WHEN TO EDM

The first part of this presentation provides a brief educational overview of the Electrical Discharge Machining Process (EDM)

Second, a detailed analysis of When, Why and Where EDM can provide a huge benefit in the engineering, design and implementation of the overall tool manufacturing process.

I hope you enjoy the show!
WHEN TO EDM™
The origin of electrical discharge machining goes back to 1770, when English scientist Joseph Priestly discovered the erosive effect of electrical discharges. In 1943, Soviet scientists B. Lazarenko and N. Lazarenko had the idea of exploiting the destructive effect of an electrical discharge and developing a controlled process for machining materials that are conductors of electricity. With that idea, the EDM process was born.

Mr. & Mrs. Lazarenko at the presentation of the Eleroda D1 at the EMO exhibition in Milan Italy.

First industrial EDM machine in the world.

Mrs. Lazarenko
The Lazarenkos perfected the electrical discharge process, which consisted of a succession of discharges made to take place between two conductors separated from each other by a film of non-conducting liquid, called a dielectric. The Lazarenkos achieved a form of immortality with this circuit, which today bears their name. Today, many EDMs use an advanced version of the Lazarenko circuit.

Back in 1952 Mr. and Mrs. Lazarenko shown here meeting with Jean Pfau-Physicist at Charmilles who who heads up a team of engineers to create a machine that will use the erosive effects of electrical discharges to cut metals.

Mr. Jean Pfau the “Father of EDM” at Charmilles. (photo taken in 2002)
# PROCESS COMPARISON

<table>
<thead>
<tr>
<th>CHARACTERISTIC</th>
<th>MILLING / TURNING</th>
<th>EDM</th>
</tr>
</thead>
<tbody>
<tr>
<td>• CONTACT</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>• FORCE</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>• TOOL/WORKPIECE ROTATION NORMALLY</td>
<td>YES</td>
<td>NOT</td>
</tr>
<tr>
<td>• TOOL/WORKPIECE CONDUCTIVE</td>
<td>NOT REQUIRED</td>
<td>REQUIRED</td>
</tr>
<tr>
<td>• MATERIAL REMOVAL METHOD</td>
<td>SHEAR</td>
<td>MELT/VAPORIZE</td>
</tr>
</tbody>
</table>
An electrical tension is applied between the piece and the wire. When the voltage becomes high enough, the breakdown of the dielectric occurs and an ionized channel is created. The dielectric becomes locally conductive and the discharge can start.
**Step 1:**
An electrical voltage $V$ is applied. When the voltage becomes high enough, the breakdown of the dielectric occurs.

**Step 2:**
An electrical current $I$ circulates through the ionized channel and so a discharge is created. It is possible to control the duration and the intensity of the discharge. Two craters appear on the attachment points of the channel.
Each discharge creates a crater
The plasma

- Bombardment of the cathode by ions
- Plasma
- Pressure (> 40 bar)
- Force onto molten material
- Electrical parameters determine amount of molten material, gap and surface quality
Basics: Material removal phase

- Interruption of electrical current
- Implosion of the plasma
  (= fast pressure release)
- Boiling & evaporation of molten metal
- Ejection of metallic droplets into the gap
- Consolidation of parts of the molten metal
  - on the electrode /part
- Particles can move in the gap
PRINCIPLE OF EDM SUMMARY

- Application of an electrical potential between wire and workpiece
- Creation of an ionized channel
- Spark
- Implosion of the plasma channel
- Material ejection

- Temperatures: 10,000 - 20,000 °C
- Pressures app. 40 bars
- Energy density app. $10^{11} - 10^{14}$ W/m²
- Temperature gradients
  $10^8^0$C/m
  $10^9^0$C/s
WIRE EDM SYSTEM
WIRE EDM
Uses water as a dielectric

• Submerged or un-submerged workpiece

• Cuts materials that are conductive

• Uses brass or stratified coated wire

Wire breakage protection strategy
Cutting speed
WIRE EDM

Wire supply
(0.004” to 0.013” diam.)

CNC control
(WIN NT, Touch screen)

Generator cabinet
(Fast cutting, 37 Sq.In./hr)

Submerged worktank
(Thermal stability)
WIRE EDM SYSTEM

Wire basket

Wire spool

Wire chopper
The Wire EDM System

Wire diameters from: 0.001” to 0.012”
Coated or Brass wires specific for either speed, accuracy or tapers

“0” tolerance closed wire guides for accuracy
What is a ROUGH & FINISH Cut?

