

Levelling up ICT Research and education

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COLOFON

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INTRODUCTION



In 2018 and 2022, the Dutch government made a targeted investment in the foundations of various scientific sectors by means of the sector plan funds. For the young and rapidly expanding field of computer science, this funding has made a significant impact. Yet, the ever increasing importance of digitalisation and the high student numbers keep calling for additional investments.

'Computer science is a relatively young but fast-growing scientific discipline. Investments like these are crucial to not only keep up with the growth but to also get ahead and set the agenda of future technology development.'

ASKE PLAAT, UL

'If you focus your research on just today's applications, you miss out on tomorrow's challenges and opportunities. The sector plan funds allow us to explore these types of new routes.'

ARJEN DE VRIES, RU

The sector plans were meant to stimulate cooperation between and within universities, and to strengthen the foundation of education and research by increasing the number of permanent contracts, reducing work pressure, and attracting, training, and retaining scientific talent.

For the computer science field, this financial impulse was much needed, since the field was and is still dealing with the highest student to staff ratio's of all academic fields. While in this field, over the past fifteen years the student numbers have more than quadrupled, the amount of staff members remained more or less the same. This has led to a situation where it is not unusual for a single staff member to supervise 35 master's students.

What's more: the size and impact of computer science keeps on growing. Where the total number of students enrolled in higher education in the academic year 2024-2025 decreased with 2,100 compared to the academic year 2023-2024, the computer science departments still witnessed an increase of over 400 students.

This development is the result of a pressing need: The far-reaching digitisation of society is accompanied by an ever-increasing need for highly educated ICT specialists in virtually all sectors.

Over the past years, IPN has issued a series of interviews in its I/O Magazine about the impact of the sector plan funding on the computer science divisions of Dutch universities. The sector plan hires not only relieved a small part of the educational burden, but also led to new collaborations across the borders of subdisciplines and institutions, and a rejuvenation of research topics. This resulted in large scale, yet often temporary, collaborative programs and projects on topics like hybrid intelligence, human-computer interaction and sustainable software, which already materialised in front-runner positions in these fields.

In order to capitalise on investments made in the past, and prepare our society for the digital future, further investments in computer science remain a necessity. This booklet illustrates how investments in computer science will keep generating revenue for science, society and economy for generations to come.

'The sector plan budgets allowed us to jointly appoint people together with other institutions, which is not that easy with other types of funding.'

JOHAN JEURING, UU

'The importance of open schemes like the sector plan funds cannot be overstated. At both the national and institutional levels, setting priorities and developing long-term research strategies is crucial.'

DIRK HEYLEN, UT

'The sector plan funds enabled us to strategically establish new connections between individual research themes by appointing people at the intersections, for example between data science and security.'

JOHAN LUKKIEN, TU/E

IMPROVING COMPUTER SCIENCE EDUCATION

Johan Jeuring

Former head Department of Information and Computing Sciences, current Professor of Software Technology for Learning and Teaching at Utrecht University



'The whole process of developing a strategic document like a sector plan in itself can be a rather useful exercise. In 2017, when I started as head of the department, we wrote a strategic plan, identifying three main areas of interest for our research. At that time, Utrecht had one of the largest computer science programmes in the Netherlands. In the discussions with our external advisory board, we identified an important theme to focus on as a department with many students: computer science education.

For the first sector plan, we identified seven themes at a national level that the Netherlands should invest in. We looked at where we experienced the biggest pressure from education and tried to relieve the burden there. After talking to external partners and taking stock of who was working on which topics and providing what kind of education, we defined priorities for the positions to be filled in. At Utrecht University, that resulted in seven new junior positions on our, then three (now four, having added AI & Data Science, ed) themes Algorithms, Interaction, and Intelligent software systems, one of which we decided to fill in jointly with Eindhoven University of Technology.

As a head of department, you are constantly balancing budgets. What plan or ambition are we going to fund from which budget? Although

for the Computer Sciences part of Utrecht University, the sector plan budgets are rather modest in size when compared to the overall departmental budget, the nice thing about them is the freedom to operate that they bring. For example, these budgets allow us to jointly appoint people together with other institutions, which is not that easy with other types of funding. And they offer possibilities to solve some of the bottlenecks we are confronted with, or to invest in upcoming areas of interest.

One of these areas is research into computer science education. What is the best way to teach someone to code or to develop new algorithms? Our Software Technology for Learning and Teaching group is one of the largest in this field in the Netherlands, with a clear and visible impact on both science and society. New hires need to bring in fresh perspectives. And that is exactly what we got with Hieke, not in the least because of her background and extensive practical experience in teaching.'

At Utrecht University, the sector plan funds were used to both relieve the burden of education and invest in research into the best way to teach computer science. Former Head of the Department of Information and Computing Sciences Johan Jeuring reflects on how they decided on where to invest, and assistant professor Hieke Keuning explains how her appointment contributes to keeping ICT students on board.

