World class thermal engineering inspired by additive manufacturing
HiETA Technologies Limited is a product design, development and production company, based in Bristol and Bath Science Park, exploiting additive manufacturing. Using Selective Laser Melting, we can ‘grow’ components from layers of very fine metal powders.

The really high levels of design freedom provided by this approach allow us to deploy complex geometries, including lattices and to integrate multiple components into single designs. This enables us to create more compact and efficient components than with conventional manufacturing techniques.

From our Technology Centre, we provide products and services in the areas of:

+ High-Temperature Heat Exchangers
+ Low-Temperature Heat Exchangers
+ Turbo Machinery
+ Combustion and Fuel Delivery Parts
+ Integrated Systems
+ Design Engineering
+ Materials & Applications
+ Additive Manufacturing

HiETA exists to realise energy efficiency and performance through the use of Additive Manufacturing.”

Mike Adams CEO
HiETA’s world class thermal engineering technology, inspired and enabled by Additive Manufacturing, results in heat exchangers that are typically 50% smaller and lighter than our competitors’.

Serving Formula 1, automotive, energy generation, defence and aerospace markets, our products are in daily use in Formula 1 applications and in various powertrain OEM development platforms.

HiETA also offers services in design engineering, additive manufacturing and testing. Operating state of the art Renishaw Laser Powder Bed Fusion Additive Manufacturing machines in our facility, we’re fully equipped with powder acceptance testing equipment, through to specialist post-processing such as powder removal equipment and inspection including 3-D GOM scanning equipment.

We’re fast-growing but still operate an agile and open-innovation culture and are equally at home working with fast-paced Formula 1 developments or in highly quality assured and safety-critical applications such as civil aerospace. If your application demands a high efficiency, lightweight solution we look forward to working with you.
Technology Centre

HiETA’s Technology Centre has been purpose-built to rapidly deliver high-performance products by using high quality additive manufacturing. It brings the design, analysis and production capabilities together under one roof in Bristol & Bath Science Park.

Working with our customers and partners, we address the whole product life-cycle, from initial concept through design, analysis, manufacture, post-processing, quality assurance and component testing, all linked by fast-paced agile processes.

The Technology Centre’s strategic location also enables us to access facilities at the National Composite Centre and the forthcoming Institute for Advanced Automotive Propulsion Systems (IAAPS). Our high-temperature and phase-change test facilities are located just a few minutes’ drive away and Renishaw, the supplier of our additive manufacturing machines, is located just 30 minutes away. Also emerging in the area is a cluster of high-end users of additive manufacturing, which offers exciting opportunities for future collaboration.

Flexible Entry to the Supply Chain
HiETA’s full service offers sophisticated analysis and modelling tools, with additive manufacturing machines to facilitate rapid development to reduce business’s lead times.

Whatever the level of market readiness, HIETA can help build the framework and optimise designs for additive manufacturing, provide flexible manufacturing solutions and ensure that, when ready, there is a validated supply route to deliver right the first time.

Manufacturing Capability
The Technology Centre houses a number of high specification additive manufacturing machines, supported by a strong local supply base, ensuring that HIETA offers flexibility in its design and production solutions as products move through their life cycle to full production volumes.
End-to-end product development

The Technology Centre provides HiETA's expertise for each function:

- Design
- FEA
- CFD analysis
- Topology optimisation
- Materials analysis
- Build optimisation
- Additive manufacturing
- Post-processing
- Component inspection
- Component testing
- Project management

“Whatever stage a customer brings a product to us, HiETA has the expertise and resource to add real value and accelerate delivery.”
Design Engineering

HIETA are experts in thermal engineering and additive manufacturing. Our team of engineers have delivered products that are lighter, smaller, higher performing and last longer than competing products. Our design engineering service is core to achieving market leading gains in demanding applications through additive manufacturing.

Specific skill sets include thermal modelling via in-house developed codes, CAD, Computation Fluid Dynamics, Finite Element Analysis and Validation Testing. This expertise allows us to provide an end-to-end solution; delivering rapid product development projects for our customers in markets such as Aerospace, Motorsport, Electronics, Energy and Oil & Gas.

The following provides a summary of our service offering and examples of how they have been applied to deliver advantage.

**Finite Element Analysis**

Our stress engineers have developed FEA methods and approaches to streamline the required structural analysis, ensuring fit for purpose components. We have used topology optimisation to reduce mass of turbine wheels by 50%, reducing inertia, spool up times and bearing wear.

Our team have created approaches to analyse pressure and thermal loads in heat exchangers to identify and design out highly stressed areas to allow heat exchangers to run at 900°C and pressures of over 200bar.

