



# Making EV components with sand casting

How the sand casting process supports electric vehicle (EV) production with MLP, prototyping, bespoke alloy applications and lightweighting.



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# Market-driven innovation

In the long term, and to achieve a carbon neutral future, EV is considered key to achieving carbon-neutral transport globally. The upward trend of the electrification of transport vehicles is undeniable. In 2018, 2.1 million electric vehicles were sold, up 65% from 2017. Sales remained steady in 2019 but saw a 25% reduction in 2020 due to the Coronavirus pandemic.

However, according to Bloomberg New Energy Finance report, EVs will come to dominate passenger vehicle sales over the next 20 years. The study predicts that EV will make up 10% of all passenger vehicle sales in 2025, growing to 28% in 2030 and 58% in 2040.

Given this growing demand for electric vehicles, existing automotive manufacturers and new entrants are looking to innovate and adapt existing technologies. Innovations such as IDRA's Giga Casting machine are driving a paradigm shift in automotive manufacturing.

Given the high levels of investment in high-volume automotive manufacturing, the ability to innovate and produce rapid prototypes provides manufactures with a discrete competitive advantage. This ebook seeks to give an overview of how sand casting can assist in the rapid prototyping of innovative EV components.

Part 1

# What is sand casting?



# Overview of sand casting



Want to know more about sand casting? Download our ebook **The Basics of the Sand Casting Process**

Sand casting is a **flexible, relatively low cost, precision and data-driven manufacturing** process capable of meeting the highly technical demands required by EV.

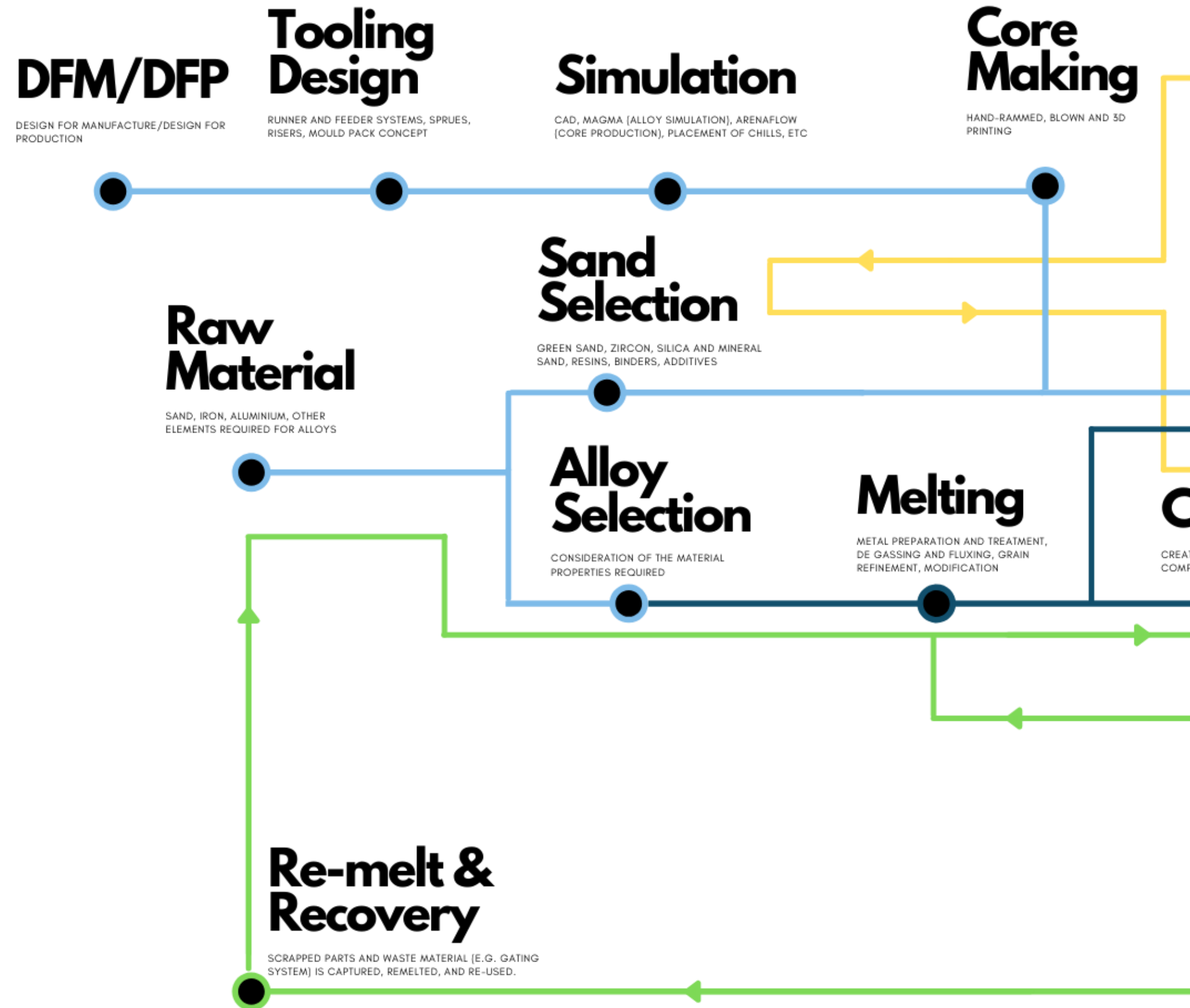
The **versatility of sand casting** allows large, lightweight structural castings to be created, in almost **any alloy**, at **any size** and with **complex geometries** in a single part. This flexibility makes sand casting suitable for prototyping, as well as enhancing the specific material properties required in electric vehicle (EV) components for lightweighting and strength.

