Advanced Forming Research Centre
Equipment Directory

2015-16
Introduction

What is the AFRC?
The Advanced Forming Research Centre is a collaborative venture between the University of Strathclyde, Scottish Enterprise, the UK Government and leading multinational engineering firms.

The £80 million facility focuses on developing forming and forging technologies to support the development of high integrity components to exploit applied research to improve the cost effectiveness of industries supply chains and the inherent capability of their products.

Capabilities
The key challenge that the AFRC addresses is the need to take low maturity technology developed within a research environment and deploy it in a manufacturing facility.

The AFRC houses over £25M-worth of equipment, built to industry’s specifications. AFRC can heat, shape, finish, measure, test and analyse metal parts and components, in-house.

Strategy
The AFRC’s focus on high forging and forming is based on the need for current and next generation manufacturing methods which can produce metallic parts to the highest standards of structural integrity.

Work with us
The AFRC provides companies with solutions to industrial problems as well as providing results to ensure competitiveness in years to come. Through the AFRC, collaborative R&D is possible by accessing public funding and working with other industrial partners.

By means of Directly Funded R&D, industrial partners can deliver projects with the AFRC, controlling the intellectual property of outputs.
We also undertake private research for companies/consortiums.

## Tiers of membership

### Tier 1
- Invest and direct the R&D agenda of the centre
- Access the AFRC Core Research Programme outputs

### Tier 2
- Contribute and showcase your capabilities through the centre
- Extend your professional networks

AFRC has eight lab areas
Total floor space: 592m²

AFRC has three workshops
Total floor space: 2376m²
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Hot forging and forming capability

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Hot forging and forming capability
Schuler AG 2100 tonne screw press

Purpose
A state of the art high speed forging press suitable for undertaking forging trials on a wide range of components and material types. The Schuler AG 2100 is a 2100 tonne direct drive screw press with 400mm press stroke. It has been integrated into an automated forging cell with robot loading/unloading and die spraying.

Interesting fact: Screw presses have been used since Roman times, when they were used for pressing of grapes.

Specifications
- 2100T Screw press
- Ejection system which enables machine to be used for upsetting
- Cooling platens eliminate variability created by the body of the press heating up
- Maximum energy – 160kJ
- Max force 21000 kN
- Die temperature up to 360°C
- Maximum stroke – 520mm
- Bolster can accommodate varying dies
- Die with flat surface available at dimension 290x180x120mm
Hot forging and forming capability
ACB Loire 200T Superplastic Forming Press

**Purpose**
Supports forming of mid-sized single and multi-sheet structures with design features representative of production parts to validate via experimental trials finite element modelling studies and optimal forming curves.

**Specifications**
- 200T press capable of SPF and diffusion bonding of alloys
- Control & monitoring system ensures close loop management for ram force, temperature & argon pressure
- Static force from 200kN to 2000kN
- Platen dimensions 760 x 760mm
- Max daylight 700 mm
- Main ram stroke ~ 500mm
- Tool thermocouples: 6
- Heating power 28kW
- Temperature accuracy at 920°C: ±10°C
- Number of gas lines: 3
Hot forging and forming capability

ACB 1200T Superplastic Forming/
600T Hot Creep Forming Press

Purpose

Supports experimental research programmes one step further with test work performed on large single and multi-sheet production components. This work usually follows the validation of simulation models and forming curves carried out via experimental trials on smaller-scale representative geometries on the ACB 200T SPF Press.

It has a unique capability for a research environment to form large full-scale aerospace parts for a range of applications including jet engines.

Specifications

- 1200 T press capable of SPF and diffusion bonding
- Overall dimensions – H7656mm, W6515mm, D4499mm
- 2400x2000mm heating platens
- Machine control & monitoring system
- Static force from 500kN to 12000kN
- Max daylight 2000mm
- Main ram stroke 1500mm
- Tool thermocouples – 12
- Heating power 375kW
- Temperature accuracy at 950oC - +/10oC
- Number of gas lines: 3
Hot forging and forming capability

Die Wear Cell

Purpose
To replicate hot forming die-part interface conditions for the investigation of die wear mechanisms.

The cell robot allows for the replication of 24 hour production cycles by continuously loading and unloading metallic test samples from the die set.

Specifications
— Custom built mechanical rig for analysis of die/part interface interactions during SPF process
— Retractable furnace for part heating up to 1000 °C
— Variable stack load of 0 – 19.25kN
— Ability to rotate the upper die
— Thermocouple attachment points allow for continuous monitoring of furnace, stack, die and part temperature changes
— Die design enables varying part sizes, materials and coatings to be trialled
— Analysis tools-thermal camera
Hot forging and forming capability

Schuler Multiforme – 3500kN

Purpose
This press was designed and built by Schuler to AFRC requirements. It is typically used as a preforming press, converting cylindrical billets or slugs into basic shapes, and features Schuler Servo-Drive technology which allows user control of the press stroke. It is a direct drive horizontal split die upsetting press with separate servo drive motors providing up to 5000kN grip load and 3500kN upsetting force respectively, and features a three position die set providing options for progressive upsetting in one operation.

