ELIMINATE OCCUPATIONAL CANCER

WHITEPAPER
October 2017

TNO innovation for life

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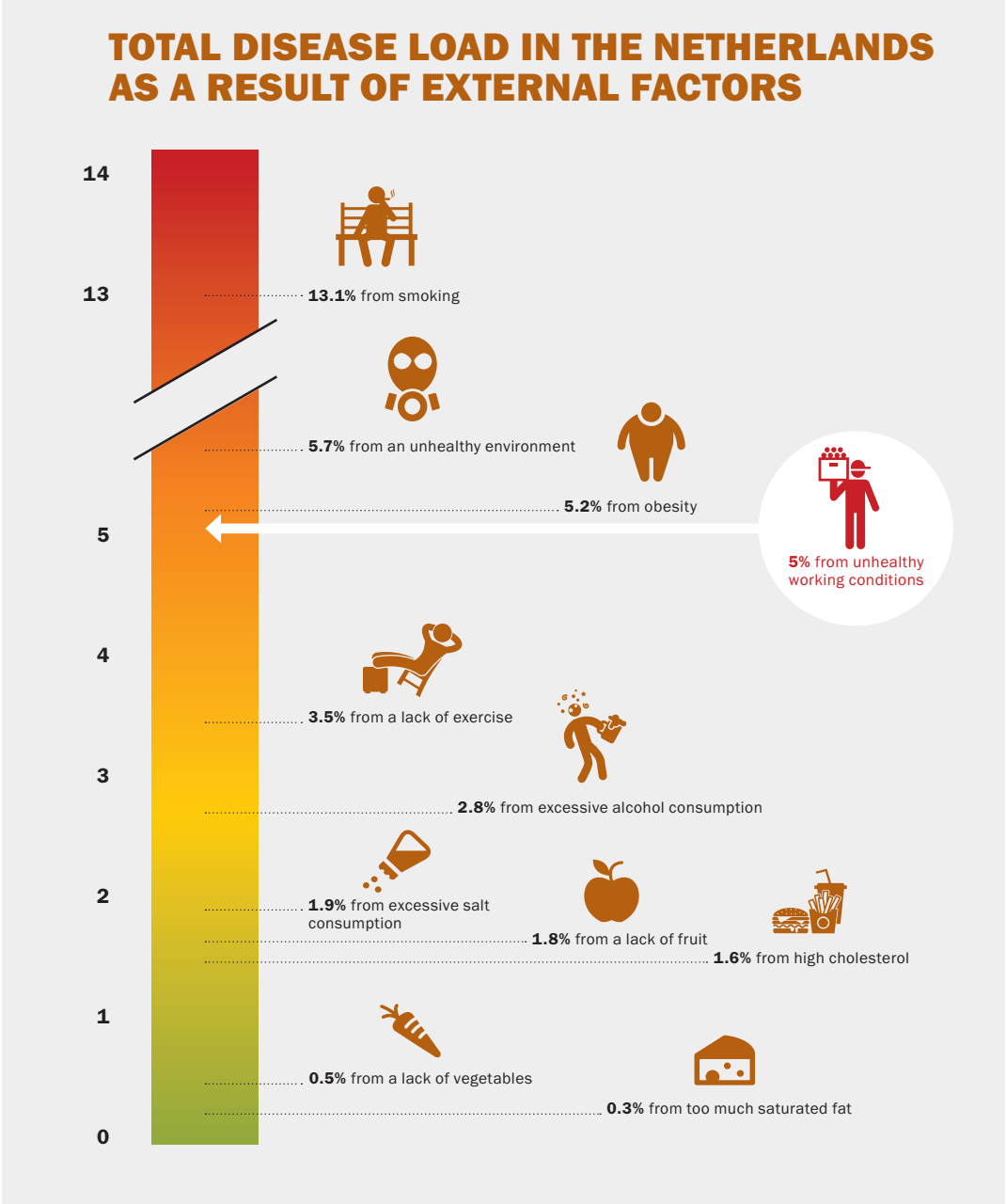
Although work is good for you, it can actually be bad for your health, too. Poor working conditions are responsible for 5% of the total disease burden[1], a percentage that is the same as the figure for the adverse health effects resulting from an unhealthy environment or obesity (see the figure below). After smoking, these three factors are responsible for the major health risks of an external nature.