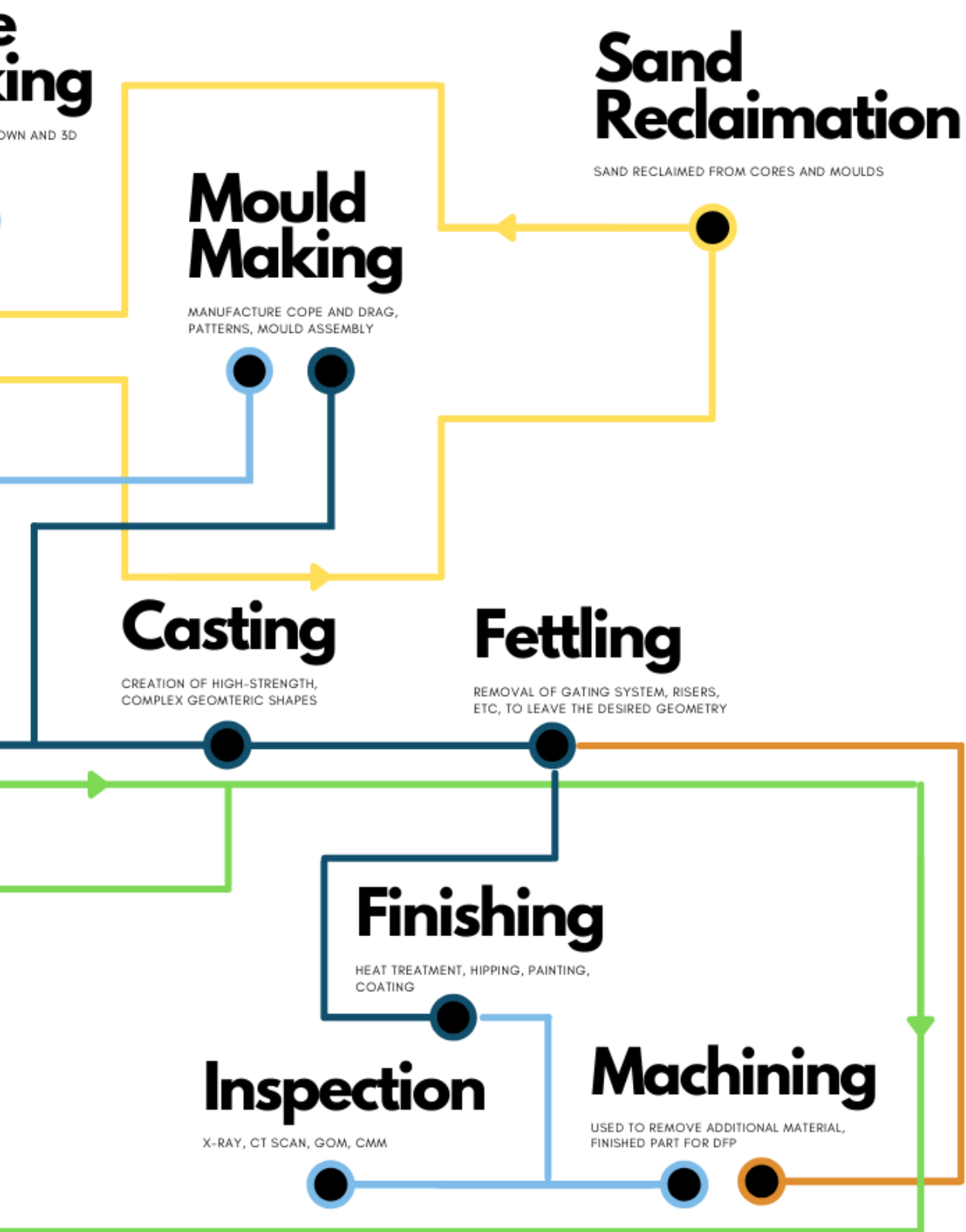
# The Sand Casting Process

**High-integrity, reliable EV sand castings. Fast.** Design for Manufacture optimises part and process design to achieve innovative, complex castings with the Make Like Production (MLP) characteristics needed in large, lightweight parts for electric vehicles. Rapid prototyping means these can be produced quickly.

## Developing bespoke alloys

One of the greatest advantages of sand casting is the ability to cast with a range of aluminium alloys. We have access to a huge range of compositions which we tailor to achieve customer attributes of strength, durability and ductility.





## Sand Casting for Electric Vehicles

"Pouring a casting is like pouring a Guinness - it's all about controlling the flow."

### A sustainable production process

Sand casting is a sustainable method of manufacturing and almost 100% circular. The sand and metal used can be recycled and reused across the process.

### Precision EV sand castings

Finishing, machining and inspection capabilities ensure component parts meet the high tolerances specified in EV automotive applications.

Part 2

# The benefits of sand casting for electric vehicles



Create Large,  
Lightweight,  
Structural Parts

## Rapid Prototyping for EV

# Innovative rapid prototyping with sand casting.

**3D additive sand printing** of cores and moulds enables rapid prototyping of components for electric vehicles. We're a leader in this technology and have a large 3D additive sand printing facility in-house at G&W.

Rapid prototyping delivers **proof of concept**, **design validation** and **safety testing** quickly, as well as the ability to alter or optimise structural part designs. This allows us to replicate fully the production intent ahead of mass production, getting production started very quickly.

For fast moving EV automotive projects, this versatility and speed is extremely valuable.



## Large, flexible sand castings

Producing complex, large, lightweight castings for EV in any alloy, at any size.

Sand casting is limited only by the size of mould produced. This means that **large, lightweight structural parts** can be produced in any alloy and at any complexity. While upscaled production is unlikely to be a sand casting, fully replicating function, shape and performance relevance with a high-precision sand casting will save your project time and cost in the long run.

The flexibility of sand casting has huge benefits for electric vehicle components, allowing large structures such as EDU housings and battery trays to be cast in a single net part. This reduces the need for extra joining, reducing weight.

## Alloy choice and optimisation

# Maximising material properties of EV components with bespoke aluminium alloys.

Sand casting offers huge versatility in achieving the **mechanical and material properties required in each EV component**. The ability to create bespoke aluminium alloys means properties such as strength, ductility and elongation can be maximised by controlling the solidification rates - often without requiring additional heat treatment.

High-tech simulation with process modelling can also model alloy behaviour.

To find out more, read our [case study on the role of alloys in an EV battery tray component](#).

