MTC - Private - Commercial in Confidence

AILEEN

Applying Problem-Based Learning in Aerospace & Defence Training

Hannah Jones

MTC

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them. PROJECT REFERENCE NO. 101103507

Co-funded by the European Union

Contents

- Traditional Training vs Problem Based Learning
- General Benefits for Students and Employers
- Specific Benefits for PBL for Aerospace and Defence
- MTC PBL Use Examples
- MTC Training PBL Examples
- Challenges and Lessons Learnt
- Opportunities for AILEEN
- Future Vision and Key Takeaways



This Photo by Unknown Author is licensed under CC BY-SA-NC

This presentation includes content generated with the assistance of Microsoft Copilot (AI). The author is responsible for the final content, interpretation, and accuracy of all information presented.

Traditional Training vs Problem Based Learning

Comparing Traditional and PBL Approaches for Students

Traditional Training Approach

- Simple **information transfer.**
- Resources include **lecture notes.**
- Assessments are **recall focused** not on knowledge application.
- **Passive student role.**
- Limited industry readiness
- **"Tell, Show, Practice, Test"**

Problem Based Learning Approach

- **Real-world** problems.
- **Learner focused teaching.**
- **Encourages collaboration** between students for idea creation.
- Contains **open-ended challenges** and multiple solutions.
- **Applying knowledge** from lectures.
- Students required to **engage in discussions.**
- **"Challenge, Investigate, Learn, Apply, Reflect."**

General Benefits for Students and Employers

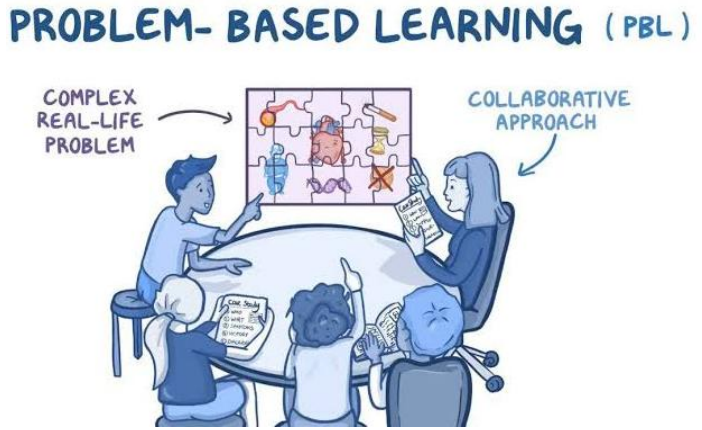
The Key Benefits for Students and Employers for Using PBL.

For Learners:

- Higher engagement
- Better knowledge retention
- Increased confidence
- Improved teamwork
- Application of knowledge

For Employers:

- Job-ready skills
- Faster workplace integration
- Better decision making
- More innovative thinking



Thearath Lim (2023) 'Problem-Based Learning: Benefits, Challenges, and the Way Forward'. In: K. Heng, K. Sol, S. Kaing and S. Em (eds.) Innovations and Challenges in Cambodian Education: Youth's Perspectives. Phnom Penh: Cambodian Education Forum. Available at: https://www.researchgate.net/publication/375671323_Problem-Based_Learning_Benefits_Challenges_and_the_Way_Forward (Accessed: 15 September 2026).
Teacher Pedia (n.d.) Benefits of Problem-Based Learning to Students and Teachers. Available at: https://teacherpedia.net/benefits-of-problem-based-learning-to-students-and-teachers/ (Accessed: 16 September 2026).

Specific Benefits for PBL for Aerospace and Defence

Highlighting the key benefits of PBL for Aerospace and Defence Applications.

AILEEN

- Aligns students to **real-world problems for industry.**
- Reflects **real engineering approach** – e.g. customers do not have all the information, clear instructions and a known solution. As engineers we must gather data, conduct RCA and create solutions.
- Encourages **innovation** required in A&D challenges.
- Develop **systems thinking -** crucial for the aerospace and defence industry (high risk).
- Highlights the **safety implications** within A&D in all problems.
- Encourages **innovation and trade-off analysis.**
- Develops **teamwork** and cross-functional collaboration.
- Strengthens **communication** and **technical** justification skills.