ROUGH CUT:
Rough surface finish
Large particles (chips)

FINISH CUT:
Fine surface finish
Small particles (chips)
First, there are 3 things you must learn about EDM:

1. Flushing
2. Flushing
3. Flushing

“Cut-away view of part being machined”

Direction of wire travel

Path of chips going back out...
PILOT EXPERT SYSTEM

Pilot Expert - Maximizes speed while maintaining wire stability through varying part height and flushing conditions.
Corners

Conventional Corner  EDM Corner

Sharp corners are no problem with EDM
Steel extrusion die for fibers

Slot width: 0.002"
Min. inner radii: 0.0001"
Total form diameter: 0.080”
Wire EDM Performance History

Performance vs Price 1978 to 2002

- Speed
- Travel
- Price

Feb. 19th 2007  GF AgieCharmilles
DIESINKER EDM SYSTEM
Die Sinking Principle
DIESINKING EDM
CNC / Generator
(operator console / spark generator)

Electrode changer
(automatically change electrodes)

Flushing control
(removes particles in the gap)

Automatic door
(easy access)

DIESINKER
Many die-sinking application fields ...
DOWN & ORBITING BASICS

DOWN
Straight down Z-axis burn using max. power in what is called “roughing” mode. The goal is to remove material quickly. Electrode wear of the Graphite material could be from 0.001 to 0.0015 per side.

ORBITING 45°
XY axes translation with low power settings in what is called “finishing” mode. Orbiting provides consistent surface finish, even wear, and maintains perfect round geometry or sharp details depending on the orbiting cycle chosen. Electrode wear of the Graphite material could be as low as 0.1%.
Machining Cycles

DOWN
ORB
ANGUL
EXPAN
VECT
HELIC
CONE
SPHERE
High Speed hole drilling with coreless electrodes

**Diameters**

- $\Phi 0.3$ mm (0.012”)
- $\Phi 0.5$ mm (0.020”)
- $\Phi 0.8$ mm (0.032”)
- $\Phi 1.0$ mm (0.040”)
- $\Phi 1.2$ mm (0.048”)
- $\Phi 1.5$ mm (0.060”)
- $\Phi 1.8$ mm (0.072”)
- $\Phi 2.0$ mm (0.080”)
- $\Phi 2.5$ mm (0.100”)
- $\Phi 3.0$ mm (0.120”)
For years the EDM process has been utilized in making Dies and Molds. There are other areas where EDM excels in the manufacturing of specialized components.

Let’s take a look at other instances where EDM is an alternative solution …. 
WHEN TO EDM BY GEOMETRY

WHEN?
VERY THIN WALLS

WHY?
• NO CONTACT
• NO FORCE
• NO DEFORMATION

EXAMPLES?
- SURGICAL TOOLS
- SATELLITE COMPONENTS
- INERTIAL GUIDANCE
- MICROWAVE HОРNS
- HONEYCOMB

This satellite structural component was wirecut from solid CAL-4V titanium by Numerical Precision, Inc., Wheeling, Illinois.
Honeycomb

Honey comb or rib shape- WEDM makes it easy to machine deep and thin walls in copper or graphite.

Complex shapes- Any 4 axes shape can be cut. This reduces the number of electrodes needed for the mold and therefore the time and cost to do it.
WHEN?
INTERNAL RADIUS LESS THAN 1/32” PARALLEL TO TOOL AXIS

