intellegens

DATA - DRIVEN DISCOVERY

Deep learning for materials and additive manufacturing

Webinar - 23 February 2021

Today’s speakers

Dr Gareth Conduit
Chief Technical Officer
Intellegens

Ian Brooks
Technical Fellow
AMRC North West

Today’s agenda

Host	Stephen Warde
Introduction	Dr Gareth Conduit
Case study	Ian Brooks
Alchemite™ demo	Dr Gareth Conduit
Q&A	Please use the “Questions” box on the control panel

A recording will be available soon at intellegens.ai/webinars

Introducing Intellegens

Unique **deep learning** software and expertise

- Proven to generate value from ‘real world’ sparse and noisy data

Key focus: **data-driven discovery and development**

- Materials and chemicals, life sciences, manufacturing
- Technology works for any numerical dataset

Technology originated in the Cavendish Laboratory, **University of Cambridge**

- Further development and innovation by the Intellegens team

Alchemite™

Machine learning for
sparse and noisy data

intellegens

UNIVERSITY OF CAMBRIDGE

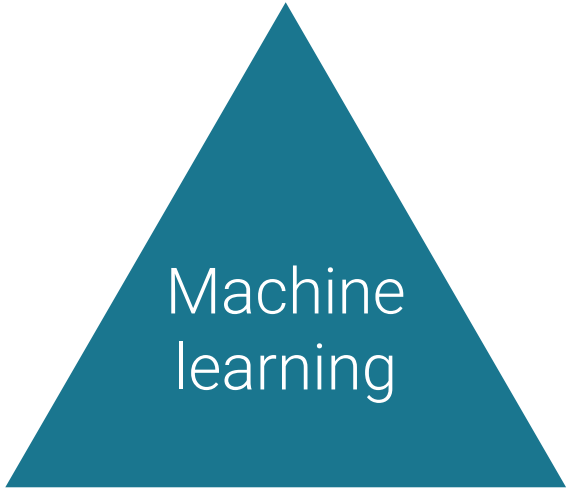
Gareth Conduit
Chief Technical Officer
Intellegens

Alchemite™ solves three challenges on real-world data

Computation

Complex multi-parameter

Setup requires knowledge



Experiment

Typical program costs $millions and takes years

Focus on the routes most likely to succeed?

Data analysis

Training data is sparse & noisy, so conventional methods fail

Hard to combine disparate data sets

Materials, process, and product landscape

Materials, process, and product landscape

Experiment	Characterise, experimental design, qualify, and certify
Computation	Materials modeling and process simulation
Data analysis	Statistical analysis, quality assurance, process control

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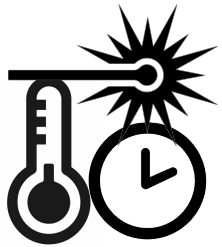
Machine learning maximizes return from valuable data and simulations, getting the material to market quicker and cheaper, and enables concurrent materials design

Many problems approached with a black box

Formulation

Processing



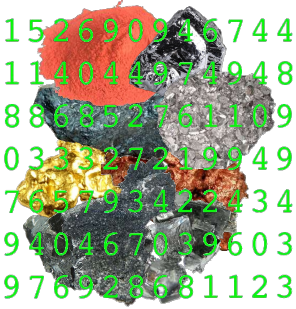
Black box

Properties

Strength
Defects
Cost
Weight
Fatigue
Environmental

Training the machine learning

Formulation



Processing

Black box

Properties

Strength
Defects
Cost
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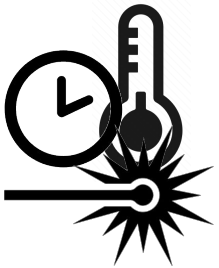
Fatigue
Environmental

Using the machine learning

Formulation

Processing



Black box

Properties

Strength
Defects
Cost
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Fatigue
Environmental

Applied to alloys, composites, plastics, chemicals, batteries, drugs, and ceramics

