HUBCAP
Digital Innovation HUBs and Collaborative Platform for Cyber-Physical Systems

Newsletter 7 October 2022

SME Successes in Model-Based Design

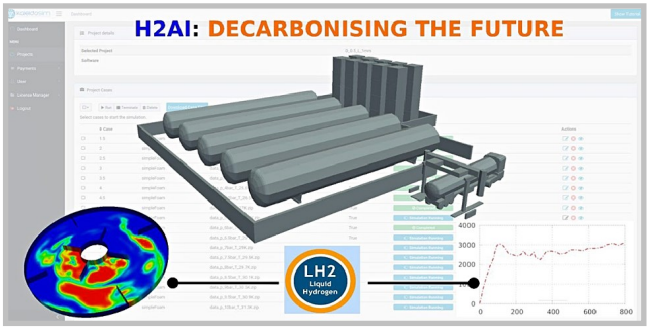
HUBCAP brings together Digital Innovation Hubs to support SMEs embracing digital innovation. Our focus is on model-based technologies and solutions to develop Cyber-Physical Systems (CPSs), for which HUBCAP has developed an open, cloud-based Collaboration Platform. This innovation portal enables businesses to contribute and access digital assets needed to undertake Model-Based Design (MBD) for building Cyber-Physical System solutions on the scale required for SMEs. Assets include both models and services, and they are made available to allow businesses to manage their investment in MBD technology and to promote experimentation.

HUBCAP has run three calls: PULL, EXPERIMENT, and INNOVATE. PULL attracted and engaged with individual SMEs to join and to integrate existing CPS and MBD tools in the HUBCAP platform to enlarge the HUBCAP ecosystem. EXPERIMENT encouraged SMEs to adopt or improve CPS products and services by applying assets from the HUBCAP platform in a two-SME consortium. INNOVATE funded the deployment of new products and demonstrations of highly-innovative collaborations using the HUBCAP platform.

In this newsletter, you can read about the outcomes of our calls to SMEs and see what they have been able to achieve with help from HUBCAP.

Exploiting cloud computing and AI technology for hydrogen storage & transportation towards net zero by 2050 (H2AI)

Energy security and decarbonisation are top priorities of the EU, which supports numerous changes across the energy sector with the use of hydrogen being one of the biggest.



The project aimed to develop a viable solution for simulating liquid hydrogen storage/transportation for hydrogen-based energy systems. The solution in this case was to combine traditional methods of performing simulations, such as computational fluid dynamics (CFD), with machine learning (ML), and simulate hydrogen-based storage/transportation scenarios more quickly and cheaply than the current solutions on the market.

The CFD simulations were performed using the massive simultaneous cloud computing facilities of **KaleidoSim** OpenFoam®. The simulation output data was used to train the convolutional neural network (CNN) of **MultiFluidX** MPflow®. About 500 simulations were performed, of which 100 were used to validate the CNN. The validation was successful, and comparison of CNN output with published empirical data was favourable.

H2AI has developed a CFD/ML-based workflow that uses computer simulations to perform 'virtual experiments', which can be used to make near-instant accurate predictions, and thereby help to produce a product that is both safe and performs optimally.

"HUBCAP has funded the first project for improving design for hydrogen energy infrastructure using HPC and machine-learning-accelerated digital tools." - H2AI Team

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Model-based design of the public transport operation run by zero-emissions buses

Efficient operation of a public bus service has always been important. Today, such operation has even greater significance, since society must become both energy-efficient and decarbonised because of climate change.

The project aimed to predict bus energy consumption, and thereby optimize their battery capacity, minimize running costs and CO_2 generation, and consequently reduce the duration and costs of bus operation planning.

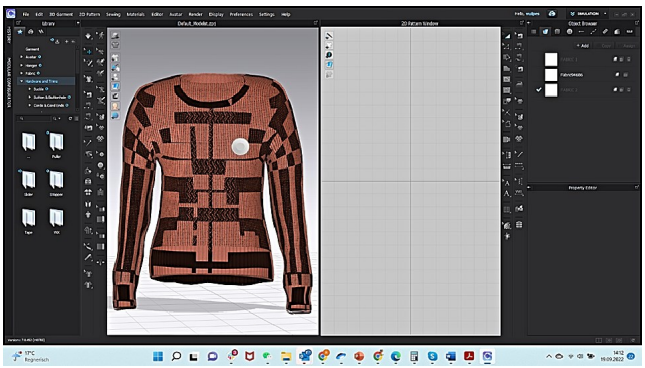
A mathematical model of an electric bus was built and data collected from third parties about bus routes. An existing simulator was used to run 180 scenarios of 4 bus routes with different parameters, including ground elevation, weather conditions (temperature, rain/snow), and passenger numbers.