**Thermal modelling**

We have a team of engineers dedicated to thermal modelling which allows us to take your requirements and model product concepts, providing performance predictions for given boundary conditions. For heat exchangers, we have developed tools to provide optimum sizings depending on design objectives such as pressure drop, effectiveness, size and mass.

Our library of heat transfer data provides rapid design concepts and significant size, mass and performance gains.
Computational Fluid Dynamics

Our CFD team support the design process by analysing flow distribution, heat transfer and pressure drop of fluids. We have developed tools and techniques for optimising heat transfer surfaces in a variety of heat exchanger applications including Water Charge Air Coolers for Internal Combustion Engines and Recuperators for Micro Gas Turbines.

We have also developed tools for analysing phase change of fluids including condensers for solid oxide fuel cells and evaporators for exhaust heat recovery systems. These have delivered size reductions of >75%.

Test & Validation

To confirm that our designs deliver the performance and life duty we have test rigs capable of providing boundary conditions matching your applications requirements. We have small scaled heat exchanger rigs to rapidly test at scaled conditions to support the design process.

We have capabilities to test using water, oil and air. In previous projects we have performed hydraulic burst tests on our heat exchangers up to 200 bar. Our testing partners are capable of supplying air at flow rates above 3 kg/s at temperatures upwards of 900C.
Additive Manufacturing

In our state-of-the-art production facility in Bristol we have the latest in powder-bed process including Renishaw 500Qs in many materials.

Our people are our strongest assets. With a market-leading technical understanding of powder bed material processes, we are able to produce high quality complex manufactured parts to your requirements.

Safety, quality and efficiency are central to our manufacturing services.

Within the facility, our people have created some of the most advanced engineered products produced in the Metal AM industry. Our customers return to us because of our deep understanding of AM processes, powder metallurgy, design for AM, powder extraction and NDT/NDI techniques.

Unlike other Additive Manufacturing service providers, we are able to provide you with an end to end service through our validated supply chain.

We work with our customers on both one-offs and low volume production batches from our facility in the South West of the UK. We also work with our customers in aerospace, automotive, energy and processing industries to scale up and overcome barriers. Specifically productivity and qualification to provide a validated Additive Manufacturing solutions in higher volumes.

+ Inconel 625
+ Inconel 718
+ AlSi10Mg
+ Hastelloy X
+ SS316 L
+ Ti6Al4v
+ Refractory Metals

Renishaw’s RenAM 500Q has four high-power 500 W lasers giving us significantly higher build rates and productivity.
Benefits of Additive Manufacturing

The benefits of Additive Manufacturing vary on a product to product basis. Broadly speaking they fall into five different categories:

**Increased performance**
Devices such as manifolds, waveguides, combustors and heat exchangers perform better when functional elements can be shaped optimally.

**Reduced weight**
Outputs from topology optimisation can be closely followed. High-performance materials can be justified as a result of high material utilisation rates.

**Improved packaging**
Devices can be shaped to occupy a non-uniform space envelope.

**Component integration**
Multiple components previously assembled can be integrated reducing assembly costs and the additional weight of fasteners.

**Reduced lead time**
Long lead times associated with tooling design and acquisition are eliminated.

HiETA are well placed to advise you on how, or if, Additive Manufacturing can benefit a product and in what way it should be introduced.

These benefits are often realised in stages:

**Part replacement**
Outputs from topology optimisation can be closely followed. High-performance materials can be justified as a result of high material utilisation rates.

**Repackaging**
Devices can be shaped to occupy a non-uniform space envelope.

**Part integration**
Multiple components previously assembled can be integrated reducing assembly costs and the additional weight of fasteners.

**System re-design**
When taken to its fullest extent clean sheet designs can dramatically benefit from the utilisation of additive manufacturing. Often significant performance or efficiency improvements can be realised, and in a virtuous circle, the reduced size of these systems can also lead to a dramatic cost saving versus a previous design.

At HiETA we like to help our customers and partners progress through these stages as quickly and as cost-effectively as possible. Additionally, the close working relationship we have with Additive Manufacturing machine OEMs, allows us to develop product solutions optimised to take advantage of future generations of machines.
HiETA has a supply chain to provide additive manufacturing services and products in the following materials:

We have a highly qualified team of chartered engineers and PhDs in our applications and materials team, with extensive experience in processing new materials in powder-bed additive manufacturing. From customer requirements, using our up-to-date knowledge of additive manufacturing and core metallurgical concepts, we have a network of partners who can supply alloy compositions according to your requirements.

Utilising a design of experiments, HiETA generates a systematic selection of parameters, which are applied to a set of samples. These are polished and imaged to determine an optical density, using exclusive software tools developed by HiETA. The results are fed into a model to determine an optimal parameter set and which can be validated through physical testing.

