INNOVATIONS FOR A **FUTURE-PROOF WAY OF WORKING**

TNO KNOWLEDGE INVESTMENTS
WORK

TNO innovation for life

OVERVIEW

INNOVATIONS FOR A FUTURE-PROOF WAY OF WORKING

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This link will redirect you to **another segment** within this brochure

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CONTENT

FOREWORD

INNOVATIONS FOR A FUTURE-PROOF WAY OF WORKING

The world of work is changing at an ever-increasing rate. Digitalisation, with the COVID-19 pandemic as a catalyst, climate change and demographic developments are causing shifts in the labour market. Some jobs are changing, others are disappearing and new jobs are taking their place. These changes offer opportunities, but are at the same time resulting in new health and employability risks and a looming segregation.

TNO is developing knowledge, substantiated interventions and a vision that will strengthen the labour supply and increase the responsiveness of the labour market. The ultimate goal is a future-proof labour market, featuring high-quality work. In our projects, we work with multidisciplinary teams to find solutions at the level of the individual, the organisation, ecosystems (including regional ecosystems) and society as a whole. When designing solutions, we combine insight in the human factors and technical, organisational and data sciences. We also link this combination of insights to practical experience, by carrying out projects in collaboration with public and private partners in the form of pilot projects, Fieldlabs, Living Labs and other experimental environments. We do so in the sure and certain knowledge that human capital and social innovation are critical to successful innovation. The central element in these processes is therefore our participatory approach to each and every stakeholder, which maximises the chances of successful implementation. The benefits include specific innovative tools that can help jobseekers, employees and companies in their day-to-day practice. In this way, we are paving the way for the future of work in The Netherlands.

In this brochure we present a number of engaging knowledge investment projects carried out in the TNO strategy period 2018–2021. The knowledge programming in this strategy period comprised three main themes, focusing on three social challenges:

1. Inclusive work: how do we ensure that more people find and remain in meaningful and sustainable employment?
2. Sustainable work: how can people, in all stages of life, work longer productively and in good health?
3. Future of work: How can we ensure that people and organisations are well prepared for the labour market and the future of work?

These three main themes have been fleshed out with structural information by collecting high-quality data from employees, the self-employed and employers (see monitorarbeid.nl).

A number of projects have also been initiated in response to the COVID-19 pandemic, three of which we will highlight in this brochure: a project that looks at hybrid work models, the Care and Welfare Transfer Point and the NEA-COVID-19 survey.

In the new strategy period (2022–2025) we will continue to focus on innovations for healthy and sustainable work and an inclusive and adaptive labour market. This will involve an even greater number of projects at the interface of artificial intelligence and work. There will also be a greater focus on foresight studies and system innovation, in particular the innovation of the labour market itself: a crucial step in facilitating the major societal transitions The Netherlands is currently undergoing. Helping people understand the future of work.

We hope you enjoy reading this brochure and that it gives you plenty of inspiration!

Seth van den Bossche
Head of the Work & Health knowledge programme

Steven Dhondt
Head of the Smart Working knowledge programme

Wouter Fransman
Head of the Safe Chemical Innovation knowledge programme

FOR MORE INFORMATION

TNO Strategy 2022–2025

Go to Monitoring of Labour

INCLUSIVE WORK

An integrated approach to a more inclusive labour market

The driver behind the advancement and intake of people trained in practical skills

Exoskeleton supports workers during heavy work

Inclusive technology helping more vulnerable people to find work

Shared decision making: empowering jobseekers with healthcare knowledge

Work contributes significantly to one's sense of belonging to society. That is why TNO, together with its partners, is working to promote an inclusive labour market. We are doing this with the aid of technology such as the exoskeleton, the use of jobseekers' experiences in 'De Startmotor Rotterdam' and a pilot project on shared decision making in the work and income domain.

AN **INTEGRATED APPROACH** TO A MORE INCLUSIVE LABOUR MARKET

Work is important for people: it offers security, challenge and meaning, and contributes to our health. Even in times of tightness on the labour market it isn't a given that everyone will find work or stay at work. Expertise and innovation are enormously important if we are to improve sustainable employability and employment rates for those who have a distance to the labour market.

Through this Inclusive Work programme, We are exploring ways in which we can support people who have a vulnerable position in the labour market – from looking for work to staying in work on a long-term basis. We are doing this by working with effective approaches developed for re-integration professionals which stimulates a systematic, transparent and purposeful guidance for job seekers. However, it does not only revolves along the realisation of enhancements in practice. It also involves the willingness and the ability of employers to obtain and sustain persons with a distance to the labour market. Technique could be helpful. The commitment on the workfloor of innovative inclusive technologies like augmented reality, exoskeletons or for example robots, gives people with a disability new chances on the labour market.

COMBINING SCIENCE WITH PRACTICE

"With due pride we are looking back at what we have achieved together the past couple of years in collaboration with our partners, like several large and small municipalities, SAM, Divosa, the Vereniging Nederlandse Gemeenten, companies, trainers, knowledge institutes and technology developers. It has been inspiring developing approaches with our partners in which practical performance knowledge of professionals was combined with TNO's scientific knowledge" says Projectleader Astrid Hazelzet. "In the interactive brochure 'Op weg naar Inclusivië', we take our readers and viewers on the journey we have traveled within the framework of the knowledge programme Inclusive Work. We also present the knowledge and approaches we have developed together with our partners."

WEIGHTED CUSTOMISATION

Coaching en guiding of (longterm) homeless job seekers enquires craftmanship. Professionals need room to do what is necessary for individual clients, without leading to arbitrariness. Together with a few municipallities TNO has developed a shared assessment framework. This is an instrument with which the professional can weigh the obstacles and possibilities of the individual client, to be able to come to the best fitting route for them which can be evaluated afterwards to see whether the chosen route was effective enough. "The formation of the 'Weighted Customisation' Community of Practice, which consists of seven municipalities, the professional association SAM, Divosa, TNO, universities of applied sciences and Tilburg University, is an entirely new way of collaborating in the work and income sector", says Astrid Hazelzet.

"The aim of the Community of Practice is to better share, develop and implement existing knowledge, which in turn raises new knowledge questions relevant to the field of work and the curriculum of the participating universities of applied sciences."
We also need to mention the Deciding Together (Samen Beslissen) approach in this context. This approach accommodates reintegration professionals with their collaboration with their client. This leads to the client's needs and experiences being fully reflected."

QUESTIONNAIRE INCLUSIVE BUSINESS

When it comes to stimulating inclusive business practices, we already know a thing or two about the factors associated with the desire and the ability to employ and retain people who have a distance to the labour market. Based on these insights, we developed the Inclusive Business Practices Questionnaire (VIO). The VIO distinguishes between intention (wanting to offer work to the people from target groups) and the behavior itself (actually offering work). Companies can, with the help of the Employer Service Point (WSP), fill out the VIO. The scores on the factors that can and will be able to influence it are presented directly on a dashboard. According to a 'traffic light system', they can see at a glance what they can work with and follow advice on how to tackle this. For companies that say they would like to become more inclusive but do not know how, we are exploring how new technologies can be used both to optimize work processes and to make work more accessible for people on the sidelines of the labour market. The VIO is scientifically researched and deployed in labour market region Helmond-De Peel.

INTEGRATED APPROACH

"Startmotor Rotterdam" is a good example of a project where different innovations – developed in collaboration with multiple stakeholders – are tried out together to stimulate the throughput and influx of practically skilled workers. This has led to the blue print 'de Motor', a plan to redesign the integrated development-oriented approach of the labour market in Rotterdam-Zuid.

THE FUTURE

The task of making The Netherlands more inclusive currently features high on the political agenda.
"At TNO we are intensively working on this for over more a decade, and we are very driven to keep going" says Astrid Hazelzet. "The development, customization and successfully scaling up of initiatives that are proven to work, is a challenge. There is no single route to the solution, which is why we are trying to work with a team consisting of approximately 25 TNO experts operating in different knowledge areas and with a diversity of stakeholders to work on solutions. How to build these ecosystems and under what conditions cooperation is sustainable and has an impact within them is an important question that we want to answer in the coming strategy period. Thanks to our expertise in sustainable employability, issues affecting the lower end of the labour market, effective interventions that bring people closer to the labour market, technology and social innovation, we are ideally placed to tackle this complex challenge."

MORE INFORMATIE

- More about the *Inclusive Work* programme
- More about meaningful and appropriate work with technological support
- More about using technology for inclusive work
- Read more about De Startmotor in the article *The engine behind the advancement and intake of people trained in practical skills*
- Or read more on the *Deciding Together* (Samen Beslissen) approach
- The regional labour market analyses in the Helmond-De Peel region by VIO

THE MOTOR BEHIND THE ADVANCEMENT AND INTAKE OF PEOPLE TRAINED IN PRACTICAL SKILLS

Over the past two years, TNO, in collaboration with companies, educational and knowledge institutions, has been exploring how the labour market for people trained in practical skills in Rotterdam-South can be activated, thus offering more opportunities to both employees and jobseekers. Sustainable employability and talent development are major challenges, given the prevailing socioeconomic climate in Rotterdam-South (high unemployment and a large percentage of people trained in practical skills but with little perspective or career development). 'De Startmotor Rotterdam', an exploratory, research and design project in one, looked at how companies can offer development perspectives to people trained in practical skills. This led to the 'De Motor' blueprint: a plan to redesign the labour market in Rotterdam-South through an integrated development-oriented approach.

FROM STARTER MOTOR TO RUNNING MOTOR

The idea behind 'De Startmotor Rotterdam' and the follow-up project 'De Motor' is unique. The underlying concept is that investing in the development of workers trained in practical skills ensures that these workers add value to their company and/or can progress to other work. This, in turn, creates opportunities for unemployed people to get a job in that company. This 'chimney effect' is vital to generate greater mobility at the bottom of the labour market, while creating added value for all stakeholders. "Through the 'Startmotor' project, we have worked with all stakeholders to analyse the ecosystem. This has resulted in the blueprint: the manual explaining how we can work together with all stakeholders to achieve the chimney effect. Each based on their own role as employer, trainer, municipality or social organisation, but also based on the power of joint action. The Motor was launched in June 2021. The plan is being put into practice and tested step by step, so now the Motor is really running!" says Marloes van der Klauw.

UNLOCKING POTENTIAL THROUGH AN INTEGRATED APPROACH

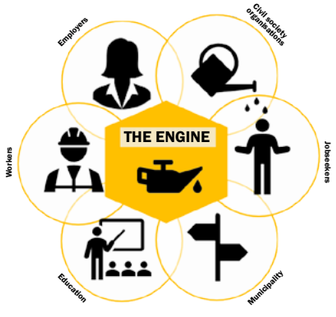
Many people trained in practical skills have more to offer than they are able to put to use in their current jobs. They also have the ambition to grow and develop. If this drive and these talents go unrecognised, both by the employer and by the worker or jobseeker, upward mobility is blocked with all the resulting consequences: less motivation, less productivity, more absenteeism and fewer entry-level jobs. "To stimulate upward mobility, a system intervention is needed: an integrated approach that includes a wide range of aspects of development, both in formal education and in workplace learning. And that is exactly what we are trying to achieve with the Motor and the partners in Rotterdam-South. There are a surprising number of initiatives in Rotterdam. We want to connect these and new initiatives with the Motor to optimise the synergy between them. We are doing this by experimenting with advancement and intake in small steps and in a small-scale setting in a Living Lab," explains Marloes Vooijs.

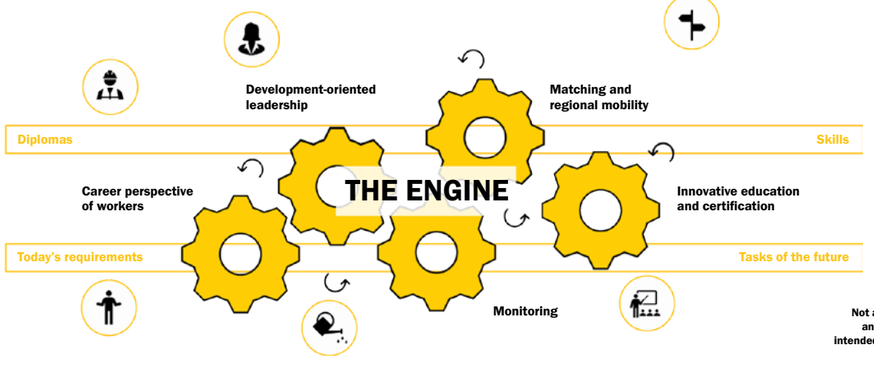
GEARS & THE OILMAN

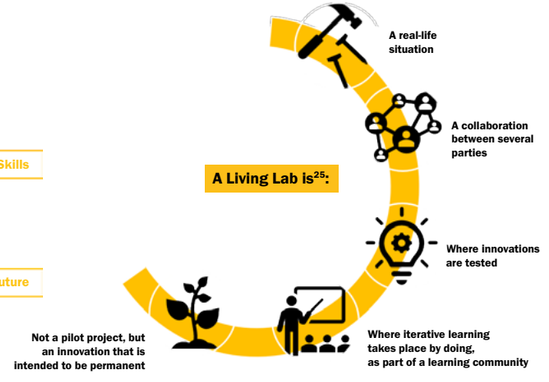
The Motor consists of five fundamental mechanisms, or gears, that reinforce each other to make the Motor run: 1) development perspectives of employees and jobseekers, 2) development-oriented management and guidance, 3) innovative education and recognition, 4) matching and regional mobility, and 5) monitoring. In each of these cogs, there is a role for employers, educational institutions, the municipality, civil society organisations, employees and jobseekers in Rotterdam-South. To get the Living Lab moving and connected, there is a Motor Team that acts as a mediator and, together with partners, keeps the Motor running. Within the integrative gear mechanism, the focus lies on skills and the craftsmanship of the future. Shifting the focus to skills rather than diplomas alone means that people trained in practical skills will have more opportunities in the labour market. Because work is also rapidly changing, it is necessary to focus right now on the tasks and skills of the future. By looking ahead together, employers, employees and educational institutions can safeguard the craftsmanship of the near future.
"There is enormous potential, we need to unlock it. Doing so benefits everyone, from workers trained in practical skills, jobseekers and employers to educational institutions, the municipality and civil society organisations," concludes Marloes van der Klauw.