Project MEDAL

Machine Learning for Additive Manufacturing Experimental Design

NATEP award

intellegens

The University Of Sheffield. AMRC Advanced Manufacturing Research Centre

BOEING

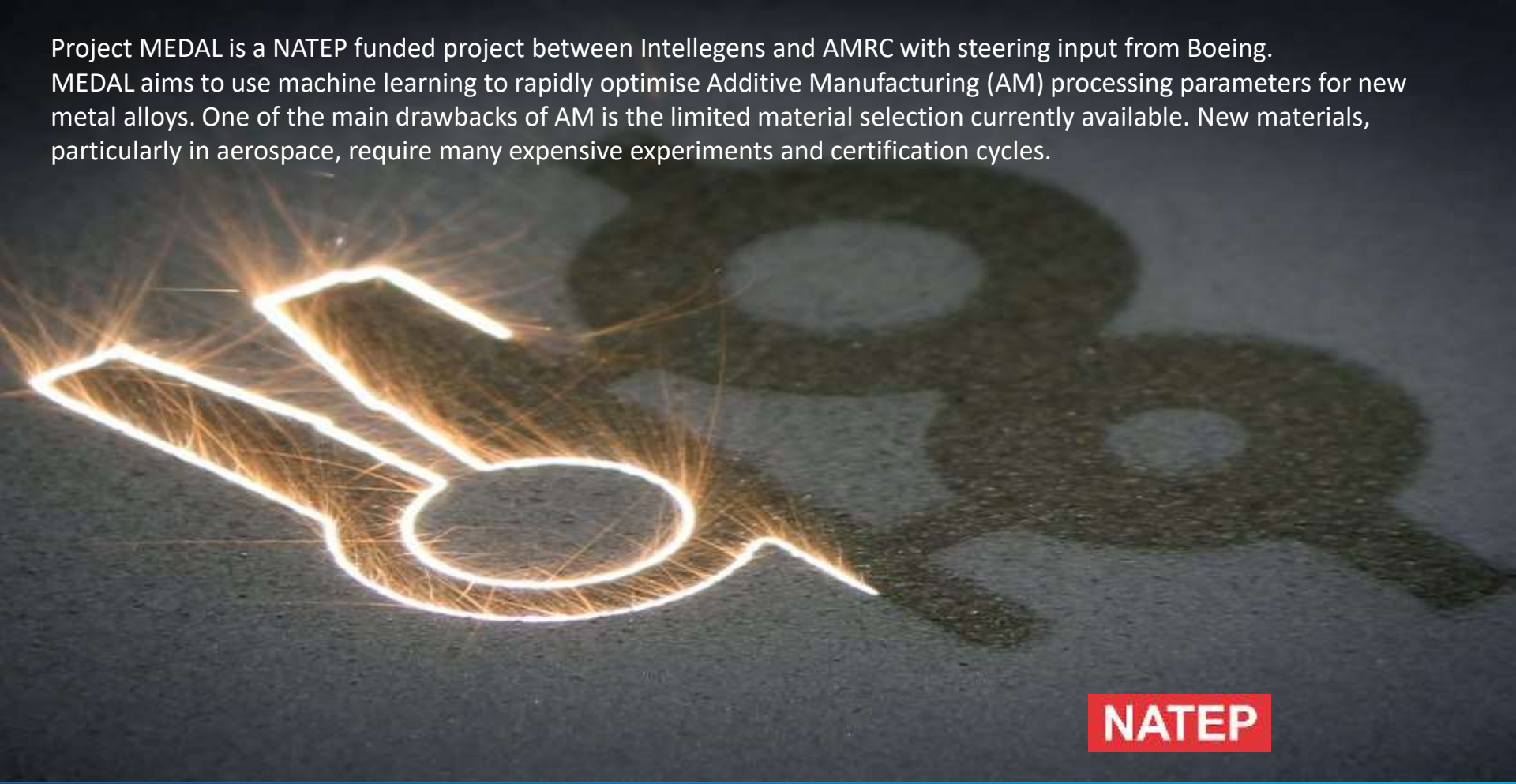
Ian Brooks
Technical Fellow
AMRC North West

Machine Learning for AM Process Development

Ian Brooks

23.02.2022

Project MEDAL is a NATEP funded project between Intellegens and AMRC with steering input from Boeing.
MEDAL aims to use machine learning to rapidly optimise Additive Manufacturing (AM) processing parameters for new metal alloys. One of the main drawbacks of AM is the limited material selection currently available. New materials, particularly in aerospace, require many expensive experiments and certification cycles.