Using machine learning techniques, we aim to optimise scan strategies and machine settings to improve surface roughness, density, mechanical properties and build time. We are also developing novel post-processing methods, for example surface treatments such as hot isostatic pressing (HIP), vacuum and inert gas furnace solutions and aging cycles, and powder removal.

Material characterisations are performed through mechanical testing such as tensile testing, hardness, stress rupture, creep, fatigue, thermal conductivity and metallography, among others.

We are also capable of performing alloy development via our partners. In our state-of-the-art facility we have reduced build volume systems for initial powder trials. This reduces the need for large volumes of powders and offers the flexibility to swiftly change alloy compositions in the early stages of development. We also use open machine platforms from Renishaw which allow tailored parameter sets to be developed.

Once base parameters are established, we have the deep understanding of machines and equipment to scale up to production, with validated multi-laser parameter development programmes and capability.

The Renishaw Build Volume (RBV) allows HiETA’s materials engineers to accelerate development of new materials. By limiting the size of the build area, we can accelerate material changeovers, use smaller batches of powder and faster build turn-around times.
Low-Temperature Compact Heat Exchangers

HiETA has developed low-temperature compact heat exchangers, such as charge air coolers, air/oil coolers and water/oil coolers, for demanding applications across a variety of materials.

The freedoms of the process allow our designers to employ novel manifold optimisation techniques to ensure flow distribution to the core is such that performance of the unit is maximised.

The opportunity is enhanced in applications where package space is limited, as the core and manifolds can be formed into novel shapes to fit the design space available. Using our expert knowledge of advanced computational fluid dynamic (CFD) modelling techniques, we optimise the shapes to reduce thermal and pressure losses.

HiETA continues to innovate in the area of low-temperature compact heat exchangers including its development of integrated condensing and separation stages, integrated as part of the compact heat exchangers design. This engineering and additive manufacturing understanding has been applied to various system designs, such as exhaust heat recovery systems, fuel cell cooling, and steam generator systems.

To support these innovations, HIETA has developed material data sets for a portfolio of materials properties, through tensile, fatigue and corrosion testing of representative core geometry. Thermo-mechanical endurance is ensured through extensive experience in finite element analysis of complex heat exchanger models and experimental validation through material testing and transient cycling of scaled and full-size compact heat exchanger articles.

>10,000 cycles on highest life aluminium heat exchangers.

Materials:
+ AlSi10Mg
+ Ti6A14V
+ SS316 L
+ A20X

Markets:
+ Energy
+ Automotive
+ Defence
+ Aerospace
+ Motorsport

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Since HiETA’s beginnings, heat exchangers have been at the centre of our research and development activities. Indeed, the IP on which the company was founded was in the application of metal powder-bed additive manufacturing processes for the manufacture of compact heat exchangers.

This was, and remains, ‘core’ to HiETA’s offering as we believe that producing compact heat exchangers, particularly those made of high-temperature capable materials such as Inconel 625, through additive manufacturing, provides compelling technical and commercial benefits. For example, heat exchangers over 50% smaller than competing technologies.

The design freedom of the process allows us to create highly efficient heat transfer surfaces, which result in highly effective core technologies with minimal pressure drop.

HiETA continues to innovate in the area of high-temperature compact heat exchangers through the integration of these high performing units with other components.

To support these innovations, HiETA has developed material data sets for a portfolio of materials, including nickel superalloys such as Inconel 625, through tensile and fatigue testing of representative core geometry. Through its group of partners, it also has the capability to validate performance at high mass flow rates and temperatures. Historic applications explored by HiETA include a recuperator used to increase efficiency in Brayton cycle MGTs and heat exchangers in exhaust heat recovery such as the inverted Brayton cycle.

Without the need for tooling and with an extensive library of performance and materials data, we can rapidly realise the benefits of HiETA compact heat exchangers and meet your application requirements.
Turbo Machinery

HIETA has developed an in-depth set of high-performance turbomachinery technologies for both stationary and rotating components.

Exploiting the design freedoms of additive manufacturing, large performance gains and mass reductions have been realised.

Applications & Markets:
+ Stationary Power - Micro Gas Turbines
+ Automotive – F1, WRAC

Lightweight and Internally Cooled Radial Turbine Wheel

HIETA Technologies has designed and tested a lightweight and internally cooled radial turbine wheel capable of operating at 1200°C turbine inlet temperature. By increasing the turbine inlet temperatures to 1200°C, the thermal efficiency of the turbine stage is drastically increased and thus the overall efficiency of the engine system can be increased.