FOR MORE INFORMATION

- View the 'De Motor' Blueprint
- Listen to the podcast episode *How can we improve movement within the labour market?* on Soundcloud
- Watch the 1.5-minute video *De Startmotor – contributing to employment*







EXOSKELETON SUPPORTS WORKERS DURING HEAVY WORK

In professions that are physically demanding, overexertion poses a real risk of injury. This risk can result in low productivity, incapacity or even disability. TNO is carrying out research into the possibilities for effective support in demanding working conditions. One example is a wearable skeleton, an ‘exoskeleton’, which can reduce the physical strain on workers.

DEVELOPMENT AND IMPROVING APPLICABILITY

TNO is working with knowledge institutions and companies on the development of exoskeletons. “As part of a European project we aim to accelerate the practical implementation of exoskeletons. Construction and industry are both examples of sectors where exoskeletons can be used. TNO is focusing on several aspects. We are contributing to the design (ergonomics, biomechanics) and carrying out impact studies in the lab and in the field. We are involved in the development of both the current generation of passive exoskeletons, which work using a suspension system, and the next generation of active exoskeletons. These active exoskeletons are powered by sensors and motors. Together with the Vrije Universiteit Amsterdam and the University of Twente, we are researching the optimal sensor sets and algorithms for control. We are also looking at the impact: do the exoskeletons do what they are supposed to do and are they accepted? On top of this, we are exploring the barriers that are preventing companies from deploying exoskeletons right now. We want to remove those barriers,” says Michiel de Looze.

SUCCESSFUL TEST IN PLASTERERS

The effectiveness of an arm-supporting exoskeleton in the work of plasterers has been tested in collaboration with Knauf. “We had already demonstrated the supportive effect of exoskeletons in this kind of work where the arms are raised in laboratory studies, but not yet in practice. By getting eleven plasterers to carry out realistic work in the workshop hall of the Netherlands Business Association for Finishing Companies (NOA), we were able to measure the impact of the exoskeleton on the load. During plastering, the muscle activity of six affected muscles was measured for each task. The plasterers were also asked about the load they experienced and about the advantages and disadvantages of using the exoskeleton,” says Michiel de Looze. The measurements show when plasterers used an exoskeleton, muscle activity in the arms was reduced by up to 30%–40% for specific tasks. For all tasks except applying plaster to the wall, the plasterers also found the perceived load to be lower when the exoskeleton was worn. Considerable reductions in the perceived load were found mainly when working on the ceiling. Wearing an exoskeleton can also have disadvantages, such as heat generation or restricted movement. Ten of the eleven plasterers stated that the advantages outweighed the disadvantages. One plasterer stated that there was an even balance of advantages and disadvantages.

THE FUTURE

A practical follow-up study is currently underway in which 45 plasterers use an exoskeleton for their daily work over a six-week period. “We are looking at the impact on behaviour and use of the exoskeleton, on fatigue and productivity. We expect to publish the results at the end of 2021. There are many sectors in which passive exoskeletons can be used. We are keen to test the application of exoskeletons with companies and help them with implementation and evaluation. Parallel to this, we are continuing to develop the new generation of active exoskeletons, which potentially have a wide range of applications,” says Michiel de Looze.

In addition to supporting physically demanding work, innovative technologies such as exoskeletons can also support people with disabilities, enabling them to do work that was not previously possible.

FOR MORE INFORMATION

- Read more in the article *Technological innovations helping more vulnerable people to find work*
- Watch this 2.5-minute video about the exoskeleton
- Read this news report on the testing of the exoskeleton by plasterers

INCLUSIVE TECHNOLOGY

HELPING MORE VULNERABLE PEOPLE TO FIND WORK

Unfortunately, it isn't a given for everyone to find work or stay at work, particularly for people with an occupational disability such as a cognitive impairment. TNO is exploring ways in which technology could be used to support people in a vulnerable position within the labour market across the spectrum – from looking for work to staying at work on a long-term basis. The key question here is: what opportunities does new technology offer for vulnerable groups at the labour market? For us, answering this question does not start with the technology, but with the jobseekers and workers who are struggling.

CUSTOMISED INCLUSIVE TECHNOLOGY

The requisite technology often already exists, but needs to be adapted to better meet the needs of vulnerable target groups within the labour market. Such adaptations are enormously important, if technology is to play its part in helping more vulnerable people to find work and to stay at work. The use of innovative technologies in the workplace – such as augmented reality, exoskeletons, or robots – offers people with disabilities new opportunities in the labour market. In addition, other technologies – such as virtual reality (VR) – can also provide support to people in seeking and finding work, or in strengthening various routes related to sustainable employability. Aside from task support, these involve staying vital, learning and developing, and mobility in the labour market. "For example, we are exploring whether people on long-term social benefit make more informed choices if they first take a look in a store, factory or construction site using VR glasses to get an idea of a future workplace," says Kim Kranenborg.

TESTING WITHIN PILOT PROJECTS

"We are tackling this complex challenge by combining expertise in a variety of areas. These include sustainable employability, issues affecting the lower end of the labour market, effective interventions that bring people closer to the labour market, technology, and social innovation. We have a good grasp of today's practical issues, and the ability to bring different parties together to develop and test promising technologies and to learn from one another. Together we develop technological applications that accurately target the obstacles faced by specific groups. Pilot projects are then set up to test these applications, in cooperation with sheltered workshops", explains Michiel de Looze. A good example of this is the pilot project involving operator support systems (OSS) in collaboration with Senzer and Arkite (see box). "In this and other pilot projects, we are seeing that the use of technology helps people to stay focused, stops them from forgetting tasks, and, because they see that they are making progress, boosts their self-efficacy," adds Kranenborg. It also has advantages for the employer in terms of wider employability of employees, less time needed for clarification and greater scope for employee development.

THE FUTURE

"In the coming strategy period, we will look at how we can further personalise our solutions using artificial intelligence. We will continue to focus on both cognitive and physical disabilities and psychosocial problems and the support in these areas. We also want to broaden our activities to other target groups and other technologies. Stress, too, is a subject of the vitality theme and one on which we will increasingly focus. For example, we are carrying out a pilot project involving a stress management app for people with autism spectrum disorder in the context of care and hope to start a project in the context of employment. Another of our priorities is to improve the jobseeker reintegration service offered by municipalities," says Kranenborg. More pilot projects at companies are planned for the coming period and we will look at how we can tie in with initiatives such as Sharehouse, various Fieldlabs and hubs. This involves joining forces with the Knowledge Alliance for Inclusion and Technology (KIT).

OPERATOR SUPPORT SYSTEMS PILOT PROJECT

The public employment service Senzer has tested the functioning of two operator support systems, an adaptive and non-adaptive OSS, where employees were guided through the assembly process of children's car seats step by step with the aid of projected operating instructions. All employees learned how to assemble in a relatively short time with the help of an OSS. The use of OSS not only improved the quality of the work, but also increased the flexibility and employability of the employee and reduced 'learning time'. The employees themselves were also positive about working with an OSS. According to De Looze, "What's special about this project is that we worked with an adaptive OSS in which the operating instructions adapt to the level of the employees. The level of instruction could actually be reduced automatically, depending on the pace of work. This shows that the adaptive operating instruction system has great potential to provide employees with even better support in their work. In a follow-up project, the adaptive system will be enhanced with artificial intelligence."

MORE ON INCLUSIVE TECHNOLOGY

- Download the inclusive technology white paper
- Read more about the Operator Support Systems pilot project at Senzer
- View the Guide to Inclusive Technology
- See the different inclusive technologies
- View the employer guide to technology support for employees
- Read more about the jobseeker reintegration services offered by municipalities in the article *Deciding together: empowering jobseekers with knowledge from the care sector*
- Or about Sharehouse in the article *Sharehouse – a unique learning and innovation environment for logistics*
- For more information on inclusive technology please visit the TNO website
- Read the article in which the stressmanagement app is anounced as the winner of the Healthy Valley Bridge Award 2021

SHARED DECISION MAKING: EMPOWERING JOBSEEKERS WITH HEALTHCARE KNOWLEDGE

Shared decision making has already proven its worth and established a place for itself within the healthcare sector. This shared decision making gives the patient more control: patients who are involved in the decision-making process are better informed, more satisfied, more motivated and have more realistic expectations of the treatment. They also show higher treatment compliance. Can shared decision making also be applied to the work and income sector? Can it perhaps help to get long-term jobseekers more involved in decision making during job counselling by municipal reintegration supervisors?

METHODICAL COLLABORATION

"Shared decision making is an attractive and valuable way of collaborating with patients in healthcare to achieve the best possible result. Of course, healthcare is a different sector to work and income. But the way in which healthcare professionals take into account the values and standards, wishes, goals and circumstances of patients is worth transferring to other situations. Together with Astrid Hazelzet, Nicole van Kesteren, Helen Verhoef and Marloes Vooijs, I started looking at whether shared decision making is a good fit for the work and income domain, taking into account the rules ('lawfulness') and efficiency," says Wilma Otten, who has herself spent a long time working in the healthcare domain. In the first phase of the Methodical Collaboration project, a literature study revealed that little is known about the extent to which reintegration counsellors and jobseekers make decisions together. It did, however, provide guidance on how to support reintegration counsellors in shaping client collaboration in a way that takes into account the needs and experiences of the client. According to Otten, "It is important to the client, for instance, to be treated with respect and as an authentic person, where values, experiences and feelings are recognised. In the second phase of the project, we used interviews with reintegration professionals and jobseekers to explore how they would like to work together. Glyn Elwyn's 'three-talk' model was used as a framework (see figure)."

TEAMWORK

The three-talk model outlines three steps required for shared decision making: Team Talk, Option Talk and Decision Talk (see the Three-Talk model figure). "Team talk is about working together as a team, explaining the decision process and setting goals and sub-goals together. It is important to build a good relationship first. Trust is essential – the way we approach jobseekers sometimes seems to be at odds with this. One example is letters that say 'if you don't do this, X, Y and Z will happen'. Option talk is about informing people about the choices available to achieve the goals set. This does not yet happen very often, but is vital for the client to understand the process and its added value. Decision talk is about combining the experiences and preferences of the jobseeker with the knowledge and experience of the professional in order to reach a balanced joint decision. The professionals were interested and would like to work more like this," said Otten.

Next, we looked at which tools could be used to support professionals and jobseekers during the different 'talks'. In a project in Arnhem, we are adapting a number of tools to the domain of work and income (see box 'SHARED DECISION MAKING PILOT PROJECT'). A change team from the municipality, made up of both professionals and jobseekers, is involved in adapting the tools.

THE FUTURE

In 2021, the focus of the shared decision making research lay on trust, interpersonal conduct and the importance of the first contact. "We will further expand on the theme of shared decision making in the coming years. In collaboration with a growing number of municipalities and the Employee Insurance Agency, we want to give more and more jobseekers a fair chance of employment. We will do this by developing customised tools and training courses and experimenting with what does, and what doesn't, work. A great development is that, in collaboration with the Association of Netherlands Municipalities and various municipalities, we are working on the digital instrument guide EVA: a decision aid to help professionals and jobseekers find instruments to facilitate guidance towards work and participation, such as various job application courses. This means that the reintegration counsellors and jobseekers will soon have something to choose from."

