CASE STUDY

University of Birmingham: high performance computing and visualisation equipment for the National Buried Infrastructure Facility

Dr Asaad Faramarzi – Associate Professor in Civil Engineering – University of Birmingham

DAFNI hardware funds have been spent on purchasing High Performance Computing, some visualisation equipment, including a set of VR goggles, and a large screen in the National Buried Infrastructure Facility's visualisation room.

The National Buried Infrastructure Facility: a unique research site

The National Buried Infrastructure Facility (NBIF) at the University of Birmingham is a 'one of a kind' facility spanning research, innovation, education, Continuing Professional Development (CPD) and training in buried infrastructure-ground interaction. It is part of the UK Collaboratorium for Research on Infrastructure and Cities (UKCRIC).

The broad NBIF research group brings people from across different subjects together, including geo technology, structural engineering, materials engineering, and water engineering. There are 13 academic staff in the group, plus 5 post-doctoral researchers, 3 professional technicians, an industrial fellow, and a business engagement manager. There are over 20 PhD students and a cohort of over 60 Masters students that are associated with this facility.

DAFNI-funded hardware at the heart of Digital Twin research

The DAFNI-funded HPC and large screen have been available to the NBIF research group since its installation at the end of 2021.

Dr Asaad Faramarzi, Associate Professor in Civil Engineering, explains: "We have a number of projects within NBIF – they always involve physical experiments but for the majority of them we now also have a digital twin model of them.

I am leading the Digital Twins and computational modelling theme of NBIF, so I was particularly interested to be involved with DAFNI and to make the most of the hardware funding available.

"We are using the DAFNI HPC installed at the NBIF to simulate different scenarios, to carry out data analysis, numerical modelling (finite element modelling/analysis), machine learning based on data collection from the experiments, and data visualisation.

In particular, NBIF is using the DAFNI hardware to extend and enhance some of the ongoing research projects funded by UKRI and/or industry partners:

Quantum Technology Hub in Sensing and Timing – this £30m project is a collaboration between 7 universities and several research organisations and has over 100 industrial partners to bring disruptive new capability to real world applications with high economic and societal impact to the UK.

CASE STUDY

University of Birmingham: high performance computing and visualisation equipment for the National Buried Infrastructure Facility

As a part of this project, researchers at the University of Birmingham have developed computational procedures to infer data from quantum technology (QT) gravity gradient sensors to map underground space. Additionally, they are developing computational framework for machine learning -based map matching navigation, as an alternative approach for both positioning and navigating vehicles particularly in GPS difficult environments. **The data inference and numerical modelling of QT gravity data have benefitted from the DAFNI hardware.**

Low carbon smart pipes project (in collaboration with AquaSpira) –
Funded via a grant from Innovate UK, this research programme has the potential to make a significant step-change in helping the construction sector achieve Government decarbonisation targets. The programme is led by the North-West firm AquaSpira and will support the development of composite plastic and steel drainage and storm water pipes, incorporating high levels of recycled material. Sensor technology built into the pipes will detect and report changes in environmental conditions, enabling infrastructure problems to be rapidly identified and rectified. The research also includes development of digital twin models of the new pipes which enables asset owners/managers to assess structural integrity of the pipes and their supporting ground in a real-time manner.

Using optical fibres to monitor sprayed concrete lining with BeMo –
BeMo and the University of Birmingham have conducted a laboratory experiment at NBIF to evaluate the use of optical fibres to replace automated Total Stations and optical targets to monitor the performance of sprayed concrete lining during construction. Analysing data from experiments is a critical stage in research projects especially when large and complex dataset are used. DAFNI HPC allows us to efficiently and effectively analyse the data from experiments and translate them into useful information on a local computing unit and in an accessible approach.

Please see more details about the AquaSpira and BeMo projects here: https://www.birmingham.ac.uk/research/activity/ukcric/nbif/case-studies/index.aspx

DAFNI hardware a 'significant asset' to NBIF

The DAFNI HPC is providing access to a higher computing facility or platform through local computing nodes, and enabling researchers to connect to the wider DAFNI platform.

The dedicated HPC funded by DAFNI for NBIF enables researchers to benefit from faster run times, improving computational time, and to carry out simulations that include wider, deeper or more scenarios than previously done, whilst having greater control over the pre- and post-processing stages.

Asaad says, "Using the new hardware we have the ability to build digital twins of physical models that are to be carried out in NBIF. This will help to understand the response of physical models in real time but also, predict additional scenarios that are otherwise not possible or difficult to study with other approaches.

"The hardware will also be a significant asset as NBIF bids for more ambitious projects, as it extends our skills, and makes us more competitive when we offer our services to industrial project partners and research councils. It adds to our toolbox to put us in a better position to win bids."

University of Birmingham: high performance computing and visualisation equipment for the National Buried Infrastructure Facility

Future use and research links with the DAFNI national platform

Asaad adds, "We are likely to extend the use of the DAFNI hardware in the future – NBIF anticipates growth in the use of the DAFNI HPC and to bring in a wider set of users from both the academic research side and from industry."

Asaad further explains, "We have a number of people across NBIF who have signed up and are interested in or already actively using the DAFNI national platform, both on the engineering and chemical engineering side. One of the staff, Dr Xilin Xia, who been with Birmingham since 2022, was instrumental in developing the CreDO model which is now on DAFNI – . Dr Grant Wilson in the School of Chemical Engineering is active in multi-scale data analytics in the chemical engineering space and is already using the national DAFNI platform in his research."

The Hardware

Processor: AMD Ryzen Threadripper PRO 3975WX 32-Cores, 3.50 GHz

Memory: 256 GB

Operating System: Windows

Graphic: GeForce RTX 2080 SUPER

Storage: 2TB