WHY?
RADIUS IS AS SMALL AS THE SPARK GAP.
GENERALLY TOOL IS NOT ROTATED

EXAMPLES?
- MOLD & DIE COMPONENTS
- REPAIR WORK
WHEN TO EDM BY GEOMETRY

WHEN?
HIGH RATIOS OF CAVITY DEPTH TO WIDTHS, SLOTS AND RIBS

WHY?
NO FORCE MEANS VERY THIN, LONG ELECTRODES CAN BE USED

EXAMPLES?
- FLEXURES
- COLLETS
- JET ENGINE BLADE SLOTS
- MOLD COOLING RIBS
- REINFORCING RIBS
WHEN TO EDM BY GEOMETRY

WHEN?
NON-ROUND CAVITIES & OPENINGS

WHY?
ELECTRODES DON’T HAVE TO ROTATE

EXAMPLES?
- FUEL METERING VALVES
- PRINTER COMPONENTS
- MOLDS & MOLD REPAIRS

Wire + Sinker
WHEN?
INTERMITTENT CUTS

WHY?
NO CONTACT
NO FORCE

EXAMPLES?
- ENGINE MOUNTS
- FORMULA 1 REAR HOUSING SUPPORT

Wire + Sinker
WHEN TO EDM BY GEOMETRY

WHEN?
VERY SMALL PARTS
EX. 0.25” CUBE

WHY?
EASY TO FIXTURE SINCE
NO FORCE OR VIBRATION

EXAMPLES?
- DENTAL FIXTURES
- MEDICAL CLAWS
- WATCH PARTS
WHEN TO EDM BY GEOMETRY

WHEN?
RECESSED CUTS

WHY?
CUTTING TOOLS COULDN'T REACH CUTTING AREA
GENERATE DESIRED SHAPE

EXAMPLES?
- KEYWAYS
- BOTTLING INDUSTRY

Wire + Sinker
WHEN?
WOULD HAVE TO MAKE A SPECIAL TOOL......COSTLY. EDM IS A BETTER IDEA FOR ONLY 10-20 PARTS.

WHY?
ELECTRODES ARE LESS $ THAN SPECIAL CUTTING TOOLS AND EASY TO MACHINE.

EXAMPLES?
- THIN RIBS WITH CONTOURED SHAPE.
- REPLACE BROACHING WITH EDM. FOR SMALL QUANTITIES NO NEED FOR STAMPING DIE.
WHEN?
ACCURACIES THAT ARE DIFFICULT TO HOLD, MAINTAIN AFTER HEAT TREATING, STRESS RELIEF, ETC.

WHY?
CAN EDM CONDUCTIVE MATERIAL OF ANY HARDNESS

EXAMPLES?
MOLD THAT NEEDS TO BE HEAT TREATED, ROUGH MACHINED, FINISHED WITH EDM. STEEL TO STEEL PARTING LINE.

Characteristics of the mold
Hardened Steel 35NDC16, 185 daN/mm², 52 HRc

Wire + Sinker
WHEN TO EDM BY GEOMETRY

WHEN?
DIFFERENT GEOMETRY AT TOP AND BOTTOM

WHY?
WIRE EDM CUTS RULED SURFACES WITH SIMPLER PROGRAM + MACHINE THAN MILLING.

EXAMPLES?
- JET ENGINE BLADES
- PLASTIC EXTRUSION DIES
WHEN TO EDM BY GEOMETRY

WHEN?
COMPLEX SHAPES

WHY?
EASIER TO PROGRAM BECAUSE YOU ARE USING A TOOL OF CONSTANT DIMENSION INSTEAD OF A VARIETY OF DIFFERENT DIAMETER MILLING CUTTERS.

EXAMPLES?
EXTREME TAPERS
WHEN TO EDM BY GEOMETRY

WHEN?
REQUIRES MULTIPLE COMPONENT ASSEMBLIES

WHY?
USE TAPER OR RECESS OR DEPTH: DIAMETER CAPABILITY TO MAKE IT ONE PIECE.

EXAMPLES?
EXTRUSION DIES

Wire + Sinker
WHEN TO EDM BY GEOMETRY

WHEN?
ANGLED CUTS

WHY?
ABILITY TO 3D ORBIT IN SPACE, NO FORCE BETWEEN PIECE/TOOL AT AN ANGLE

EXAMPLES?
SUBGATES

Sinker
WHEN TO EDM BY GEOMETRY

WHEN?
REQUIRES MANY DIFFERENT MACHINING PROCESSES

WHY?
EDM CAN GENERATE ALMOST ANY SHAPE IN ALMOST ANY CONDUCTIVE MATERIAL

EXAMPLES?
GENERAL MECHANICS PART
SAVE TIME & LABOR TO TRANSFER BETWEEN OPERATIONS/PROCESSES
WHEN?
HARDNESS ABOVE RC 38:
HARDENED STEEL, STELLITE,
TUNGSTEN CARBIDE

WHY?
EDM VAPORIZES MATERIAL
RATHER THAN CUTTING IT.

EXAMPLES?
- DIES
- GRINDING TOOLS

These carbide samples are courtesy of L.H. Carbide located in Fort Wayne Indiana.
WHEN TO EDM BY MATERIAL

WHEN?
TOUGHNESS: INCONEL, MONEL, HASTALLOY, NITRALLOY, WASPALLOY, NIMONIC, UDIME

WHY?
EDM IS NON CONTACT; THEREFORE, NO ADHESION OF WORKPIECE TO TOOL.