MORE ABOUT SHARED DECISION MAKING

See the report *Methodical collaboration in the domain of work and income*

Read the article *Shared decision making: how promising is this approach in the work and income domain?* (in Dutch) in Sociaal Bestek

Read the article *Shared decision making from reintegration professionals' perspectives to support return to work: a qualitative study published in BMC Public Health*

SHARED DECISON MAKING PILOT PROJECT

In this project with the municipality of Arnhem, we made the three-talk model applicable for the support provided to jobseekers. Together with the change team, we are developing tangible tools and practices in which the professionals are trained. Jobseekers and reintegration counsellors work together in seven steps:

1. preparing and informing,
2. personal situation and assessment,
3. incentives and motives,
4. goal setting,
5. options,
6. decision making and
7. evaluation.

We combine these steps with promoting the self-management skills of jobseekers. Our next step is to investigate whether the developed method of shared decision making leads to better informed jobseekers, higher commitment and participation in the pathway chosen together, jobseekers' experience that their autonomy is respected, reintegration counsellors' experience that their guidance has a positive effect on the jobseekers' progress towards work and participation, and their own progress in becoming more professional in the guidance they provide to jobseekers.

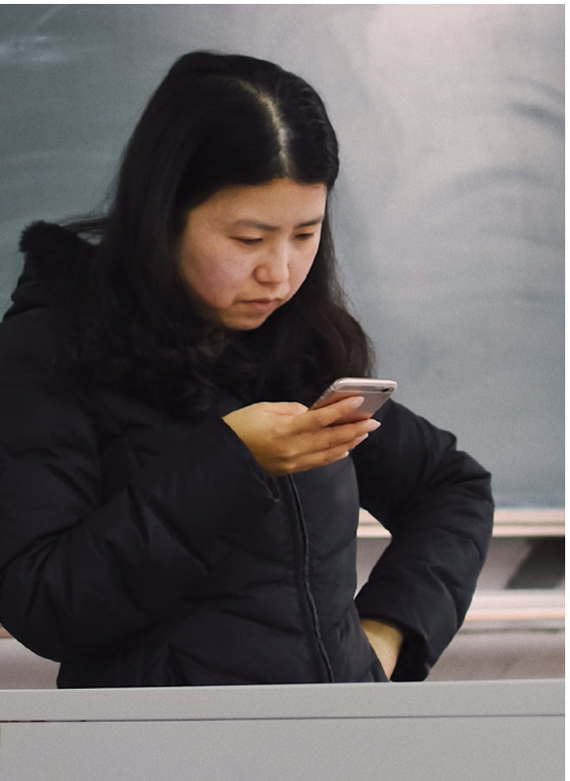
PARTNERS
INCLUSIVE WORK

- AKC
- Anne Frank Stichting
- Arbeidsmarkt regio Midden Brabant
- Beroepsverenigingen SAM; NVvA
- CBS
- Cedris
- CIAO
- CNV en CNV Jongeren
- College voor de Rechten van de Mens
- CTI
- Divosa
- Ecosysteem rondom Hart van Zuid
- Ecosysteem rondom Project Economische Veerkracht voor Vrouwen
- FME
- FNV
- Gemeenten/uitvoeringsorganisaties (Den Haag, Den Bosch, Tilburg, Rotterdam, Arnhem, Amersfoort, Leiden, Amsterdam)
- Hogescholen (Fontys, Hogeschool Rotterdam en Hanzehogeschool Hogescholen en andere onderwijsinstellingen zoals Fontys Hogeschool, Hogeschool Rotterdam en Hanzehogeschool, Brain Industry Campus, Hogeschool Arnhem, Hogeschool Nijmegen)
- Ingenieurs Bureau Zuid
- Innovation Quarter
- Investeringsfondsen (Goldschmeding Foundation en regionale investeringsfondsen), Instituut GAK, ZonMw, European Social Network
- Kansen voor West
- Kennisalliantie Inclusieve Technologie
- Landelijke cliëntenraad, lokale cliëntenraden
- MKB NL
- Nederlandse InclusiviteitsMonitor
- NIM
- Opleiders (zoals VSO-PRO-scholen, ROC's, Albeda college, AWVN/Normaalste Zaak)
- POM Vlaanderen
- PSO-Nederland
- RCT Gelderland
- Reguliere (industriële) bedrijven
- Rotterdam Rijnmond
- SBCM
- SER
- Sharebouw Amsterdam
- SMITZH (RoboHouse)
- Social Finance Nederland
- Sociale werkvoorziening/sociale ondernemingen: oa. Senzer, Amfors, DZB Leiden, Ergon Eindhoven, Konnected, UW, Tomin en Gresbo, IBN, Westrom en Werkse, Werkzaak, Baanbrekers, IJmond Werkt, Weener XL en WVS Roosendaal
- Stedin
- Technologie ontwikkelaars: All Sensing, Arkite, Skelex, Wij Doen Dingen, SRay diagnostics, Eagle Science
- Universiteiten (Tilburg University, Bergen University, University of Oslo, KU Leuven, Universiteit Maastricht (Centrum voor Inclusieve Arbeidsorganisatie), UMC Amsterdam, North West University, South Africa Universiteit Utrecht, Universiteit Leiden en Universiteit Groningen, UMC Amsterdam, TU Delft)
- UWV Rotterdam, Arnhem, UWV Werkbedrijf, UWV SMZ
- Vebego
- Vierwerk
- VNG
- VNO/NCW
- Women Inc
- ZonMw

SUSTAINABLE WORK

A healthy society asks for healthy work environments that acknowledge the critical importance of human capital. Therefore our innovations are aimed at creating environments that help people to stay healthy and in which they can continue to develop during their working lives. This way we reduce the burden of work-related ill-health and increase labour market adaptivity.

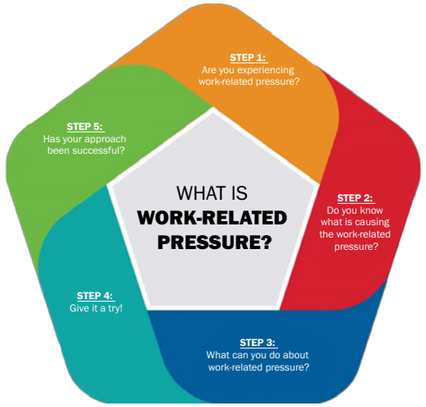
REDUCE WORK-RELATED STRESS BY MEANS OF AN INTEGRATED APPROACH



For many years now, there has been a rising trend of stress and stress-related complaints among workers. This is reflected by employee absenteeism due to these complaints, reduced employability, and rising absenteeism costs. As a result, work-related stress causes personal suffering for employees, at considerable cost to employers and to society at large. Sadly, a comprehensive approach is seldom available. Yet tailoring and expert knowledge about every facet of stress are vital if we are to tackle work-related stress effectively.

TAKING ALL ASPECTS INTO ACCOUNT

Every person, organisation and industry is different, and so are the causes of work-related stress. A wide range of individual, organisational, and social factors are involved, each of which interconnects and interacts with the others. More than thirty years' experience in work-related stress has given TNO a profound understanding of this complex and dynamic problem. "We are carrying out research into the causes of work-related stress and how to reduce the risks of stress by tackling these causes. We are combining this research with looking at how people deal with and recover from stress. In doing so, we are focusing on various levels. At the level of the individual, for instance, this would involve an examination of the relevant physiological and psychological aspects. And at team or organisation level, the focus would be on workload, work processes, employee autonomy, leadership, organisational culture, and more far-reaching organisational structures and processes. The context of an organisation or sector is also taken into account," explains TNO's Noortje Wiezer. To understand the problem, we measure and analyse the situation using measuring instruments that we partly develop in-house.



INNOVATIVE TOOLS

The innovative monitoring methods and analysis techniques developed and validated by TNO are used to formulate advice on ways of tackling work-related stress in a well-founded and integrated manner. We are convinced that our approach could substantially reduce the number of employees with stress-related symptoms in The Netherlands. With the aid of various tools and mostly large-scale projects, we have already made significant progress.

One example is the EMA (Ecological Momentary Assessment) app developed by TNO, which identifies the causes and consequences of work-related stress by asking people specific questions, a couple of times each day. As Wiezer explains, "We use the app to analyse what causes work-related stress and, at the same time, raise users' awareness of this type of stress. We are now expanding the app with feedback modules. On the basis of your answers, we aim to be able to indicate which factors are causing you to experience stress, what you can do about it yourself and what could be done differently in your organisation. Another example is the 'Wellbeing Dashboard', which is based on dynamic calculation models that take into account all factors relevant to wellbeing and the relationships between them."

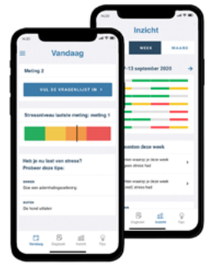
THE FUTURE

Technological innovations play an increasingly important role in our research. There are two sides to this: first, technological innovations can help us identify work-related stress, link it to environmental factors and provide feedback. But technology can also cause stress (technostress). That is why we are going to explore the impact of technology on aspects such as task requirements and the quality of work. We also want to do more with the data we already have. Companies and employees already collect many data, from which a lot of information can be extracted through analysis. We want to develop the EMA app into a tool for 'Just In Time Adaptive Interventions' – giving users tailored advice when they need it.

FOR MORE INFORMATION

Read more about the Wellbeing Dashboard in the article *Prioritising workplace wellbeing with a systems approach and AI*

Read the white paper about how we view work-related stress from various perspectives and what our vision is on how to prevent it



AN EXAMPLE FROM EVERYDAY PRACTICE – VIVO

Our work in the context of the public-private research programme VIVO ('Vitality and Employability for (Primary) Education'), involves bringing together the perspectives and areas of aforementioned expertise, in an effort to reduce work-related stress. "We are cooperating with two comprehensive schools to explore the risks involved. In this context, we are developing and validating a model for monitoring and reducing work-related stress, and for enhancing people's ability to cope with it. 'What is desired behaviour?' and 'What behavioural change techniques can be used to achieve this?' are important aspects that we take into account," says Wiezer. All steps involve employees from all levels of the organisation in order to stimulate learning capacity, to ensure that work-related stress can also be handled with confidence in the long term. This is a good example of a project in which we combine system dynamics with our knowledge of behaviour.

HOW CAN WE MAKE THE HYBRID MODEL WORK?

COVID-19 has had a substantial impact on our lives since the start of 2020, particularly when it comes to the way we work. By the end of 2020 almost half of all employees were working from home, although the numbers differed significantly depending on the sector. Research conducted by TNO shows that many employees would like to continue working from home, even after the COVID-19 pandemic. Large-scale hybrid working is a new development. It is not yet clear what the consequences will be and what the best model is for hybrid working. TNO monitored a representative group of Dutch employees during the COVID-19 pandemic. Data on the employees' working conditions and the impact of these conditions on their productivity and wellbeing can be translated into short or long-term future focus areas.

MONITORING IMPACT

In recent years, TNO has already been carrying out projects relating to the 'new way of working'. "And then came the coronavirus. The government made an urgent appeal to employees to work at home as much as possible – it became the norm for those who could do work from home. Since then, a third of employees work from home on a full-time basis, while another 15% combine working at home with working on location. Naturally, this has a huge impact on the working conditions and wellbeing of employees. We therefore started monitoring these effects immediately. One of the ways we did this was through a specific COVID-19 questionnaire survey (NEA-COVID-19). A group of participants in the 2019 NEA (National Survey on Working Conditions) was asked to complete NEA-COVID-19 questionnaires at several points during the pandemic. This yielded a great deal of information," says Noortje Wiezer.

WHAT HAS WORKING IN THE AGE OF THE CORONAVIRUS TAUGHT US?

Based on research such as this NEA-COVID-19 survey, we saw that working from home has both positive and negative effects on the work-life balance. The line between work life and private life is blurring and some people find it difficult to protect their private time, but working from home also provides many opportunities for a better work-life balance. The consequences of working from home are not the same for everyone. While some workers benefit, others feel lonely having to work at home. "Homeworkers spend too much time sitting in front of a screen and don't take enough short breaks. We are much too sedentary, both at work and in our free time. And not everyone has an ideal workplace. Young workers in particular tend not to have a good place to work at home, but women are also less likely to have a good place to work. Nevertheless, two out of three workers want to continue working from home even after the COVID-19 pandemic. Organisations are also seeing a positive impact and want to switch to hybrid working after the crisis," explains Wiezer.

TOOLS FOR A HYBRID FUTURE

Hybrid working can be done in different ways: sometimes at home, sometimes on location, part of the group at the office, part at home, and hybrid in terms of hours. If hybrid work becomes the norm in many organisations, where work permits, the question naturally arises as to how organisations, teams and employees can minimise the risks and increase the positive effects. When more employees are spending more of their time working from home, it is important that organisations, but also employees, are aware of the risks of working at home. A proper risk analysis is required and employees must be informed about these risks and what can be done to reduce them. The leadership style best suited to hybrid working is one of trust (rather than control). This requires an organisational culture in which trust plays an important role. Only then can hybrid working strengthen autonomy. An important condition for autonomy is that employees know what is expected of them. Clear strategic organisational goals that are translated into team goals and a clear picture for employees of how they contribute to these goals can help.