## Make Like Production (MLP)

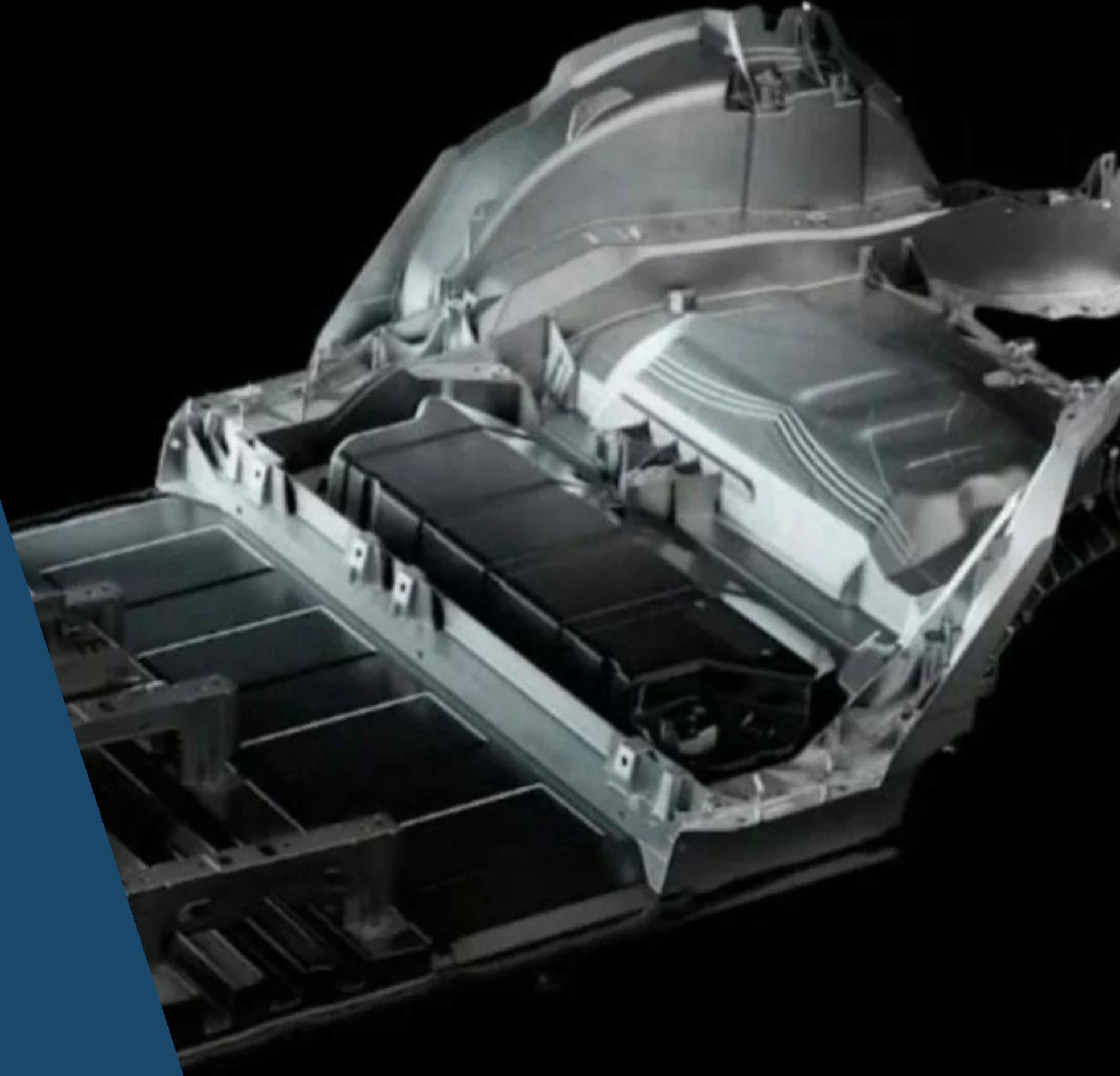
# Proving concept with high-integrity Make Like Production prototyping capability.

Prototyping with sand casting delivers **Make Like Production (MLP)** parts quickly, accurately and at a relatively low cost compared to other manufacturing methods.

For EV automotive, this delivers proof of concept at an MLP integrity level. This is true for product and concept, but it also fast tracks proof of manufacturing concept. Ultimately, this will speed up manufacturing and reduce programme risk, while also supporting the move into low volume and potential mass production; testing for safety, tolerance and specification.

Part 3

# Benefits of using sand casting for MLP prototyping



# Driving casting innovation with make like production

IDRA's giga press casting has been used by Tesla to massively drive casting innovation, effectively casting half a car. The benefits for electric vehicles are huge- including 370 fewer parts, 10% mass reduction, 14% range increase.