Hieke Keuning

Assistant professor in the Software Technology for Learning and Teaching group since September 2020

‘Soon after obtaining my Bachelor in Informatics from Hanze University of Applied Sciences in Groningen, I started working as a lecturer in software engineering at Windesheim University of Applied Sciences. As I wanted to expand on my expertise then in addition to my daytime job as a lecturer, I studied for my Master in Computer Science at the Open University. My master’s thesis was about tutoring systems for learning programming. That’s when I got interested in the subject.

When I heard about the NWO Doctoral Grant for Teachers, I applied, and, besides keeping up my job as a teacher for three days a week, I became a PhD researcher. Johan was one of my thesis supervisors, and during my PhD, I visited his group as a guest researcher on several occasions. So when this vacancy came up, briefly before I finished my PhD, I did not hesitate to apply for it.

My research focuses on the question of how to use software techniques such as automatic code analysis and automatic feedback systems to optimise the learning process of computer science students. What kinds of problems do students encounter when they learn, and what tools could help them overcome these? What is the best way to give feedback to them and what should this feedback consist of? How do

students use these types of tools, and what problems do they encounter while using them?

My main aim is to help students learn to write good-quality code. Code should not only do what it is supposed to do but should also be understandable for and maintainable by others. In my research, I mostly focus on the student’s perspective. So what do they think is good code? And how can we use tools to help them see the flaws in their work and improve on them? In addition, from a teacher’s perspective, we look into what is perceived as valuable and helpful feedback and at what moment in time that should be given.

We already know a lot about how to teach courses related to computer science, and how to improve learning experiences. However, we could use that knowledge more in practice. Especially in computer science, we need to keep as many people on board as possible, ranging from the first-year undergraduates who have never written a line of code to those who started coding from a very young age.’



LOGICAL CONNECTIONS

Dirk Heylen

Former head of the Computer Science department and current leader of the Human Media Interaction group at the University of Twente



'At a national level, a series of computer science topics had been chosen that we felt should be reinforced. All of the group leaders from our department came together and discussed which of these topics were most urgent for us. We decided to define positions at the interfaces of existing groups to establish a more coherent research agenda for the department as a whole.

One of the positions we defined aimed to expand our expertise in artificial intelligence, specifically on the knowledge base and reasoning part of it. At the University of Twente, we have many projects related to conversational agents. We put a lot of effort into the graphical design of the user interface, and in collecting data, for example, by automatically capturing and analysing facial expressions and speech to recognise emotions and other social signals. But we had a blank spot when it came to the reasoning component that needs to go in between what an agent recognises and how it should respond.

Birna is now the personal connection between two of our largest projects: the Gravitation programmes "Ethics of Socially Disruptive Technologies" and "Hybrid Intelligence". In addition, she links us to other groups, such as that of one of the other sector plan hires, Giancarlo Guizzardi. It is great to see that our initial idea

of using these sector plan funds to create better connections between our different groups is playing out as planned.

The importance of open schemes like the sector plan funds cannot be overstated. At both the national and institutional levels, setting priorities and developing long-term research strategies is crucial. Over the past few years, new appointments were mainly driven by an educational need due to the steep rise in student numbers. And although I think the growth in student numbers for computer science is a positive development, since society is craving for experts in this field, the fact that we had to pull out all the stops to provide our students with the quality of education they deserve has come at a cost. The funds from the second sector plan will hopefully help to reduce the student-staff ratio to more workable proportions so that our scientists can pay more attention to their groundbreaking research.'

The sector plan funds enabled the University of Twente to establish a more coherent computer science research agenda. Dirk Heylen, former head of the Computer Science department, explains how the interconnectedness between the different groups was improved, and associate professor Birna van Riemsdijk explains how her appointment benefits both her own research agenda and that of the university.

M. Birna van Riemsdijk

Associate professor of Intimate Computing at the University of Twente since November 2019

‘Ever since I received the Dutch Prize for ICT Research back in 2014, I have been waiting for the perfect occasion to spend the prize money. That time has finally come: the starter pack associated with my appointment here at the University of Twente enabled me to develop an out-of-the-box research idea, which would be fairly impossible to fund by other means. That project called “Designing intimate technology through dance” creates a dance performance with intimate technologies to study questions about what it means to be human in a society where people and digital technologies become intimately connected.

When I received the prize, I was working on digital technologies that take personal values into account. Over the years, that research evolved into an entirely new research area which I call intimate computing. With that term, I refer to digital technologies that, in some sense, come close to us in our daily lives. You can think of things like wearables, high-tech clothing, social media, and smart homes. These technologies collect all kinds of information about you, and by doing so, create new human vulnerabilities. How does being confronted with very personal things like your stress levels or sharing those data with, for example, healthcare workers influence you, your behaviour and your relationships with others? How can we identify

these possible vulnerabilities at an early stage of technology development and take them into account in our design? How can we represent users with all their personal and individual features in our computational model in such a way that we do justice to them?