MTC PBL Use Examples

Main Examples where MTC Uses PBL

- **Apprentice Automation Challenge from IMechE**.
- MTC Training follow PBL principles. During student's apprenticeships, their modules have incorporated PBL tasks.
- **WorldSkills UK Competition** – competition-based training.
  - Exposing the students to problem solving in a competitive environment.
  - Focused on AM techniques.
- **Work Experience** Students
- **Industrial Placements**
- **PhD** Students





Three laser technology PhD op
MTC & UK universities

Three laser technology-based PhD opportunities
MTC – 2 with the University of Birmingham and 1 with the University of
Nottingham.

1. **Joint MTC – University of Birmingham PhD Scholarship** on Laser Enabled Hybrid-Manufacturing Technologies for Surface Functionalisation

   Supervisors: Professor Stefan Dimov (Mechanical Engineering, UoB) and Dr Reza Nekouie Esfahani & Dr. Tian Long See (MTC)

   Eligibility: Funding requirements dictate only UK nationals can apply

   Start Date: ASAP but not later than Oct 2023

MTC Training PBL Material

Case Studies/PBL used within AM CUs for AILEEN

- Used during the competency unit piloting for delegates.
- Marotta Controls AM-Optimised Manifold (Lightweighting, part consolidation)
- Lightweight, high-performance cold plate development using additive manufacturing and generative design
- Structure of the case study is:
  - The Challenge
  - The Solution
  - The Outcomes
  - The Benefits

Marotta Controls AM-Optimised Manifold (Lightweig consolidation)

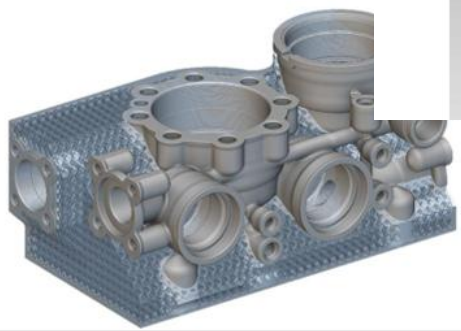
The Challenge

Marotta Controls' naval manifolds were traditionally manufactu solid billet, resulting in significant material waste, under-utilise high production costs.

The Solution

The naval manifold was redesigned specifically for Laser Powder new part becomes cost effective if Manifold is optimised for the of the solution included:

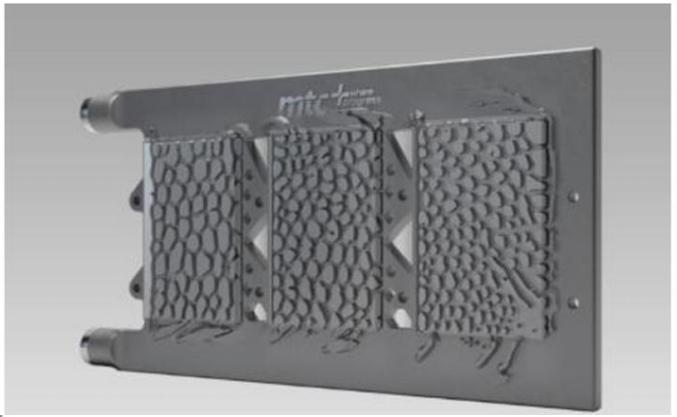
- PBF-LB fabrication using Inconel 625.
- Modified internal flow paths, transitioning from round cha teardrop profiles to eliminate the need for internal suppor
- Lattice geometry used as internal infill, reducing mass an



Lightweight, High-Performance Cold Plate Development Using Additive Manufacturing and Generative Design (Topology Optimization + Lightweighting)

The Challenge

Rising power densities in aerospace and automotive electronics continue to push the boundaries of thermal management. As devices become smaller yet more powerful, heat generation increases within tightly constrained spaces. Without effective heat dissipation, components face temperature spikes, reduced performance, and shorter operational life. MTC collaborated with ToffeeX to explore advanced digital engineering and metal additive manufacturing methods to develop an optimised cold plate that delivers improved thermal performance while significantly reducing weight.



America Makes. (2025). 5557 AM Phase 4, Application Development (Rev. 1). America Makes. https://www.americamakes.us/wp-content/uploads/2025/09/SS-5557-rev-1-2025.pdf, Manufacturing Technology Centre (MTC) (2026) Lightweight, high-performance cold plate development using additive manufacturing and generative design. Available at: https://www.the-mtc.org/insights/lightweight-high-performance-cold-plate-development-using-additive-manufacturing-and (Accessed: 15 September 2026)

MTC Training PBL Material

Case Studies/PBL used within AM CUs for AILEEN

Lightweight, High-Performance Cold Plate Development Using Additive Manufacturing and Generative Design (Topology Optimization + Lightweighting)

- **The Challenge:** Dissipating heat effectively in high-power, space-constrained applications.
- **The Solution:** using generative design (ToffeeX's cloud-based physics software) and PBF-LB.
- **The Outcomes:** Reduction in weight, reduced pressure drop and higher efficiency and increased maximum junction temperature.
- **The Benefits:** reduced production costs, minimised environmental impact by maximising energy efficiency.

