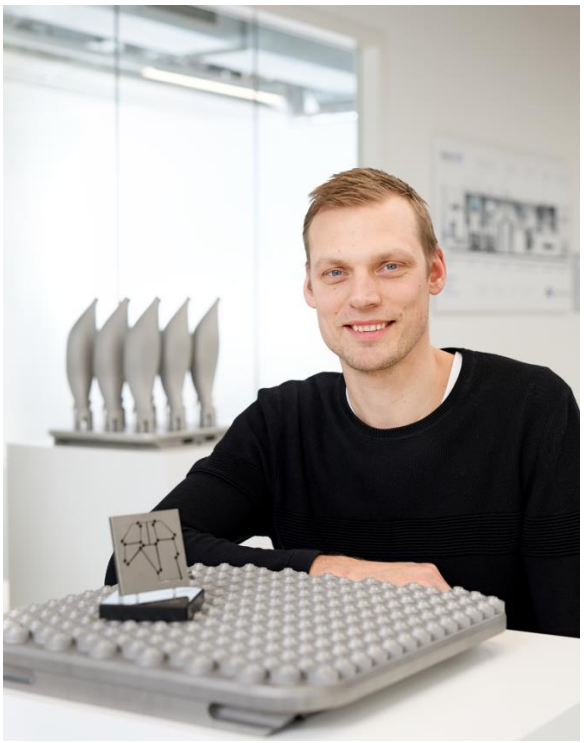
Constructeur 03-2020 Author: Hans van Eerden Photos: Bart van Overbeeke

Wim van der Hoek Award 2007 recipient: Rob van Haendel

“Defining the machine together”

In 2007, Rob van Haendel won the Wim van der Hoek Award for his design of a telescope mirror suspension system. He had fallen in love with the design principles at Eindhoven University of Technology. He then truly learned the design profession from experienced chief engineers at Philips Innovation Services, where he worked on projects for ASML. Since 2014, he has been a chief engineer himself at Additive Industries. “Together with the CTO, I started defining the machine.”



Rob van Haendel showing the Wim van der Hoek Award he received in 2007.

Rob van Haendel (Utrecht, 1981) was drawn to technology from an early age. “Construction toys, wood, Lego, anything you could make and create with. And mopeds, of course. It quickly became clear that after secondary school (VWO), I would study mechanical engineering, so I started looking in Delft, Eindhoven and Twente. In Eindhoven, I was drawn to the design-driven learning that had just been introduced in 1999: the combination of building theoretical knowledge in the morning and immediately applying it in projects in the afternoon, right from the first year. Moreover, my father studied electrical engineering here—we had interesting conversations at home about ‘spark-blowers’ versus ‘bicycle repairers’.”

‘A world opened up for me’

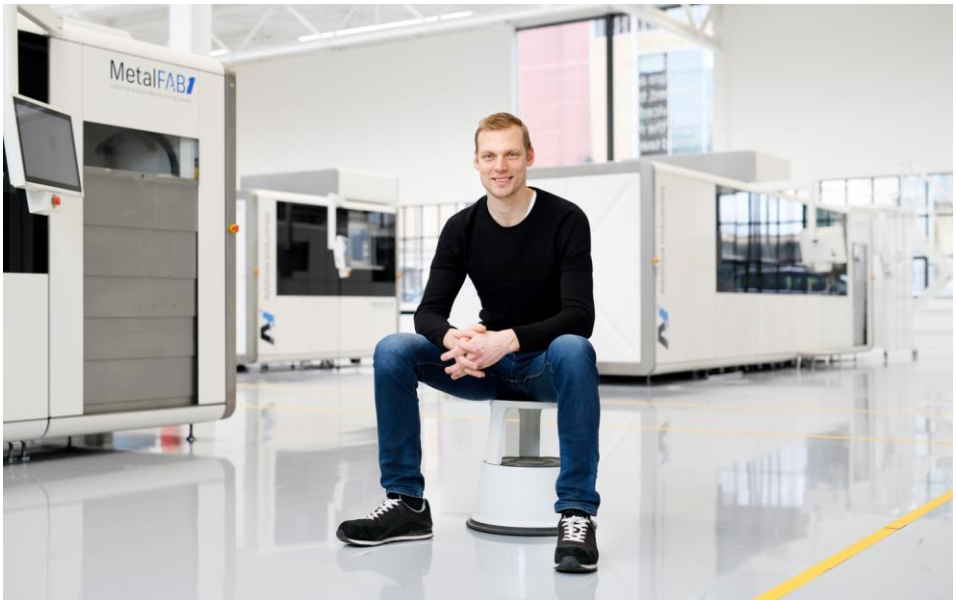
At Eindhoven University of Technology (TU/e), Design Principles was Van Haendel’s favourite subject. It was taught by Nick Rosielle, from the department where Wim van der Hoek was a professor until the end of 1984. “A whole new world opened up for me: being able to think about constructions in that way. After a short internship in that group, I knew for sure that’s what I wanted to graduate on.” The extracurricular activities at the Simon Stevin student association also helped. “There, I got a very practical start with the fabrication courses they offered in the evenings: turning, milling and welding. It was great to work with my hands and experience how production techniques work; it taught me how to properly sketch something and what was easy or difficult to make. As a designer, I gained a better sense of manufacturability and also knowledge of, for example, clamping tools and workpieces.”

‘Continuous sketching’

From the available graduation projects, Van Haendel chose the design for the suspension of a telescope mirror. That’s how he ended up at TNO, in the optomechanical instrumentation group. “From Tuesday to Friday, I was at TNO in Delft, and the week started in Eindhoven with the Monday meeting with Nick Rosielle. We met with all his graduates and interns and spent the whole day at the table. We just talked about constructions, a problem we were facing, or a solution we had devised. Everyone was free to brainstorm and sketch together. The field has a wide variety of applications, from a medical robot to a production machine, but the rules are generic. This led to all sorts of great

ideas and designs. What I remember most was the constant sketching, exploring each other's ideas, and iterating on them. Nick Rosielle was a fantastic mentor."