Specifications
- Dual-action, horizontal forging press driven by 2 servomotors
- High-performance servomotors enables programming of diverse ram speed profiles and stroke sequences
- Gripping capacity of vertical slide: 5000 kN
- Upsetting capacity of horizontal derive: 3500 kN
- Vertical and horizontal slide strokes: 140 x 200mm
- Accommodates a 3-station bolster
- Possibility of upsetting in the central station during the die closing with a force of 1000kN
Hot forging and forming capability

HARE clipping press – Model 63HP

Purpose
The HARE clipping press is designed for trimming flash from forgings. It is a Hydraulic 63 tonne press which is synchronised for automated operation with 2100 tonne screw press and Electrotherm furnace.

Specifications
- High speed hydraulic clipping press for removal of forging flash from as-forged parts
- Max tonnage: 63 T
- Ram return load: 7.5 T
- Max daylight 530 mm
- Max stroke 150 mm
- Bed dimension: 900 x 580 mm
- Advance speed 384 mm/sec
- Pressing speed 33 mm/sec
- Return speed 309 mm/sec
- Throat depth 300 mm
- Tool spigot 50 mm
Hot forging and forming capability

Fanuc M-61B Robot

Purpose
This is a 6 axis robot with a 6kg payload capacity and is designed for operation in compact spaces. It works in conjunction with the integrated forging cell to provide controlled, repeatable lubricant application to forging dies. Programs can be tailored to provide the optimum lubrication to the dies during forging trials.

Specifications
- Flexible robot for pick & place and machine tending operations
- Currently installed to autoforge cell for automated lubrication of forging dies
- Max load capacity – 20 kg
- Maximum speed J1 200°/sec
- Maximum speed J6 720 °/sec
- Maximum reach: 951 mm
- Repeatability of ± 0.08 mm
- J4 moment: 15.7 Nm
- J5 moment: 9.8 Nm
- J6 moment: 5.9 Nm
Hot forging and forming capability

Fanuc M-710iC Robot

Purpose
This is a 6-axis robot that can handle a 50kg payload. It is mounted to a track (effectively a 7th axis). This significantly increases the working envelope, allowing integration of a forging press, a clipping press and a furnace.

Specifications
- Flexible robot for material handling and machine loading/unloading
- Currently installed to into autoforge gantry system for pick and place operations
- Max load capacity – 50 kg
- Maximum speed J1 175°/sec
- Maximum speed J6 355°/sec
- Maximum reach: 2050 mm
- Repeatability of ± 0.07 mm
- J4 moment: 206 Nm
- J5 moment: 206 Nm
- J6 moment: 127 Nm
Hot forging and forming capability

LAND thermal imaging cameras

Purpose
For high temperature measurement and thermal imaging, capable of looking inside a furnace to provide vital asset management and failure prevention information.

Specifications
- High resolution thermal imaging and temperature measurement cameras
- 3 different models available in AFRC
- Model 1: FTI-e, from 600°C to 1000°C, short wavelength: 0.78–1.1 µm
- Model 2: from 750°C to 1250°C, short wavelength: 0.78–1.1 µm
- Model 3: LAND ARC 0 - 500°C, long wavelength: 8–14 µm
Cold forming capability

Jean Perrot Maneo CNC Press-Brake

Purpose
A press brake, also known as a brake press, is a machine tool for bending sheet and plate material, most commonly sheet metal. It forms predetermined bends by clamping the workpiece between a matching punch and die and is capable of bending a range of materials at a range of thicknesses.

Specifications
- 1000 kN CNC press-brake
- 3m horizontal bend length
- Automatic bend correction capability
- The lower tool hydraulic clamping system with opposing wave technology crowning system
- Maximum stroke 250 mm
- 6 axis powered CNC back-gauge (X1, X2, Z1, Z2, R1 & R2)
Purpose
Net-shape, hot and cold metal-working of dimensionally precise tubular and other rotationally symmetric products. Process applies compression to the outside diameter of a cylindrical preform attached to a rotating mandrel.

Interesting fact: In the Middle Ages, spinning of metal was carried out on a wooden spinning lathe using a stick-like tool

Specifications

<table>
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<td>Applications include tubular and rotationally symmetric products with high precision</td>
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<td>Work piece Diameter: Min: 60 mm, Max: 600 mm</td>
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<td>Work piece Length: Forward flow forming: 1950 mm</td>
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<td>Reverse flow forming: 3900 mm</td>
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Purpose
Manufacturing of axisymmetric parts and flanges on cylindrical parts. Two-die forging process that deforms only a small portion of the work piece at a time in a continuous manner.

