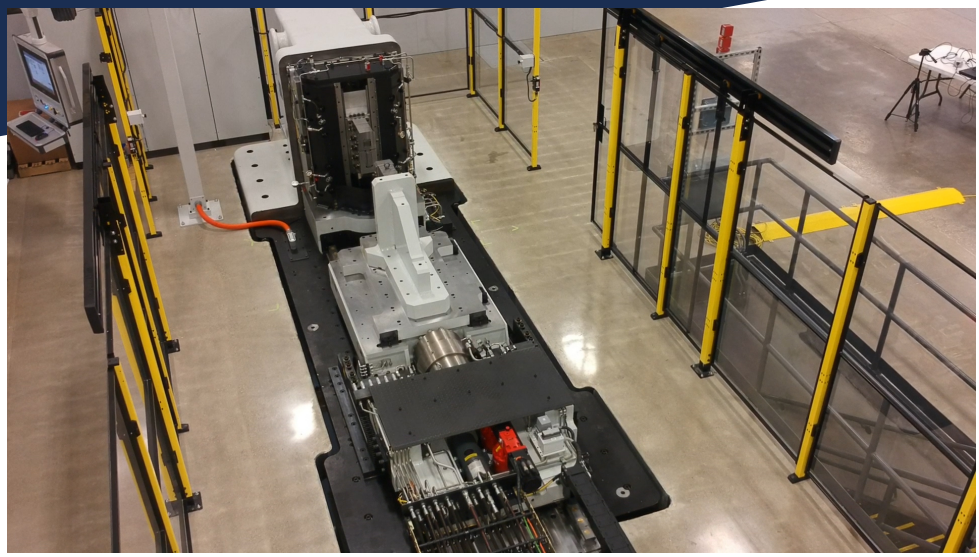
SOLID STATE JOINING

Linear Friction Welding



VENDOR

MTI

MATERIALS

Metals

Linear Friction Welding, is a solid-state process in which one part moved in a linear motion at high speed and is pressed against another part held stationary. The resulting friction heats the parts, causing them to forge together.

The LF35-75 is a 35 ton oscillating 75 ton forge capacity (150,000 lbs. down to 10,000 lbs) universal machine capable of solid state welding a variety of materials, sizes and geometries.

ADVANTAGES

- Superior Joint Quality
- Energy Efficient
- Ecologically Friendly
- Eliminates Block Machining with "Near Net Shape" Joining
- Forged-quality Welds for Complex Geometries of Nearly Any Metal Type
- Quick Welding Process Meets the Demands of any Supply Chain
- Minimal Joint Preparation Reduces Prep Time and Speeds Up Productions
- Defect-free Welding Decreases waste and Saves Money
- Scalable Welding Sizes for any Magnitude of Applications

SPECIFICATIONS

- Equipment Dimensions: 22' x 8' x 14'
- Weight: 122,000 lbs (61 metric tons)
- Forge Force: 7.5t U.S., 6.8 metric tons to 75t US, 68.05 metric tons
- Oscillation Process: Oscillation, frequency and amplitude are customized to each friction welding application
- 30 to 1 stationary to moving mass ratio

COMPUTED TOMOGRAPHY

CT Scanner

VENDOR

VJ Technologies

MATERIALS

Metals
Composites
Ceramics

Computed Tomography scanning, or **CT scanning**, is used in industrial and medical industrial applications.

This imaging technique is incredibly powerful, and uses x-rays to produce three-dimensional representations of the scanned object both externally and internally.

Industrial CT scanning is used for for non-destructive internal investigation of components.

Some of the key uses for CT scanning have been flaw detection, failure analysis, metrology, assembly analysis and reverse engineering applications.

The LIFT CT Scanner is configurable with several micrometer-focus x-ray tubes for high resolution applications and high-power millimeter-focus x-ray sources for castings, munitions, automotive assemblies, aerospace assemblies and other non-destructive test inspections.

APPLICATIONS

X-ray technology allows manufacturers to easily scan components for flaws, to investigate internal structure and geometry, or for reverse engineering purposes.

SPECIFICATIONS

- Equipment Dimensions: 2,590, x 2,330 mm x 2,336 mm
- X-ray Source: 150kV, 0.0 - 500µA, 5 µm focal spot at 4W
- 60 kg weight capacity
- Detector: 2,048 x 2,048 pixels, pixel size 200 µm
- 600 mm x 900 mm sample envelope
- 225 kv shielded cabinet with motorized parts door

MEDC
MICHIGAN ECONOMIC DEVELOPMENT CORPORATION

THERMO MECHANICAL PROCESSING

Extrusion Press

VENDOR

Danieli Breda

MATERIALS

Aluminum and
Magnesium alloys

An **Extrusion Press** is a thermo-mechanical processing machine which forces metal through a die, using using elevated temperature and high pressure to form a piece with a uniform cross section along its length.