"Large-scale hybrid working is not yet a reality. We do not yet know what the impact of this situation will be and how best to organise it. In the coming period, we will work with organisations to explore what does and does not work by simply trying it out and monitoring the effects. We will look at what tools can be used, what technological innovations can help, and whether these tools deliver on their promises," says Wiezer.

FOR MORE INFORMATION

Read more about NEA-COVID-19 and the impact of COVID-19 on the workplace in the article *The impact of COVID-19 on the workplace*

Go to our website

A UNIVERSAL SKILLS LANGUAGE FOR A FUTURE-PROOF LABOUR MARKET

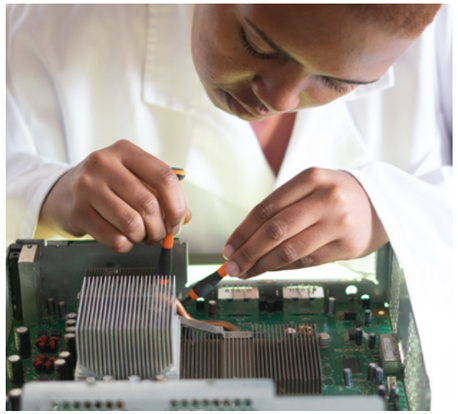
The current labour market is unable to deal with the social challenges we face. TNO believes that a future-proof and shock-resistant labour market needs to revolve around 'skills' (knowledge, skills and characteristics). An important step in this transition is to develop a common language, or skills ontology, that clearly sets out the skills required for different work activities and tasks. That is why TNO is working with its partners to develop a skills ontology for the Netherlands. An ontology that adapts itself to changes in the labour market, whilst also helping to combat prejudice and discrimination in job advertisements.

SKILLS ONTOLOGY

The labour market of the future will be about skills, not diplomas. There will be a growing focus on the development of skills and the matching of people and work based on skills. "Mismatches are a common problem today, because employers are not able to assess candidates on their skills. They mainly focus on education and work experience. The result is that many jobseekers with the right skills are not being found. To assess candidates on their skills, employers need to know what skills are required for the job and what these skills entail. To find and stay in a job that is a good fit, jobseekers need to know what skills they have and what skills they still need to develop. A universal skills language or 'skills ontology' provides this information. A skills ontology provides clarity on the importance of skills for work in different sectors. The skills ontology must reflect the rapid changes in the labour market, however, because if it provides outdated information it can contribute to skills mismatches", explains Joost van Genabeek, Senior Researcher in the Skills-Based Labour Market.

A DYNAMIC LANGUAGE THANKS TO AI

TNO, the Employee Insurance Agency, Statistics Netherlands and the CPB Netherlands Bureau for Economic Policy Analysis have joined forces to set up a national 'Skills Matching Innovation Lab' with the aim of developing a skills ontology. In the lab, they explore the possibilities and requirements for a skills ontology. "We are working with our partners to develop a skills ontology for the Netherlands – Competent NL.



The methods we are using for this are innovative. The project is attracting a great deal of interest at national and international level. The Competent NL skills language adapts to changes in the labour market with the help of artificial intelligence (AI) technology. We are also developing technology to detect and mitigate prejudice and discrimination in labour market information, such as job advertisements," explains Van Genabeek.

Developing this skills ontology involves:

- Linking existing skills taxonomies and qualification or training structures. Doing so provides us with insight into what skills are needed for which professions and tasks and what training is needed to acquire which skills.
- Making the skills ontology dynamic. How can we ensure that the skills ontology adapts to changes in the labour market?
- Translating the dynamic labour market information into skills. How can we extract skills from job advertisements?
- Ensuring that job advertisements are free from bias. Can we make job ads more neutral and detect discriminating terms and descriptions?
- Validation by experts. Are the descriptions of skills and tasks and the links created in the skills ontology between skills, tasks, professions and training courses correct?
- Testing the ontology within various projects in different sectors. How does the application work in practice?

THE FUTURE

The aim is to make the first version of Competent NL publicly available in the course of 2022. "We will continue to improve Competent NL after it goes live. We are working with the Cooperation Organisation for Vocational Education, Training and the Labour Market (SBB) to integrate vocational education qualifications into Competent NL. The ultimate goal is to translate the entire labour market and all training into skills terms in a way that identifies changes in work," concludes Van Genabeek.

FOR MORE INFORMATION

- Listen to the podcast with Joost van Genabeek and Judith van Heeswerk *The labour market of the future revolves around skills on Soundcloud*
- Read the white paper 'Skills wanted!'
- Visit the NL AI Coalition website on skills ontology

CARE AND WELFARE TRANSFER POINT FOR MORE HANDS IN CARE

The outbreak of the COVID-19 crisis in March 2020, was soon accompanied by a severe shortage of intensive care staff. Shortages also arose in the rest of the care sector as care providers were diverted to COVID-19 patients. In response to these sudden labour shortages in the care sector, the House of Skills (a public-private partnership in the Amsterdam metropolitan area) set up the Care and Welfare Transfer Point. Since then, this Transfer Point has been organising a sustainable flow of employees into care, based on skills and with the aid of short-term training programmes that are in line with professional practice.

A SKILLS-BASED TRANSFER POINT

The 'Extra hands for care' initiative by the Dutch Ministry of Health, Welfare and Sport elicited many responses from people interested in working in care. However, many were not placed. "BIG registration was a requirement, so only a small proportion of the people who applied got through the selection stage. We have been looking for a solution that could help to improve intake. Through the House of Skills (see box), employers in the care and welfare sector, trainers, municipalities, the Employee Insurance Agency and trade unions have joined forces. This has led to an innovative approach that is proving successful," says Joost van Genabeek. The Care and Welfare Transfer Point went live in September 2020. TNO is primarily involved in the development/adaptation of tools used within the transfer point.

CARE SCAN & THE FITTING ROOM

How does the Care and Welfare Transfer Point work? Two online tools, the Care Scan and the Fitting Room, plot the shortest route to a job in care or welfare on the basis of your work and education history and your talents (skills). The tools also reveal which part of the care sector suits you best, as well as looking at the training you need. After completing the Care Scan and the Fitting Room, users have an interview with a career coach. They then start the process of taking the step towards working in care by means of a combination of working and learning. During this process, the Transfer Point works with healthcare, senior secondary vocational and higher professional education institutions in the region.

THE FUTURE

The Care and Welfare Transfer Point has already given many people the opportunity to make the transition to a new or different job in the care sector. According to Van Genabeek, "The COVID-19 pandemic has exposed where the vulnerabilities lie, but the shortages in healthcare are structural. The Transfer Point therefore still has a role to play and is expected to be followed up in other regions. Because the labour market is changing and some sectors are shrinking while others are growing, this concept is also interesting for other sectors. As a result, a Technology and Construction Transfer Point is in the pipeline and a Transport Transfer Point is being considered."

THE HOUSE OF SKILLS

The House of Skills experiments with skills-based recruitment, skills-assessment, modular vocational education, and skills-based job matching. It does so by developing and applying innovative approaches and setting up a digital platform (mijnhouseofskills) where employers and employees can get together. TNO is an innovation partner to the House of Skills. Jobseekers still show little inclination to switch to jobs in other sectors, even though some sectors have experienced many redundancies while others are suffering from staff shortages. The House of Skills has turned the current approach to job matching upside down, by focusing on people's skills rather than on job requirements and diplomas. The result is that jobseekers find out that there are all kinds of jobs that they can do because they have the skills for them.

FOR MORE INFORMATION

- Read more about skills in the article *A universal skills language for a future-proof labour market*
- House of Skills website. Go to the online tool Care and Welfare Transfer Point: the care scan
- House of Skills website. Go to the matching tool *The Fitting Room*
- Watch the one-minute video *What is the Care and Welfare Transfer Point?* (in Dutch) on YouTube.

USING DATA TO GET TO GRIPS WITH **DEVELOPMENTS** IN THE WORKPLACE

In the context of the Monitoring Work & Employment programme, TNO is investigating changes in the Dutch labour market and the associated impact in terms of productivity, innovative ability, health, and sustainable employability. One of the things we are looking at is how policy changes affect people. The collection and combination of data plays an important role in this. Drawing on this data, we provide advice on workers' jobs, health and employability. The ultimate objective is to enable people to go on working in a way that is as healthy as possible.

UNIQUE DATA COLLECTION

"We collect data through a number of structured labour monitors among employees, employers, and self-employed individuals. One example is the annual National Survey on Working Conditions (NEA), one of the largest periodic surveys of the working situation of employees in The Netherlands, which we conduct together with Statistics Netherlands. The NEA keeps track of the working population", says Wendela Hooftman. Other examples include the WEA (Employer's' Survey on Working Conditions) and ZEA (Self-Employed Survey on Working Conditions). The large numbers mean that statements can also be made about subgroups. New datasets and the ability to interlink data sources (drawing on income and health data from Statistics Netherlands, for example) have taught us valuable lessons. This will not only help us to get to grips with the dynamics of the labour market, it will also enable us to identify trends and factors that are vitally important for things like sustainable employability.

LABOUR PARTICIPATION AND HEALTH

One example is the use of econometric statistical methods to look at the impact of national policy and the economic climate on the labour participation of various groups, such as employees with a low socioeconomic status or poor health. "Our focus is always on the interplay between employment and health. Consider, for example, research into the effect of abolishing the early retirement scheme – a policy measure to encourage people to continue working longer (see box). In other research, we focus on the policy changes relating to the Disablement Assistance Act for Handicapped Young Persons (Wajong). The aim of these changes is to ensure that it pays to work or to work more. We are investigating whether that effect is actually being achieved. But more importantly, how do policy changes affect people's health and are there any differences between different subgroups," explains Karen Oude Hengel.

THE FUTURE

In the future, our research will also focus on the impact of labour market transitions in addition to the impact of policies. New jobs and professions will be created. We want to know how this affects employees, their productivity, innovative ability and health. We are continuing to develop and validate our models to extract as much knowledge as possible from the available data and new and existing data sources. We will continue to report our findings, since our aim is to facilitate governments, social partners, sector organisations and companies in formulating new policies.

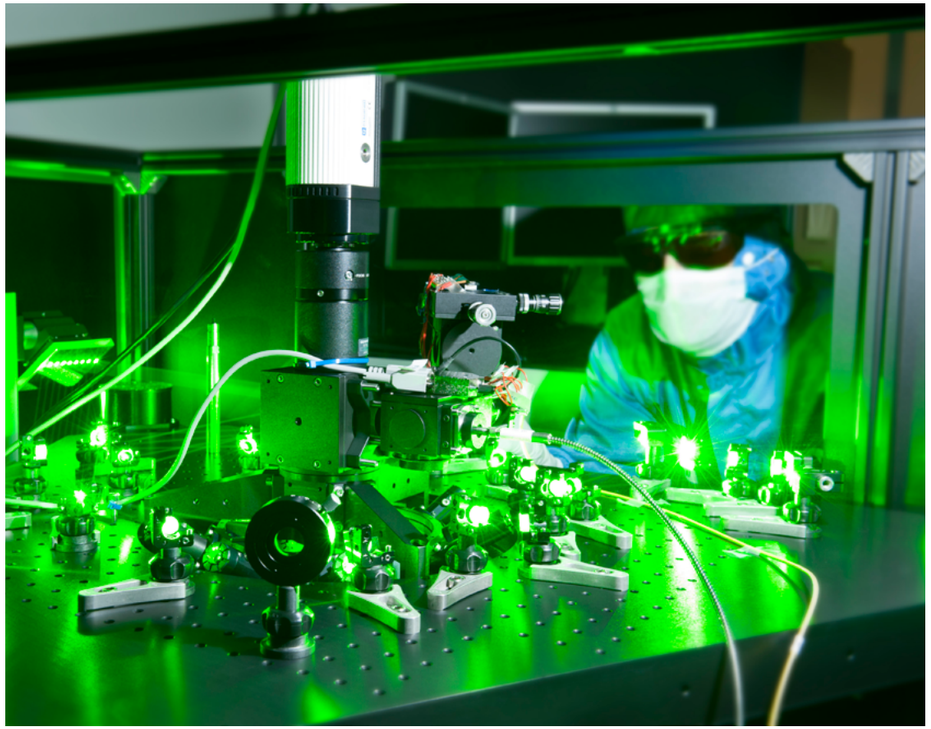
IN OR OUT OF EMPLOYMENT?

The recently completed project 'In or Out of Employment?' is a great example of a project in which linking data (from TNO and Statistics Netherlands databases) provides new insights into the workplace. We examined the effect of abolishing the early retirement scheme on working longer until the state retirement age in The Netherlands. To do this, we compared people born in 1950, who were no longer able to make use of the early retirement scheme, to people born in 1949. "The study shows that the effect of the policy change is not the same for everyone. Women, people with chronic illnesses and middle-income earners were more likely to leave the labour market to become unemployed or economically inactive. The next step we want to take is to look at the impact of early retirement and longer working hours on health," says Oude Hengel.