Interesting fact: Rotary forging was invented by Edwin Elmer Slick in 1910

Specifications
- Work piece diameter: min 50 mm, max 400 mm
- To achieve the localised deformation of the small area, upper die is tilted (nutation angle) slightly with respect to the axis of the lower die
- Automatic bend correction capability
Cold forming capability

500 Tonne Hydraulic Press

Purpose

A small but versatile hydraulic press, with uses which include, Ti sheet forming, cold forming of gears, open/closed die forming trials. Fully controllable to provide a constant displacement speed, load or strain rate. Can be programmed to vary these parameters during upset stroke. Maximum ram speed 6mm/sec.

Interesting fact: Joseph Brammer invented the Hydraulic press in 1795

Specifications

- 500 Tonne capacity for sheet forming of a range of materials
- Cold and hot forming capability
- Temperatures up to 400°C
- Max sheet forming size of 350mm x250mm
- Max daylight: 400mm
- Closing speeds: 160 to 250mm/sec
Materials capability

HA 250 Servo-hydraulic test machine

Purpose
Hydraulically operated machine used to study the mechanical behaviour of metallic materials under compression, tensile and cyclic loading conditions.

Specifications
- HA 250 servo-hydraulic test machine
- 250kN servo-hydraulic machine
- Can be used in either tension or compression
- Can be configured for Low Cycle testing
- Primary use for testing at higher strain rates than those covered by the Z250
- Displacement rates of up to 150mm per second
- Used in support of material characterisation programmes linked to the simulation of the forging process
Materials capability

Zwick/Roell Amsler Z250 Material Testing Machine

**Purpose**
Screw driven machine used to study the mechanical behaviour of metallic materials under compression, tensile and cyclic loading conditions.

**Specifications**
- Mechanically driven test frame
- Capacity of 250kN
- Temperature range: ambient to 1500°C
- Low strain rates: 10^-5/s to 0.1/s
- Tensile / compression
- Gas retort for high temperature testing of materials
- Contact / non-contact extensometry
- Can be controlled in either a positional, load-controlled or true strain rate mode
- Bespoke software designed for complex testing modes involving rapid changes to the strain rate
Materials capability

Zwick/Roell Z150 Material Testing Machine

Purpose
Screw driven machine used to study the mechanical behaviour of metallic materials under compression, tensile and cyclic loading conditions.

Specifications
- Screw driven test frame
- Load cell: 150kN
- Strain rates: 10^{-5} to 0.5 s^{-1}
- Controlled in either a positional, load-controlled or true strain rate mode
- Bespoke software designed for complex testing modes involving rapid changes to the strain rate
- Tensile / compression testing
- Strain rate jump testing
- Stress relaxation testing
- MTS extensometer and GOM® Aramis for deriving the plastic strain ratio ($\tau$) value
Materials capability
Instron Electro-Thermal Mechanical Tester (ETMT)

Purpose
The Electrothermal Mechanical Testing System (ETMT) was developed in conjunction with the National Physical Laboratory (NPL) for testing metals and other conductive materials. Using miniature test pieces, the system is capable of achieving high fatigue loading rates and very rapid rates of heating and cooling. It is designed for full reverse stress loading and includes a direct resistance heating system.

Specifications
- Load capacity: 5kN
- 400 Amps – resistance heating
- Environmental chamber (vacuum, protective atmosphere)
- Small sample size
- Designed for the testing on miniaturised test specimens
- Capable of imposing heating cycles using a electrical resistance heating methodology
- Can apply mechanical stressing cycles, either in isolation, or, simultaneously with a superimposed heating waveform
Materials capability

Phoenix High Strain Rate testing machine

Purpose

The Phoenix Forge Simulator is a materials testing machine capable of conducting experiments in the range of "medium" strain rates up to a maximum of 500s^-1 at high temperatures up to 1200°C. This machine is ideal for the detailed simulation of the thermo-mechanical conditions taking place during hot forging in screw-presses and hammers. This helps in the study and prediction of the mechanical properties of various alloys under forging conditions.

