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Smarter, greener, better – redefining the future of machine power

In an age of smart machines, EU-funded researchers are ensuring that they are being designed with sustainability and societal well-being in mind.

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Machines have always fascinated Dr Didem Gürdür Broo, a computer scientist from Cyprus with a PhD in mechatronics. It was a childhood dream of hers to learn to code and build things. So, as soon as she was old enough, she decided to enter the field of computer science.

As her studies advanced, however, Gürdür Broo became aware that the field as a whole was focused almost solely on how machines could be made more productive, with other questions largely ignored.

“I realised that a focus on productivity alone was a very narrow view of what we could get out of machines,” she said.

Cyber-physical future

Drawing on her interest in environmental issues, Gürdür Broo, now head of the Cyber-Physical Systems Lab at the University of Uppsala in Sweden, began to question the prevailing wisdom of the field.

She developed an interest in how mechanical processes could be made more energy-efficient, more sustainable and more socially responsible, rather than just more productive.

In 2021, she was awarded a research grant from the EU to pursue this idea further and explore how to make emerging cyber-physical systems (CPS) – basically any system that involves a physical process in a feedback loop with a computer – more sustainable.

Her research, carried out in part at Stanford University in the US, was part of a four-year research project called Sustainable-CPS.

“It is very important to think about how we can design and operate CPS in a more sustainable way,” she said.

European momentum

Machines and computers are becoming integral to the way we live, work and interact. From self-driving cars to advanced manufacturing systems, the seamless interaction between machines and computers is reshaping industries and daily life.

The EU is supporting research into CPS, with the goal of speeding up their development and ensuring these technologies address real-world needs while contributing to Europe’s competitiveness and sustainability.

The foundations of current CPS development were laid by earlier EU-funded researchers in projects like EXCELL, coordinated by the HUN-REN Institute for Computer Science and Control (SZTAKI) in Budapest, Hungary.

Academics from Hungary, Germany, Belgium and the UK set out to explore big data applications for CPS in production and logistics networks. The main scientific and innovation focus was based on a combination of global trends and local requirements.

Industry 4.0

According to Dr Elisabeth Zudor, the coordinator of the EXCELL research, the transformation of industrial manufacturing through concepts like the Internet of Things (IoT) and the Factory of the Future will rely on efficient and sustainable CPS.

“The fourth industrial revolution will be based on CPS that will monitor, analyse and automate business processes, transforming production and logistic processes,” said Zudor, who is a senior researcher and advisor at SZTAKI.

Through a series of academic exchanges, secondments and training programmes, the EXCELL team helped to develop the knowledge base on CPS across Europe. “EXCELL helped the people involved in the research project to accelerate their knowledge growth,” she said.

It also put in place a lasting transnational collaboration that has continued well beyond the end of the project itself.

The research team focused on aspects such as human-system interactions, IoT for business and next-generation authorisation solutions, among others.

A strong emphasis was placed on ensuring the research outcomes could benefit industries by introducing innovative solutions in production and logistics.

A shift in mindset

CPS are part of Europe’s Digital Decade policy, which has set concrete targets and objectives for 2030 aimed at empowering businesses and people in “a human-centred, sustainable and more prosperous digital future”. This includes an ambition to have 75% of EU companies using Cloud, AI, or Big Data.

An important part of Gürdür Broo’s work was to change how issues of sustainability are addressed when it comes to CPS.

“Sustainability is such a complex issue that it requires you to think differently,” she said. “When we design CPS, we need to look at not only the system itself, but all the systems adjacent to that and how they interact.”

According to Gürdür Broo, sustainable development has economic, social and environmental dimensions. And the only way to solve challenges in all three is to shift how we think about them.

Her work on the implementation of intelligent systems such as collaborative robots, autonomous vehicles and smart cities has earned her recognition in the field. In 2023, she was selected by Women in Robotics as one of the 50 Women in Robotics You Need to Know About.

Her research produced a framework for developing CPS which combines different skills and looks at CPS development through three different lenses: a systems mindset, a design mindset and a futuristic mindset.

She said the way in which the framework addresses multiple perspectives is very useful when considering how to integrate sustainability into research.

“Otherwise, you can get tunnel vision and forget to think about how different topics relate to each other.”

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- Sustainable-CPS
- EXCELL
- Europe’s Digital Decade
- A Europe fit for the digital age