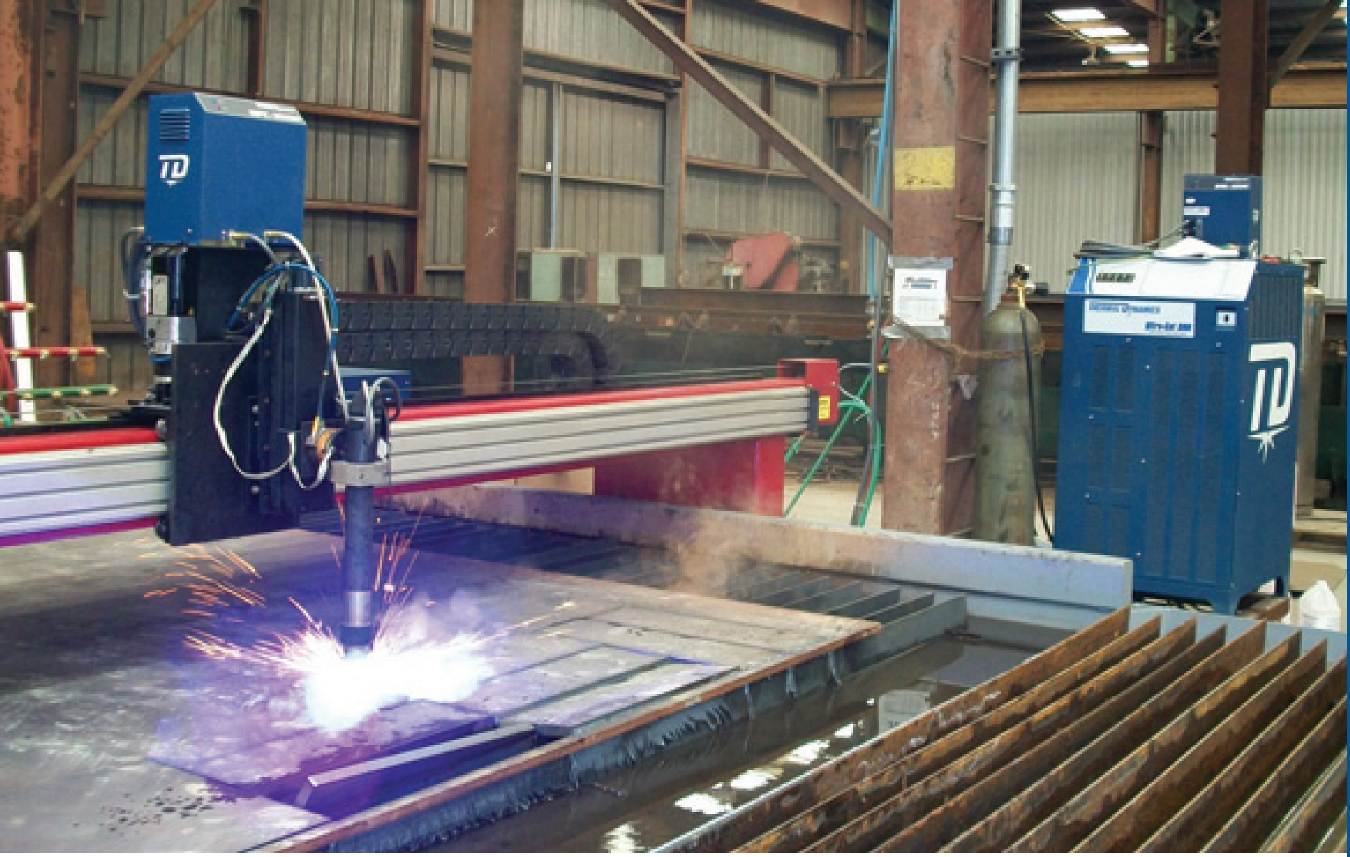
In short, whether cutting steel, stainless or aluminum, high precision plasma reduces cycle time, frees up nearly all man-hours related to grinding* and reduces the cost of grinding consumables. Further, products such as Thermal Dynamics® Automation's Ultra-Cut® provide all of the processes in a single system. For precision mild steel cut performance, select oxygen plasma with air shield. For precision aluminum or stainless steel, select nitrogen plasma with water mist secondary to achieve best-in-class cut performance.

Ultra-Cut systems can also be used for clean, efficient plasma marking without changing consumable parts. This flexibility may enable expanding into new markets, eliminate outsourcing and otherwise increase cutting system utilization rates to produce a better ROI and faster payback.

* Note that while the surface of the cut will be smooth and nitride free, weld procedure specifications and codes may require some surface preparation prior to welding.

Torch Advancements

An automated plasma torch may not look like much from the outside, but on the inside, it's a marvel of precision machining combined with thousands of hours of engineering and testing. Plasma and shielding gases are highly controlled, and how they are controlled greatly affects cut



quality. As a result, factory original consumables will outperform aftermarket products.

Torch cartridge technology has also advanced. Some torch cartridges offer tool-less change-out, such as Thermadyne® Automation's SpeedLok® cartridge. In about one minute, operators can switch to consumables for cutting at higher and lower amperages or different alloys. Keeping a spare cartridge loaded with the correct consumables for the current process almost eliminates downtime when unforeseen events dictate a consumables change.