For manufacturing lightweight components, high-temperature metallic billets (aluminum or magnesium, for example) are forced through a die to create an elongated product with a cross-sectional shape determined by the die shape.

The elongated material, now in the shape of the die, can be cut into desired lengths and/or reshaped using additional thermo-mechanical, additive, or subtractive processes. A common example of an extruded product is the aluminum perimeter of window screens.

APPLICATIONS

Industries and applications supported by an extrusion press include: **aerospace**, **automotive**, **renewable energy**, **telecommunications**, **electronics**, **mass transit**, **construction**, **and others**.

SPECIFICATIONS

- Produces up to 50' long sections
- Uses 1,344 U.S. tons of force
- Furnace preheats 200lb. billets at 900˚F

Capacity	12MN/1344 Tons
Nominal Pressure	250 Bar/3336 PSI
Extrusion Speed	16mm/s , 0.63"/s
Exit hold width	200mm/7.9"
Exit Slotted Width	300mm/11.8"
Container (Ø)	157mm/6.18"
Container Length	830mm/32.67"
Extrusion Length	up to 50'

Die Stack Dimension	Ø355 x 355 ; 13.98" x 13.98"
Billet Specifications	
Billet (Ø)	152.4mm/6" +0mm/-2mm/0.08"
Billet Max Length	800mm/31.5"
Billet Furnace	
Temperature	530C/986F
Quench	n/a

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JOINING AND ASSEMBLY

Flexible Joining System

VENDOR

Comau

MATERIALS

Steel, Aluminum Alloys and Titanium Alloys

The **Flexible Joining System** can be used for many joining needs in the metalworking process, including wire-feed welding and spot welding, as well as fixturing, positioning, and alignment of components and assemblies.

APPLICATIONS

Joining needs include: **arc welding, spot welding, adhesive bonding, mechanical joining, surface treatment—cleaning or coating, and alignment and fixturing of components for joining.**

SPECIFICATIONS

- 40′ x 50′ cell
- 16′ x 40′ work zone for tooling: Small assemblies, Large assemblies such as heavy truck frames, Large plates for ships (both sides being welded simultaneously), Arc Welding, Spot Welding , Adhesive (bonding) Joining, Mechanical Joining, Surface Treatment , Wide Access Doors, Overhead Crane Access
- Arc and spot welding
- Bonding
- Mechanical Joining
- Component positioning and alignment

Robots 1 & 2	Smart5 NJ 370 - 3.0 Payload 370 kg - Reach 3.0 m
Robots 3 & 4	Smart5 NJ 16 - 3.10 Payload 16 kg - Reach 3.10m
2 - Comau TMF4 7.29M	Over 7 meter slide length
4 - Control Panels	Reamer
20 ft. Comau Rail System	Multi-purpose Tooling System
1 Fronius Cold Metal Transfer wire feed welder	Aluminum and Steel Capability

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POWDER PROCESSING

Hot Isostatic Processing

VENDOR

American Isostatic Presses Inc.

MATERIALS

Common materials are super alloys, titanium and aluminum alloys, high strength steels (HSS) and stainless steels.

Other applications involve pressing beryllium and tungsten components for highly specialized applications.

Hot isostatic pressing (HIP) is a manufacturing process used to eliminate internal microporosity in metal castings and other materials. Enables the solidification, sintering, and densification of metal, polymer, ceramic and composite powders in the solid state. This method, coupled with powder metallurgy allows for the formation of components from metals (such as refractory metals) that are otherwise inaccessible with other techniques, and results in superior material and mechanical properties. The HIP process subjects a component to both elevated temperature and isostatic (or equal) gas pressure in a high-pressure containment vessel. The chamber is heated, and argon gas is pumped into the cell until the desired pressure and temperature are achieved. The pressure is applied to the material from all directions.

APPLICATIONS

Primary applications are the **consolidation of** powdered metals, powdered ceramics, and composites. Hot isostatic pressing is also used as part of a **sintering (powder metallurgy) process and for fabrication of metal matrix composites**.

SPECIFICATIONS

- 30,000 psi of working pressure
- Interior: 10" diameter x 30" length
- Hot Zone: 6" diameter x 12" length
- Rapid Cooling
- Furnace 1400 C molybdenum two-zone furnace with a 150mm diameter x 30mm long hot zone

Vessel Type ASME Section VIII
Div 2 code stamped pressure vessel, National Board registered.
SA-723 steel.

Hydro
Tested and stamped.

Cooling
Treated closed loop cooling system with reservoir, pump and heat exchanger. Connects to customer coolant (city, re-circ, or chiller) at 15 gpm

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THERMO MECHANICAL PROCESSING

Hydroforming Press

VENDOR

Interlaken Technology Company (ITC)

MATERIALS

Metals

A **Hydroforming Press** shapes ductile metals such as aluminum, brass, steel, and stainless steel into lightweight, structurally stiff and strong pieces.