FOR MORE INFORMATION

- About the National Survey on Working Conditions (NEA)
- About the Employers' Survey on Working Conditions (WEA)
- About the Self-Employed Survey on Working Conditions (ZEA)

SAFE DESIGN OF **INNOVATIVE PRODUCTS** THROUGH SAFE CHEMICAL INNOVATION



Health and safety policy in relation to chemical substances has evolved over the last few years. Until recently, safety policy revolved around the management of unsafe situations and the effects of harmful substances on health and the environment. The focus is now gradually shifting towards primary prevention: preventing the undesirable effects of new and existing chemical materials as much as possible by means of intelligent design. TNO is working on developing tools that can contribute to the design of healthier and safer innovative products in order to prevent harmful products from entering the market.

SAFE-BY-DESIGN

Although health and safety aspects are taken into account during the design of chemical substances, products and processes, it is too often the case that substances and products enter the market that later turn out to be more harmful than previously thought. Safety regulations increasingly demand that the consideration of functionality and health is embedded in the design process. “With the introduction of nanomaterials, this idea of risk governance has taken off. TNO has started to develop tools and models to assess the benefits and potential risks of exposure to nanomaterials. This has now been extended to all conceivable new ‘advanced materials’. It is an enormous challenge for companies to develop innovative products that are simultaneously functional, durable and safe and that also comply with the applicable legislation. The problem is that the pace of product development outstrips the pace of health research. It is important to coordinate risk management with all stakeholders at an early stage. Focusing on smart design, or safe-by-design, pays off. After all, change is easiest and least expensive in the early stages”, explains Wouter Fransman.

DEVELOPING TOOLS & CONSORTIA

TNO’s strength lies in the development of online and offline tools that can help companies to integrate safety in the design phase. How can exposures and health effects be calculated and characterised? “The use of data is essential here. We can extrapolate old data and use it to make predictions about new substances. For example, we can help companies determine the dustiness of new substances. We also provide advice on measures to reduce exposure at the source. In addition to safe-by-design, substitution, in other words the replacement of a harmful substance that is already on the market, is an important step,” says Fransman. TNO works in several large consortia, such as SbD4Nano (Safe-by-Design for Nano), HARMLESS and Gov4Nano, on the development and implementation of safe-by-design strategies and future-proof risk governance models. In addition, the European H2020 project PeroCUBE is working on the development of flexible, lightweight, perovskite-based electronics: a promising game changer for the energy sector. Fransman explains, “We were asked to look at the potential risks to human health and the environment across the entire value chain. We are brainstorming with the developers to discuss this issue.”

THE FUTURE

TNO is continuing to invest in the development of innovative tools, guidance and training to support safe innovation (safe-by-design) and risk governance for companies. We help companies take health and safety into account during the innovation of new materials and products. And make it clear whether or not they should proceed with the development of a particular innovative substance. “We are also on the brink of a collaboration with the knowledge centre Brightsite, which is working to promote a sustainable, competitive chemical

industry. The Chemelot-based Brightsite can make a key contribution to the chemical industry’s transition to renewable energy and raw materials. TNO is already contributing in the field of sustainability – we are going to add health to that,” concludes Fransman.

FOR MORE INFORMATION

- Go to Brightsite Knowledge Centre
- Read the news report about the European H2020 project PeroCUBE
- About the Gov4Nano consortium
- About the Safe-by-Design for Nano (SbD4Nano) consortium
- Go to HARMLESS

MEMREC: A NEW TREATMENT FOR ANXIETY AND PSYCHOTRAUMA

Nowadays, anxiety disorders can be treated with a reasonable degree of success. Sadly, however, many patients find that the effects are short-lived and the anxiety symptoms regularly recur. TNO, in collaboration with partners, is exploring the effectiveness of a short-term method for the treatment of anxiety disorders and psychotrauma based on the plasticity of our brain.

MODIFYING THE FEAR MEMORY

Although existing treatments for anxiety disorders and psychotrauma are reasonably effective, up to 60% of patients experience a partial or complete recurrence of symptoms. A common explanation for the recurrence of anxiety is that patients can learn new behaviours, but the learned fears cannot be erased. It is said that they are forever engraved in our memory. “Yet there is cause for optimism”, says Marieke Soeter.

Insights from neuroscience show that fear memory is not necessarily permanent. When the fear memory is retrieved, the memory trace can temporarily open up to change. Protein synthesis is then necessary to store the fear memory again, a process also referred to as ‘reconsolidation’. “This protein synthesis therefore offers a unique opportunity to modify or perhaps even delete the memory trace. Indeed, both animal and human research indicates that the recurrence of anxiety can be prevented by influencing this protein synthesis in the brain, for example through the one-off administration of the beta blocker propranolol. The beta blocker stops the connections from being stored in the same way in our brain. Think of it as a file on your computer that, once opened, is no longer stored in the same way on the hard drive. Disrupting the reconsolidation process therefore enables us to revise an existing fear memory, making it a promising treatment for anxiety disorders and psychotrauma,” explains Soeter.

ELIMINATE ANXIETY IN ONE SESSION

Inspired by the promising findings from experimental studies in laboratory animals, the reconsolidation intervention has been further developed for the treatment of irrational fears following years of fundamental research at institutions including the University of Amsterdam (UvA). This new Memrec method modifies the memory within one treatment session to completely eliminate excessive anxiety.

A wide range of fears have been successfully treated, from phobias and panic to post-traumatic stress. The treatment is short and very effective, with over 80% of patients eliminating their anxiety within one session.

At TNO, Soeter is currently working with ARQ Centrum’45[1] and the UvA to explore the effectiveness of the method in the treatment of veterans with war-related post-traumatic stress. ARQ Centrum’45 is the Dutch national centre for specialist diagnostics and treatment of people with complex psychotrauma complaints. The initial results are promising.

THE FUTURE

“In view of personal suffering, loss of productivity and the high costs caused by long-term sickness absence, our aim is to ensure that this new intervention strategy can also be used for other high-risk professions such as the police, train drivers and ambulance staff,” says Soeter. In addition, Soeter is investigating whether burn-out patients affected by anxiety and panic can also benefit from this type of short-term reconsolidation intervention.

WANT TO FIND OUT MORE?

Article on PTSD: *How virtual reality and artificial intelligence can help with an effective approach*

1 National centre for specialists diagnostics and treatment of persons with complex psycho-traumatic complaints

THE IMPACT OF COVID-19 ON THE WORKPLACE

Since March 2020, the COVID-19 pandemic has significantly changed working lives. “As soon as it became clear that we would all have to work from home, we said ‘we need to do something with this’. Out of necessity, we suddenly found ourselves in the middle of the biggest ever homeworking experiment. We immediately started looking for ways to measure the impact of COVID-19 measures on work,” says Wendela Hooftman. The first step was to launch a diary study, the ‘How Am I’ study ‘working during the COVID-19 pandemic’, in which workers were asked how they were doing every day for several weeks (see box). The NEA-COVID-19 study was also launched to provide insight into the impact of the pandemic on the working population in the Netherlands.

NEA-COVID-19

NEA-COVID-19 is a questionnaire survey in which a group of participants in the 2019 NEA (National Survey on Working Conditions) were asked questions about their work and working conditions at several points during the pandemic. “We developed an NEA follow-up survey in a very short space of time. Participants were asked some of the same questions as in 2019 (before the COVID-19 pandemic), so we could see what had changed. They were also asked specific ‘COVID-19 questions’: about work location, COVID-19 measures, fear of becoming infected, as well as loneliness and wellbeing. In July 2020, November 2020 and March 2021, we asked over 25,000 workers to complete the NEA-COVID-19 survey. A further NEA-COVID survey may also be conducted. Thus far, around 10,000 participants have taken part in each survey and a total of over 5,000 participants have taken part in all four surveys. Because working life has changed for almost everyone, but not in the same way for everyone, we have identified three different target groups: those working on location, those working from home, and those with less or no work. These groups were asked some questions that were the same for all groups, and some questions that were specific to the individual group. Of course, an individual may have belonged to a different group in each survey,” says Karen Oude Hengel.

IMMEDIATE FEEDBACK

These surveys provide useful data on the working conditions, job satisfaction, wellbeing, health and future prospects of different groups of employees during this exceptional period. “That’s why we used the results immediately to inform policymakers and to give advice on key focus areas. It is striking that, on average, work stress did not increase during the pandemic for either employees who stayed on site or had to work at home, and working from home went well for most people. The article *Working from home: does it lead to more work-related stress?* provides more information about this. The fact that, on average, working from home has gone pretty well, is also the pitfall. Because there are big differences between groups. For example, parents with young children struggled with their work-life balance during the first phase, and within the care sector there are considerable differences between employees working in intensive care units and in other departments,” explains Oude Hengel.

‘HOW AM I’ STUDY

The TNO ‘How Am I’ app was used to monitor workers during the first lockdown to determine the impact of COVID-19 measures on their daily lives and work. How are you currently organising your work? What measures are being taken in companies and what impact are they having? How resilient are we and what creative initiatives are emerging? Hooftman says “We witnessed the impact of stricter or less strict measures. Based on the responses, we gave advice to help employees and employers continue to function as well as possible. These were tips on how to combine private and professional, how to plan the day, but also how employers can manage their employees remotely. What’s unusual is that we immediately shared the latest insights through those tips, which is something you don’t normally do in research.”

THE FUTURE

In the future, the data collected will enable us to say a lot about different groups of workers during a crisis. For example, about how an occupation and the working conditions affect the risk of infection, and which occupations are at higher risk. Also which groups are particularly affected in terms of aspects such as health in the event of this type of pandemic.

FOR MORE INFORMATION

- Go to the article mentioned above *Working from home: does it lead to more stress?*
- Watch the 1.5-minute video *The use of the NEA benchmark tool* on YouTube
- Read the article *Using data to get to grips with developments in the workplace*
- Watch the animation *Working in the age of the coronavirus*
- See the *Fact sheet on the impact of COVID-19 on employees – Key figures March 2021*
- Read the blogs on the TNO study ‘Working during the COVID-19 pandemic’

PREVENTING DISEASE BY REDUCING EXPOSURE TO **HAZARDOUS SUBSTANCES**

Our working environment has a considerable impact on our health. Exposure to hazardous substances in the workplace contributes to many diseases. The corresponding social and economic pressure has made the pursuit of a healthy working environment a strategic objective for governments. However, effective prevention is difficult because much is still unknown about the link between exposure and health. A better understanding is needed of which workers are exposed where, to what, and to what extent, and which workers are at greater risk of illness. The emergence of new technologies, such as sensor technology, the Internet of Things, Omics, and Big Data, is improving our understanding of this complex system. Through applied research, TNO measures occupational exposures, examines their interrelationships and how these exposures can be lowered in order to reduce the burden of disease.

EXPOSOME PROGRAMME

The sum total of exposures during someone's life (also known as the 'exposome') and the way in which their body responds to this can help us to better understand and quantify the burden of disease. Unlike genetic factors, external exposures can be avoided, which offers scope for prevention. With this research, TNO is helping to improve our knowledge of how combinations of and interactions between exposures (the external exposome) are related to the biological response in the body (the internal exposome). "However, in recent years we have made significant progress towards a proof of concept in sub-areas. We and our partners are developing innovative techniques to measure external and internal personal exposures and to assess the relationship between the exposome and health. We are also developing and testing preventive strategies and interventions to improve people's health. Here, we are focusing on at-risk populations, such as those who are exposed to hazardous substances in the course of their work", says Anjoeka Pronk.

REAL-TIME MEASUREMENT & INTERVENTION WHERE NECESSARY

We are using sensors and digital technology to develop tools that can detect exposure at a high temporal and spatial resolution. This will make it possible to take action immediately where and when needed. "We are working with companies to develop and test specific sensors in practice. A good example of this is a sensor to determine the concentration of crystalline silicon – a component of building materials that can cause silicosis and lung cancer. TNO has tested the prototype on a building site in partnership with construction company Mateboer Groep B.V.", explains Pronk. The development of this crystalline silicon sensor ties in well within TNO's vision for the VOHA (Virtual Occupational Hygiene Assistant), through which we aim to make sensor data available to employers and employees. TNO also coordinates the European EPHOR project (2020–2024), which focuses on 'working life health'. "Together with 19 partners, we are exploring how to analyse worker exposures using innovative sensors or big data technology and link them to effects in large population studies. We are also looking at how this data can ultimately be translated into tools to prevent health damage from occupational exposures. The first EPHOR toolbox, including project data, methods and models, will be made available to health scientists, policymakers and occupational health professionals by the end of 2021," says Pronk.

THE FUTURE

"We are convinced that continuous monitoring of exposure data offers opportunities for proactive risk management and targeted prevention. To reflect the real-time nature of sensors, we are developing the data infrastructure EXCITE, which aims to bring together things like sensor data and exposure models in the future. EXCITE is a modular system that allows us to flexibly link sensor data to other types of information or models. The measured data can also be directly converted into feedback via channels such as an app for employees," explains Wouter Fransman. On top of this, we will be exploring the user-friendliness of sensors and the EXCITE platform in collaboration with a large occupational health and safety service. Finally, we will continue to make our knowledge and methods in the field of working life health available to companies and policymakers.

