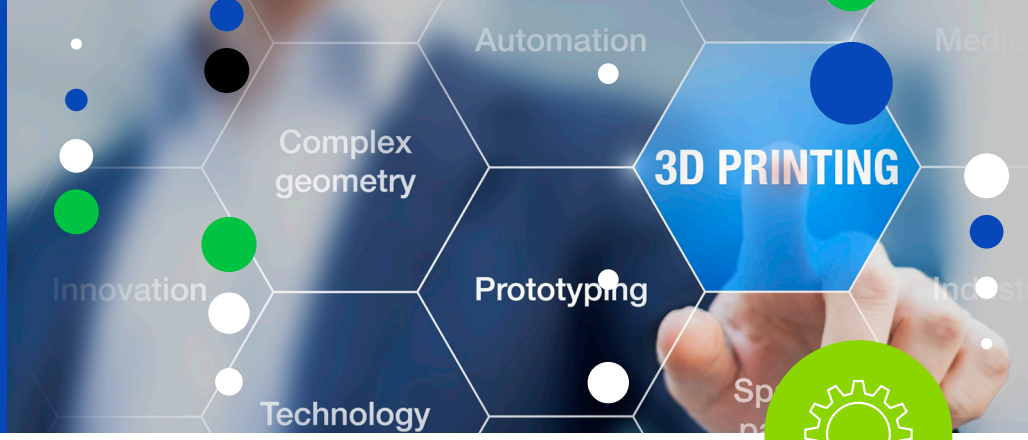


Project Results

SAMUEL

An intelligent platform for additive manufacturing

The ITEA project SAMUEL (Smart Additive Manufacturing – an AM Intelligent Platform) leverages knowledge and experience in additive manufacturing (AM) via machine learning (ML) tools, a platform connecting AM suppliers with potential customers and a platform connecting AM suppliers based on their manufacturing experience. This will increase AM accessibility while driving down costs for both sets of users.

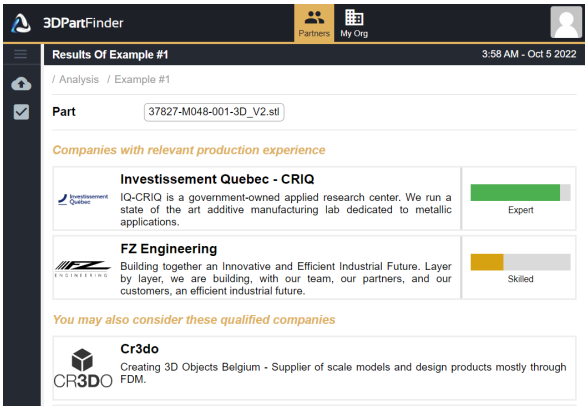
The AM industry is rapidly progressing in terms of technology, materials, processes and software. However, knowledge is held by experts who have developed experience on the shopfloor. Although AM is inherently data-driven, no safe mechanisms exist to extract, valorise and monetise data from heterogenous silos while preserving intellectual property (IP) rights. Companies considering AM (particularly SMEs) lack the capacity to identify the right technologies and applications for their needs. Combined with a high cost of entry, new players are reticent to invest, hindering AM market growth.

SAMUEL's main objectives were to provide AM users with useful, transferable knowledge and assist stakeholders along the AM workflow, making this process more consistent, reliable and dependable. The key innovation is to leverage a company's historical data. On one hand, AI prediction models that draw on previous AM experience help answer questions such as build time or part orientation. On the other hand, geometric search makes it easy to reuse knowledge and compare similar cases. This makes it less likely that a part will fail or that an assignment will be underquoted, for instance. SAMUEL also helps contractors navigate the AM industry via a web platform that allows users to privately upload their designs and automatically locate the most experienced AM suppliers for these. By finding manufacturers who have produced similar parts, costs are reduced and quality is maximised. This disruptive AI platform targets the AM industry but can be expanded to many manufacturing fields.