Before coming to Twente, I worked at TU Delft, where the 4TU.NIRICT institute offered support to people who wanted to engage in exchange projects between the four technical universities. Here at the University of Twente, there has always been a strong focus on the interconnectedness of humans and technology. I initially decided to come to Twente for one day a week, but now I work here full-time. Topics like trust between human and machine, ethical aspects of technology development, and cyber-physical systems are well developed here, which means this is the ideal place for me to further develop my research vision. Ultimately, I hope that with my work, I can help build a caring and inspiring digital society that also encourages self-expression.’



BUILDING BRIDGES

Marcel Worrying

Former director of the Informatics Institute and current leader of the MultiX group at the University of Amsterdam



The sector plan funds have helped us to bundle existing, yet rather fragmented, initiatives and strengthen them. By doing this, we've managed to establish firm foundations on which we've built new relationships with the world outside of academia, such as companies, hospitals and municipalities.

As an institute, we decided to define new positions at the interfaces of areas we already excelled in. Therefore most of the first seven sector plan positions are, in one way or another, related to artificial intelligence. That also applies to the research of Thomas, which is centred around data exchange systems and how to make sure we exchange data in the right way. That is a core topic within the field of AI. Furthermore, we invested in combining AI and health, which has already paid off. That interdisciplinary field has grown tremendously, and our relations with Amsterdam UMC and the Netherlands Cancer Institute have intensified. This is reflected in dual appointments of staff and the establishment of joint labs. Similarly, the investments we made in quantum computing have acted as a multiplier. The University of Amsterdam was already highly active in quantum computing, but the Informatics Institute was not. We used the sector plan funds to appoint someone dedicated to the subject. Since then, other groups have also redirected

their research towards quantum computing. As a result, we now have a strong and visible position in that field.

For me, the most important advantage of the sector plan funds was and remains that they help relieve the burden of education. Currently, our student-to-staff ratio is 35:1, which means that every staff member has to supervise 35 master students. In addition, sector plan funds urge every institute to rethink its priorities: In which field do you really want to be at the top of the game? It is good to be forced to think about what you really stand for and in which subjects you want to go the extra mile and offer true excellence. That is especially important in the master phase since that is where you distinguish yourself from other academic institutes. I am very pleased that in the discussions with IPN, we managed to draw a national landscape with different peaks at different locations.'

For the University of Amsterdam, the sectorplan funds have acted as a multiplier on existing initiatives, explains Marcel Worrying, former director of the Informatics Institute at the University of Amsterdam. Assistant professor Thomas van Binsbergen tells how his current position enables him to explore two research directions, which have more in common than one would think at first glance.

L. Thomas van Binsbergen

Assistant Professor Data Exchange Systems at the University of Amsterdam since November 2020

My appointment here in Amsterdam quite naturally followed from the project I worked on as a postdoc at CWI. This joint project between CWI and the University of Amsterdam aimed to develop a data exchange system that automatically takes into account norms like laws, regulations and codes of conduct formalised as code in the eFLINT language. One of the two research lines I am pursuing builds further on this work.

Central to that research are a number of use cases provided by societal organisations such as hospitals and municipalities, for example through the Amsterdam data exchange project. We want to design a reconfigurable system that enables the different participants in a data-sharing consortium to take control over which parts of their data they share and under which conditions, and that is compliant with and adjustable to the relevant laws and regulations. The system should bring together existing technology for data sharing and, depending on the case-specific requirements, will be reconfigured to select an appropriate technical solution. To realise this, we need to translate all of the legal requirements into software specifications. Though that may sound rather straightforward, it involves many challenges in practice. For example, legal documents are subject to interpretation, which is something that software finds hard to deal with, and legal obligations are difficult to enforce.

My second line of research, the PPlanCompS project, is more theoretical in nature. Together with a PhD student, I am studying commonalities in the semantics of programming languages. There are hundreds of different programming languages. Most of these share high-level characteristics, such as ways to structure data or the notion that variables are subjected to rules about when they are available. We decouple the syntax of the languages from their semantics, seek fundamental constructs of languages, and provide mathematically sound descriptions of those. The project has produced a library of fundamental constructs. This work can be used to construct new languages, improve programming environments, or prevent code from turning into legacy code.

Legal documents and programming languages have a lot in common. For example, they are both extremely structured, and rely on correct cross references. I love the interaction between fundamental theory and practical applications in my work. It would be great if the concepts I develop end up in applications that help professionals in public organisations, or in methods to develop new programming languages and programming environments that people without a background in computer science can also use.'



GETTING A HEAD START

Aske Plaat

Former Scientific Director of LIACS, current Professor of Data Science at Leiden University



The first time informatics was mentioned as one of the sectors to receive sector plan funds, the news was extremely welcome. All over the country, student numbers were going through the roof. Here in Leiden, we spent a good half year developing a coherent set of plans for all four sectors that were to be stimulated with funding back in 2018. For computer science, this resulted in six new positions.

