

ACQUIRING PRACTICAL AND PROFESSIONAL SKILLS

The two-year, full-time PDEng programme Mechatronic Systems Design focuses on combining in-depth understanding of the classical engineering fields, with multi-disciplinary, model-based systems engineering to conceive, predict and verify cutting-edge system functionalities and architecture. A major aim of the programme is to further define and improve a tailored systems engineering approach for high-end mechatronic systems.

EDITORIAL NOTE

This article was contributed by the TU/e HTSC.

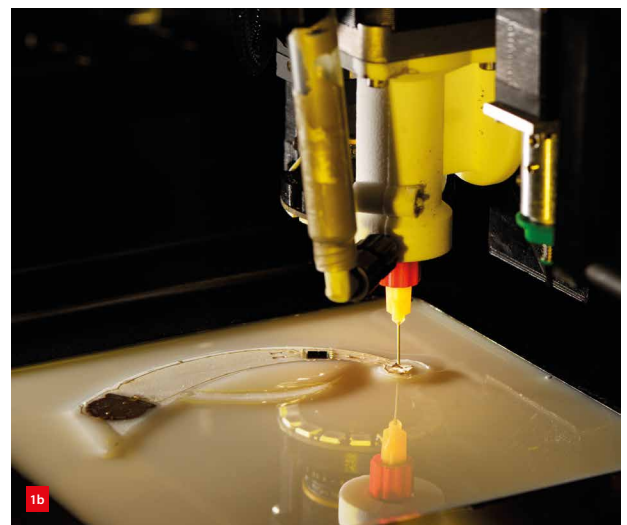
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Tim Verdonschot is an Eindhoven University of Technology (TU/e) graduate, first as a Bachelor of Electrical Engineering and then as a Master in Systems & Control (an interdepartmental Master's programme of the departments of Electrical and Mechanical Engineering), who was faced, like many fellow graduates, with a choice about the next step in his career. The Ph.D. route offered one option but more attractive was the PDEng education, Professional Doctorate in Engineering, at the High Tech Systems Center (TU/e HTSC) on the TU/e campus in Eindhoven, in Mechatronic System Design, a two-year programme with an industry link and the opportunity to work in teams.

Verdonschot is currently engaged in the second year of this two-year programme and focusing on a project aimed at developing the machine control system architecture for the so-called 'Lepus Next Gen' printing equipment (Figure 1) of the AMSYSTEMS Center, a joint innovation centre of TNO and TU/e HTSC, such that actuators, sensors and feedback control can be incorporated into the machine control. This Mechatronic Systems Design project called for a mechanical or electronical engineering education, specialised in systems and control, with an affinity for control systems design and (firmware/software) implementation. Step in Tim Verdonschot.

More than just an engineer

"What appealed to me was the opportunity to be practical. I am more motivated by application than by academic research. During my first year I followed a dedicated curriculum of courses, interactive workshops and group and practical assignments, often in close cooperation with industrial partners, the core of which is formed by system architecture and design. But apart from the more technological content, we also had to acquire professional skills such as project management, communications and how to handle conflicts. These are things that can give you that bit extra that companies are looking for these days, and especially in a



- 1 The Lepus Next Gen printing equipment. (Photos: Bart van Overbeeke)
 (a) Tim Verdonschot in front of the machine.
 (b) Close-up of a dispensing unit for deposition of conductive tracks for 3D-printed electronics applications.

design project, which covers the second year of the programme, where I am right now, we get the chance to show what we can contribute."

Control loops

Gregor van Baars, senior system engineer and project manager at AMSYSTEMS Center, where Verdonschot is doing his project, explains the nature of the problem. "At TNO we have developed prototype AM (additive manufacturing) equipment based on vat photo-polymerisation (stereolithography). The machine platform, called Lepus Next Gen, contains a unique lighting module that enables scaling up to large-area additive manufacturing for pure (curing) polymers as well as photopolymers mixed with ceramics particles."