Technology applied

The project's core philosophy is that a company's AM experience resides in the 3D models printed. SAMUEL's technology is therefore built on the pillars of AI, 3D model analysis and data collection. For the latter, Cr3do has developed a machine-agnostic solution to gather AM production data from external sensors. These sensors can also be used to detect errors, allowing layering to quickly be stopped to avoid wasting time and material. An automated design checking system also helps users validate their 3D models before sending them to the printers. Materialise, meanwhile, has worked on ML-based build time estimation, which trains AI models to more accurately predict planning, pricing and optimisation. Also developed during the project are solutions for automatic build preparation, build quality surveillance, part recognition and automatic print preparation via ML. 3D model analysis and 3DPartFinder geometric search were instrumental in the development of these innovations.

3D model analysis is also the basis for 3DSemantix's AM partner search platform, which takes production data valorisation to another level. This solution matches AM production experience with submitted 3D designs. An AI model representing the AM Manufacturing experience is created for each supplier. A user simply submits the 3D model of the part to be printed and the platform performs an affinity analysis to identify the most experienced ones. Crucially, SAMUEL performs geometric indexing without revealing designs, allowing relevant knowledge to be extracted without infringing IP rights. All these innovations make for a powerful and advanced AM Toolkit.



Search result of 3DPartFinder partner search platform

Making the difference

SAMUEL is a world-first: no prior tools existed to leverage AM knowledge and

experience within a user's organisation, offering ample technical and business opportunities. ML models for build time estimation, for example, have achieved an estimation error rate <10% (and <5% for a significant number of cases). Improvements have also been seen in the AM process itself, with the design guidelines and sensor-based build monitoring contributing to a design error rate reduction of 67% and a manufacturing error rate reduction of ~20%. These figures will continue to evolve as the project is commercialised.

Regarding business, the platform will enable manufacturing cost reductions for product makers due to easy access to the most affordable AM options available, allowing many SMEs to access AM for the first time. By opening up new business opportunities, SAMUEL will also contribute to the development of the global AM market, which grew from USD 5 billion in 2014 to USD 15 billion in 2020. As roughly 75% of companies have not integrated AM into their manufacturing processes, even greater growth is still to come. Early uptake of the project's results will allow companies to establish a stronger market position in this emerging domain.

SAMUEL is now in the process of dissemination and platform expansion with new partners. For AM suppliers, use of the platform will increase their visibility and potentially their market share. The toolkit solutions will help them to reuse internal knowledge to provide more accurate quotes and retain know-how after AM experts move on. Following the introduction of data management systems to secure data, documents and process flows, the next evolution is data valorisation to leverage experience and knowledge with AI models that answer business questions. Companies that recognise this early will be more competitive – if they can act upon it, as SAMUEL will enable them to do within the additive manufacturing realm.

Major project outcomes

Dissemination

- Scientific article "Data-Driven Divide-and-Conquer for Estimating Build Times of 3D Objects" as part of 2021 IEEE International Conference on Data Mining (ICDM) Workshops, as well as several other news articles
- Several presentations, notably at "First EluciDATA Tech Talk, HI-AM 2020, ICDM 2021, Montreal Manufacturing Technology Show (MMTS) 2022 and IVADO Zoom on Multidisciplinary AI 2022

Exploitation (so far)

New products:

- **AM Partner Search Platform:** find manufacturers with production experience of your design
- **3DPartFinder AM Data Valorisation:** efficiently find valuable information through powerful geometric search
- **Automatic Build Preparation:** use your company's experience to streamline build preparations
- **Build Time Estimation for FDM:** a new AI modeling approach which tackles the challenges of FDM estimation
- **Build Quality Surveillance:** live AM anomaly detection with high accuracy and actionable results

New services:

- **Data-driven AI workflow for Build Time Estimation:** user-friendly way to approach training of BTE AI model

New systems:

- **3DPartFinder Geometric Search with Mesh 3D Models support:** same great geometric search capabilities, now with tessellated models
- **Build Time Prediction AI Module:** leverage the production experience of your company to quickly estimate build times
- **AM Part Orientation Prediction AI Module:** use your production history to define an optimal print orientation
- **Part Recognition Module:** train a part labeling vision system whilst your parts are being printed

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SAMUEL

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Partners

Belgium

- Cr3do
- Materialise
- Sirris

Canada

- 3DSemantix
- Centre de Recherche Industriel de Quebec
- FUSIA
- FZ Engineering
- Tekna Plasma Systems

Project start

September 2019

Project end

November 2022

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