EXAMPLES?
- MAGNETIC READER HEADS
- ARTIFICIAL JOINTS
- TURBINE BLADES
- CAR ENGINE PROTOTYPES
WHEN TO EDM BY MATERIAL

WHEN?
TENDS TO LEAVE TOUGH BURRS WHEN MACHINED CONVENTIONALLY

WHY?
VAPORIZED MATERIAL IS FLUSHED AWAY LEAVING "NO" BURR.

EXAMPLES?
- COPPER ELECTRODE
- SURGICAL TOOLS
MEDICAL - NO BURRS
0.001” wire slot
WHEN TO EDM BY MATERIAL

WHEN?
FRAIL/FRAGILE
CAN’T TAKE STRESS OF MACHINING

WHY?
- NO CONTACT
- NO FORCE

EXAMPLES?
- PRINTER HAMMER
- GRAPHITE ELECTRODES
- HONEYCOMB
- LEAD FRAME DIE
WHEN?
EXPENSIVE MATERIAL

WHY?
LOWER CHIP: WORKPIECE MASS RATIO. SLUGS ARE REUSABLE. CHIPS ARE ONLY RECYCLALBE.

EXAMPLES?
- DENTAL FIXTURES
- ENDOSCOPIC CUTTERS
- HIGH ALLOYS
WHEN TO EDM BY MATERIAL

WHEN?
EXPLOSIVE OR FLAMMABLE MATERIALS

WHY?
EDM TAKES PLACE UNDER WATER

EXAMPLES?
MAGNESIUM
WHEN TO EDM BY MATERIAL

WHEN?
MATERIAL WITH HAZARDOUS DUST PARTICLES

WHY?
PARTICLES ARE FLUSHED AWAY TO THE FILTER. REDUCED RISK OF FUMES

EXAMPLES?
BERYLLIUM COPPER

Wire + Sinker
## WHEN TO EDM BY PROCESS REPLACED

<table>
<thead>
<tr>
<th>WHEN</th>
<th>WHY</th>
</tr>
</thead>
</table>
| GRINDING:  
- FORM  
- CRUSH  
- JIG | EDM ALLOWS UNATTENDED MACHINING, LESS EXPENSIVE DESIGN AND SIMPLIFIED OPERATION |

**EXAMPLES:**
DIES, POWDER METAL DIES, PUNCHES, CORE PINS, DOWEL HOLES, etc.

**CONVENTIONAL:**
- Several steps  
- Several tools  
- Several machines

**EDM:**
- Only one operation  
- Only one tool  
- Only one machine
WHEN TO EDM BY PROCESS REPLACED

WHEN
• 2+ AXIS MILLING

WHY
CAN SLAB OFF LARGE SLUGS INSTEAD OF PILES OF CHIPS.

EXAMPLE:
WHEN TO EDM BY PROCESS REPLACED

WHEN

• ACID ETCHING OR POLISHING TO ACHIEVE TEXTURED FINISH

WHY

ELIMINATE ETCHING OR POLISHING THEREFORE REDUCE # OF OPERATIONS, TIME, AND COST.

EXAMPLES:

CONTAINERS
- BEVERAGE
- FOOD
- PERFUME
- PHONE MOLD
<table>
<thead>
<tr>
<th>WHEN</th>
<th>WHY</th>
<th>EXAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>• SHORT RUN STAMPING (&lt; 5,000 PIECES)</td>
<td>NO NEED TO MAKE A DIE SET.</td>
<td>SEWING MACHINE COMPONENTS, PROTOTYPES</td>
</tr>
<tr>
<td>• BROACHING (LOW VOLUME)</td>
<td>LOW COST TOOLING.</td>
<td>SPLINES GEAR TEETH</td>
</tr>
<tr>
<td>• SLITTING OR SLOTTING</td>
<td>ELIMINATES BURRS AND BLADE WEAR PROBLEMS.</td>
<td></td>
</tr>
<tr>
<td>• PARTS REQUIRING COMPLEX EXPENSIVE FIXTURING WITH CONVENTIONAL MACHINING</td>
<td>NO CONTACT NO FORCE MEANS SIMPLE FIXTURING</td>
<td></td>
</tr>
</tbody>
</table>
## WHEN TO EDM LIMITATIONS BY SHAPE