As already noted, torch height significantly affects cut quality. High precision plasma cutting normally requires cutting closer to the metal compared to older systems. However, controlling torch height during arc starts and piercing also significantly affects consumables life. To prevent the molten metal from splashing back and damaging the end cap, shield cup and tip orifice, torch height may be as much as 1-3/4" off the metal in a 400-amp system. After piercing, the torch must then drop to the appropriate cutting height, but must do so in a manner that prevents it from becoming buried in the molten metal.

To optimize cut quality and consumables life, a retrofit should also include a ball screw driven torch lifter station, new linear rails and a brushless servomotor with pulse encoder for torch position feedback. Note that the latest generation of system controls, such as Thermal Dynamics® Automation's XT™ CNC series, feature embedded torch height control. Machine operators only need to select "best cut," "fastest cut" or "pierce," select the process desired and enter material type and thickness. The system then automatically sets and controls pierce height, cut height and timing of all torch movements. In turn, this extends parts life by several hundred arc starts. Costs savings can amount to tens of thousands of dollars per year per torch.

CNC Controls

Fabrication shops that repeatedly cut the same handful of parts might want to continue with their existing controls. However, any company that changes parts, processes or materials on an occasional basis should consider the time, consistency and cost savings possible from a new CNC control.

First, CNC controls simplify operator training and promote consistency by storing a cut parameter database. Operators can recall programs using the touch screen controls. As noted above, they can also enter basic information about the job and let the system automatically set and control cutting parameters. Operators can actually monitor cutting in one window while setting up the next program in a second window.

Chart 3: Modern Automated Plasma Process Options

Process		Application(s)	Advantages
Plasma	Shield		
Air	Air	Conventional mild steel technology	Economical operation cost, good cut quality
Air	Air	Conventional non-ferrous technology	Economical operation cost
N2	N2	Conventional technology for thin non-ferrous	Better parts life and cut surface than air/air
O2	Air	High precision cuts at 50-400 amps on mild steel	Weld-ready cut surface
O2	O2	High precision cuts at 30 amps on mild steel	Weld-ready cut surface
N2	H20*	High precision cuts on non-ferrous metals	Best quality cuts on aluminum and stainless up to 3/4"
H35**	N2	High precision cuts on thicker non-ferrous	Faster cutting on aluminum and stainless greater than 3/4"

* Commonly called "water mist secondary" or WMS.
** H35=35% Hydrogen + 65% Argon

CNC controls typically feature a standard part shapes library, include a "micro-CAD" function for editing existing shapes and creating new ones and include an automatic converter for DXF files (however, note that DXF files created for laser cutting systems cannot be directly imported). Users communicate with the controller through USB ports and can connect it to enterprise software or other controls using an RS-485 or RS-232 connector. Optional upgrades include productivity software that maximizes material efficiency, minimizes scrap, increases machine productivity and streamlines overall production. Other functions can include automatic part pattern recognition, cost and time estimators, job tracking and inventory control solutions.

Gas Flow Control

Older automated plasma systems typically feature manual gas controls that require re-setting gas flow rates and pressures for each new setting (and possibly disconnecting and reconnecting gas hoses). Such a system opens itself to set-up errors and parameters that lead to wasted gas, inconsistent cut quality and reduced consumables life. Switching between marking and cutting may also be difficult.

Conversely, digital flow control systems provides programmability, automatically control gas flow rate and pressure and function as the central manifold for incoming gases (typically up to seven) and output gases (typically up to five). Systems such as Thermal Dynamics Automation's DFC-3000 Automatic Gas Control offer independent programmability; operators can store and choose from thousands of programs and start cutting simply by touching a "Go" button. Automated digital flow controls can operate independently, or they can be integrated into most CNC controls.

Training and Support

Retrofitting an old plasma or oxy-fuel cutting table with a new, high-precision plasma cutting system can significantly enhance the productivity and competitive position of any fabricator. As has been shown, however, selecting and incorporating any of the new system components isn't quite a "plug and play" activity. For this reason, work with an automated plasma partner who will provide the support necessary to select the right equipment and ensure successful installation and start up.

Support is necessary when a new system and components are installed and the operator is trying to use previous parameters of his old equipment. This usually results in poor performance and frustration. A good automation partner will develop recommendations for travel speed, amperage, torch consumables, torch height and gas flow, then work with the customer to successfully implement them.

New system controls are easier to use, but require training in their proper use. Working with a supplier that offers hands-on training is the best way to ensure all of the potential benefits of an automated plasma retrofit are realized. ■

Chart 4: How to Calculate ROI and Payback

Six Steps for Calculating ROI (%) and Payback Period

1. What are the annual savings? Estimate if necessary*	$25,000
2. Plasma automation investment	$50,000
3. Straight line annual depreciation (Line 2 ÷ 5 years)	$10,000
4. Annual savings after depreciation (Line 1 minus Line 3)	$15,000
5. Profit after taxes (Line 4 X 0.66)	$ 9,900
6. Annual savings (Line 3 + Line 5)	$19,900
Line 6 ÷ Line 2 X 100 = **Return on Investment**	39.8 %
Line 2 ÷ Line 6 X 12 months = **Payback Period**	30.1 months

Always express ROI as a percentage and payback as a time period.

*To calculate annual estimated savings, compare costs per foot, cut costs per part and/or costs for consumables, labor time, rework and other individual factors for both new and old technology. Ask your automated plasma supplier for help.

Chart 5: A plasma retrofit increases expected parts life by several hundreds starts