We decided to divide the funding over topics that are either at the basis of informatics, like programming languages and theoretical informatics, or upcoming, like the combination of artificial intelligence and reasoning. With Nele's appointment, we followed up on a recommendation made by an external visitation committee. They observed that our education on cyber security in the bachelor could use an impulse. The sector plan funding made it possible for us to fill in that void. At the time we hired Nele, we had one assistant professor on the topic. And now, only three years later, the group has grown into one of the biggest of our institute, with some thirty members.

Not only for our institute but also for the Netherlands as a whole, the sector plans have resulted in an important rejuvenation and reinforcement of scientific staff. In the eight years that I've been a scientific director here we have

more than quadrupled in terms of staff, partly as a result of the sector plan funds.

And we have been able to strengthen the foundations of the discipline and to explore exciting new directions. With the positions we've created in quantum technology, machine learning and large language models, we've been able to get ahead of the troops in emerging fields. When we wrote the plans, large language models weren't that much of a subject. And now, we have a dedicated group with two full professors working on it, and even society is aware of the importance of this topic with applications like ChatGPT.

The sector plan funds have enabled us to determine a strategic line and build a coherent workforce. Computer science is a relatively young but fast-growing scientific discipline. Investments like these are crucial to not only keep up with the growth but to also get ahead and set the agenda of future technology development.'

Aske Plaat, Former Scientific Director of the Leiden Institute of Advanced Computer Science, explains how the sector plans funds have enabled the institute to strengthen the foundations and take a head start in promising new developments. Professor Nele Mentens illustrates this by explaining how her appointment kickstarted the fast-growing new security branch for the institute.

Nele Mentens

Professor of Applied Cryptography and Security at LIACS since June 2020 and Professor of Embedded Systems & Security at KU Leuven

'Ever since I visited LIACS for the first time, I have really liked its open atmosphere. As I saw ample possibilities for interesting collaborations between my group at KU Leuven and the people in Leiden, I applied as soon as a vacancy came up.

My research is aimed at hardware security and embedded security. The leading question is how we can efficiently secure small devices and make chips with built-in efficient and cost-effective cryptography. For example, I develop practical security solutions for Internet-of-Things devices that take into account factors such as energy usage, performance and cost of goods of the device. Nobody will use a smart coffee machine that has become ten times slower due to security measures or a mobile device of which the battery is draining too fast due to cryptography procedures.

Over the past three years, I have been involved in several joint project proposals with other groups here. Currently, I am working on two projects that combine several strengths of the institute. In one project, we are looking at chips that execute artificial intelligence algorithms. In a traditional cryptographic chip, side-channel attacks, for example, measuring the power consumption or time duration of specific proce-

dures, are used to discover secret data. In AI chips, however, the architecture is often a valuable asset for the owner and therefore needs protection. We want to know what kinds of side-channel attacks can be used to acquire this information so that we can develop efficient countermeasures.

The second project is about remote updates and reconfigurable chips. How can we ensure that the configuration that must be uploaded is free of viruses and malware? And how can we identify components in the software that can damage the chip, for example by drawing too much current?

My appointment here in the Netherlands provided me with an inspiring extra working environment and made it a lot easier for me to collaborate with other Dutch knowledge institutions. For example, just after I came here, the PROACT project was awarded, which is a collaboration with Radboud University and Riscure. This project allowed me to hit the ground running in my new job and has meant an important impulse for our Systems and Security group as a whole.'



EVOLVING TOGETHER

Johan Lukkien

Former Dean of the Department of Mathematics and Computer Science and current Professor of System Architecture and Networking at Eindhoven University of Technology



'When the first round of sector plan funding was announced in 2018, I was dean of the department and, as such, very concerned about the workload of the research staff. We had adopted data science as a developing research field at a relatively early stage and defined both bachelor's and master's programmes together with Tilburg University. The educational burden on our staff in that field was way too high – they barely got to conduct their own research. Student numbers in computer science and these newly developed data science programmes had increased rapidly: bachelor's intake in computer science had tripled, and master's intake had doubled since 2012. On top of that, the overall increase in student numbers in Eindhoven added to the workload of our staff, as the department provides quite some general bachelor courses.

At the moment the sector plans were submitted in 2019, we had already created a broad hiring for 4 positions in computer science and data science. The additional 8 positions for these fields that we could finance from the first sector plan round restored the balance somewhat. Computer science and data science growth continued, leading to a second round in 2021. I found the fluent and productive cooperation among the different universities and the lead-

ership of IPN in developing the plans remarkable.

In addition to providing the research staff with some more freedom to operate, the sector plan funds also enabled us to strategically establish new connections between the individual research themes by appointing people at the intersections, for example between data science and security. The funding of joint positions with Utrecht University in the first round was special and strengthened the collaboration.