<table>
<thead>
<tr>
<th>CHARACTERISTIC</th>
<th>WIRE</th>
<th>SINKER</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>THINNEST WALL</strong></td>
<td>0.005”</td>
<td>0.002”</td>
</tr>
<tr>
<td><strong>MINIMUM</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- INTERNAL RADII</td>
<td>0.0008”</td>
<td>0.001”</td>
</tr>
<tr>
<td>- EXTERNAL RADII</td>
<td>SHARP</td>
<td>SHARP</td>
</tr>
<tr>
<td>- SLOT WIDTH</td>
<td>0.0016”</td>
<td>0.0004”</td>
</tr>
<tr>
<td>- HOLE DIAMETER</td>
<td>0.0016”</td>
<td>0.0006” (MICROHOLE)</td>
</tr>
<tr>
<td><strong>TAPER</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- MAX. ANGLE</td>
<td>+/- 45º</td>
<td>N/A</td>
</tr>
<tr>
<td>- MAX. HEIGHT/ANGLE</td>
<td>30º TO 16” HIGH</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>HOLE DEPTH TO DIAMETER RATIO</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- CONVENTIONAL</td>
<td>N/A</td>
<td>20:1</td>
</tr>
<tr>
<td>- SPEC. SMALL HOLE</td>
<td>N/A</td>
<td>900:1</td>
</tr>
<tr>
<td>- MICROHOLE</td>
<td>N/A</td>
<td>10:1</td>
</tr>
<tr>
<td><strong>RECESS DEPTH</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- FROM ROUND ENTRY</td>
<td>N/A</td>
<td>1/2 HOLE DIAM. - 1/2 ELECTRODE SHANK DIAM.</td>
</tr>
<tr>
<td>- FROM STRAIGHT ENTRY</td>
<td>N/A</td>
<td>HOLE WIDTH - ELECTRODE SHANK DIAM.</td>
</tr>
</tbody>
</table>
## WHEN TO EDM LIMITATIONS BY OTHER CHARACTERISTICS

<table>
<thead>
<tr>
<th>CHARACTERISTIC</th>
<th>WIRE</th>
<th>SINKER</th>
</tr>
</thead>
<tbody>
<tr>
<td>• WORKPIECE CONDUCTIVITY AND FIXTURE MAX.</td>
<td>APPROX. (0.5 - 5) OHM CENTIMETER</td>
<td>SAME</td>
</tr>
<tr>
<td>• ACCURACY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- CONVENTIONAL</td>
<td>+/- 0.000040”</td>
<td>+/- 0.0001”</td>
</tr>
<tr>
<td>- MICROHOLE</td>
<td>N/A</td>
<td>+/-0.0004”</td>
</tr>
<tr>
<td>• SURFACE FINISH</td>
<td>VDI 0</td>
<td>VDI -5</td>
</tr>
<tr>
<td>- MICROINCH</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>• TEXTURE FINISH</td>
<td>RANDOM, UNIFORM TEXTURE ONLY</td>
<td>SAME</td>
</tr>
<tr>
<td>• SURFACE INTEGRITY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- RECAST LAYER THICKNESS</td>
<td>20 MILLIONTHS</td>
<td>20 MILLIONTHS</td>
</tr>
<tr>
<td>- MICRO CRACK LENGTH</td>
<td>20 MILLIONTHS</td>
<td>20 MILLIONTHS</td>
</tr>
</tbody>
</table>
EXACT
DIFFICULT
MACHINING
The U.S. and World’s Largest Supplier of EDM’s for the Tooling & Machining Industries

<table>
<thead>
<tr>
<th>Location</th>
<th>Address</th>
<th>Phone Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lincolnshire, IL</td>
<td>560 Bond Street Lincolnshire, IL 60069</td>
<td>(847) 913-5300 (847) 383-8264</td>
</tr>
<tr>
<td>Holliston, MA</td>
<td>150 Hopping Brook Road Holliston, MA 01746</td>
<td>(508) 474-1100</td>
</tr>
<tr>
<td>Charlotte, NC</td>
<td>9009-G Perimeter Woods Drive Charlotte, NC 28216</td>
<td>(800) 438-5021</td>
</tr>
<tr>
<td>Yorba Linda, CA</td>
<td>22667 Old Canal Road Yorba Linda, CA 92887</td>
<td>(714) 637-6853</td>
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</tbody>
</table>
# WIRE EDM PRODUCT LINE

