The goal of this seminar is to provide the necessary knowledge and understanding of laser material processing on a variety of materials so that you can effectively achieve the same quality results for your business.

Seminar Outline

• When to use different optics with your lasers systems
• Understanding Laser Processes
• Understanding your Laser System
• Choosing the correct materials
• Creative ways to grow your business- No cost materials
• Leathers
• Stainless Steel
• Woods
• Acrylics
• Fabrics
• Creating fixtures/jigs with your laser
Laser Optics (Lenses)

- In general, all optics are the same; they are designed to bend light.
- Using the correct laser optic will drastically improve output quality.

How Laser Optics Work

Light enters a lens and converges to a focal point. Upon crossing the focal point, the light diverges.

Lens type determines how light will react and the size of the focal point.

Lens Options

- Spot Size
  - Ø0.005" Spot size
    - Excellent for cutting
    - Smaller for cutting, the cutting
  - Ø0.010" Spot size
    - Excellent for cutting
    - Smaller for cutting, the cutting
  - Ø0.015" Spot size
    - Excellent for cutting
    - Smaller for cutting, the cutting
Optics Example
Same image run with same power settings at same resolution on same laser system with 3 different lenses

Questions

Understanding Laser Processes

- Laser Cutting
- Laser Engraving
- Laser Marking
- Laser Fusing
- Laser Imaging
Raster and Vector

Two motion modes: Raster & Vector

- Raster – moves left and right in lines going down the “page,” like ink jet printer. Covers area such as a filled shape or text. For engraving.

- Vector - follows path or outline of an object. Like tracing with a pencil. For cutting, scribing, line marking.  
  (Line width less than 0.003” / 0.0007mm to be recognized as a vector.)

Types of Laser Processes

Engraving
- Vaporizing some of the base material
- Cone shape indentation
- Wood, leather, rubber...

Marking
- Vaporizing cover layer
- Materials with 2 or more layers
  - Coated metal, engravers plastics ...

Fusing
- Add layer with ceramic powders
- For some metal surfaces
  - Cermark® over bare Metal

Cutting
- Apply enough power at a low enough speed to completely vaporize material all the way through

Laser Imaging
Understanding your laser system

There are 4 things that may hinder your goal toward maximizing results:

• Accessories
• Laser Power
• Field Size
• Laser Optics

Accessories

• Cutting Table
• Air Assist
• Pin Table
Understanding Laser Power will allow you to understand your limitations with laser power; all laser wattages have some limitations.

**Laser Power**

- All CO$_2$ laser output is at full power.
- CO$_2$ laser power is controlled by pulse duration.
- Example –

![Graph showing power vs time with different power levels]

- Choosing the right laser power.
- Lower power, more control.
- Higher laser power = Higher productivity?
- 80% of materials are power dependent.
Field Size

• Size is productivity.
• Larger field, larger parts.
• More parts per field.

Questions

Choosing the right laser processing material

• Understand and know your material.
• Understand what capabilities a CO₂ laser has when working with a material.
Material Types

- **Organic**
  - Material composed of remains of biological or botanical origin, such as plants and animals.

- **Inorganic**
  - Material composed of substances of mineral origin such as ceramics, metals, and synthetic plastics.

- **Composites**
  - Material made up of several parts or elements (organic or inorganic).

**Organic Material**

- Woods
- Leathers
- Papers
- Wools
- Cotton

**Inorganic Material**

- Plastics
- Metals
- Stone
Composite Material
- Concrete
- Fiberglass
- Plywood

Material Variation Example
1” Styrofoam vs. 1” Polyurethane foam

The reaction when applied with CO₂ laser energy is totally different.

Material Resource  www.McMaster.com
Questions

Creative ways to grow your business

• Develop new laser applications that are attractive to your current customers
• Find new markets for the products and services that you already provide
• Create new value with novel laser processing ideas
• Diversify your business
Creative Ways to Grow your business

- Understand the Standard materials that can be processed
- It is time to get you out of that "Box"
- If you are not learning and improving then you are dying

Success stories
Example of business growth

**Used** Cardboard, Trash?

NOT if you have access to a laser system!