All in all, together with the new hires we had planned ourselves already, both rounds of the sector plans have resulted in a substantial influx of new people, both in junior and in more senior positions. This has done the department a lot of good. It has been very stimulating to bring in new people with their own, often international, backgrounds, networks, ideas and visions, like Jacob. Computer science as a field is young and rapidly changing. The new positions we have managed to create over the past six years enabled us to contribute to fascinating new developments.'

Eindhoven University of Technology used the sector plan funds to strategically establish new connections between the individual research themes by appointing people at the intersections, says Johan Lukkien, former Dean of the Mathematics and Computer Science Department. Jacob Krüger tells how his research interlinks different themes within the group he joined.

Jacob Krüger

Assistant professor of software engineering at Eindhoven University of Technology since September 2022

‘After obtaining my Master in Business Informatics from the Otto-von-Guericke University of Magdeburg, I pursued a PhD on the implementation of large, customisable software platforms at the same university. One factor that is vital for the quality of the final software solutions turned out to be the knowledge of the developers involved. For me, that human factor was the most interesting part of the work. That is how I got hooked on the topic of human aspects in software evolution.

Through my PhD research, I got to know people from the Software Engineering and Technology group at Eindhoven University of Technology. This is a very diverse group that conducts research very close to my interests. So when they heard that I was looking for an exchange project, they notified me about a job opening at their group, which I successfully applied for.

The common thread in my research is software evolution and how that impacts the humans involved. I focus on developing variant-rich systems, such as fork-based software platforms, where forks arise when developers take a copy of the source code and start independent development on it. These systems typically become very complex, containing hundreds to thousands of forks. This makes it hard to get an

overview of how individual forks evolve and to determine how and when to synchronise them. My research focuses on questions like: How can developers understand what is happening? What do they need to know to successfully evolve the software and maintain a high overall quality? How do they interact with each other and with external stakeholders to translate requirements into implementations? Though my primary focus is scientific, we also develop tools to simplify workflows or help automate the integration of individual forks.

My ambition here is to establish my own line of research on the role of developers’ cognition in software evolution, intersecting with and adding to the other research lines in the group. For example, together with Loek Cleophas, I am currently looking into possibilities of using visualisations that can help compare forks or groups of forks. And the studies by Alexander Serebrenik into social aspects of software engineering and by Michel Chaudron into software architecture are great sources of inspiration for my work.’



DECISIVE IMPULSE

Mark Winands

Chair of the Department of Advanced Computing Sciences at Maastricht University



'For us, the first sector plan round came exactly at the right time. We had just combined all of our natural sciences and engineering efforts into a dedicated Faculty of Science and Engineering, and as such had established a connection with the national organisation of science faculty deans.

Until that time, computer science as a discipline was not very visible at our university, since our work in the fields of artificial intelligence, data science, computer science, applied mathematics and robotics used to be accommodated by two different departments. We did have a strong track record in data science and AI though. The sector plans forced us to rethink and refine our mission and vision when it came to research in these fields.

We decided to open up two senior positions and supply some additional funding for the new hires to start their own groups. One of these positions is related to data fusion and intelligent interaction, and the other position, which we hired Nava for, is oriented towards explainable AI. Explainability is a strong theme at our university, and we wanted to give a boost to research into explainable, human-oriented systems. While searching for the right candidate for this position, I went to the SIKS research day. There, Nava was one of the keynote speakers.

After her talk I turned over to my colleague and said: "We have found her". Nava was and is the perfect match with what our department needed and wished for.

The sector plan funds have put us as a relatively young department on the map, not only within our own university, but also on a national level. For example, through Nava, we have now established two of the three ICAI labs here in Maastricht, and our department has managed to establish closer connections to other groups within the university.

Developments like these are not only important for the university but also for our region as a whole. Maastricht University is at the heart of the Euregion Meuse-Rhine. Many of our students end up in companies in the region. I am afraid that with the current plans to cut down on sector plan funding, the process of building and strengthening a strong regional IT ecosystem here in the south of the Netherlands will come to a screeching halt.'

Sector plan funding is instrumental in building a regional IT ecosystem, states Mark Winands, Chair of the Department of Advanced Computing Sciences at Maastricht University. So far, the sector plans created critical mass on several topics that are important for the Netherlands and Dutch society, like explainable AI, adds Nava Tintarev, Professor in Explainable AI and Director of Research at the same department.

Nava Tintarev

Professor in Explainable AI at Maastricht University since October 2020

'I have been working on explainable artificial intelligence ever since obtaining my PhD. When Maastricht University decided to dedicate part of the sector plan funds to a chair on human-centred explainable AI, that was a perfect match for me. I have a rather unusual approach for a computer scientist, since I include user studies in my research. I generate explanations and then evaluate the efficacy and efficiency of these explanations. How helpful are explaining systems to end users? Do the explanations given help them in making good decisions?