<table>
<thead>
<tr>
<th>Price / Performance</th>
<th>Automation</th>
<th>Flexibility</th>
<th>Cutting performance</th>
<th>Ergonomics</th>
<th>Control Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>VERTEX /F</td>
<td></td>
<td></td>
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<tr>
<td>VERTEX 2 / 2F</td>
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</tr>
<tr>
<td>FI 2050 TW</td>
<td></td>
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<tr>
<td>VERTEX 3 / 3F</td>
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<tr>
<td>FI 6050 TW</td>
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<tr>
<td>CHALLENGE V2</td>
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<tr>
<td>CHALLENGE V3</td>
<td></td>
<td></td>
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<tr>
<td>PROGRESS V2</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>FI 240 CC</td>
<td></td>
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<tr>
<td>PROGRESS V3</td>
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<tr>
<td>FI 440 CC</td>
<td></td>
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<tr>
<td>PROGRESS V4</td>
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<tr>
<td>FI 640 CC</td>
<td></td>
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<tr>
<td>CLASSIC V2</td>
<td></td>
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<tr>
<td>FI 240 SLP</td>
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<tr>
<td>CLASSIC V3</td>
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<tr>
<td>FI 440 SLP</td>
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<tr>
<td>220 x 150</td>
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<tr>
<td>350 x 250</td>
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<tr>
<td>500 x 350</td>
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<tr>
<td>700 x 500</td>
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GF AgieCharmilles
<table>
<thead>
<tr>
<th>Size</th>
<th>Axes XY</th>
<th>Accuracy</th>
<th>Performance</th>
<th>Autonomy</th>
<th>Flexibility</th>
<th>Automation</th>
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<tbody>
<tr>
<td>220 x 150</td>
<td>200 x 150</td>
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<tr>
<td>350 x 250</td>
<td>350 x 250</td>
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**DIE SINKER PRODUCT RANGE**

- HYPERSPARK
  - EXACT 2 HS
  - FO350 µ
  - EXACT 3 HS
  - FO550 µ
  - EXACT 4 HS

- SPIRIT
  - 2
  - 3
  - 4

- FM20 ZNC
  - FO23P
  - FO35P
  - FO350 µ
  - FO350 µ (S)
  - FO53P
  - FO550 µ

- Price / Performance

**GF AgieCharmilles**

Feb. 19th 2007
WHAT ELSE CAN YOU GET FROM CHARMILLES TO HELP YOU?

- School prices on new and used Charmilles EDM’s
- Help in recruiting students
- Information on NIMS certification

HOW TO GET IT?

EDM Machines for Schools
Phone: 800-CTC-1EDM Ext. 170

Contact your AgieCharmilles Distributor
www.agiecharmilles.us
# EDM Machines for Shops

**Phone:** 800-CTC-1EDM Ext. 115

<table>
<thead>
<tr>
<th>WHO ARE YOU?</th>
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<tbody>
<tr>
<td>Charmilles EDM operators &amp; Programmers</td>
<td>Basic &amp; Advanced Operator Training</td>
<td><a href="http://www.charmillesus.com/training/training.cfm">www.charmillesus.com/training/training.cfm</a></td>
</tr>
<tr>
<td>Charmilles EDM job shops, CNC job shops and tool rooms inside large companies</td>
<td>Help promoting your services to your current and prospective customers. We will help you present When to EDM™ as a way of promoting your services.</td>
<td>Contact your Charmilles Distributor. <a href="http://www.charmillesus.com/salesnet.cfm">www.charmillesus.com/salesnet.cfm</a></td>
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</tbody>
</table>
| Manufacturers with a workpiece that has manufacturability problems | Help you evaluate if When to EDM™ is “now.”                                                                       | - Call your Charmilles distributor.  
- E-mail part, photograph, print, description of the manufacturability problem to [wire.applications@charmillesus.com](mailto:wire.applications@charmillesus.com) or [sinker.application@charmillesus.com](mailto:sinker.application@charmillesus.com). |
| A manufacturer that wants to justify an EDM for in-house use.    | Provide EDM ROI spreadsheet to perform the analysis, based on the economics of your application.                     | Contact your Charmilles distributor.  
[www.charmillesus.com/salesnet.cfm](http://www.charmillesus.com/salesnet.cfm) |
| A manufacturer that wants to find an EDM job shop to make your parts. | Provide access to the top EDM job shops in the U.S. and Canada.                                                      | Contact your Charmilles distributor  
[www.charmillesus.com/salesnet.cfm](http://www.charmillesus.com/salesnet.cfm) |
How to Promote Careers in Tooling & Machining
Phone: 800-CTC-1EDM Ext. 170
GF AgieCharmilles
Feb. 19th 2007