With the right type of innovation, sand casting can be used to prototype large structural parts that exhibit production properties (i.e. similar characteristics to parts produced using high-pressure die casting). The prototype development time can be measured in weeks. It helps provide proof of concept, validates performance, design, safety and material properties, before moving into mass EV component production.

This advance in casting technology presents exciting opportunities for the EV automotive industry, driving technical innovation and potential to hit the price points required for mass adoption.

Adopting a "Make Like Production" approach to prototyping can help shorten product development cycles significantly. Ensuring that your foundry has access to the relevant skills in casting simulation, rapid core printing, alloy/material selection, and casting validation techniques (e.g. CT Scanning, GOM, etc.) is critical to capturing the benefits of rapid prototyping and MLP.

# How can sand casting help you over the valley of innovation



The journey from the 'art of the possible' to reliable production of a complex metal part can be a difficult (and expensive) path for engineers to navigate, particularly in producing EV components. Many projects do not survive the **Valley of Death**.

But sand casting can provide the solution. Its ability to manipulate material composition and properties, part structure and process design enables moving from design theory to '**lighter, faster and cleaner**' production much more likely.

Prototyping with the sand casting process, including with 3D sand printing is fast, allowing for various iterations and innovations in design and production to be made quickly, and at a relatively low cost. This allows the necessary versatility and high tech capability required in **EV automotive engineering** projects.

Part 4

# The application of future shape technology to EV components



# Innovative sand casting technology

Much of the work that we do is confidential as we are working with market leaders at the cutting-edge of innovation.

However, sometimes we take on projects or research that we can share. The next few pages outline the research G&W have performed with specific application to EV casting technology.

We have developed insight and experience of casting battery trays, EDU housing, Front/Rear under body components, and other EV structural parts.



# Large battery enclosure: Alloy Specification

## What we did

- Created a large casting of a battery enclosure, intended to be HPDC. We achieved mechanical properties not normally achieved with sand casting, as well as a dimensionally large scale casting that met the specification.
- Customer requested high level of elongation for battery tray specification, ensuring good ductility across the entire part.
- Customer requested alloy A356 to be used, to ensure castability, integrity and machinability post-casting.
- Through significant heat treatment development, we developed an alloy specification and heat treatment process to meet EI% target for crash structure performance.