When the AMSYSTEMS Center was established, TNO brought in the Lepus Next Gen into the cooperation and common infrastructure. "Most of the current AM equipment, however, is operated in open loop, which means the machine parameters are set to fixed values without corrections during the manufacturing of the part. Since AM offers new opportunities for the design and manufacturing of high-tech ceramic machine parts, at reduced cost and shorter lead times than conventional ceramics manufacturing technologies, we want to develop the tightly coupled AM process, materials and equipment in an integrated fashion."

So within AMSYSTEMS Center there is an ongoing research programme on large-scale ceramics AM. One of the routes to improvement is to introduce control loops, Van Baars continues. "This requires the integration of actuation, sensing and feedback control principles into the Lepus Next Gen platform. So we took the option to strengthen our AM ceramics research with three PDEng final year projects to be carried out as a team of PDEng engineers at the facilities of AMSYSTEMS Center. Tim Verdonschot is working on the control loop."

Valuable feedback

Tim Verdonschot: "What we want to do is to add sensors to measure the process so that when the layers are added, the resin hardens in the right way and the whole process is controlled and optimised. My role is to ensure that the hardware and machine software that is used can be adapted such that other sensors and actuators can be added, and to modify the software so that everything works in harmony and that the sensor readings are clear and give us the information to be able to make the necessary adjustments."

In fact, Van Baars adds, "what Tim is doing in this project plays quite an important role in the development of these machines since what we have with the first generation is not the ultimate. Mechatronics and system engineering is becoming increasingly integral to 3D printing equipment. After all, it involves processes and materials that demand a different kind of control issue than, for instance, the precision motion systems in ASML's lithography wafer scanners. So what we try to do is to exploit available system engineering and mechatronics expertise for new applications like 3D printing. And what we have tried to do with the three PDEng projects is to look at the three different aspects: measurement, layer deposition (recoating) and control. And this last aspect is the focus of Tim's work."

Perfect fit

The fit with the first year of Verdonschot's programme where systems engineering was a key component makes the project even more rewarding since he is able to really put to the test what he has learned. "My study and the project slotted together perfectly. And another thing that is really pleasing is the collaboration and collegiality at AMSYSTEMS Center. I feel I'm always able to knock on the door and ask questions, and everyone is willing to share their knowledge and experience with me. While it is great to be using and developing my own knowledge and skills, the sense of being part of the greater whole is an added bonus. You certainly get a feel for what it is to work in the 'real world' as it were."

Van Baars comments: "That's quite essential, too, in this relatively new world of 3D printing. Both sides benefit from each other. Through asking questions and getting answers, needs can be met. So this access to expertise gets Tim further along the path of his assignment."

To be continued ...

Verdonschot's assignment is for a year and while he is making real progress, the likelihood of him completing the goals of the project is hampered by the time factor. "Along the way we have encountered several problems that had not been anticipated so it is not realistic to think that we will be able to finish everything in the time we have. But we have reached the point where the software and hardware are such that we can add the sensors and actuators, and implement closed-loop process control in the system. So, in that respect, we are not running behind what we set out to do. It is a fairly new and unexplored area, so you often have to take one step back to go two steps forward."

This progress benefits not only Tim Verdonschot but also AMSYSTEMS Center. "It helps us move forward", says Gregor van Baars. "We will have gone from nothing to something, so that is a very tangible yardstick of achievement. The PDEng trainees in this project will have brought us to the point that we can now measure and control. To get from there towards the ultimate system performance, the work will continue, and PDEng trainees will certainly be part of that continuation." ■

The two-year, full-time PDEng programme Mechatronic Systems Design

In the first year, the PDEng student learns new technologies and broadens and deepens his/her knowledge of mechatronics in a broad sense, spending about half of the time following courses and workshops, and the other half working in multidisciplinary teams on projects (real problems) from industry that are assigned by industrial partners, including well-known international companies such as ASML, TNO, ESA, VDL, and NXP, but also promising high tech start-up companies in the Brainport region. The second year is spent in industry working on an individual, challenging and innovative technological design project – a real problem that needs a solution.

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