Simple recycled cardboard transformed into an elegant lamps
Customer: www.greypants.com

Examples

Example of business growth

River Stones (Low to Zero cost to get)
Easy to engrave
Quickly converted with a laser system into tokens, favors, garden markers, paperweights and even photos.

Examples
Driftwood (Low to Zero cost to get)
Has a very rustic look that cannot be reproduced

Can easily be converted into signs, jewelry or gifts
Exotic Materials
Dry tree leaf (Low to Zero cost to get)
Laser etch on to Compress finished leaf between two pieces of acrylic to protect and preserve it for use in gifts and awards

Questions

Material categories to be covered
- Micro Surfaced Plastic
- Teflon® (PTFE)
- Leathers
- Polyurethane foam
Leathers

- A durable, flexible material created by the tanning of animal rawhide and skin
- Produced in both cottage and heavy industry
- Used for various purposes including clothing, bookbinding, wallpaper, and furniture
- Produced in a wide variety of types and styles
- Decorated using a wide range of techniques

Leather Description

Leather Reaction to CO₂ Laser

The leather absorbs light and converts to heat, chemically degrading and vaporizing the organic material producing a surface darkening effect or cut.

Preferred Laser Wavelength is: 10.6 µm CO₂
Leather Types

- Animals
- Tanning types
- Thicknesses
- Subdivisions

Leather Types

- Bovine
- Snakes
- Deer/Elk
- Stingray
- Alligator
- Ostrich
- Many more

Thicknesses

Thickness or Weight - Leather is measured in terms of ounces. One ounce equals 1/64th inch thickness.

<table>
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<th>Thickness</th>
<th>Fractional Inch</th>
<th>Decimal Inch</th>
<th>Millimeter</th>
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<td>0.016</td>
<td>0.43</td>
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<tr>
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<td>0.375</td>
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<tr>
<td>14</td>
<td>7/32</td>
<td>0.438</td>
<td>11.11</td>
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<tr>
<td>16</td>
<td>1/2</td>
<td>0.500</td>
<td>12.70</td>
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</table>

In leather thickness terms, one ounce equals:
Leather Terms & Subdivisions

- Grain
- Full Grain
- Split
- Suede Split
- Back
- Belly
- Kip

Subdivisions of Leather

- Belly .......... F or G
- Single Bend ..... D or E
- Double Back .... B+C+D+E+A
- Side .............. A+B+D+F or A+C+E+G
- Back ............ A+B+D or A+C+E
- Double Shoulder ... B+C
- Single Shoulder ... A+B or A+C

Common Applications

Leather is commonly used for shoes, clothing trim, personal accessories, and upholstery.

Leather Advantages

- High contrast (on most leathers)
- Unique
- High engraving details
- High perceived value

Leather Limitations

- Must masked before cutting
- Grain issues
- Focus issues
- Difficult to keep flat
Keeping Leather Flat
Use spray or brush adhesive (contact adhesive) to adhere leather to a flat object

1. Spray each part
2. Put together
3. Press together
4. Trim excess
5. Edge close-up
6. Ready for laser

Laser Processing Leather

1. Place on Cutting table
2. Tape Edge, Engrave
3. Mask over engraving
4. Squeegee mask
5. Cut file
6. Peel mask, finished

Laser Cut Leather Examples
Laser Marked Leather Examples

Laser Imaged Leather Examples

Large Laser Photo Imaged Leather (24"x36")
Laser Marking and Cutting Leather

- Marking design and cutting for stunning new looks

Deep Engraving

- Mask the leather
- Place into laser on cutting table
- Engrave through the mask
- Remove and peel mask
- Clean out the engraving

Cleaning Leather

- When cutting thick leather or deep engraving you may need to clean the charred or sooty residue from the leather.
- Scrub it gently with Fast Orange or a similar non-abrasive hand cleaner. Apply the hand cleaner liberally to a small area of the leather and then scrub in small circles with a toothbrush. Wipe the excess off with a paper towel and then repeat the process on the next area. Avoid letting the leather soak up water.
What is stainless steel?

- Carbon metal steel with chromium.
- Corrosion, rust and stain resistance.
- Different grades and surface finishes.
- Applications where steel properties and resistance to corrosion are required.