CAREERS

For More Information, Call

National Tooling & Machining Association (NTMA)
9300 Livingston Road
FL, Washington, MD 20744
Phone: 800/248-6200
FAX: 301/248-7104

Training Facilities:

CALIFORNIA:                 Ontario    909/947-0363
                            Nerwalk    569/921-3722
                            Costa Mesa  714/545-3202
                            Fremont     510/226-3760

INDIANA:                     Indianapolis  317/921-4955
KANSAS:                      Wichita     316/262-7000
MARYLAND:                    Calabasas  410/455-7188
Massachusetts:               Springfield  413/781-0166
MICHIGAN:                    Warren       610/445-7640
                             Grand Rapids  616/234-3800
MISSOURI:                    Kansas City  816/842-5620
NEW YORK:                    Depew        716/684-1400
                             Rochester   716/392-3760
NORTH CAROLINA:             Jamestown  336/334-4822
OHIO:                        Middleburg  440/891-7600
                             Dayton       570/752-2570
                             Nortin      330/745-1111
PENNSYLVANIA:               Upper St. Clair  412/854-2199
RHODE ISLAND:               Warwick    401/825-2156
TENNESSEE:                  Nashville  615/353-3725
TEXAS:                      Houston  713/928-6821
WASHINGTON:                 Auburn    253/833-9111

American Mold Builders Association (AMBA)
P.O. Box 404
Medinah, IL 60157
Phone: 630/980-7867
FAX: 630/980-9714

Dayton Tooling & Machining Association (DTMA)
240 W. Fifth St. Room 13-125
Dayton, OH 45402
Phone: 937/225-3862
FAX: 937/225-3840

New Jersey Tooling & Manufacturing Association
277 Fairfield Road, Suite 126
Fairfield, NJ 07004-1931
Phone: 973/882-3880
FAX: 973/882-5086

JANUARY, 2002

North Texas Chapter, NTMA
P.O. Box 1506
Grapevine, TX 76054
Phone: 817/483-6144
FAX: 817/483-6144

Pacific Coast Manufacturers Association
1224 East Warner Avenue
Santa Ana, CA 92707-0157
Phone: 714/553-6144
FAX: 714/553-6144

Precision Machined Products Association (PMPA)
6700 West Snowville Road
Breckenridge, OH 44414
Phone: 440/586-0503
FAX: 440/586-0503

Precision Metalforming Association (PMA)
6363 Oak Tree Boulevard
Independence, OH 44131
Phone: 216/901-8800
FAX: 216/901-9190

Society of the Plastics Industry (SPI)
1001 K Street, NW, Suite 606
Washington, DC 20005
Phone: 202/784-5200
FAX: 202/784-5041

Tooling & Manufacturing Association (TMA)
1177 S. Dee Road
Park Ridge, IL 60068-4396
Phone: 847/825-1120
FAX: 847/825-0041

TriState Tooling & Machining Association
7180 East Kemper Road
Cincinnati, OH 45249
Phone: 513/889-8724
FAX: 513/889-8778

CHARMILLES TECHNOLOGIES CORPORATION
The U.S. and World's Largest Supplier of EDM's for the Tooling & Machining Industries

560 Bond Street
Lincolnshire, IL 60069
Phone: 800/CTC-1EDM
FAX: 847/913-5340
Web: www.charmillesus.com

Montville Center V
26 Chaplin Road
Pine Brook, NJ 07058-9718
Phone: 973/882-1435
FAX: 973/882-1438

22667 Old Canal Road
Yorba Linda, CA 92887
Phone: 714/637-6853
FAX: 714/637-2372

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www.charmillesus.com
<table>
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<tr>
<th>Glossary of EDM Terms</th>
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<tr>
<td><strong>Amperage</strong> - In EDM, the amount of average current measured during the cut.</td>
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<tr>
<td><strong>Arc</strong> - A continuous flow of electrical current. This continuous flow causes damage to both the electrode and work piece.</td>
</tr>
<tr>
<td><strong>Blind hole</strong> - Any cavity that has a bottom surface and that doesn’t connect with any other openings.</td>
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<tr>
<td><strong>Capacitor</strong> - An electrode component that stores an electrical charge. In EDM it is used frequently for cutting metals with high melting temperatures and during fine finishing cycles.</td>
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<tr>
<td><strong>Carbon</strong> - An abundant, naturally occurring element. Graphite is a form of the element carbon.</td>
</tr>
<tr>
<td><strong>Core</strong> - The stalagmite caused by EDMing with an electrode drilled with holes for flushing in it.</td>
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<tr>
<td><strong>Corner wear</strong> - The measurement of wear on the corners of the electrode.</td>
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<tr>
<td><strong>Cubic inches per hour</strong> (in3/hr) - The unit of measure used to describe the metal removal rate of sinking type EDMs.</td>
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</table>
**Glossary of EDM Terms**

**DC arcing** - same as ARC.

**Deionization** - Bringing the dielectric to a non-conductive state.

**Dielectric fluid** - In EDM, a non-conductive fluid used to control the sparking condition. Also used to cool and remove the cutting debris from the erosion area.