Specifications

- Very high strain rate testing machine
- Maximum testing load of 200kN
- Max speed of 3.6m/sec with +/-5% speed control
- Temperature capability up to 1150°C
- 580kN load frame
- Maximum frame stiffness of 225kN/mm at crosshead separation of 1090mm
- Working footprint: 1600x1200x3300 mm
- Unique system for displacement measurement which removes elastic deformation of the system
**Materials capability**

**Alicona Infinite Focus IFM G4**

**Purpose**
Optical surface characterisation.

**Specifications**
- Non-contact optical 3 dim. surface digitisation based on Focus-Variation
- Surface profile form and roughness measurement
- Surface topography Ra above 10-15 nm with a Lc of 2um, surface structure dependent
- Minimum vertical repeatability less than 0.12
- Best vertical resolution in the range of 10 to 410 nm
- Fully automated and programmable xyz stages
- 5x, 20x, 50x and 100x objective
Materials capability

FEI/Oxford Instruments Quanta 250 FEG SEM

Purpose

Used for structural and chemical analysis of metallographic specimens. Magnification up to x1,000,000 and down to a resolution of 3nm

Specifications

- Scanning Electron Microscope (SEM) allows the observation of microstructure in high magnification and superior resolution
- Equipped with EBSD and EDX characterisation
- Equipped with WDS/WDX
- Electron Back-Scatter Diffraction (EBSD) for obtaining crystallographic information of materials
- Energy-dispersive X-ray spectroscopy (EDS or EDX): analytical technique used for the elemental analysis or chemical characterization
Materials capability

MTS3000 hole drilling system for residual stress measurements

Purpose
The AFRC's MTS3000 Hole Drilling Equipment made by SINT Technology is capable of automatic step by step drilling and strain measurement with a controllable feed rate.

Interesting fact: Gorilla Glass, a registered trademark brand of a specialized toughened glass developed and manufactured by Corning, which was a key enabler in the development of the iPhone, achieves its toughened state through ion exchange - a process by which smaller sodium ions in the glass are replaced by larger potassium ions from the salt bath. The larger ions occupy more space and thereby create a surface layer of high residual compressive stress at the surface, giving the glass surface increased strength, ability to contain flaws, and overall crack-resistance.

Specifications
- Automatic system for measuring residual stresses by hole drilling method
- Uses optical-mechanical system and electronic control unit
- Hole achieved with high-speed air turbine (350,000 RPM) such that no stresses are induced in the material during drilling
- Test is fully automatic and operator can select a number of drilling steps, drilling profiles, feed rates, etc.
Materials capability

Electronic Speckle Pattern Interferometry (ESPI)

Purpose
This technique measures residual stresses within a component by drilling a narrow hole into the component and using a laser light source and video recording equipment to measure distortions.

Specifications
- Automatic system for measuring residual stresses by hole drilling method
- Measures surface distortion using electronic speckle pattern interferometry (ESPI)
- Hole achieved with high-speed drill such that no stresses are induced in the material during drilling
- Test is fully automatic and operator can select a number of drilling steps, drilling profiles, feed rates, etc.
Materials capability

PROTO LXRD

Purpose
The AFRC’s LXRD MODULAR MAPPING system is a high-powered residual stress mapping machine capable of measurements on large components. Oversized parts composed of difficult to measure materials such as titanium, are no longer restricted to low-power portable systems. With over 2 meters of measurement space, heavy-duty XY mapping stages, and a removable mapping stage, it has the flexibility to meet all of your complex measurement needs.

Specifications
- Automatic system for measuring residual stresses by X-ray diffraction
- Measures surface Residual Stress in a range of materials including Ti alloys, Ni alloys, Al alloys, steel and stainless steel
- Can measure stress in large components
- Data capture is fully automatic and operator can select a range of angles of incidence to optimise the measurement for different materials
Materials capability
Flexible Automation Cell

Purpose
The flexible nature of the cell will allow for new fundamental research and knowledge exchange to be supported, with large volume precision positioning equipment, the latest advanced ultrasonic phased array inspection capability and state of the art metrology systems.

The linear tracks on which the robots are mounted and move on, were installed and levelled to gravity using novel lasers and software developed in the University. This pioneering approach has potential benefits in robot accuracy, repeatability and lifetime.

Specifications
- 3 off KUKA KR90 R3100 HA Extra robots mounted on 7 metre linear tracks
- Integrated 8th axis rotary stage for part sizes to 3.5 metre x 3.5 metre
- Independent or co-operating robot strategies
- Flexible programming
- Reconfigurable cell for larger components to length 8 metre
- Integrated NDT and metrology capabilities
- Ultrasonic phased array inspection capability
Materials capability

Zwick ZHV1 – micro Vickers hardness tester

Purpose
Used for hardness testing of metallographic specimens

Specifications
- Hardness testing on all materials using indenter technique
- Test load applied perpendicularly, without shock, and with defined application time and duration
- Instantaneous read-out of hardness
- Motor-operated table
Materials capability

Olympus GX51 inverted optical microscope

Purpose
Optical analysis of metallographic specimens. Capable of brightfield, darkfield, DIC, and simple polarization observations.