The project has developed a simulator for planning and managing electric bus operation, also implemented on the HUBCAP platform, and produced two simulation reports for the Dancer Bus 530.

"HUBCAP funding enabled us to justify our place in the public transport value chain, which is much more than shooting blindly."
- Electrification of Public Transport Team

SmarTexMod — designing smart clothes

The Internet of Things is becoming integrated with clothing, and the aim of this project is to improve the efficiency of designers in designing, developing, and prototyping smart clothes.



The project created 10 parameterized items (assets) required to create models of smart clothes, using Rhino and Autodesk Fusion 360. The models can be downloaded and imported into existing clothing design software (Clo3D) and rapid prototyping software (Slicer Cura, Ultimaker and MakerBot). Models were tested with these tools and the results were satisfactory.

SmarTexMod has produced 10 parameterized models for smart textile design, prototyping, and production, which can be downloaded from **https://smartexmod.com** along with a user guide. There is also a tool on the HUBCAP platform based on these models.

Flood and fire risk mitigation in wetlands using microwire sensing (FF-RIWER)

Wetlands are fragile ecosystems that are susceptible to flooding and bush fires, which can damage the habitat, cause pollution, and hamper the movement of people in the affected area. This project used a novel sensor technology to create an early warning system for flooding and fire in wetlands.

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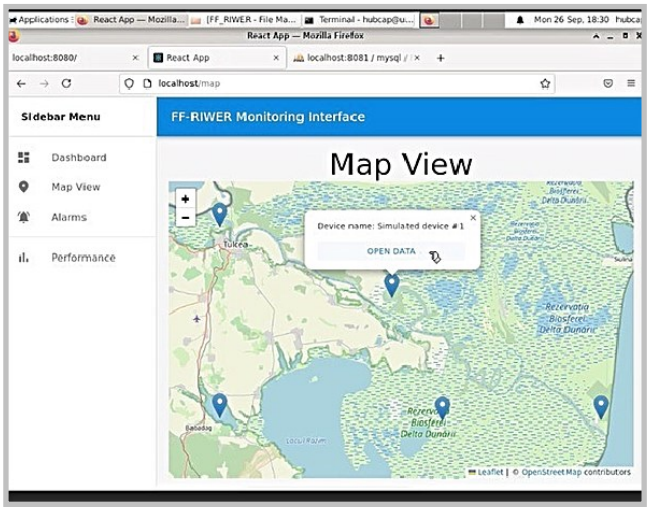


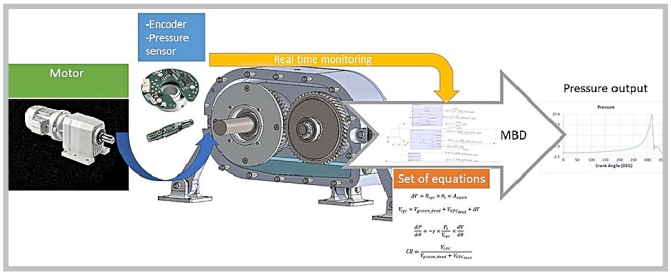
The project developed software to read data in real-time from MicroWire sensors, and transmit it wirelessly to a server for storage, generating alerts, and visualization of alerts. MicroWire is the world's smallest passive sensor, developed by **RVmagnetics** (one of the SMEs) to measure magnetic field, pressure, and temperature. The system was validated by varying the water level in a pool, and by varying the temperature using a hand dryer. The testing was done at the Center for Advanced Research on New Materials, Products and Innovative Processes in Bucharest, and showed no false alarm and >95% correct sensing.

The software system is an asset on the HUBCAP platform.