One of the topics I am currently working on is related to filter bubbles and fake news. We are developing ways of making people aware that they are consuming information that is skewed. We started off by diving into disputed, yet relatively "safe" topics like school uniforms and intellectual property. We built explanation interfaces to create awareness about viewpoints and stance: is certain information more in favour of the topic or more against, and why is that the case? My ambition is to help people who want to be aware of their biases take note of alternative viewpoints. Not to persuade them, but to show the plurality as a countermeasure against polarisation.

The two things I like best about Maastricht University are the team-science-minded way of working, and the fact that it is a general univer-

sity, allowing me access to the social sciences and humanities.

In addition to managing my own group, I am also part of the department's management team. As I have worked in different groups in different countries over the course of my career, I can make a valuable contribution to the team. My main aim as research director is to support early career researchers, for example in writing and pitching grant proposals.

Overall, the sector plan position has been decisive for my career, since it allowed me to start my own group and move my research agenda forward. But also nationally, the impact of this type of funding is huge. The first sector plan round created critical mass on several topics that are important for the Netherlands and Dutch society, like explainable AI. And it has done a lot in terms of increasing diversity. For example, here in Maastricht, the sector plan has directly resulted in a growth in the number of female (associate and full) professors.

The fact that the sector plan funds are now under debate will have significant consequences. It will limit our capacity to grow and keep up with developments in fields like AI with the associated risk that we will fall behind in comparison to our neighbouring countries. We cannot let that happen.'



ROOM FOR BLUE SKY RESEARCH

Arjen de Vries

Professor of Information Retrieval and Research Director of the Institute for Computing and Information Sciences at Radboud University



'Serendipitous findings are crucial to developing really new things. However, this type of blue sky research is hardly funded anymore. If you focus your research on just today's applications, you miss out on tomorrow's challenges and opportunities. The sector plan funds allow us to explore these types of new routes.

As we are not a very large institute, we wanted the entire organisation to benefit from the new hires. We therefore aligned the new positions with the strengths we already had in our three research themes Software Science, Digital Security, and Data Science. Furthermore, we wanted to enhance our expertise in human-computer interaction in Nijmegen. Therefore, in the first sector plan round, we hired two junior researchers on that topic, and in the second round, we managed to get Roel to join us as a full professor. All in all, the sector plan funds allowed us to grow quite a bit, from approximately 35 FTE to about 45 FTE.

We decided not to draw up compelling vacancies but to focus on the people instead. We were mainly interested in what ideas they brought to the table and what their added value would be to our existing expertise. Thanks to the new hires, cross-overs in topics have arisen, such as software verification and AI. Now, we are also working on a new master's programme that combines AI and security.

I think our special welcome meetings, where all new hires got to know each other, really helped. Another plus point is the Interdisciplinary Hub for Digitalization and Society in Nijmegen. That brings together computer scientists with legal, ethical, psychological and philosophical experts, broadening our researchers' horizons.

Unfortunately, much of what we were able to build up is starting to fall apart again. Personnel appointed during the first sector plan are now part of the permanent budgets, and those are being cut. When someone leaves, I can no longer fill that vacancy. It troubles me to see how all the good things we so carefully built up are now being made undone.'

The sector plan funds allowed Radboud University Nijmegen to bring in new staff who could add to their existing expertise, says Arjen de Vries, Research Director of the Institute for Computing and Information Sciences. This opportunity convinced Roel Vertegaal to return to the Netherlands after having worked overseas for 25 years.

Roel Vertegaal

Professor of Human-Computer Interaction at Radboud University since May 2024

I left the Netherlands 25 years ago because of the then prevailing climate for my field, interactive technologies. Research into these types of systems – like a computer mouse or a touch-screen – was much more advanced and better funded in the US and Canada. About two years ago, the situation seemed reversed: with Robbert Dijkgraaf as the then Minister of Education, Culture and Science and investments in science such as the sector plan funds, the climate here seemed more favourable than that in Canada. As I had been wanting to return for a while, the time seemed ripe to move back.

Although I do not regret my decision, the situation here has now completely changed. Substantial cuts have been made in budgets for science and arts, which form an important source of inspiration for academics. That makes it harder for me to acquire the funds I need to expand my team.

My research is about novel interaction techniques. For example, I invented the foldable smartphone. This technology is now in the hands of billions of users. Such inventions all start with simple, long-term ideas. Take bending as an interaction technique. We wanted to add a third dimension to the two-dimensional movement of a mouse or a touch screen so that users could navigate information more efficiently.

Generally, computer systems use only a limited part of our human interaction capabilities. In the Human Media Lab, which moved with me from Canada to Nijmegen, we are looking for richer ways to communicate with each other, with the ultimate aim of better communicating through and with digital systems. Right now, we are working on models that allow us to implement new findings from neuroscience about how people perform tasks. We are modelling the information transfer required in human tasks, ranging from moving your hand to conducting more complex tasks.