Specifications
- General optical microscopy
- X1000 magnification
- AnaSIS software embedded
- Single lever switchover for brightfield/darkfield observation
Materials capability
Leica DM12000M Optical Microscope

Purpose
Optical analysis of metallographic specimens. Fully motorised stage with automatic objective lens recognition, and automatic grain size analysis capability. Brightfield, DIC, Oblique and simple polarization observations available.

Specifications
— General optical microscopy
— Up to x1000 magnification
— Leica Application Software (LAS) embedded, with automatic grain size module
— Touch-screen control for magnification change/ lens mode selection (Brightfield/DIC/Oblique)
Metallographic preparation

Buehler Vibromet 2 vibratory polisher

Purpose
Used to prepare high quality polished surfaces on a wide variety of materials, including EBSD applications for SEM analysis. The 7200 cycles per minute horizontal motion produces a very effective polishing action, providing superior results, exceptional flatness and less deformation.

Specifications
- Preparation of high quality polished surfaces for variety of materials
- Capability for EBSD applications
- Maximum single force of 80N
- 7200 cycles/min horizontal motion
Metallographic preparation

Buehler EcoMet 300/AutoMet 300 grinder/polisher

Purpose
Used to prepare high quality polished surfaces on a wide variety of metallographic materials for microscopy analysis. May be used in automatic or manual modes.

Specifications
- Grinding and polishing of metallographic samples
- Colour touch-screen control panel for Z-axis removal by depth
- Method creation/storage and automated dispenser programmability
- Unique bowl shape for easy access to platens
- Multi-purpose water nozzle capability
- Platen cooling to minimize heat-build-up and reduce sample deformation
Purpose
Used for automatic, micro-processor controlled electrolytic polishing and etching of metallographic specimens. With a scanning function for easy determinations of parameters, built-in safety features, and a database with methods for various materials, short polishing times and maximum reproducibility are achieved.

Specifications
- Automatic micro process control of electrolytic polishing and etching of metallographic specimens
- Scanning function for easy determination of parameters
- Short polishing times
- Polish unit width 220mm
- Polish unit depth 350mm
- Polish unit height 160mm
Metallographic preparation

Buehler Abrasimatic 300

Purpose
Used for sectioning larger specimens prior to metallographic preparation. Manual cutting action in 3 directions or automated cutting in one direction is possible.

Specifications
- Bench-top cutter for sample cutting and preparation
- Manual and automated cutting action in 3 directions
- Four sectioning methods: Z-axis chop direction, X-axis serial section direction, Y-axis longitudinal direction, automatic Y-axis sectioning
- Wheel capacity: 305mm
- Touch-screen interface for all operations
- Cutting wheel torque: 14Nm
- Maximum cut diameter: 110mm
- Motor power: 3.7kW
- Dimension: 849 x 585 x 678 mm
Metallographic preparation

Buehler IsoMet 5000

Purpose
Used for cutting smaller specimens, various material types, with minimal deformation. 2 micron sample positioning allows for precise sectioning of specimens. User selectable feed rate allows for ultimate versatility. Enhanced software options enable 55 programmed methods and automatic serial sectioning, as well as the ability to mount cup grinders for automatically grinding to depth.

Specifications
- Precision saw for preparation of metallurgical samples
- 2 micron positioning for precise sectioning
- Programmable for automatic sectioning
- Ability to mount cup grinders for automatically grinding to depth
- User selectable feed rates
Metrology capability

GOM ATOS TripleScan III/rotary table

Purpose

Using blue light technology this equipment is capable of digitizing various geometries into a CAD representation of the actual component, this can then be used to take precise measurements or comparison against a nominal CAD model. This equipment is also excellent for reverse engineering where an initial drawing or CAD model of the geometry is not available and therefore its application in a research environment is ideal.

Interesting Fact: A GOM ATOS TripleScan III was used to scan the last airworthy Spitfire MkIIa that flew sorties in the Battle of Britain during World War II, the resulting scan was used to create replica models and as a benchmark for repairs and maintenance to the aircraft.

Specifications

- Uses blue light technology to enable precise measurement, independent of environmental lighting conditions
- Measurement volumes from 38mm to 2m
- 2 x 8,000,000 pixels
- Point spacing 0.01-0.61mm
- Working distance: from 490 to 2000 mm
- Integrated into full tilt and turn rotary table system for controlled part movement
Metrology capability

GOM ARAMIS 5M optical 3D deformation system

Purpose

GOM ARAMIS is a non-contact and material independent measuring system providing, for static or dynamically loaded test objects. It provides accurate:

• 3D surface coordinates
• 3D displacements and velocities
• Surface strain values (major and minor strain, thickness reduction)
• Strain rates