Introduction

Problem Statement

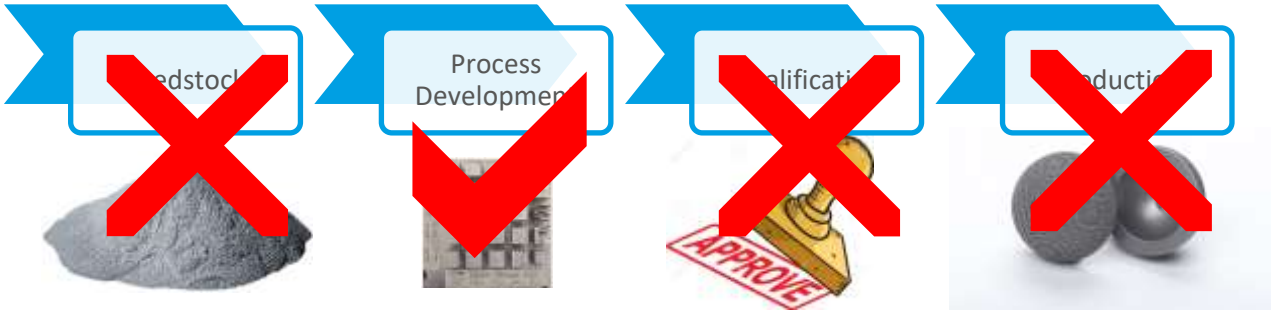
Additive Manufacturing (AM) is a broad term for many different technologies. Specific differences centre around the type of feedstock and the heat source.

There is one characteristic of all AM processes that differ from that of conventional manufacturing techniques. They all manufacture the material concurrently with the geometry as opposed conventional whereby the geometry is created from a known material. This brings about a number of problems:

- AM material is ‘different’
- It requires a unique set of process parameters for each feedstock
- Qualification, particularly for metal AM target applications, has to consider new materials and processes
- Feedstock in its raw form must be qualified
- There are interdependent relationships between the geometry and the process parameters

Problem Statement

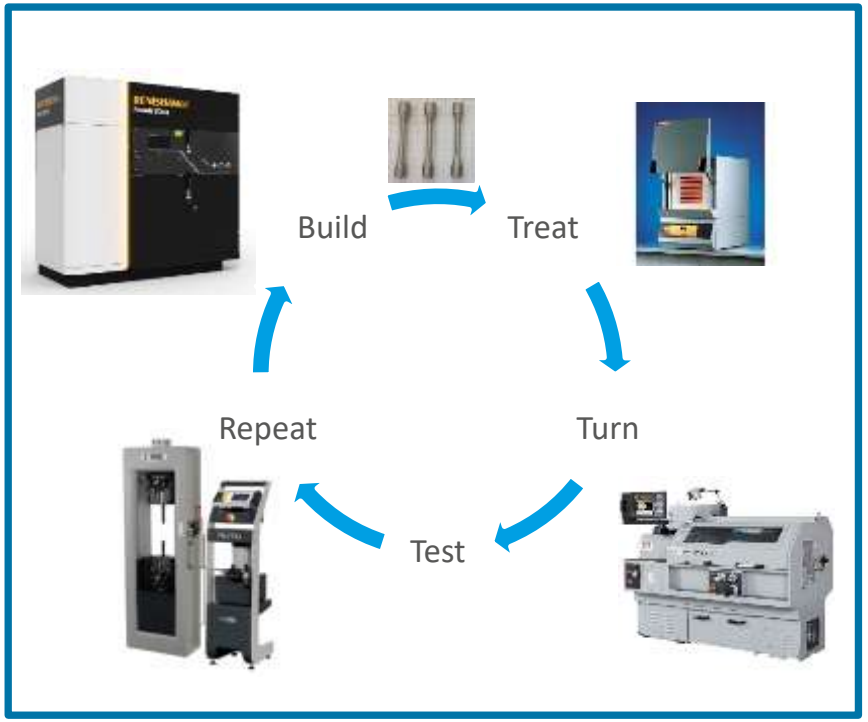
- It requires a unique set of process parameters for each feedstock
- There are interdependent relationships between the geometry and the process parameters



What is Process Development….and what are the problems?

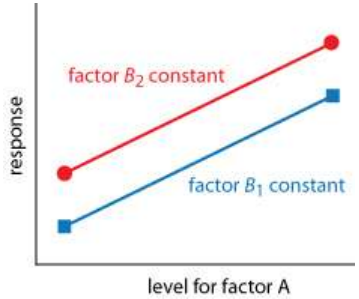
- Optimising the process variables to satisfy end use requirements

- Noise variables
- Many variables / dimensionality
- Interacting variables
- Process is ‘complex’
- Response variables are varied and onerous to establish
- Machine/s ‘idiosyncrasies’
- Knowledge resides in a close circle
- Varied experimental methodology