In essence, all of our human actions come down to information-processing tasks. In my group, we develop new user interfaces to acquire and process that information, for example, in wearable computers that automatically assist you in everyday tasks. That type of research fits well with the data science expertise of the computer science institute as well as the neuroscientific work at the Donders Institute for Brain, Cognition, and Behaviour here on campus. Our work aims to develop cheap, private, wearable, real-time artificial intelligence that everyone can use in their everyday tasks. As a society, we need to support such work on future breakthrough technologies.'



EMPHASIS ON THE HUMAN SIDE

Stefan Schlobach

Head of the Department of Computer Science at VU University



'In recent decades, computer science education has grown tremendously. We now have four times as many students as twenty years ago. Unfortunately, we were not able to hire enough new talent to meet the growing need for education. As a result, our staff hardly had enough time to be competitive, let alone to develop new out-of-the-box ideas.

The sector plan funds represented a structural investment in Dutch computer science expertise, bringing a more stable perspective that is necessary to foster creativity. In the two successive sector plan rounds, our department was awarded a total of 14 new positions. We not only used these to fill the gaps and reinforce the relationship between research and education, but also to strengthen the fields we had already established a position in and enrich them with a human-oriented angle.

We deliberately invested in the socio-technical side of computing, resulting in new collaborations and interesting crossovers. For example, we created a position on privacy and security for AI systems, thus linking our foundational security group to our AI-oriented work.

Since many of our new hires are internationals and female, the diversity among the staff has definitely increased, which also contributes to

the creativity. In addition, the composition of our staff now better matches that of our international student population.

The sector plans have brought our department a more stable perspective, also for the longer term. For example, we invested in the human side of artificial intelligence in connection with the NWO Gravitation programme Hybrid Intelligence. That is a temporary, ten-year programme. By linking new permanent positions to it through the sector plan funds, we have ensured that when the programme ends, we can continue building further on its results. Without the sector plan funds, there would have been no guarantee that the Hybrid Intelligence work could be continued. What's more, the people-oriented side of security research that is now well established at VU University would not have been there at all. And since we were able to solve certain bottlenecks with the sector plan funds, we could use our existing budget to invest in other areas as well. For example, we managed to strengthen our commitment to massive computer systems, and we made room for topics like digital sustainable societies and bioinformatics. All in all, we have achieved critical mass in a variety of subject areas, which will keep bearing fruit for decades to come.'

By linking new permanent positions to temporary projects, VU University used the sector plan funds to create stability in its computer science research, explains Stefan Schlobach, Head of the Department of Computer Science. Emitzá Guzmán, assistant professor at his department, tells how she values the possibility to continuously reinvent herself and stay relevant.

Emitzá Guzmán

Assistant Professor in Socio-technical Systems at VU University since July 2019

‘After obtaining my PhD at the Technical University of Munich, I went to Zurich for a postdoc. Since I do applied research, I wanted to gain a better understanding of our field in practice. So, I found a job in industry. Even though I really liked my work as a data scientist, I soon realised that my place is in research. Being an academic enables me to continuously reinvent myself and to remain relevant throughout many hypes.

My PhD research was about socio-technical problems in software development. What attracted me to the position here in Amsterdam was that I did not have to sneak in the social part; from the start, the job was open to taking the human angle to computer science.

My work roughly focuses on two areas. The first is about understanding the organisation and dynamics of software teams, and how those affect the software they deliver. How, for example, do micro-inequities, like constantly getting eye rolls or being interrupted, impact people and their performance and, in turn, the software they design and develop?

My second main area is on ethical issues in software from an end-user perspective. We answer questions like: What are users worried about when working with software like social media, productivity apps, or games? We conduct inter-

views, design and distribute surveys, and look at texts online, for example, in the App store or in Reddit reviews, to take stock of what people have to say about privacy, content moderation and discrimination in software platforms, and their environmental impact. With automated approaches that use AI and general statistical methods, we analyse, classify and prioritise how these concerns change over time.

We do not take just a Western point of view, but also include concerns of marginalised or minoritised groups and countries from the Global South and the Middle East. It is very interesting to see how local cultures influence the ethical concerns users have. For example, privacy is of a much higher concern in Germany than in Pakistan, where people are used to sharing one phone among family members. I would like to continue my research into ethics and team dynamics, and analyse how both are connected. In the future, I would like to extend this work to include policymakers and make suggestions for change. When it comes to ethical concerns about software, we are only scratching the surface. There is so much more work to be done on the topic.’