"In FF-RIWER we combine RVMagnetics environmental sensors (a HUBCAP asset) with newly created software modules for communication, data storage and processing and visual data presentation (alerts, history etc) for a new CPS solution to be used in use cases related to wetlands (and envisioned to be first deployed in the Romanian Danube Delta). RVM's technology allows for precise fire and flood sensing with little energy consumption and small, unobtrusive devices, making it ideal for the fragile wetland ecosystem."
- Laurenţiu Boicescu, ACC Team Lead

Accelerating the experimental process of a gas compressor's prototype, called SARC, using MODELTA platform (SARCproject)

The project aimed to develop a model-based design method that combines mathematical models with input from sensors to improve the design and operation of a novel rotary compressor.



The operation of the SARC compressor was modelled and analyzed using computational fluid dynamics and finite element analysis. The models were tuned using sensor measurements of temperature, pressure output and angular motion (made using a previous prototype). The MODELTA web platform was developed to support this. MODELTA was also used for real-time monitoring of sensors, and to predict through simulation (using Simulink) the performance of SARC.

Model-based design supported by MODELTA has had multiple benefits: the final SARC prototype has 25% less weight than the previous prototype, better performance and reliability, and lower costs for manufacturing and operation. Rapid prototyping was another benefit. The experience of using model-based design during the project has proved crucial for the development of other prototypes: a rotary internal combustion engine, an expander, and a pump based on the novel rotary working principle.

MODELTA is an asset on the HUBCAP platform, and has resulted in further projects: one commercial, one research.

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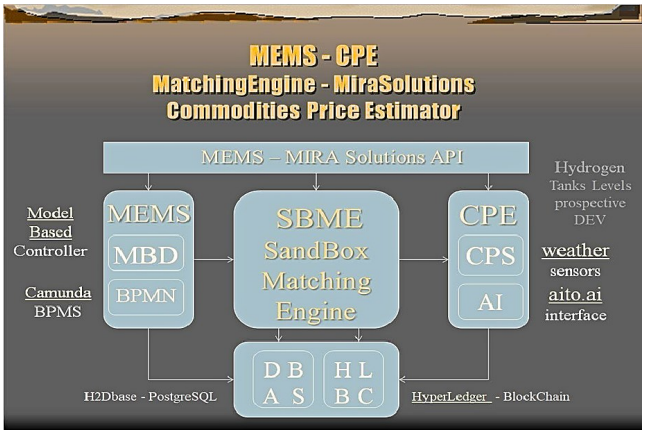
"MBD can substantially facilitate the functionality optimization of physical assets. We observed through HUBCAP that the steps followed to build MBD really give a thorough understanding of the asset, preparing it for rapid development and prototyping. Furthermore, the critical parameters allocation and their control can improve performance and decrease cost.

"Our advice as DELTA MPIS is for SMEs to get to know Model-Based Design and IoT in order to enter the rapidly growing sector of Cyber Physical Systems and also make their product and services up to speed with industry 4.0, smart manufacturing and Digital Twinning."
- DELTA MPIS Team Lead

MEMS CPE — Matching Engine Mira Solutions Commodities Price Estimator

In Romania, mid-range farmers often underestimate the value of their crops in the international marketplace. This project aimed to develop software to help the farmers identify the best time for selling and buying crops, based on analysis of international market prices (e.g. in EU, USA, and South Africa) and weather predictions, and obtain a good price for their produce.

Three modules were developed and integrated: the Commodities Price Estimator (CPE) gathers commodities data (on sunflower, wheat, corn, and rapeseed) from different sources, including historical crop prices and estimated crop models, and predicts daily and weekly market prices for the commodities using historical simulation models, supply-and-demand matching models, and weather data from sensors. The SandBox MatchingEngine (SBME) models the supply-and-demand matching processes of commodities. The MEMS CPE is



the central controller and is used to calculate the insurance for the commodities, as crops cannot be sold without insurance.

SBME is an asset on the HUBCAP platform, CPE models have been uploaded, and there is a web GUI to MEMS CPE.

MEMS CPE was developed as a digital twin of real world business and physical processes, using the Business Process Model and Notation (BPMN). The SMEs found that experimentation with model-based design and simulation before implementation increased the speed of development and improved the quality of the product.

"We kindly advise EU-based SMEs, especially applicants to EU-funded projects, to model their business flows, their eventual experiments and their proposed projects using BPMN process modelling. It will enable them to fast-visualise concepts, their interaction with company systems, and any outside APIs or CPSs (Cyber-Physical Systems) integrated in their projects" - MEMS CPE Team