'Learning from experienced chief design engineers'
Those Monday sessions certainly contributed to the quality of Van Haendel's thesis, which was awarded the Wim van der Hoek Award. After graduating, he joined Philips Applied Technologies (which began in 1968 as Philips CFT and became part of Philips Innovation Services in 2011). A logical choice: "I wanted to learn the trade from experienced chief design engineers. Because the world of design principles appealed to me, I looked for a company that followed that approach and applied it daily. I was pretty sure that was Philips."
Van Haendel primarily worked on projects for ASML, contributing to the development of wafer and reticle stages. He was responsible, among other things, for a so-called cable robot. This robot moves along a linear axis at the bottom of the wafer stage, along with the positioning module on which the wafer rests. The cable robot must minimise the interference forces from all cables – for "water, electricity and gas" – on that module. The performance requirements for the cable robot are almost as strict as those for the positioning module. "It receives the current position of the module as a setpoint and must have a servo error of only a few tenths of a millimeter. The cable robot is either an air-bearing table that moves across a beam or – in the case of the EUV machines – a magnetic levitation motor controlled in six degrees of freedom within the magnetic field. The design is packed with design principles; everything is included: air bearings, vacuum technology, motor design, frame design, encoders, etc."



Rob van Haendel has worked as lead mechanical engineer at Additive Industries since 2014 (ed. note: until 2023).

'Intrigued by 3D printing'
In short, work that Van Haendel was truly passionate about. Yet, after more than seven years, he left for Additive Industries. This was entirely due to his interest in 3D printing. "I started working on this within the framework of 'advanced competence development', which Philips was investing in to build expertise in specific domains. I was intrigued by what 3D printing, additive manufacturing, could offer me as a designer: greater design freedom, allowing me to create designs in a different way. This was separate from my work for ASML; I simply started creating designs and having them printed externally. That's how I got into conversation with the founders of Additive Industries, Daan Kersten and Jonas Wintermans, who were starting AddLab (open innovation around 3D printing, ed.). We wanted to see if Philips could participate."

‘Given the right experience’
However, when Van Haendel discovered that Additive Industries wanted to design a printing machine itself and was looking for a lead designer, the move was quickly made. “That seemed like a really exciting challenge: the dynamism of a start-up and having my own product, very different from Philips’s contract R&D. Moreover, the development of a 450-mm wafer table I was working on at Philips was discontinued by ASML. That’s how everything came together, and the blank sheet of paper beckoned me to start working on a completely new machine. In 2014, I became the fifth employee at Additive Industries. CTO Mark Vaes and I started working together to define the machine. That was a fascinating phase, and at Philips, I had acquired exactly the right background for mechanical engineering: thinking in modules, grouping functions and assigning them to modules, specifying, creating good interface definitions, and working with the V-model.” Van Haendel has now been the lead mechanical engineer at Additive Industries for six years. “As a system architect, I’m responsible for the new machines and modules we develop. The key to our machine concept is that we automate everything necessary for printing products – from machine calibration to powder handling to heat treatment and machine unloading – as much as possible to deliver a truly industrial solution for metal printing.

‘Cost per printed part down’
The machine’s design is packed with design principles for precision printing. “I still use the TU/e lecture notes on a weekly basis to generate ideas. Printing is a thermal process, involving numerous temperature gradients. So, we often design a thermal centre (where thermal expansion is zero, ed.), for example, with elastic leafsprings or ball bearings in V-grooves.” Precision is no longer the biggest challenge, however, as the current printing tolerance of approximately 50 micrometers is sufficient for most applications. “The main goal now is to reduce the cost per printed part.” Here too, Van der Hoek’s design principles play a role, as with the build plate. In competing machines, this is screwed or clamped to the piston that provides the vertical movement for layer-by-layer printing. When loading and unloading the machine, this attachment creates additional work that is difficult to automate. The handling robot in the Additive Industries machine does not have to do this, because the build plate remains loose there. “You don’t need a clamping system at all, because printing is a forceless process. That’s why I chose to mill three V-grooves into the bottom of the plate, which then remains statically fixed on the piston with a ball bearing.” Another advantage is that no thermal stresses arise in the plate; with bolted connections, these can discharge through slippage, leading to printing errors.

‘A beautiful journey’
Highest productivity is how Additive Industries aims to distinguish itself. “When our machine came on the market, it was the first with four lasers – now that’s more or less standard. But while in other machines the lasers cover overlapping quadrants, our four lasers all operate ‘full field’, meaning prints have fewer seams.” Controlling these four laser beams is the most complex control technology in the printers. At the top of the print room are four scanners, one for each laser, which control the laser beams at lightning speed. “The optics of these scanners incorporate the necessary design principles for adjusting and stress-free mounting of the mirrors, so that the mirror surfaces don’t deform under thermal influence.”
In the coming years, Van Haendel wants to continue working on new printing machines and modules that further increase productivity. “The trends are higher laser power, more lasers, faster printing, and larger build volumes. I regularly visit customers to get a feel for how they work with our machines and how we can meet their expectations with product development.” Many of these customers are in the automotive or aerospace sectors, and the latter sector, primarily space travel, particularly appeals to him – more so than astronomy, where he originally began his design career. For now, Rob van Haendel sees plenty of room for development at Additive Industries. “When I started here six years ago, we were a team of five, now we have four locations with a total of 130 employees. That’s already quite a journey.”

www.additiveindustries.com