Hydroforming is a specialized type of die forming that uses a high-pressure fluid to press room temperature working material into a die.

It is popular in the auto industry to produce stronger, lighter, and more rigid unibody structures for vehicles, particularly high-end sports cars, high-performance constant-volume exhaust systems, and shaping aluminum for bicycle frames.

Hydroformed parts have a higher stiffness-to-weight ratio and at a lower cost than traditional stamped parts.

APPLICATIONS

Virtually all metals capable of cold forming can be hydroformed, including aluminium, brass, carbon and stainless steel, copper, and high strength alloys.

SPECIFICATIONS

- 1,000 ton clamping actuator
- 64"x 76.5"x 36"
- 20,000 psi pressure intensifier
- 20" Shut Height

Deflection Reaction Frame	Near-zero
Open and Close Rate	3 inches/second
Column Spacing	32" column side to side
Column Spacing	32" column front to back
Two feed actuators	115 tons each, 8" stroke
Reaction plate/die shoe for tooling	
Hydraulic power supply	
Forming-fluid handling system	Closed-loop

Complete control system with multiple open channels for user inputs and outputs.

Preloaded with software for tube hydroforming

High rate data acquisition

All interconnecting hoses, tubes, piping, wiring and cables

Position control to within 0.001", force control to within 5% of full scale

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POWDER PROCESSING

Metal Injection Molding

VENDOR

Arburg

MATERIALS

Powdered metals
Powdered Ceramics
Composites
Plastics

Metal injection molding (MIM) is a process which combines finely-powdered metal (or other material) with a binder material to comprise a "feedstock" material capable of being molded.
The "feedstock" is injected as a mixture of powder in liquified binder into a mold using injection molding machines. After molding, the part is heated to drive off the binder and densify the powder. Powdered metal and ceramic applications require subsequent sintering at an elevated temperature.

Often, the molded parts are processed in a final step in a hot isostatic press (HIP) to further consolidate the particles and refine the mechanical properties of the components.

The variety of metals capable of implementation within MIM feedstock are broad, including refractory metals like tungsten and rhenium, however stainless steels are most common.

APPLICATIONS

Final products are small and used in a broad range of applications, including: **industrial, medical, firearms, aerospace, and automotive.**

SPECIFICATIONS

- 110 U.S. tons total clamping force
- Distance between tie bars: 18.5" x 18.5"
- Injection Unit Horizontal: 25mm screw @ 59 cm3 volume

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PLASMA

Plasmatreat Cell

VENDOR

Plasmatreat

MATERIALS

Metals, carbon fiber, plastics, glass, cardboard, textiles and composites.

Plasma pretreatment, or **Plasmatreat**, is the key enabling technology for microfine cleaning, surface activation and plasma coating of nearly all kinds of materials – from metals, carbon fiber, plastics and glass, to cardboard, textiles and composites.
When materials are subjected to atmospheric plasma, their surface chemistry and topology are altered at atomic and microscopic levels. The treated surfaces are activated toward accepting surface amendments such as insulating/protective coatings and structural adhesives.

Often, the insulating and protective coatings are deposited via plasma coating technology, which is also provided by Plasmatreat. Together, plasma treatment and plasma coating increases the chemical and environmental stability of materials, as well as the strength of connections formed through the application of structural adhesives.

In the manufacturing industry, this principle is used for selective modification of material characteristics to increase in the adhesiveness and wettability of surfaces.

APPLICATIONS

Aerospace, automotive, energy, defense, shipbuilding

SPECIFICATIONS

- Robot: R1000A, 2.23 m reach, 80 Kg, 6 axis
- Operating power: 1kW at 480V AC
- Large Working Area: 6' x 5'

AGILE PROCESSING

Robotic Blacksmithing

VENDOR

FANUC

MATERIALS

Sheet metals

The LIFT **Robotic Blacksmithing** cell is investigating the next wave of manufacturing.

Imagine if a machine can act like a blacksmith does, squeezing and bending metal into shape, and doing this at temperatures and with deformation pathways that improve the materials properties. We refer to this as metamorphic manufacturing and believe it will take its place alongside existing digital manufacturing: additive and subtractive manufacturing.

In order for this approach to truly thrive, it will need to be adopted to the extent that validation and verification protocols exist so components made in this way can be certified for safety critical use (for example in aircraft.)

The rewards that can drive this are large. This approach can eliminate the expensive cost of traditional tooling, on the order of $100k to $1M, and promises high-quality parts that have low environmental footprint, can have low-cost and are produced locally.