FOR MORE INFORMATION

- Watch the 3.5 minute video about VOHA
- Read the article or watch the 2.5 minute video on the testing of the first VOHA prototype at the construction company Mateboer.
- More about the applied exposome programme
- Or visit the website for more background information
- Learn more about the EU EPHOR project
- Read more about the tentative version of the WeExpose Toolbox

PRIORITISING WORKPLACE WELLBEING WITH A SYSTEMS APPROACH AND AI

Employee wellbeing is essential for an organisation to perform at an optimum level. However, only a small proportion of organisations manage to put this into practice. At the same time, the number of workers with chronic stress-related complaints has been rising for several years. A growing focus on this problem has failed to reverse this trend. That is why TNO is working on a system solution, supported by artificial intelligence (AI), to maintain the mental and physical health of people at work. By working with practitioners to develop innovative solutions, we help to maintain the wellbeing of workers and organisations.

A SYSTEM DYNAMIC APPROACH

Prioritising employee wellbeing is an extremely complex task. An individual's wellbeing depends on many factors, which are interrelated and constantly influence each other. Improving health and wellbeing in order to tackle problems such as burn-out or long-term absenteeism requires an understanding of the dynamics between all the factors in this complex system. "Only a system approach can enable us to find out what ensures the most sustainable result for both the employee and the organisation. To this end, we are developing an innovative Wellbeing Dashboard (see box) that supports the movement towards a mentally healthy environment. The basis is our scientifically substantiated Wellbeing model, which brings together both theory and practical knowledge about all mental, physical and social components and the relationships between these components. The model uses artificial intelligence (AI) to apply learning algorithms and scenario simulations. The underlying calculation model is fed with data from employees, management and HR management over time. We carry out simulations to test what does and does not work in practice and to determine the efficiency of certain programmes, including in terms of costs," explains Heleen Wortelboer.

WORKING TOGETHER TO IMPROVE HEALTH

With this systems approach, not only are we making wellbeing measurable but we also aim to teach workers, management and HR management how to manage it. Confidence in both the calculation model and in the safe and respectful handling of data is crucial. That is why we work with partners and end users from development right through to implementation and evaluation. We then use the knowledge obtained to help organisations develop and implement a sustainable strategy for maintaining the wellbeing of all employees. Because systems are constantly changing, it is important to look ahead. In our projects, we steer towards the desired result via a learning process based on demand. "Part of this is a Wellbeing Community, in which sixteen organisations are now involved. We share knowledge and together we raise awareness on mental health and the importance of wellbeing at work. We also collaborate with occupational health and safety services to prevent physical problems. For example, we are developing a calculation model called 'My real age, my health gain', which provides employees with tailored health advice. We use data and smart algorithms to advise individuals and coaches on how to be able to benefit from good health for longer," says Wortelboer.

THE FUTURE

To determine what works for who and in what context, we plan to tailor our advice to different subtypes. This process involves not only examining what set of measures works for different teams, locations, age groups and functions, but also what works for specific individuals. More data gives us a better understanding of the 'digital individual like me' and 'the digital team like ours'. Using the same technology, we are working on innovative dashboards to support the most appropriate route for overweight clients in municipalities.

FIND OUT MORE ABOUT THE WELLBEING DASHBOARD

- 'The Wellbeing Dashboard project: a summary' info sheet
- Project website
- Watch the two-minute video 'Wellbeing Community 2021'
- Watch the Wellbeing Science Webinar (1 hour and 40 minutes) where Wellbeing is being approached within a 'system thinking' way to have a better understanding on preserving and the navigating of wellbeing within companies

WELLBEING DASHBOARD

We are developing the Wellbeing Dashboard together with Deloitte and Zilveren Kruis and a network of companies. The dashboard is an interactive tool that provides insight into the current wellbeing of employees. It also uses simulations to provide insight into the potential impact of measures on wellbeing. The prototype received an enthusiastic response and will be developed further into a usable innovative web application. We are expanding the existing consortium to include organisations that will use the dashboard. As a result, more data will become available and the underlying calculation model can be further refined. The outcome will be a tool that can issue accurate advice to individual employees, team leaders, management and HR management. Although everything is constantly changing and nothing is certain, the systems approach allows the tool to efficiently focus on preventing absence due to illness and incapacity.

PARTNERS
SUSTAINABLE WORK

- Acumenist
- Aczon
- AIRI
- Ambrosialab
- ApplyNano
- ArboUnie
- ART-ER
- Arttic
- AURA
- Avanzare
- BASF
- BAuA
- BAYER
- Besturen primair onderwijs Cordeo en STIP
- BFR
- Bioclavis
- Biodetection systems
- BNN
- CEA
- Cedris
- CEFIC
- CERTARA UK
- Charles River
- Chemelot
- CNRS
- ControlNano
- Cosmetics Europe
- Creative Nano
- Deloitte
- Dialog Basis
- DTU
- EBRC
- ECAMRICERT
- Edelweiss Connect
- EMBL
- EMERGE
- EMPA
- EULAM
- EU-OSHA
- Eurometaux
- European Research Services
- FOPH
- Fraunhofer
- GGZ Centraal
- Grupo Antolin
- HIQ-Nano
- HMGU
- Holland Casino
- HSE
- IDEA Consult
- IFA
- ILT
- Industria De Desino Textil
- INERIS
- INL
- INRS
- INSERM
- IOM
- ISS
- ITENE
- IUTA
- JRC
- KI
- KIT
- KRISS
- L'Oreal
- Laurentia
- LEITAT
- LIOS
- LNE
- MBIS
- Ministeries (I&W, SZW, VWS)
- Misvik
- NanoLUND
- Nanovector
- Nederlandse Arbeidsinspectie
- NIA
- NIOH
- NIOSH
- Nouryon
- NRCWE
- NWA
- OM
- Onderzoeksinstituten (inter)nationaal
- PILZ NL
- RISE
- RIVM
- Signatope
- Solvay
- Steinbeis
- SUN
- Syntro
- TaQa
- TATA Steel
- TEMASOL
- Thinkworks
- Tissuse
- Unilever
- (Inter)nationale universiteiten (Universiteit Huddersfield, Universiteit Leiden, Universiteit Maastricht, Universiteit Utrecht, Vrije Universiteit Amsterdam, Universiteit Gdansk, Universiteit Konstanz, Copenhagen University, Duke University, Liverpool John Moores University, Lund University, KU Leuven, Swansea University, Uppsala University, University of Vienna, UMC Utrecht, University of Oxford, Universiteit Pompeu Fabra, Universitat Rovira i Virgili)
- UPAT
- VBC
- VODAF
- VOTOB
- VTT
- YORDAS
- Zilveren Kruis Achmea
- ZonMw
- Zorg van de Zaak

FUTURE OF WORK

Robotics are playing an increasingly important role in our society and therefore also in the workplace. What are the implications for employees' tasks? What forms will the interaction between man and machine take? What is the impact on safety and the ethical aspects of work? These are all questions that TNO is addressing with the aim of creating a labour market that contributes to people's resilience, prosperity, wellbeing and solving major social challenges.

BEYOND 4.0 BRINGS US CLOSER TO AN INCLUSIVE EUROPEAN FUTURE

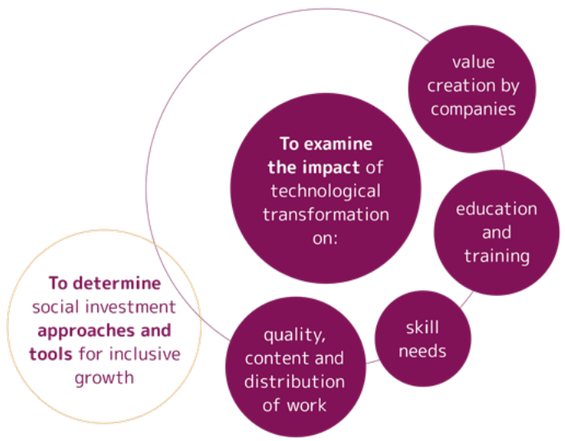
Continuous innovation is essential in order to maintain the high level of knowledge of the Dutch and European economy. In practice, however, sectors and companies often do not know how to innovate processes and implement them successfully. In almost every case, the key to implementing renewal is to involve every employee in the company. But how do you do that effectively and efficiently? A major obstacle is the unjustified notion that the digital transformation, in other words the application of all kinds of disruptive new information technologies, constitutes a threat to many existing jobs and business models. That is why, in the framework of the European BEYOND 4.0 project, we are exploring the potential impact of new digital technology on jobs, skills, working conditions and social security.

LEARNING FROM SUCCESSES IN EVERYDAY PRACTICE

TNO is the initiator and coordinator of BEYOND 4.0, a project in the context of the European H2020 Work Programme 'Europe in a changing world: inclusive, innovative and reflective societies', which is running from early 2019 until the end of 2022. The aim of BEYOND 4.0 is to bring us closer to an inclusive European future. "We are doing this by studying the impact of new technology on future jobs, business models and prosperity. BEYOND 4.0 is unique in its combination of research into ecosystems and the companies within them, and the impact of policy.
As well as fundamental technological know-how, we are bringing together expertise in the areas of work, trends, policy development, social innovation, and the implementation of innovations" explains Peter Oeij, Project Coordinator on behalf of TNO.
At the heart of BEYOND 4.0 lies the study of ecosystems that are successfully handling the transition to new technologies. Drawing on these examples from everyday practice, we learn how regions can successfully handle digital transformation. In addition to exploring this transformation's impact on work processes, on people's work and in terms of social cohesion, we outline scenarios for policymakers.

RESULTS & IMPACT

Despite the COVID-19 pandemic, many steps have been taken and the foundation has been laid. BEYOND 4.0 goes further than other European research projects. "We want to carry out sound scientific research that can also be applied in practice. Historical research, regional field research and data analysis on what is happening at company and regional level are being combined in order to bring us closer to an inclusive European future. Social innovation is a vital element of the digital transition. That's why BEYOND 4.0 places a greater focus on organisations and regional stakeholders than on technology alone," says Oeij.
Six regions in Finland, Germany, the Basque Country, Bulgaria, England and the Netherlands each provide an existing ecosystem and a new one. Two ecosystems from North Brabant are participating on behalf of the Netherlands: Brainport Eindhoven (advanced manufacturing) and the emerging Aerospace (a cluster of logistics, maintenance of military systems and work involving new materials such as composites).
The twelve ecosystems are scored and compared on various elements of the entrepreneurial ecosystem model. This makes it possible to determine what works and what merits policy recommendations that enable the successful implementation of new technology.



THE FUTURE

We are looking not only at the situation in companies and regions, but also at the availability and quality of statistical data. More is needed to combine data at individual level, organisation level and regional/national level. For example, there is no data on how new ecosystems are created. It is also vital to know more about the past: how technological change has impacted our society. Based on all this data and what works in practice, we will offer policy tools to companies, stakeholders and policymakers. We link the latest technological developments in Europe with social and organisational developments. As a result, BEYOND 4.0 is a collective learning experience that supports the digital transformation while taking into account economic and social goals.

FOR MORE INFORMATION

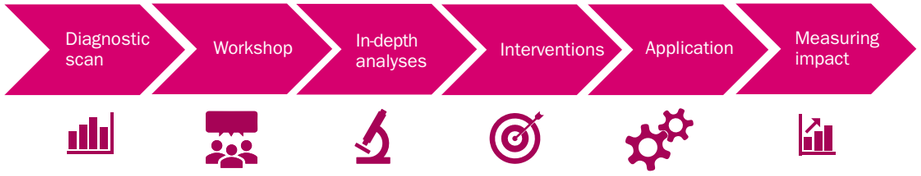
The BEYOND 4.0 website

Watch the video in which Prof. Steven Dhondt gives a six-minute overview of the research framework for this project.

BEYOND 4.0

HOW CAN WE PREPARE FOR THE **FUTURE OF WORK?**

How can we ensure that people and organisations are well prepared for the future of work? We conduct research and develop interventions that contribute to learning and innovative employees, organisations, sectors and regions that respond proactively to changing circumstances. In doing so, we focus on the impact of technology on work and on providing people, organisations and regions with perspective for action.



IMPACT ON TECHNOLOGY

We bring transparency to the specific effect of technology on work. What are the forecasts, in terms of the types of technology that will be used in the near future? What are the implications of a given technology for employees' tasks and for their job quality (job variation, job challenge)? Also, to what extent does that match their competencies and development needs? We use approaches such as the Technology Impact Method (TIM, see box) for this purpose. "TIM has already helped many organisations to make strategic choices and to draw up a human capital agenda. One specific technology we are researching is that of digital work platforms (such as Uber). What does it mean when a worker is controlled by an app? An illustrative milestone is that we were consulted as a platform expert for the Parliamentary Committee on the Digital Future," says Sarike Verbiest.