Marotta Controls AM-Optimised Manifold (Lightweighting, part Consolidation)

- **The Challenge:** Minimising material waste and production costs in naval manifolds.
- **The Solution:** Redesigned manifold for additive manufacturing, reducing waste, improving material efficiency, and enabling qualification.
- **The Outcomes:** AM-optimised manifold passed testing, reduced waste, and improved manufacturability.
- **The Benefits:** Reduced material waste, lower costs, improved performance, and qualification readiness.

America Makes. (2025). 5557 AM Phase 4, Application Development (Rev. 1). America Makes. https://www.americamakes.us/wp-content/uploads/2025/09/SS-5557-rev-1-2025.pdf, Manufacturing Technology Centre (MTC) (2026) Lightweight, high-performance cold plate development using additive manufacturing and generative design. Available at: https://www.the-mtc.org/insights/lightweight-high-performance-cold-plate-development-using-additive-manufacturing-and (Accessed: 15 September 2026)

Challenges and Lessons Learnt

The key Challenges and Lessons Learnt for Implementing PBL into Training Material.

Key Challenges

- Additional preparation time and cost required.
- Trainer requires **additional training** (coach students rather than lecturing.)
- **Assessing PBL assignments** can be more challenging than traditional worksheets etc.
- Some learners **prefer traditional** learning tools.

Lessons Learnt

- Use **industrial data** – integrate our industrial partners within each CoVE to directly link for learners.
- Trainers need **specific guidance/training** for PBL.
- **Keep scenarios and solutions authentic** and include all problems faced – e.g. if the solution provided to the customer was unsuccessful mention and explain why.

Opportunities for AILEEN

AILEEN Opportunities for Implementing PBL Learning Further

- Utilising knowledge within the CoVES.
- List of MTC Case Studies for potential PBL use cases:
  - Project Convergence with Moog Aircraft Segment.
  - Water Jet Guided Laser Machining of Ceramic Matrix Composites (CMC).
  - DRAMA: accelerating additive adoption in aerospace.
  - Demonstration of selective electroless plating for telecommunication components.







Example 1 of MTC Case Study to PBL

How to take an MTC Case Study into a PBL Brief for a Student.



PBL Fictional Brief -

‘An aerospace customer requires a lightweight engine component made from advanced composites. Existing machining methods are causing excessive defects. Recommend and justify a manufacturing process.’

Skills targeted:

- Materials engineering
- Manufacturing process selection
- Quality engineering
- Root cause analysis

The Manufacturing Technology Centre (MTC) (2024) Water Jet Guided Laser Machining | Ceramic Matrix Composites. Available at: https://www.the-mtc.org/insights/water-jet-guided-laser-machining-ceramic-matrix-composites-cmc (Accessed: 15 September 2026).

Example 2 of MTC Case Study to PBL

How to take an MTC Case Study into a PBL Brief for a Student.



PBL Fictional Brief -

‘A military communications system requires smaller, lighter, more integrated antennas for deployment on autonomous vehicles. Develop a concept using additive manufactured electronics.’

Skills targeted:

- Materials engineering
- Manufacturing process selection
- Quality engineering
- Root cause analysis

The Manufacturing Technology Centre (MTC) (2025) Demonstration of selective electroless plating for telecommunication components. Available at: https://www.the-mtc.org/insights/demonstration-selective-electroless-plating-telecommunication-components (Accessed: 15 September 2026).

Future Vision and Key Takeaways

The Main Conclusions and Takeaways from Presentation

- PBL can provide learners with a skillset which **prepares them for integration into industry** and directly applies taught knowledge.
- AILEEN will benefit from the **integration of PBL examples within their Competency Units** to help students gain a deeper understanding e.g. for safety standards, compliance and regulatory complexities.
- Opportunities for AILEEN **include leveraging consortium member knowledge and using industrial examples.**
- To facilitate the integration of PBL examples into the training material, **trainers need additional development opportunities** for coaching students, additional resources for students and trainers.

The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Hannah Jones

Manufacturing Technology Centre

Hannah.Jones@the-mtc.org



AILEEN