Specifications

• High-res image processing during material loading
• Image processing based on digital image correlation
• Used for determination of materials properties, component analysis, verification of FEA, real-time control of testing devices
• Material strain calculated based on component geometry and plastic theory
• Image acquisition is time-based enabling 3D velocities and strain rates to be automatically determined
• Frame rate 15Hz to 29Hz
• Camera resol. 2448 x 2050 px
Metrology capability

Zwick/Roell BUP 1000 sheet forming machine

Purpose
Hydraulically operated testing machine used to study the room temperature formability of sheet materials (thickness: 0.3 to 4mm) by conducting tests like Nakajima test, Marciniak test, Ericsson test, earing test and cupping tests

Specifications
- Testing of formability of sheet metal
- Testing the influences of surface treatments, coatings and lubricants
- Hydraulic cup extractor through integrated piston, with piston rod functioning via punch
- Hydraulic opening and closing of tool head
- Drawing force up to 1000kN
- Ram stroke of 150mm
- Deep draw speed of 0-750mm/min
- Sample size up to 260mm wide
Metrology capability

Mitutoyo CMM Crysta Apex C 121210

Purpose
With micron resolution the Coordinate Measuring Machine (CMM) is a very flexible measurement solution and is capable of measuring most geometries with excellent accuracy. This CMM is equipped with a Renishaw PH10MQ allowing for the attachment of touch trigger and scanning probes, this allows the CMM to capture freeform geometry using scanning and also conventional 3D coordinate measurement.

Interesting Fact: The glass encoders used to determining the position of the CMM are incrementally coded, this means the CMM only knows it’s position relative to a home position, this is the reason for having to home the CMM every time it has been switched off.

Specifications

- Coordinate Measurement Machine for contact measurement capability
- Max workpiece height 1200mm
- Renishaw PH10T – motorised indexing head, repeatability 0.4µ (2o)
- Acceleration 0.23G
- Measurement range 1205 x 1205 x 1005 mm
- Max permissible error +/- (2.3+3L/1000)
- Max. moving speed = 520mm/s (3D)
- Max. measuring speed = 5mm/s
Metrology capability

EU Classic Electrolyte Marking Machine

**Purpose**
Used for permanent product marking on metallic surfaces. Easily portable.

**Specifications**
- Electrolytic marking process using stencil, electrolyte and current to create high quality marks on conductive surfaces
- Used for creating grids for tracking strain distribution on sheet formed products
- Maximum power – 310 VA to 510 VA
- Output voltage 0-24V
General machine tool capability

Agie Charmilles Hole Drill 11

**Purpose**
Has multiple point EDM hole drilling capabilities with integrated rotating spindle allows automated erosion of holes at multiple locations with minimal intervention. On-board technology includes steel, carbide, aluminium, copper, brass cutting files. A Stainless steel table and work panel and 17 Electrode Guide Sets for 0.3 to 3.0 mm diameter hole drilling.

**Specifications**
- Multiple point Electro Discharge drilling
- Automated erosion of holes at multiple locations with minimal intervention
- Drilling depths of up to 200mm
- Hole diameter min 0.3 mm/max 3 mm
- CNC control of all axes/keyless chuck eliminating need for special collets
- X-axis travel: 299.7 mm
- Y-axis travel: 198.1 mm
- Z-axis travel: 302.3 mm
General machine tool capability

Agie Charmilles Wire EDM F1440CCS

Purpose
A most versatile machine, capable of cutting 45° cones, and can do this whatever the height of the part. The principle of crossed double guiding of the X, Y, U and V axes independently and of the same dimensions, allows machining to be done with a large taper, thus widening the scope of possible applications for wire spark erosion.

Interesting fact: The history of EDM Machining techniques goes as far back as the 1770s when it was discovered by an English Scientist Joseph Priestley. However, Electrical Discharge Machining was not fully taken advantage of until 1943 when Russian scientists learned how the erosive effects of the technique could be controlled and used for machining purposes.

Specifications
- Electro-Discharge machining at cutting speeds up to 500mm²/min
- Work piece dimension 1200 x 700 x 400 mm
- CNC control of all axes
- X-axis travel ~ 550mm
- Y-axis travel ~ 350mm
- Z-axis travel ~ 400mm
- Taper angle +/- 30 degrees
General machine tool capability

Jones & Shipman CNC Surface Grinder 624 Easy

Purpose
The Jones & Shipman 524/624 Easy has been designed specifically to offer unrivalled ease-of-use coupled to the highest levels of precision and accuracy when surface grinding.

Specifications
- Produces precision ground surfaces and accurate surface finishes across wide range of materials
- Fast removal rates and rapid forming of wheel profiles
- Grinding capacities up to 600mm x 200mm x 375mm
- Grinding wheel size up to 254mm x 32mm
- Fanuc controller
General machine tool capability

HAAS CNC Mill TM-2

Purpose
The Tool room Mill, is a versatile machine that combines the functionality and simplicity of a manual mill with the power and flexibility of the Haas CNC control, making it the perfect machine for tool rooms and shops transitioning to CNC.