LEARNING AND INNOVATIVE ORGANISATIONS & EMPLOYEES

Once you understand how work is changing, the question is then how to deal with this change. Key factors here are the development of specific individual skills, lifelong development and the building of learning and innovative organisations. "We have developed an organisational model for learning and innovative organisations. This model encompasses the main organisational factors that stimulate and facilitate learning and innovative behaviour. Factors such as autonomy, challenging work, a manager who encourages development and an organisational culture that learns from mistakes. Based on this model, the Organisation Scan has been developed in collaboration with the Cooperation Organisation for Vocational Education, Training and the Labour Market (SBB) and tested at large training companies such as Defence and VDL. This scan gives organisations an insight into the extent to which various stimulating factors are present and can help organisations, and all their employees, to learn more and become more innovative," explains Wouter van der Torre.
Another example is the learning culture monitor that is being developed in collaboration with the Social and Economic Council to examine the situation with regard to work-based learning in the Netherlands as a whole. We are also researching and developing interventions for specific skills of individuals. Workers must continually develop their skills in the rapidly changing world of work. Adaptability, innovative capacity, ability to cope with stress and resilience play a vital role in an individual's prospects on the labour market. Themes that TNO is addressing in this context include mindfulness, intrapreneurship (being an enterprising employee) and individual control in the context of lifelong development.

THE FUTURE

Over the coming period, we aim to broaden and level up TIM. We will explore the impact of other developments in society beyond technology, such as the energy transition, circular economy, demographic developments and pandemics. We will also analyse the impact on the quality of work and the labour market at macro/system level, to provide solid insight into, and a broad vision of, the Future of Work. In order to deal with changes, the labour market, organisations and people must learn and innovate, which requires a skills-based labour market and systems approach to lifelong development. Two themes in which TNO strongly invests, believes and leads.

FOR MORE INFORMATION

- More about innovations at organisational, team and individual level within TNO
- For more information about a skills-based labour market, see the article *A universal skills language for a future-proof labour market*
- Read more about TIM in the brochure
- See the report *Learning and Innovative Organisations*

TECHNOLOGY IMPACT METHOD

TIM helps employers, employees and educational institutions to think systematically and in specific terms about the impact of technology on their work. "TIM is a simple tool that gives an insight into what is going on, which technologies can be applied in the coming years. Also, what the consequences of this are for products, services and for the organisation of work and employee competences and working conditions. This tool has been developed over the past four years and tested in several pilots. We plan to further develop TIM in the coming period and scale it up to sector and regional level, so that we can show what technological developments mean for a sector or region," says Wouter van der Torre.

SHAREHOUSE: A UNIQUE LEARNING AND INNOVATION ENVIRONMENT FOR LOGISTICS

The emergence of fresh innovative technologies will change the nature of work in many sectors, not least in logistics and warehousing. Any students who are planning to follow an educational programme in logistics in the upcoming years will ultimately be working in highly automated, constantly changing environments. What is the best way to prepare them for this? What forms will the interaction between man and machine take? What about the ethical and safety aspects? Also, how will companies implement these technologies? The Sharehouse Living Lab Warehouse is helping us find answers to what is perhaps the most important challenge facing the logistics sector – how to achieve flawless cooperation between man and machine.

PEOPLE FIRST IN MULTIDISCIPLINARY PRACTICAL RESEARCH

Achieving flawless cooperation between man and machine will require a new way of thinking, new skills, social innovation, innovative education, and collaboration between all stakeholders. Within Sharehouse, we are tackling this challenge together. Sharehouse is a unique collaboration environment of education, knowledge institutions, government and business for innovations in logistics and warehousing. The Sharehouse project is based on a physical 'living lab' in the building of the Shipping and Transport College (STC) in the centre of the logistics hub, the Port of Rotterdam. "In the Sharehouse lab, we carry out innovative, multidisciplinary research using various new warehouse technologies together with partners, students and pupils. These technologies include self-driving robots, exoskeletons, forklift simulators, and virtual and augmented reality (AR) applications. But Sharehouse is more than just the lab. Research also takes place at companies and partners, for example in the form of case studies and field research. The important thing is that we always put people first. For example, we are looking at the impact of these technologies on the safety of employees and their cognitive and physical load," says Paul Preenen, Sharehouse project leader.

A UNIQUE LEARNING AND INNOVATION ENVIRONMENT

Since its launch at the end of 2019, much has been achieved in spite of the COVID-19 pandemic. One of these achievements is the creation of an open, social technology warehouse lab, with a demonstration and practice area for students, companies and employees, and an inspiration-meeting place. Because the lab is located at STC, we have direct access to over 1,500 logistics workers of the future and can make use of STC's knowledge, practice areas and facilities, which include a supply chain simulator. Research has been initiated in the areas of human-technology interaction, innovation adoption, ethical and safety aspects and the alignment of education to the labour market. Within Sharehouse, companies introduce students to their innovative products through research. Science and practice are thus brought together to exchange knowledge about the latest developments and gain better insight into the tasks of the future in the logistics sector. Students learn to work with new technologies and in a multidisciplinary way. Within a short space of time, Sharehouse has become a promising and unique learning and innovation environment.

THE FUTURE

"Our aim is for new ideas, projects and spin-offs to continually emerge from the dynamics of different projects and companies, because that makes the living lab future-proof. It is nice to see that this is actually happening. In the coming period, we will build on what we are doing now as well as exploring new technologies (drone training, 5G research) and current themes (inclusive and skills-based labour market). There is a lot of interest in Sharehouse and I would advise everyone to take part in these kinds of collaborations or to set them up themselves. Suppliers who want to have technology tested, companies that want to innovate, and research institutes that want to carry out research into innovations in warehousing are, of course, welcome to approach us," concludes Preenen.

FOR MORE INFORMATION

- Visit the Sharehouse website
- You can read about the topical issue of the skills-based labour market in the article *A universal skills language for a future-proof labour market*
- You can read about the topical issue of the inclusive labour market in the articles *An integrated approach to a more inclusive labour market* and *Inclusive technology helping more vulnerable people to find work*
- Take a look at the Sharehouse with this 3.5-minute video on YouTube
- Listen to the podcast *How can we ensure that education is better aligned with the labour market?* (in Dutch)
- Read the article on the TNO website announcing the launch of Sharehouse

WITH SKILLS FROM THE HOSPITALITY INDUSTRY TO LOGISTICS

Within Sharehouse, TNO has collaborated with Olympia Uitzendbureau, training and app developer 21CC Education, Hotelschool The Hague and Rotterdam University of Applied Sciences to launch a research project into a matching method for skills. 21CC's app is used to stimulate matching inflow from the hospitality industry to logistics on the basis of skills. The aim is to design the skills matching method so that the number of positions can easily be increased and lateral entry from other sectors, such as the travel and events sector (and vice versa), is also possible. Intersectoral labour movement is difficult in practice: at TNO we want to solve this problem with the help of a skills-based labour market.

THE ROSSINI PROJECT:
OPTIMISING HUMAN-ROBOT COLLABORATION

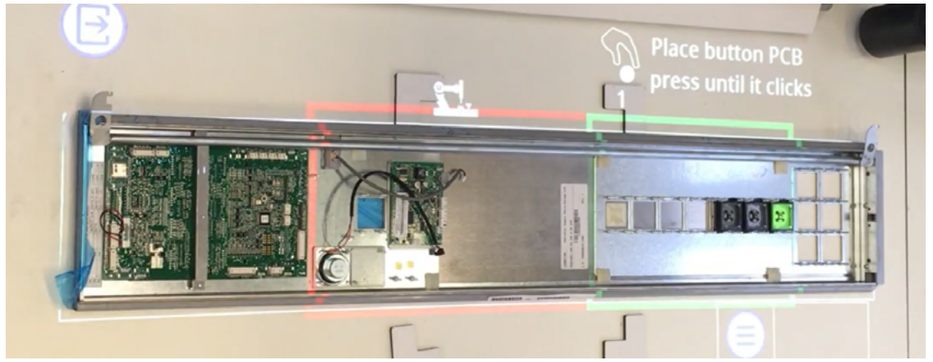
Robotics are playing an increasingly important role in industry. More robots in the workplace come with new safety challenges and impact on the work and its quality. What is needed to ensure that workers and robots can work together optimally and safely in the workplace? In the European ROSSINI project, TNO is working with several partners to explore how the collaboration between man and machine can be optimised.

ONE PLUS ONE = THREE

ROSSINI stands for 'Robot enhanced sensing intelligence and actuation to improve job quality in manufacturing'. "You want to move towards a situation where you use the strengths of both robots and workers. Collaboration with smaller and lighter collaborative robots (cobots), which can be used flexibly, is already becoming increasingly efficient. At present, the heavier industrial robots are often unsafe for employees and are therefore kept enclosed. How could we also design and programme these robots so that real collaboration can make one plus one equal three? Together, they have the potential to form a unique team, where technology supports humans, enhances their abilities and overcomes their weaknesses. The aim: improved productivity and quality of work. In order to optimise this collaboration, a systems approach is needed that takes a wide range of aspects into account. This is what we are working on in the ROSSINI project," says Frank Krause. The aim of the project is to develop a disruptive, secure hardware-software platform for the design and implementation of human-robot collaboration applications that make a positive contribution to the quality of work.

SYSTEMS APPROACH

To ensure that the human-robot collaboration is safe, efficient and pleasant, the ROSSINI platform consists of several functional layers: detection, perception, cognition, control, actuation and a human factors layer. All these layers are integrated into a single platform. Innovative detection (sensors), operation and control technologies (including artificial intelligence) are combined and integrated in an open development environment. In this way, the safety of cobots can be combined with the operating speed and load capacity of industrial robots. According to Krause, "A good division of labour is essential for collaboration. Control options are crucial to avoid feeling like a slave to the robot. This places high demands on the communication between man and machine, not least in order to trust the robot. Our part lies mainly in these human factors aspects and our ergonomic expertise. In design processes, particularly those in which technology plays a significant role, the human factor is often taken into account to only a limited extent or too late. The result is a system whose performance is suboptimal. For ROSSINI, we have developed a design tool that can help designers to take into account all human-related aspects from the outset. Together with Unimore, an Italian university, we have developed a flexible task planner that determines who does what in tasks that can be performed by both the robot and the employee. In order to communicate this, and because as an employee you need to be able to say to the task scheduler 'not right now', we are looking at which interface is most suitable for this per use case."



THE FUTURE

Our final role in the project is to demonstrate that 'you can work with it'. We will do this through practical testing, and expect to be able to present the first results at the end of 2021/start of 2022. By comparing the old and new situation, we want to prove that the ROSSINI approach improves the quality of work. "Our aim is to establish the robot as a partner that can perform tasks in a flexible manner and is easy to programme. Our unique knowledge of both the human aspect and technology means that we can make an important contribution here," says Krause.

MEER INFORMATIE

- You can find more information on the ROSSINI project on the website of the project
- Read the article *Working safely on the workplace of the future*
- Read more about the optimal collaboration between human and robot in the article *Factory of the future asks for operator 4.0*
- Watch the 1.5 minute video of the MSITZH3 example on how human and robot work together
- Watch the over a minute video with the example of a collaboration between human and robot, made for the Interregproject FOKUS - Factory of the Future
- Read more about SMITZH-3, the first innovationprogramme using Fieldlabs
- Read more about the Interregproject FOKUS-Factory of the Future on the website of Interreg Vlaanderen-Nederland and/or take a peak at the 1 minute video in which a demonstrator is made

PARADIGMS 4.0: OUTLINING THE FRAMEWORK FOR SUCCESSFUL DIGITAL TRANSFORMATION

The digital transformation of the industry is one of the biggest challenges we face. New technologies will have a major impact on the labour market, organisations, the quality of work and therefore society as a whole. However, a great deal is still unclear about the precise impact. That's why TNO is rising to the challenge within the research consortium Paradigms 4.0 and investigating the digital transformation of industry. The key question: how can new technologies promote social objectives and support high-performing organisations at the same time?

LOOKING AT THE BIG PICTURE

This Flemish programme is similar and running in parallel to the European BEYOND 4.0 project. In PARADIGMS 4.0, which started in 2018 and will run until mid-2022, TNO researchers are working together with KU Leuven and Antwerp Management School. The programme focuses on how technological applications of what is known as Industry 4.0 (also referred to as Smart Industry) can be successfully integrated. Industry 4.0 is not only a technological/digital transformation, but also a social transformation. This requires a focus at both individual level and on the organisational context. PARADIGMS 4.0 therefore looks at the big picture. "We are focusing on a wide range of topics. Based on the current knowledge gaps, research questions have been defined on the topics of technology and work organisation, skills and participation, organisational and regional strategies and impact on the labour market. These topics are being studied via an integrated approach," says Steven Dhondt, head of the Smart Working knowledge programme at TNO.