APPLICATIONS

Forming prototype or low-volume components

SPECIFICATIONS

- 2 robots: R2000iC
- 2.65 M reach
- Maximum load capacity at wrist 165 Kg
- 6 axis

J1 axis rotation	360°
J2 axis rotation	136°
J3 axis rotation	362°
J4 axis rotation	720°
J5 axis rotation	250°
J6 axis rotation	720°

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LIFT HIGH-BAY

Machine Shop

VENDOR

Knuth and FANUC

MATERIALS

Most metals and other materials. Tooling and set-up dependent.

A **machine shop** is an area for cutting, shaping, drilling, finishing, and other metal processing. The LIFT machine shop is a fully-outfitted machine shop, including a FANUC Robodrill CNC mill, in addition to machines which can cut, drill, grind, bend, and form metal into more finished products.

MACHINES

- **Vertical Drill Press**
  Multifunctional machine used on small and middle sized work pieces for drilling, spot facing, reaming, tapping and milling
- **KMT 1353 Motorized swing beam shear**
  The machine designed for cutting steel and plate shape plastic parts
- **3 in 1 Sheet metal working machine**
  For cutting, folding and roll bending or metal
- **Lathe**
  Precision lathe with constant cutting speed
- **Electric Discharge Machine**
  For processing and reshaping small and medium-sized mold cavities as well as the shaping of specialized high-strength parts
- **Disc and Combination Disc/Belt Sanders**
  For shaping and finishing materials
- **5 Ton Arbor Press**
  For press-fitting and pulling bearings, aligning, bending and broaching
- **Surface Grinder**
  High precision and cost-effective machining/grinding of steel, cast iron and nonferrous metals
- **Hydraulic Workshop Press**
  Designed for beams, profiles, pivots, shaft bending and straightening; bearings, bushings, the assembly and disassembly of pivots; stamping, punching, forming.
- **Multipurpose Milling Machine**
  Used to process plane surfaces, oblique plane at any angle, mill key slots and grooves, and to drill, ream and bore holes
- **Vertical Metal Band Saw**
  Can be used to cut out complex shapes and angles

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LIFT HIGH-BAY

Laser Bed Powder Fusion

VENDOR

EOS

MATERIALS

Most metals, tooling and set-up dependent.

The award-winning EOS M 290 employs Direct Metal Laser Solidification (DMLS™) technology. This **powder-bed based form of 3D printing** ensures maximum part density and exceptional quality.

With the most extensive materials portfolio on the market and a powerful 400-watt fiber laser beam for superior detail resolution, the EOS M 290 is ideal for producing highly complex components in a repeatable, production-ready manner for a broad range of applications.

EOS is the world's leading technology provider for additive manufacturing solutions with metals and plastics through 3D printers, materials and software.

SPECIFICATIONS

- **Building volume:** 250 x 250 x 325 mm (9.85 x 9.85 x 12.8 in) (height incl. build plate)
- **Laser type:** Yb fibre laser; 400 W
- **Precision optics:** F-theta lens; high-speed scanner
- **Scanning speed:** Up to 7.0 m/s (23 ft./sec)
- **Focus diameter:** 100 µm (0.004 in)
- **Power supply:** 32 A / 400 V
- **Power consumption:** Max. 8,5 kW / average 2,4 kW / with platform heating up to 3,2 kW
- **Inert gas supply:** 7,000 hPa; 20 m^3/h (102 psi; 706 ft^3/h)
- **Dimensions:** (W x D x H) 2,500 x 1,300 x 2,190 mm (98.4 x 51.2 x 86.2 in)
- **Recommended installation space:** Min. 4,800 x 3,600 x 2,900 mm (189 x 142 x 114 in)
- **Weight:** Approx. 1,250 kg (2,756 lb)

LIFT HIGH-BAY

Cold Spray Additive

VENDOR

SPEE3D

MATERIALS

Various types of metal powders.

Cold Spray Additive Manufacturing employs low-temperature kinetic deposition of various types of metal powders, supporting the production of custom components and functionally-graded materials.

During the process, fine powder particles are accelerated in a high-velocity compressed gas stream, and upon the impact on a substrate or backing plate, deform and bond together creating a layer. Moving the nozzle over a substrate repeatedly, a deposit is building up layer-by-layer, to form a part or component.

The world's first metal 3D printer to use patented SPEE3D technology, enabling significantly faster, more cost-effective and more scalable production than traditional manufacturing.

The SPEE3D process is also 100 to 1000 times faster than traditional 3D metal printing, making it the world's fastest way to turn your design into a usable printed metal part.

SPECIFICATIONS

- Maximum part size: Ø350 x 300mm (27L)
- Maximum part weight: 4 kg
- Deposition rate: 100g/minute (maximum)
- Materials: Copper, Aluminium
- Deposition spot size: 6 m
- Noise: < 85dBA @1m
- Machine footprint: 3130 x 1460 x 2325mm
- Machine weight: Approx 2500kgm