BOLD CHOICES

Alan Hanjalic

Head Department of Intelligent Systems and co-leader of Computer Science at TU Delft



'In Delft, our computer science activities are divided over two departments. The first sector plan offered us the opportunity to open ten scientific staff positions across both departments combined. This opportunity inspired us to define five overarching themes, building on diverse expertise and synergistic potential, and aiming at clear joint positioning not only within the Dutch computer science landscape, but also internationally. This has led to more cross-departmental collaboration and strengthened us internally as an organisation. We were happy to see this reflected in the feedback we received in the last mid-term research assessment, which we underwent jointly as a computer science entity rather than as individual departments, like in the past.

Whereas the first sector plan was aimed at strengthening science, the second was more broadly intended to provide the computer science sector with greater peace and space. The main value for us in this was the possibility not only to appoint scientific staff but also to hire a number of software engineers. With additional investments from our Faculty of Electrical Engineering, Mathematics and Computer Science, this resulted in our current pool of 12 engineers who support software development for our research projects, and manage, maintain, and expand our computer science

research infrastructure. These engineers form a structural part of our organisation, the Research Engineering and Infrastructure team, serving both departments.

Establishing this team paid off in many ways. Not only do we have in-house capacity to address increasingly complex software and infrastructure needs across different research projects, but the services the team offers also enhance our international attractiveness as an academic employer. High-quality support is nowadays just as valuable for applicants for faculty positions as the individual benefits, like salary. All in all, we strongly recommend that, should there ever be new sector-plan-type investments, room be made to fund profiles beyond just scientific staff.

It goes without saying that any new investments in our field should also align with the Wennink report, which identifies many strategic domains in which computer science expertise, especially regarding digitalisation and AI, plays a critical role. For Dutch computer science to flourish and contribute in the best possible way to the national development strategy, we need the entire ecosystem surrounding it to be on par. This means, for example, that as a field, we should have access to top-of-the-bill computing infrastructure.'

TU Delft used the sector plan funds to embark on entirely new paths. Alan Hanjalic, co-leader of Computer Science at TU Delft, explains how the second sector plan round helped establish a pool of software engineers who have significantly contributed to the research and valorisation impact. Rihan Hai, Assistant Professor of Web Information Systems, explains how the sector plan funds enabled her to take a bold leap into the unknown.

Rihan Hai

Assistant Professor of Web Information Systems at TU Delft since January 2022

‘During my PhD research at RWTH Aachen I was building software and mathematical foundations for data lakes: collections of heterogeneous data from different sources. In 2021, I came to Delft as a postdoc to expand on this work. When a position for an assistant professor opened, I seized the opportunity to build my own team, which now comprises four PhD students and one postdoc.

Over the past five years, I have been developing an entirely new research direction. I want to understand how we can apply data science knowledge to improve AI and quantum computing, and vice versa.

My first line of research in this direction is to leverage the power of databases to improve the accuracy and speed of artificial intelligence. For example, when you are using large language models on edge devices like smart watches, you cannot use computing methods that are based on large matrices, since they simply do not feed into the available memory. We are advancing “out-of-core” methods that let very large AI models run on limited memory by processing them piece by piece instead of loading everything at once.

In my second line of research, I am combining quantum computing with databases. For example, by representing quantum computation as data, we can use database theory and technologies to make quantum computation analysable and scalable on classical hardware. With existing simulation methods, you might need petabytes of memory to simulate fifty qubits. By using out-of-core methods, we hope to significantly reduce memory usage and lower hardware restrictions in simulations. This second line of research is still in a conceptual phase; we are currently thinking about what a future quantum database would look like.

As a database researcher looking to collaborate with the AI and quantum computing communities, Delft is the perfect location for me, with the TU Delft AI Initiative and QuTech around the corner. Ultimately, I want to do good research with people who share similar interests. The sector plan funding has made me more creative and productive, and has helped me open new windows into interesting cross-overs that might benefit multiple disciplines. I have made some bold choices in pursuing these high risk, high gain research directions. But the sector plan funds made me feel safe enough to do this.’



SECTORPLAN POSITIONS ROUND I AND II (IN FTE)

University	Academic positions I	Academic positions II	Related positions II
Delft University of Technology	10	6	8
Eindhoven University of Technology	8,5	7	1
Leiden University	6	2	3
Maastricht University	2	3	0,5
Radboud University	6	3	0
Tilburg University	0	4	0
Open University	0	1,6	0
University of Amsterdam	7	7	0
University of Groningen	6	4	0
University of Twente	6	5,3	0
Utrecht University	6,5	6,3	1
VU University	6	7,2	0
Wageningen University & Research	0	2	2
Total	64	58,4	15,5

Sources:

Advies over besteding beschikbare sectorplanmiddelen 14/06/2019

Voor een sterker fundament - sectorplan beta II, maart 2023

In 2018 and 2022, the Dutch government made a targeted investment in the foundations of various scientific sectors by means of the sector plan funds. Over the past years, IPN has published a series of interviews in its I/O Magazine about the impact of the sector plan funding on the Dutch universities with a computer science division. This booklet presents the collection of those stories.