NO RISK TO EMPLOYMENT

In order to answer questions such as 'What do innovative technologies mean for the labour market?', we are developing tools to gain a better understanding of technologies as well as examining the impact on employees through pilot projects. This involves comparing companies that do and do not use certain technologies, such as augmented reality, collaborative robots (cobots) and operator support systems. Safety is also a key issue. "New technologies do not fit within the traditional safety philosophy and regulations. This is still uncharted territory, so we don't know how safe developments such as cobots are in special situations. We are looking into how best to deal with this. We are also exploring the investment context in Belgium. The first results are now gradually emerging, and are in many cases consistent with those in the BEYOND 4.0 project. What's clear, for example, is that the idea that Industry 4.0 is a risk to employment is unfounded. We are dealing with a huge transition, but for the time being it poses no threat to employment", says Dhondt.

THE FUTURE

Since there is still a great deal of uncertainty about the impact of digitisation and robotisation, we need to think about how we can harness new technology to improve adoption. Humans need to be factored into this equation. Through Paradigms 4.0, we are therefore seeking to understand the relationship between technological development, organisational concepts, employment relationships and industrial innovation policy. We are developing a scientific framework that answers critical questions about the impact of Industry 4.0 on organisations, workplaces, employment relationships, performance and employees. This framework can be used in the future as a basis for guiding companies towards the successful implementation of innovative technologies that guarantee high performance and promote social goals.

FOR MORE INFORMATION

Read more about BEYOND 4.0 in the article *BEYOND 4.0 brings us closer to an inclusive European future*

WORKING SAFELY IN THE WORKPLACE OF THE FUTURE

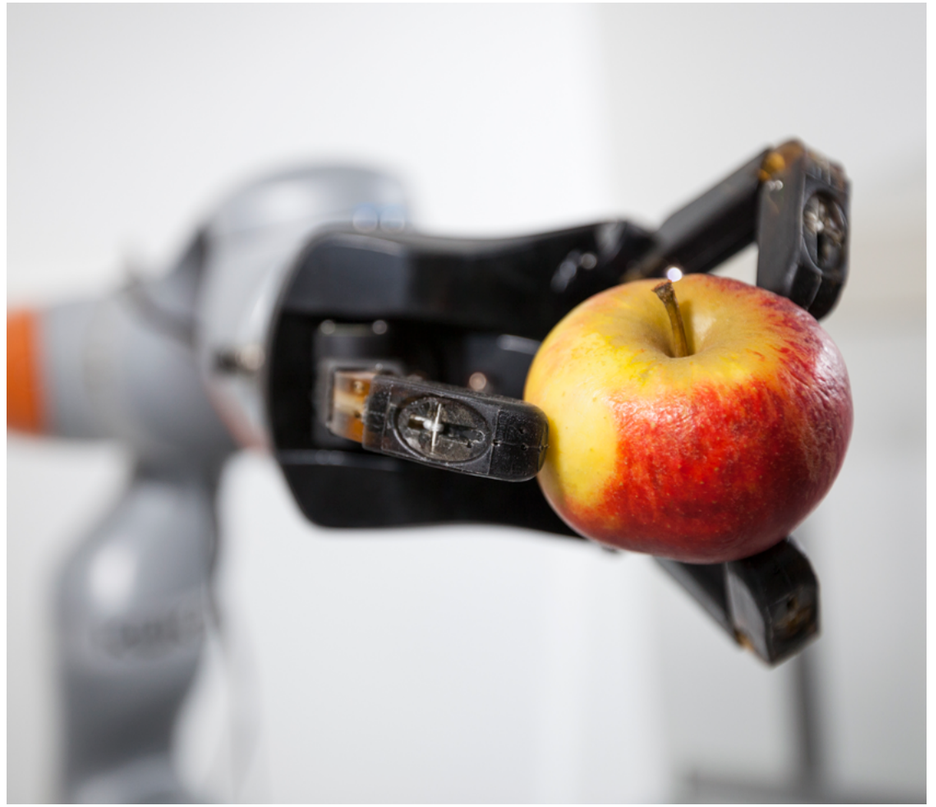
Everyone wants a workplace and working culture that prioritises the values of safety and health. But how can we achieve this in a changing working environment? Safe working practices are often associated with the prevention of exposure to hazardous substances and physical risks. However, research into the safety risks related to workplace digitisation has become increasingly important in recent years. The changing labour market requires robust and flexible safety control solutions for increasingly complex production environments. TNO supports companies and the government in this area. We do this by using digitalisation, artificial intelligence (AI) and robotisation to predict and prevent unsafe situations at work.

RISK ANALYSIS & CAPITALISING ON OPPORTUNITIES

Safety risks in the workplace are changing with the advent of 'emerging risks'. These risks must be rapidly identified and addressed to ensure process safety and safety at work. This concerns not only the arrival of new, possibly hazardous substances, but also the modernisation and updating of safety instruments. "We are therefore focusing on what the new and existing risks are in the introduction of digitisation, robotisation and AI in the workplace and how digitisation and AI can be used to predict and control safety risks. We have made substantial progress over the last few years. This is reflected, for example, in advice that we see in the EU Machinery Directive. We are also working on concrete innovations and helping companies to manage digitalisation and robotisation properly and implement them safely. The focus is on working safely with intelligent robots. We prepare ourselves for what is to come and, as early as the product development stage of a robot, we set design requirements that are in line with the essential health and safety requirements of the future. Cybersecurity is also a topic that we are working on in a European context. Through a wide range of projects, we link knowledge about robotisation, AI and cybersecurity to develop tools that allow us to look to the new future of work," explains Dolf van der Beek.

INNOVATION WITH PARTNERS

The collaboration between these robots and regular workers introduces potential new risks to the workplace. "That's why we have developed a risk analysis to determine the safety of human-robot collaboration. This GRIP method is a step-by-step plan that provides guidance on what to bear in mind when working with and training a robot. We have also entered into a partnership with parties such as Holland Robotics and the NEN (Netherlands Standardization Institute) to raise awareness of robots and occupational safety within the Dutch business sector. We organise webinars that address various topics through an interactive approach. Our joint mission is to encourage safe working with intelligent and flexible robots", says Coen van Gulijk.



In addition, we use existing data and try to collect smart data with more context to predict and prevent unsafe situations. Sensors on the bodies of employees, on machines or elsewhere in the work environment play an important role here. "But in addition, chatbots, through learning algorithms, can ask questions to find out more about incidents. We are also working with the Netherlands Labour Authority to look at how collaborative robots (cobots) can eliminate risks in healthcare (heavy lifting) among nurses and home care workers. There are numerous examples where we are innovating together with partners by developing safety solutions that are practical, effective and affordable," adds Van der Beek.

THE FUTURE

By monitoring social and technological developments, we want to contribute to the impact of changes in the labour market on working conditions and welfare at policy level. We are exploring emerging risks and coming up with solutions to keep the workplace future-proof. Our focus in the coming period will be on robotisation and digitalisation. More and more companies will start using robots/cobots, partly due to a lack of sufficient workers and technically trained staff. We will help companies choose the right technology and the competences needed to deal with advanced technology in relation to safety and security.

FOR MORE INFORMATION

- Read more about what is needed to ensure that workers and robots can work together optimally and safely in the article *The Rossini Project: optimising human-robot collaboration*
- Watch the 4-minute video on Digitalisation of Work (in Dutch) on YouTube
- Read more about how robotisation, AI and digitalisation contribute to safe working on our website
- Read about how we are working on cybersecurity in a European context
- Or go to the Holland Robotics website for the webinars held on robots and occupational safety

THE FACTORY OF THE FUTURE CALLS FOR OPERATORS 4.0

New technologies, competition from emerging markets, erratic market demand, and consumers' ever more exacting requirements mean that today's factories and production chains need to be revamped. This will be facilitated by new forms of human-robot collaboration and by techniques such as augmented reality (AR). But how exactly will a company need to tweak these techniques in order to transform itself into a 'factory of the future'?

MAXIMUM COLLABORATION BETWEEN MAN AND MACHINE

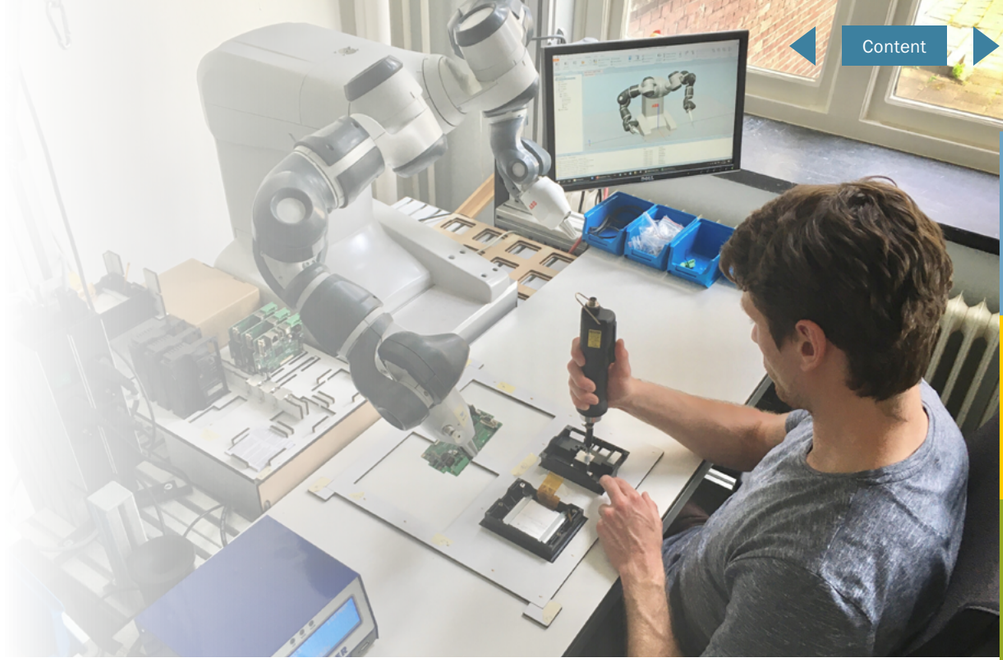
TNO is using the Factory of the Future (FOKUS) project to address this question, together with other knowledge institutions, educational institutions, and companies. "We are focusing on people-oriented technology for both the manufacturing industry and practical training companies. As well as supporting the development and tailoring of technology, we are also examining the impact on employees, employers and society. What can you do with it, what are the benefits, what is the impact on flexible and sustainable employability and employee motivation? It is important to ensure that technology is used properly. For this reason, we always determine which tasks need to be performed by people, and identify situations in which technology can be used to support both experienced and inexperienced employees. So the focus is on people," says Tim Bosch.

OPERATOR SUPPORT SYSTEM

Digitalisation and automation call for 'operators 4.0'. "We are looking at how collaborative robots (cobots) and operator support systems (OSS) can support workers. Companies are experimenting with new technologies through various Fieldlabs and projects. They are using the available knowledge and infrastructure and developing and testing applications with knowledge partners. One example is a successful pilot project involving an adaptive OSS which was carried out in cooperation with Senzer, KMWE and Arkite. Many companies are enthusiastic and keen to digitise. We support these companies in choosing the right technology and implementing it," says Gu van Rhijn.

THE FUTURE

Operating at the man-machine interface is entirely in keeping with TNO's broad-based, fundamental expertise, and with its role as a liaison between public and private parties. In the coming period, we will be working with partners to optimise and scale up the adaptive OSS within the Dutch manufacturing industry. This will take place at locations such as the Smart Industry RoboHouse Fieldlab (Delft) and Flexible Manufacturing Fieldlab (Eindhoven). The aim is that the use of OSS will help more people who are at a distance to the labour market or who have fewer technical skills to find work or to progress to regular and more complex work in the manufacturing industry. Other display methods will be also developed and tested, alongside projected operating instructions. Examples include display on screens, mixed or augmented reality via the HoloLens, or via apps on smartphones.



FOR MORE INFORMATION

- To find out more about the pilot with Senzer and Arkite go to the article *Inclusive technology helping more vulnerable people to find work*
- For more information about the use of technology as an opportunity for people at a distance to the labour market, see the article *An integrated approach to a more inclusive labour market*
- Watch the 2.5-minute video about human-robot collaboration in assembly on YouTube
- Read the news report about the OSS pilot at Senzer on the TNO website.
- Read the article *Effective human robot cooperation & augmented reality support* on our website

PARTNERS
FUTURE OF WORK

- A&O Fondsen
- Arkite
- ASML
- Blozo Ottobocj
- Boers & Co
- Bosch Rexroth
- Brainport Assembly
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- DG Grow
- DG MOVE
- Duurzaamheidsfabriek
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- Eurofound
- Europese universiteiten (CNAM, KU Leuven, UCL, Warwich University, Antwerpse Management School, University of Agder, TUDO, UPV/EHU)
- EUWIN-netwerk (WPI, Sinnergiak, TUDO, KU Leuven, Workitects, INOV.ORG, UiA, ARC Fund, IPL-BAS)
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