Specifications
- Vertical milling machine capable of machining wide range of materials
- Max spindle rating 5.6kW
- Max speed 4000rpm
- 45Nm@1200rpm
- X-axis travel – 1016mm
- Y-axis travel – 406mm
- Z-axis travel – 406mm
General machine tool capability

HAAS CNC Lathe TL-1

Purpose
The Tool room Lathe offers the precision control of the Haas CNC system. They are very easy to learn and operate – even without knowing G-code. And with the Haas Intuitive Programming System, manual machinists will transition quickly and easily into full CNC.

Specifications
- Horizontal CNC lathe capable of machining wide range of materials
- Max spindle rating: 5.6kW
- Max spindle speed 2000rpm
- Max cutting diameter: 406mm
- Maximum cutting length: 737mm
- X-axis travel – 1016 mm
- Y-axis travel – 406 mm
- Z-axis travel – 406 mm
- Maximum thrust X – 13772 N
- Maximum thrust Z – 6886 N
- Maximum X feed – 1.9m/min
- Maximum Z feed – 3.8m/min
General machine tool capability

DMG MORI DMU 125 FD DuoBLOCK

Purpose

The standard DMU 125 FD duoBLOCK is a highly accurate multitasking machine tool, and is positionally accurate to within 7 microns; however, this machine tool has been manufactured with additional cooling measures which make it EVEN more accurate. Extensive cooling of the full feed drive, a thermal shield around the base and coolant temperature control, provides 50% higher accuracy to that of a standard machine model.

Specifications

- Simultaneous 5 axis Mill/Turn
- Multitasking technology in one setup
- Adaptive Control Monitoring – OMATIVE
- Higher Accuracy enabled and pitching optimisation
- Siemens 840D control
- Strain gauge probing and laser tool setting
- Max cutting diameter: 1250mm
- Maximum height: 1000mm
- Max spindle speed 12,000 RPM milling, and 500 RPM turning
- Maximum table load: 2300kg
- X-axis travel – 1250 mm
- Y-axis travel – 1250 mm
- Z-axis travel – 1000 mm
General machine tool capability

DMG MORI HSC 75 Deckel Maho CNC

Purpose
Machine tools are generally manufactured with mechanical ball screws which allow the machines to move to position; however, the HSC 75 has high dynamic linear drives (electric) in all axes, allowing increased speed, accuracy and accelerations of up to 2g - perfect conditions for high speed machining of die and mould applications.

Specifications
- 5 axis CNC capable of machining wide range of materials
- Max spindle rating: 43.5kW
- Max spindle speed 18,000rpm
- Max cutting diameter: 750mm
- Maximum cutting length: 750mm
- X-axis travel ~ 885 mm
- Y-axis travel ~ 600 mm
- Z-axis travel ~ 600 mm
- Maximum thrust X ~ 86 Nm
- Maximum thrust Z ~ 86 Nm
- Maximum X feed ~ 90m/min
- Maximum Z feed ~ 90m/min
General machine tool capability

Sheet metal guillotine SH-5210

Purpose
Hydraulic shear offers precision cut sheet material and is capable of cutting up to 1.2m wide sheet and up to 2.5mm thick mild steels.

Horizontal band saw

Purpose
This is a dual-mitre band saw with capabilities to mitre 45° left and 60° right with just flick of the wrist and a push or pull of the head. The BS-20M-DM band saw also incorporates a heavy-duty in-feed table and out-feed table to help save strain on the operator.

Pillar drill/band saw

Purpose
The Baileigh Industrial DP-1500G is a gear driven drill press which is rigidly designed for heavy drilling. The column is a massive 5.5" diameter to help reduce possible flexing during heavy feeds at maximum capacity, which is 1.5" through mild steel. The base and table are made from a heavy casting and both have large T-slots to ensure a proper hold of the material being drilled.
TIG welding plant

Purpose
This is a welding power source, which can also be used for Stick welding. The power welding source can be used with alternating current (AC) or direct current (DC). This plant can be used to weld a range of different materials.

Hand blast cabinet, Fox-50

Purpose
The media blast cabinet is capable of sand blasting a range of materials. The cabinet provides an air and media mix at high pressure through a tungsten nozzle.