Stainless Steel Types

- Austenitic
- Ferritic
- Martensitic
- Duplex
Working with a CO₂ Laser

• Laser Material Interaction
• 10.6 micron – CO₂
• 1.06 micron (Fiber Laser)

Advantages

• Durable
• High perceived value
• Long lasting
• UV Stable material

Limitations

• Difficult to cut
• Heavy
• Time consuming to mark or cut

Laser Processing

• Metal Marking Compound
• High Power Density Optics
• Fiber Laser
Using Metal Marking Compound

- Metal must be uncoated
- Marking compound needs to be consistent

Using Metal Marking Compound

- Low cost
- Extra cost per part
- Not UV stable
- Surface marking

Direct marking with 10.6 micron – CO₂

- High density optics
- Requires 50+ watts
- UV stable
- Sub surface Mark
Marking & Engraving with 1.06 micron Fiber Laser

- Fast, direct metal marking
- Any available lens will work
- UV stable
- Sub surface mark
- Lenses, frequencies & focus

Comparing the Processes

- Direct marking, 10.6 micron CO₂ Laser
- Marking compound, 10.6 micron CO₂ Laser
- Direct marking, 1.06 micron Fiber Laser

Annealing for Color using 1.06 micron Fiber Laser

- Color effects
- Mirror effects
- Gold effects
Annealing for Color using 1.06 micron Fiber Laser

- Jewelry
- Knife Blades
- Decor

Questions
Wood absorbs light and converts to heat, chemically degrading and discoloring the organic material. Marked areas will be medium to dark brown in appearance from the heat of the laser.

Wood Advantages
- Forgiving
- Flexible
- Unique
- High Perceived value

Wood Limitations
- Grain
- Density variation
- Man-made, Plywoods, MDF
- Glue seams
Wood Laser Processing - recommendations

- Use cutting table.
- Use Air Assist.
- Use 50 Watts or more.

Laser Engraving and Cutting with Wood

- Does not require a special lens.
- Fairly easy to process.

Wood Grains

More Grain: Spruce, Oak, Pine

Less Grain: Cherry, Maple, Birch
Composite Woods/Engineered woods

Laser Processing with Wood

Laser Processing with Wood
– Laser Inlay

• Engrave Image into wood
• Outline identical image and cut.
• Glue part into engraving.
Laser Inlay Wood Example

Laser Processing with Wood – 3D Engraving

- Greyscale image.
- 3D mode.
- High resolution lens (2.0" will work).
- Multiple passes and higher speed with laser.
- Clean with water and brush.

3D Wood Example

Resource for 3D Images:
http://www.gantryco.com
Laser Processing with Wood - Multidimensional 3D

Using a 3D process and converting text to shades of grey you can achieve incredible results.

Example: Graphic images

Multidimensional 3D Wood Example

Multidimensional 3D Wood Close-up
The polymer material absorbs light from the laser, converts it to heat, and begins to depolymerize. Continuous cast acrylic behaves like cell cast acrylic in that the amount of heat that is applied by the laser beam can be controlled to create a surface frosting. This creates a frosted mark on the surface of the acrylic, without substantial material removal.
Acrylic Types

- Cell Cast
  - Laser engraving appears frosted.
  - Laser cutting easy.
- Continuous Cast
  - Laser engraving appears frosted.
  - Laser cutting easy.
- Extruded
  - Laser engraving appears clear.
  - Laser cutting produces oily residue.

Acrylic Advantages

- Flame-polished edge
- High detail and sharp depths.

Acrylic Limitations

- Flammable
- Scratches easily
- Liquid residue
Laser Processing with Acrylic
- recommendations

- Use a Cutting Table or Pin Table.
- Use Air Assist.
- Use 50 Watts or more.

Laser Engraving and Cutting
with Acrylic

- Does not require a special lens.
- Fairly easy to process.

Laser Cutting (Thick)
with Acrylic

- Best lenses are the 2.0”, 2.5” or the 3.0”.
- Elevate over a cutting table or use of a pin table.
- Add Nitrogen gas to air assist.

- Focus into the acrylic as much as 0.060”.
Laser Photo Imaging with Acrylic

3D Engraving with Acrylic
- Greyscale image.
- 3D mode.
- High resolution lens (2.0” will work).
- Multiple passes and higher speeds.
- Clean between laser passes.
- Glaze finish.