LPBF Process Development - Experimentation

- OFAT



- DoE

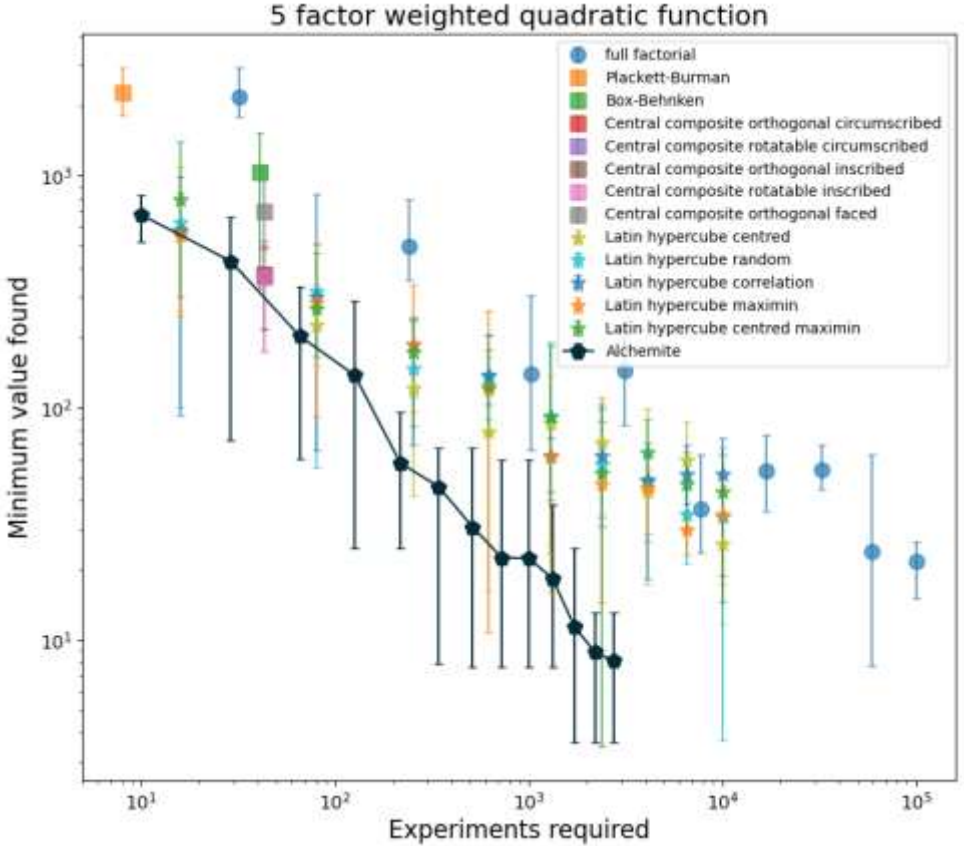
Study	DOE Design	No. Factors	No. Levels	No. Runs
[29]	Full Factorial	2	4/12	48
[31]	Full Factorial	3	3	48
[32]	Full Factorial	3	5/4/2	40
[36]	Taguchi Orthogonal Array	5	5	25
[37]	Plackett-Burnam	23	3	36
[41]	Full Factorial	5	Unclear	Unclear
[42]	Taguchi Orthogonal Array	5	5	25
[43]	Full Factorial	3	3	27
[44]	RSM Central Composite	3	5	17

Alchemite Vs DoE for LPBF Process Development

LPBF Process Development – ML Vs DoE

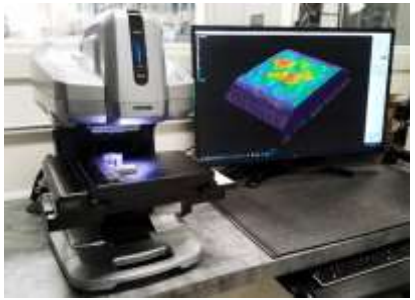
DoE Limitations	Potential Alchemite Solutions
Dimensionality	ML can seamlessly build high quality, accurate models for high dimensional systems
Sample ‘failures’ either in build or measurement stages	Identify erroneous data and impute missing data
Measurement system capability	Merges and aggregates sparse and noisy data
Knowledge	Standardised workflow / process, insights into underlying science
Expensive experimentation	Reduce no. of experiments
Experimentation ‘Time’	Select between low n + high resolution and high n + low resolution

Project MEDAL – Progress so far



Project MEDAL – Next Steps

- Generate AM specific data



- Create AM centric s/w work flow

The University Of Sheffield. AMRC Advanced Manufacturing Research Centre

Thank you. For further information please contact or visit:

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Web: amrc.co.uk

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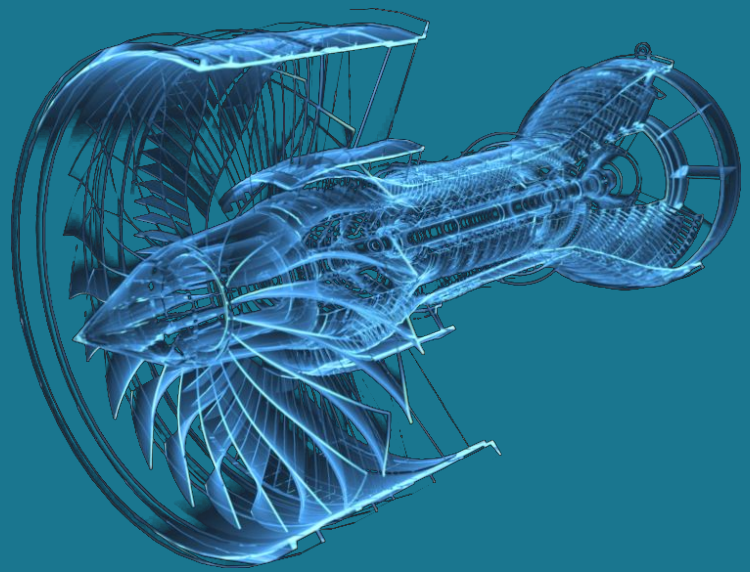
CATAPULT High Value Manufacturing | UKRI Innovate UK



High temperature alloy

90% reduction in expensive experiments

Reduced costs by $10 million

Accelerated discovery and validation from 20 to 2 years

intellegens.ai/applications/materials/

Materials & Design 168, 107644 (2019)

Hardfacing consumables

Fulfilled environmental
target to remove Cr

Cut alloying elements by 50%

intellegens.ai/applications/materials/

Welding Alloys Group

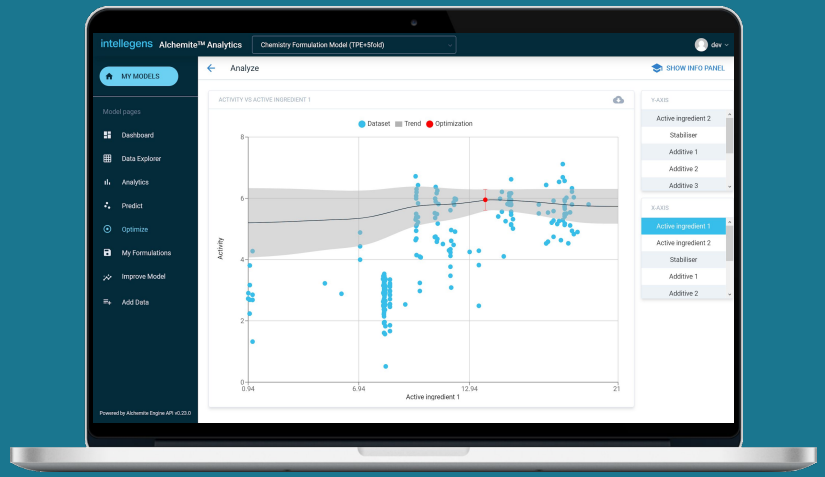
Software demonstration

Alchemite™ Analytics **intuitive** user interface

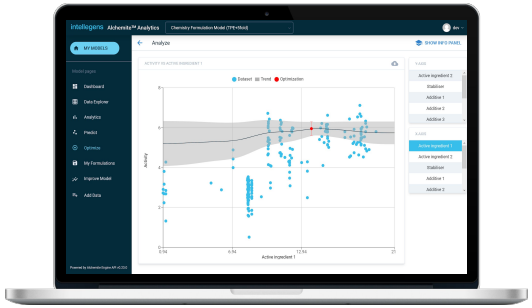
Perform **virtual** experiments

Design your **next** experiment

Optimise a new alloy and processes to achieve multiple target properties



Intellegens products



Alchemite™ Analytics

Deep learning insights on the desktop

For engineers and scientists

Alchemite™ Engine

Integrate into your workflow (API, Python)

For data scientists

Alchemite™ Success

Apply Intellegens deep learning expertise to meet your objectives

Advice to your data science team or full project management

Summary

Characterise and design alloys and additive manufacturing

Accelerate development to reduce **time to market**

Focus experiment and testing to **make best use of resources**

Project MEDAL with **AMRC** and **Boeing**

Recent news

Ansys / GRANTA

intellegens

Intellegens and Ansys to empower Additive Manufacturing with material intelligence through machine learning

The agreement will embed Intellegens' machine learning technology, Alchemite™, within the Ansys materials data management platform, Granta MI™.

More at *intellegens.ai*

Question & answer session and contact details

Please use the “Questions” box on the control panel

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