Pedestal grinder

Purpose
Grinding is an essential part of life in a metal fabrication shop and a large diameter disc grinder is a machine that fits right in. The pedestal grinder is built to last and uses only the best manufacturing processes. It features a cast iron base and work table to reduce vibration. As well as a heavy column which further increases the rigidity and ensures the smoothest grinds.
Furnace Capabilities

CMI bespoke Gas Furnace

Purpose
This is a highly instrumented representative scale gas furnace, mainly used for investigating processes for preheating material and heat treatment. This bespoke piece of equipment allows us to study a wide range of factors (flue and burner configuration, gas/air mix ratio, part stacking) that can affect heating performance, product quality and thermal efficiency. It also provides a mechanism for assessment of heating simulation capabilities, for example within DEFORM-HT.

Specifications
- Compliance to aeronautic norm AMS2750E
- Maximum operating temperature of 1200°C
- Useful zone: 1 m² x 0.7m High
- Maximum power: 180kW (up to 500kW with regenerative burners)
Furnace Capabilities

Carbolite furnace HRF 7/324

Purpose
Suited for stress relieving, tempering, normalising, annealing and other ‘low’ temperature processes.

Specifications
- Heating by resistance wire elements on both sides of chamber
- Double skin construction for cool outer skin temperature
- Single hinged double seal door to minimise heat loss
- Maximum operating temperature of 750°C
- Maximum power 24kW
- Volume 324L
- Chamber width – 600mm
- Chamber height – 600mm
- Chamber depth – 900mm
Furnace Capabilities

Carbolite furnace GPC 12/131

Purpose
Small furnace for applications where good uniformity and close control temperature needed. Working best between 600°-1200°.

Specifications
- General purpose chamber furnace
- Heating by resistance wire elements on both sides of chamber
- Maximum operating temperature 1200°C
- Maximum continuous working temperature 1200°C
- Maximum power 18kW
- Volume 131L
- Chamber width – 500mm
- Chamber height – 350mm
- Chamber depth – 750mm
Furnace capabilities

Carbolite furnace LCF 14/350

**Purpose**
Large chamber furnace for applications where good uniformity and close control temperature needed.

**Specifications**
- Large chamber furnace for applications where good uniformity and close control temperature needed
- Heating by heavy gauge spirally wound elements in roof and under hearth
- Maximum operating temperature 1400°C
- Maximum continuous working temperature 1400°C
- Maximum power 48kW
- Volume 350L
- Chamber width – 760mm
- Chamber height – 400mm
- Chamber depth – 1130mm
Furnace Capabilities

Electrotherm rotary furnace – 5700

Purpose
Israeli built rotary hearth furnace capable of heating samples to 1150°C ±10°C. Stepper motor indexing control of rotary table provides automated integration with Fanuc robots for automated furnace loading/unloading and transfer to press.

Specifications
- Pre-heating rotary furnace for a continuous precision forging stamping & forming processes
- Assures temperature uniformity of up to +/-5°C
- Working temperature range 900-1150°C
- Suitable for air or protective atmospheres
- Inner diameter – 1000 mm
- Inner useful height 350mm
- Heating power 65kW
- Volume 350L
- Oxygen levels at 900°C – 0.1% after 35mins/0.05% after 45mins
Furnace capabilities

VFE/TAV TPH25/25/35 Horizontal Vacuum Furnace

Purpose
Front loading single chamber high vacuum furnace with convection assisted heating and overpressure gas quenching system. The furnace has a maximum temperature of 1400°C and works best between 530°C-1320°C. Used mainly for vacuum heat treatments and vacuum brazing in an argon chamber H250mm, W250mm and D350mm.

Specifications
- Vacuum heat treat furnace for wide variety of alloys
- Working chamber 250mm x 250mm x 350mm (22L vol)
- Operating vacuum 10^{-4} - 10^{-5} mbar
- Operating temperature 600°C-1300°C
- 6 bar inert gas pressure quenching
- Max permissible charge 15kW
- Argon and Nitrogen gas environments
Furnace capabilities

Quench tank 1000L

Purpose
Polymer quenching is capable of producing repeatable results with less corrosion than water and with less fire risk than oil. This capability allows the AFRC to test various polymer quench parameters in order to understand quenchant performance and optimise parameters accordingly for industrial partners.

Specifications
- Quench tank to replicate production quenching environments
- Heating elements and agitation installed within the tank along with thermocouples for monitoring internal temperature
- 1000 litre capacity
- Impellor driven with 1.1kW motor
- Agitation controlled from 60rpm to 350rpm
Furnace capabilities

Polymer quench tank

Purpose

Polymer quenching is capable of producing repeatable results with less corrosion than water and with less fire risk than oil.

This capability allows the AFRC to test various polymer quench parameters in order to understand quenchant performance and optimise parameters accordingly for industrial partners.

Specifications

- Capacity is 1000L
- Heating element to heat the polymer between 35°C and 60°C
- Equipped with a handling system that enables insertion or removal of parts in the gas furnace
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