## Key points

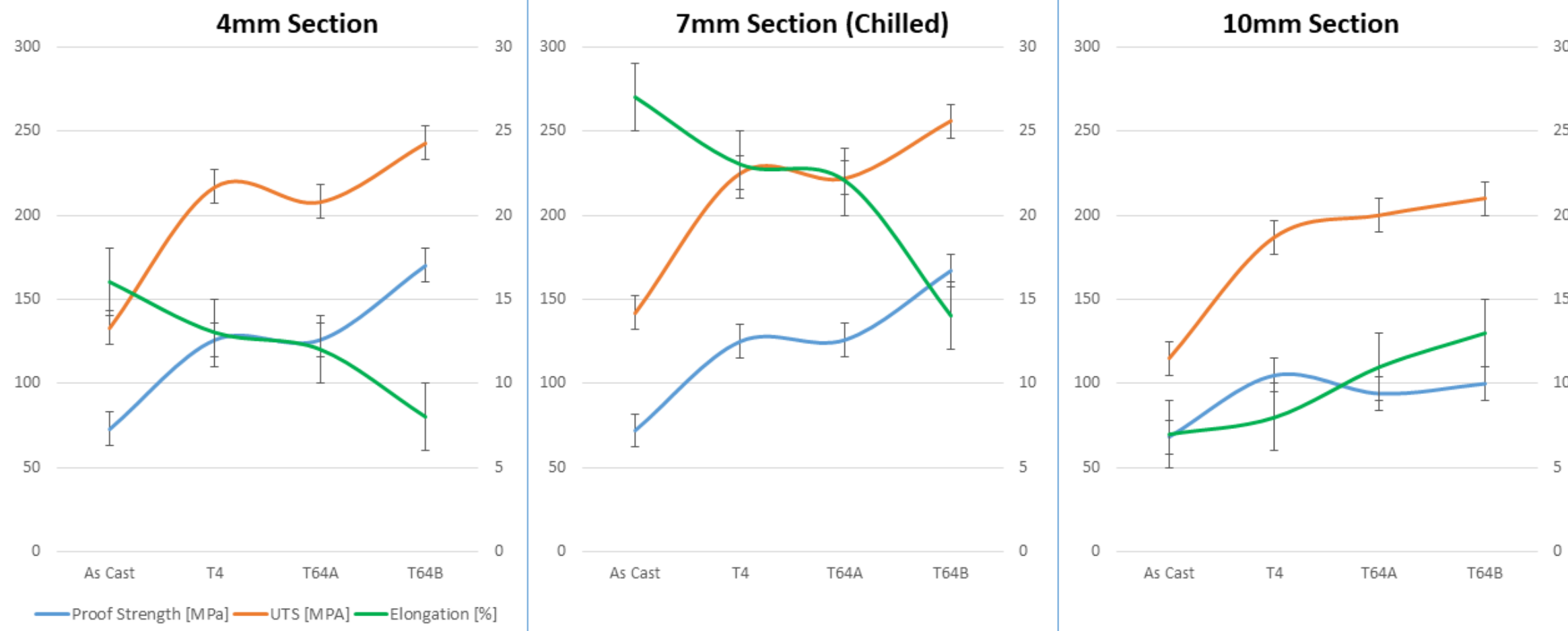
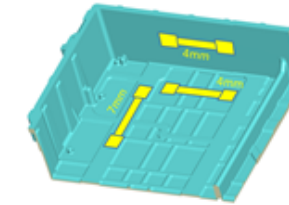
- A356 was optimised to maximise performance attributes while maintaining required levels of ductility.
- Elongation material properties achieved by thin walls, alloy development, enhanced solidification rates in specific parts of the casting and well maintained runner systems.
- We carried out extensive use of optical scanning to develop countermeasures for inherent distortions and non-conformities in castings.
- Supported multiple development phases - 500 pcs total.

# Battery enclosure: Alloy Specification

## BODY STRUCTURE CASTINGS – ALLOY DEVELOPMENT

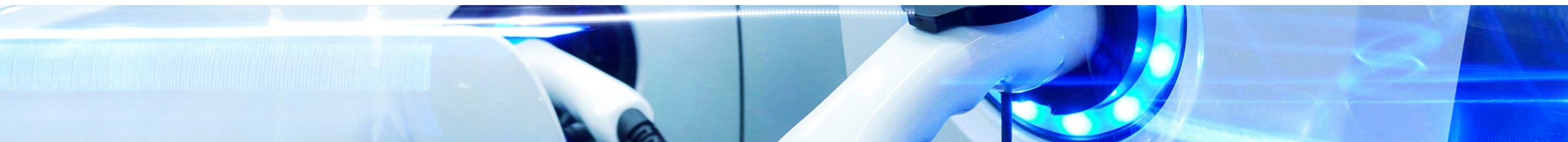
### Case Study 1: GW44219 HT Response Review

#### Mechanical Properties vs Wall Thickness



**Alloy development**

These graphs highlight the elongation values that were achieved. These would not typically be seen from a sand casting process.



# MLP Vehicle Structure: Large, structural BIW castings

## What we did

Grainger & Worrall developed a specific alloy chemistry and heat-treatment process to achieve Make Like Production (MLP) materials performance for large, body structure castings- particularly longitudinal BIW castings.

This highlights the benefits of sand casting as a prototyping method - enabling G&W to offer HPDC representative BIW prototype castings to market.

Alloy development allows prototype sand castings to be produced for BIW that optimise material properties, casting form and casting performance.