**Dielectric strength** - measurement of how resistant the fluid is to current flow.

**Duty cycle** - the percentage of on-time to the sum of on-time and off-time.

**EDM** - (Electrical Discharge Machining) - A metal removal process using electric sparks to erode conductive materials.

**Electrode** - The cutting tool in EDM.

**Electrode growth** - A plating action during certain settings causing material to build up on the electrode, causing an increase in size.

**End wear** - A measurement of wear on the frontal plane of the electrode.

**Filtering** - In EDM, a process of removing the cutting debris from the dielectric fluid.

**Finish** - The surface texture produced
Flush pot - A multipurpose box-like fixture used to hold the work piece or electrode that allows flushing to pass through. Suction or pressure flushing can be used.
Flushing - The process of removing the cutting debris from the cutting area.
Gap - (Spark gap) - The distance between the electrode and the work piece where the spark occurs.
Gap voltage - A measurement of voltage during the EDM process.
Generator - A term used to describe the EDM power supply.
Injection flushing - Pressure type flushing where dielectric fluid is forced into the cutting area through various means.
Ionization - The phenomenon by which the dielectric between two points on the electrode and work piece becomes electrically conductive.
Microsecond (μs) - One-millionth of a second
Off-time - Length of time that current is off. Measured in microseconds.
On-time - Length of time current is on. Measured in microseconds.
Overcut - measurement difference between the dimensions of the cavity EDMed and the dimensions of the electrode used to cut the cavity.
Glossary of EDM Terms

**Peak current** - Maximum current (amperage) available.

**Average amperage** = \( \frac{A}{(\text{On Time} + \text{Off Time})} \)

- e.g. 50 Amp machine 50% On time 50% Off time = 25 average Amps.

**Pulsator** - A mechanical device built into most EDMs for the purpose of moving the electrode in and out of the cavity in timed movements to aid flushing.

**Reverse polarity** - A process that reverses the flow of current.

**Vacuum flushing** - A flushing method using suction rather than injection.

**Undersize** - A term used to describe the difference between the finished cavity size and the electrode size.

*Some definitions were taken from the POCO Graphite Technical Manual*
An example of a product produced because of EDM's ability to eliminate special cutting tools is this fin deployment actuator housing for a missile. Using EDM eliminated the need for expensive broach tooling to form the through T-slot configuration into this 15-5PH forging.

Part example supplied by Numerical Precision in Wheeling, Illinois
CASE STUDY 2

Classic Die, a shop in Grand Rapids, Michigan, produces this injection mold using the fine-grain graphite electrodes above. Ram EDM often provides the only way to produce such intricate mold cavities (this mold has been cross-sectioned to reveal its tapered helical slots), as well as other workpieces which have deep slots or narrow ribs. The components produced in this mold are 2.75 inches long and are used in medical instruments for heart surgery.

Part example supplied by Classic Die in Grand Rapids Michigan.
The surface finish of the fitting surfaces made by WEDM allow air venting during the plastic injection phase. Air can escape but not plastic. This is very useful to help plastic fill the ribs. The reinforcement ribs are complex shapes. They can be machined separately and press fit.

The reinforcement ribs of this TV casing are not machined directly on the mold core. They are added (inserted). Open cavities to receive them are WEDM cut.
CASE STUDY 4

WEDM makes it easy to machine any kind of gear with high accuracy.
No need to use dedicated machine to cut cylindrical or tapered gears.
Gear modification is fast and easy.
Wire EDM reduce lead time to produce plastic gears.

Plastic gears

Gears for Formula-1 race team
Case Study #5: Gear Wheel machined with Micro WEDM

- Height of structure: 0.240”
- Outer diameter: 0.020”
- Number of teeth: 8
- Wire: 20 µm, (0.00078”) tungsten
- 1 cut
- Material: 1.2343 (X38CrMoVS_1)
http://www.agiecharmilles.us/sales/index.cfm