Actively cooling the turbine wheel increases the component life and light-weighting the wheel reduces inertia to speed up spool up times while reducing wear on bearings. Mass reductions of 22% have already been realised, with the potential to increase to 40-50% depending on the application. Temperature reductions of 60°C at LE and 100°C at TE have been physically demonstrated vs a solid wheel at turbine inlet temperature of 720°C, with reductions of 200°C at LE, 250°C at TE expected when turbine inlet temperatures are 1200°C.

Materials:
+ CM247 LC
+ Inconel 718/625

Turbine Housings

HIETA has developed proprietary designs for turbine housings as well as manufacturing customer housings using additive manufacturing. Additive manufacturing enables the use of complex wall stiffening features on housing outer skins, replacing the need for heavy, bulky wall thicknesses, whilst retaining required stiffness and impact resistance for blade retention requirements.

The benefits of this approach have been:
+ Reduced weight
+ Reduced lead-time and cost

Nozzle Guide Vanes

Working with the Bowman Power Group, HIETA designs and manufactures nozzle guide vanes (NGV) for Bowman’s Electric Turbo Compounding (ETC) technology. The flexibility of additive manufacturing alongside the expertise of the HIETA design team means tailored NGV’s are made in one piece, with minimal post processing and without specialised tooling.

>19,000 hours hot running of Inconel turbomachinery parts.
>1,000,000kg CO₂ savings against baseline diesel gensets.

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Case Study:

Microturbine Generator

Started in November 2012, the aim of the MiTRE project was to design and build a small, lightweight and, most importantly, low-cost microturbine generator for use as a range extender for electric vehicles. Its addition to an electric vehicle will reduce the vehicle’s cost (by displacing some of the batteries) whilst offering greater availability and range.

The project was worth over £3 million of investment and was a collaborative venture, part funded by the TSB (Technology Strategy Board, now Innovate UK). HiETA Technologies led the development of the microturbine recuperator which was key to achieving the target cost and performance of the range extender. The project was led by UK-based vehicle integrator Delta Motorsports in Silverstone.

Challenge:

Traditionally, heat exchange products are often made from thin sheets of material, joined through processes such as brazing, welding and diffusion bonding. The complexity of the designs makes production both challenging and time-consuming, while the material used for the joining process adds to the overall weight of the part. Prior to the work at HiETA, little research had been undertaken into the use of additive manufacturing for the manufacture of heat exchangers. The initial challenges were, therefore, to confirm that AM could generate sufficiently thin walls of the required quality and then to produce a complete component with the complexity of a typical heat exchanger.

The next challenge was to use that knowledge and experience to move the process from the manufacture of samples and prototypes into low-volume production.

Solution:

HiETA worked closely with Renishaw to develop specific parameter sets for the production of leak-free thin walls in Inconel, down to thickness of 150 microns. Both companies produced samples using a variety of settings on the AM250 at their company’s facilities. The resulting samples were heat treated and then characterised. The test results enabled both companies to confirm the optimum parameters on the machines for thin-walled structures and enabled HiETA to develop a design guidebook with parameters for heat transfer in heat exchangers manufactured using laser powder-bed fusion technology.

Having achieved a leak-free integral wall, the next stage was to move to a complete, full-size unit, which could be completed in a reasonable build time. As well as allowing further optimisation of the Renishaw equipment to handle the larger samples, HiETA used these projects to develop an extraction process to remove excess powder material from the core of heat exchangers.
Results:
The first result of the partnership between HiETA and Renishaw was to produce the basic data needed to set up the additive manufacturing equipment to produce thin-walled structures successfully and to provide the parameters needed to predict the performance of heat exchangers manufactured with the Renishaw equipment.

The resulting thermal transfer and fluid flow data has been incorporated into the CFD and finite element analysis programs used by HIETA. These programs can provide an initial assessment of the likely performance of new component designs, to confirm they have the potential to meet the customer’s requirements.

The first attempt at making a complete product on the AM250 system generated a successful component but needed a build time of seventeen days. This was reduced to eighty hours through improvements to the hardware and software, together with optimisation of the process parameters. Detailed testing showed that the component would meet the requirements in terms of pressure drop and heat transfer.

However, this performance was achieved with a weight and volume of approximately 30% lower than that of an equivalent part made by conventional methods.

Application:
Building on the output of the ‘MiTRE’ project, Delta Motorsport has developed a 35kW version of its range extender to suit the Ariel HiPERCAR.

When it came to developing a 35kW version of the MiTRE system for the HiPERCAR, Delta Motorsport turned to HiETA for a solution. In response, HiETA was able to scale-up the original 17kW design to meet the increased power demands of the HiPERCAR application.
World class thermal engineering inspired by additive manufacturing

Motorsport

Aerospace

Automotive

Energy

Processing

Electronics

Satellites