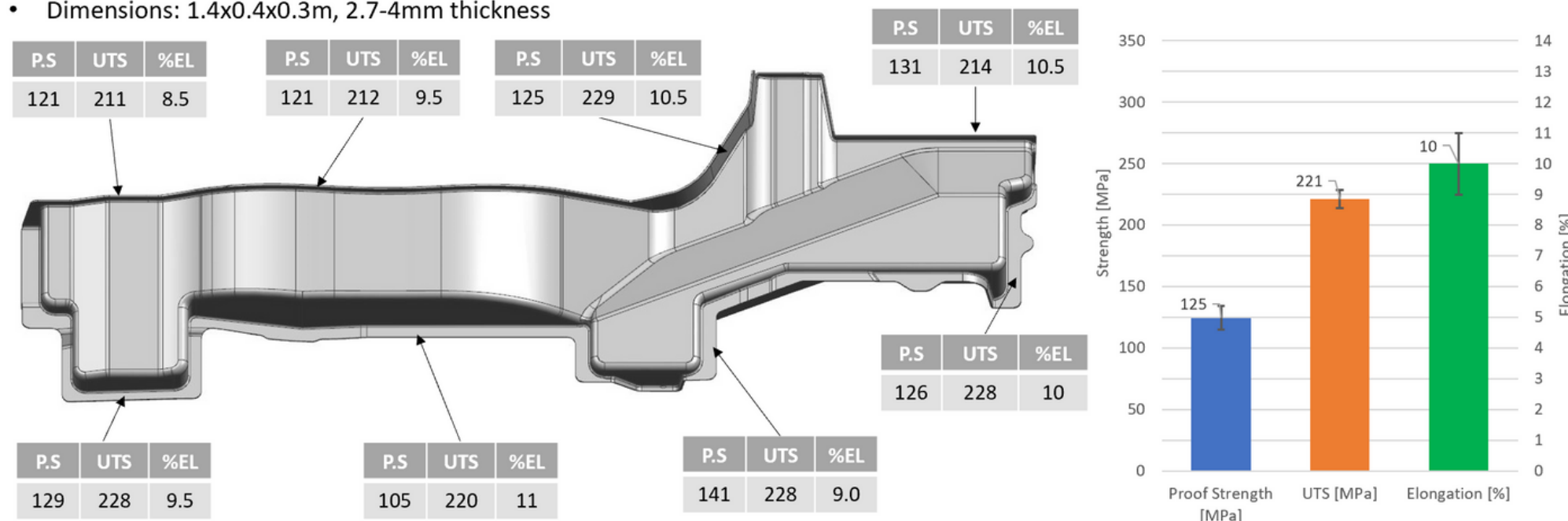
## Key points

- G&W, in association with Brunel University, developed high potency grain refinement which was compositionally similar to HPDC in material properties such as corrosion, processability and solidification rates.
- This alloy conformed to mass production methods such as HPDC, moving to 'proven concept'.
- This allowed wall thickness of around 2.5mm to be cast over a large distance, up to 1.5m.
- Very little post processing required, mitigating the influence of heat treatment distortions.

# MLP Vehicle Structure

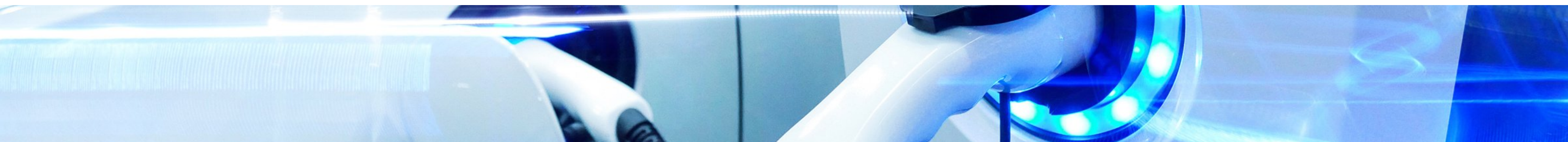
Developments in this area towards manufacturing gravity sand castings with similar properties to HPDC - EN AC-43500:

- Net Weight: 10.5kg
- Dimensions: 1.4x0.4x0.3m, 2.7-4mm thickness



## Bespoke alloy for BIW

- Alloy development allowed brittleness of sand castings to be mitigated, without need for additional heat treatment.
- The specific objective was to achieve a threshold ductility to allow machining of self piercing technology used to join to the vehicle. This threshold was exceeded.
- Alloy conformed to strength specification required for machining without heat treatment by controlling solidification and cooling rates, achieving similar composition with sand casting as with HPDC.





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If you have an EV structural part that you'd like to cast, get in touch with us to discuss next steps.

# Future Shape Technology Experts