3D Acrylic Example
Reverse Multi-dimensional Glaze Example

• LuciteLux® Vario Acrylics
• Lumicor® Architectural Panels

Exotic Acrylic

Questions
Fabric Reaction to CO₂ Laser

Fabric absorbs light and converts to heat, chemically degrading and discoloring the material. From the heat of the laser, marked areas will exhibit a light or dark response depending on the fabric type.

Laser Processing Fabric
Advantages

- Forgiving
- Flexible
- Unique
- No fraying edges
- Fast

Fabric Limitations

- Melting
- Burning
- Contrast variation
- Braking fibers
- Color issues
**Fabric Laser Processing - Recommendations**

- Use cutting table
- Large field
- Use 25 Watts or more

**Fabric types (most common)**

- Cotton
- Fleece
- Suede
- Rayon
- Chenille
- Satin
- Flannel
- Silk
- Polyester/Twill
- Wool
- Nylon
- Felt
- Many more

**Synthetics vs. Natural**

- Synthetic fabrics, such as Nylon and Polyester, are produced entirely from chemicals. Natural fabrics, such as Cotton, Silk, and Wool are made of fibers from plants and animals.
Fabrics
Synthetics vs. natural

Synthetic fabrics
Tend to produce melted edges sealing the fibers together.

Natural fabrics
Tend to yellow on the edges when Laser cut

Laser Cutting Fabrics
Accessories needed- Cutting table

Twill, (multi-layer fabrics)
- Simple 2-color contour design using
- PSA Twill from Twill USA or Stahls'
Twill, (multi-layer fabrics)

- Heat pressed and or stitched onto finished garment

Laser Marking Fabrics

Issues:

- Not all colors of fabric will mark
  - Black and white are most difficult

- Synthetic fibers melt
  - Fleece and Micro Suede work well, but most synthetic fibers will not laser mark.
  - Standard Polyester
Laser Marking Fabrics

Laser marking fabric technique:
Natural fibers like Wool, Silk and Cotton
• Wet down fabric before laser processing, this will allow the laser to "bleach" the color out of the fabric without damaging the fibers.
• Use just enough laser power to lightly mark the fabric, when fabric dries contrast will develop.

Fabrics – Multi Material Design

Sample Backing: Photo Engraved Acrylic
Runner: Photo Engraved Micro-Suede adhered to Acrylic
Clothing: engraved and heat-pressed Flock
Number: Two-layer heat-pressed Twill
Total Size: 24” X 36”

Efficiency
Fixtures and JIGS
**Simple process for uneven parts**

*Low volume*

**Modeling Clay**

1. Place Clay into laser
2. Press part into clay
3. Locate part with laser
4. Mark part
5. Place new part into divot
6. Run new part

**Quickly target a location**

- Target location using red dot pointer
- Send file to the ULS control panel
- Select “Relocate View”
- Select one of 9 handles
- Select “To Pointer”

**Efficiency**

- The more parts in a row the better

*Example:*

1. Tag ran in 16 seconds
2. 12 Tags ran in 41 seconds (3.4 seconds each)
Simple low cost fixture
Transfer Tape (Application Tape)

- Small runs
- Fast
- Inexpensive
- One-time use

1. Transfer tape (Painter’s tape)
2. Stick to laser table
3. Design file to cut
4. Cut tape with laser and peel
5. Place parts and laser process

Low-yield multi-use fixture
Cardboard

- Small runs
- Fast
- Inexpensive
- Reusable

1. Common Cardboard
2. Design file and cut
3. Cut file with laser in place
4. Remove cut parts
5. Place parts and laser process

High-yield multi-use fixtures

- Using this same concept we can design and build fixtures that will last for years
High-yield multi-use fixture
Acrylic or Wood

- Cut Wood or Acrylic, engraving some kind of indicator onto the fixture for orientation.

Multiple materials - one laser cut fixture

Tray form fixture, back plate is glued to fixture allowing for multiple parts to be loaded in advance, this way two fixtures can be fabricated. While one is running the other can be loaded in a batch process.

Final Questions
Thank You!

Unlimited possibilities!
Let's Get Creative

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Thank You!