Source: The Dutch National Institute of Public Health and Environmental Protection (RIVM)

Much of this disease burden is the result of exposure to hazardous substances at work, which is the cause of a huge amount of personal suffering and significant public expense. For example, 4,100 people died of occupational diseases in 2013, 2,700 of whom due to occupational cancer2. Exposure to hazardous substances at work is the culprit here. The Netherlands Organization for Applied Scientific Research (TNO) believes that much of the exposure to these carcinogenic substances and, as such, the disease load could be avoided if every opportunity were taken to reduce exposure to carcinogenic substances at work[5]. Workers, employers, and society would all benefit, as this would improve people's health and also help control the cost of healthcare, limit the cost of absenteeism and occupational disability, improve deployability and participation, and ensure happy employees. It is unacceptable for people in our society to be running the risk of serious illness at work while current technical solutions could be used to reduce exposure to carcinogenic substances. Fortunately, a number of good initiatives have already been launched and are also designed to tackle occupational cancer[3,4]. If employers, employees, and their organizations,

policy makers, enforcers, and technology developers join forces, it will be possible for them to achieve a significant reduction in occupational cancer.

This white paper sets out the vision that TNO has on the prevention of occupational cancer. The extent of the problem and the strategy designed to tackle the situation are outlined first. The document then describes how solutions are actually being used effectively in companies. TNO is convinced that technical solutions could be used to significantly reduce levels of occupational cancer in a number of specific industries. However, these solutions must be introduced across the board and be used correctly.

THE FIGURES: LEVELS OF EXPOSURE, CONSEQUENCES, AND HIGH-RISK INDUSTRIES

In the EU, 100,000 to 150,000 people are diagnosed with cancer every year, having been exposed to carcinogenic substances like respirable quartz, hardwood, or welding fumes while at work. Almost 80,000 people a year die as a result[11]. These premature deaths equate to almost 1.2 billion years of life lost. Cancer patients experience a reduced quality of life, require medical care and are often unable to work or are forced to work less. The suffering of the individual cancer patient is compounded by the ensuing public expense. The cost of healthcare and reduced productivity as a result of occupational cancer in the EU is estimated to be four to seven billion euros per year[11]. When the pain and suffering caused by illness and the potential for premature death are added into the equation, the total public expense increases to approximately 350 billion per year. For comparison purposes: 2,700 people died as a result of occupational cancer in 2015, in comparison with just 621 road traffic deaths, an estimated 11,000 deaths from smoking-related cancer, and just 51 fatal work accidents in 2015. These figures show that exposure to carcinogenic substances is a major risk factor, which is all the more reason to tackle this problem at the source.

TNO has identified three industries in which workers have a potentially high exposure to substances and may therefore be vulnerable to health risks: the construction industry, the woodworking industry, and the metal industry. The main carcinogenic substances that are frequently used in these industries are respirable quartz[6,7] hardwood dust[6,8] and welding fumes[6,9] (which sometimes also contain hexavelent chromium[6,10,11]). The improvement potential for each of these substances is indicated in the description of TNO innovations in this white paper.

PREVENTION IS KEY: CURRENT POLICY AND POTENTIAL SOLUTIONS

The phrase ‘prevention is better than cure’ applies equally when seeking to tackle occupational cancer. The most effective way to do this is to eliminate exposure to carcinogenic substances. This can be achieved by substituting a carcinogenic substance or process, or by opting for a different workplace- and tool-design in combination with the frequent and careful use of these dust-free tools and working methods. There is a huge potential for improvement, and some good initiatives that ensure the creation of a healthy work environment have already been launched. Dust-free tools and working methods will only be effective if they are used correctly and if sufficient checks and enforcement are in place. Our society cannot accept that workers are still being forced to work with carcinogenic substances without any form of protection and are becoming ill and dying as a result.

CURRENT POLICY

Limit values have been determined for substances (by law), with the view of limiting health risks for workers. Health damage can be minimized by ensuring that worker exposure levels remain under these limit values. This is achieved in part by the enforcement activities of the Dutch Labour Inspectorate (*Inspectie SZW*) of the Ministry of Social Affairs and Employments. It is a joint responsibility of the employer and employee or self-employed person. Technological innovations, large-scale availability, and the actual use of these innovations in practice are all necessary to ensure compliance with current limit values and any stricter limit values that might apply in the future.

TECHNOLOGICAL INNOVATIONS

Designing and producing dust-free tools and production processes is first and foremost a task for manufacturers. TNO supports these manufacturers by developing innovative techniques that minimize the amount of dust released, so that working environments do not exceed the limit value. A hand-held tool, non-hand-held tool, or production system must be inherently safe and ensure that employees can work in a healthy environment. Current technological solutions5 already offer much room for improvement to reduce exposure. Major health improvements stand to be achieved with better implementation, enforcement, and information provision in place.

BEHAVIOURAL CHANGE

To ensure that workers are able to work safely, it is also important for them to be aware of the risks posed by carcinogenic substances in their day-to-day work. It is vital to make sure that they are informed of risks and solutions at an early stage, while doing vocational training courses.

IMPLEMENTATION

To ensure that the innovations developed do actually find their way into the workplace, producers and users must be confident that the costs they incur when buying and using these improved tools are justified, in terms of achieving a healthy workplace that is often more efficient, too.

INNOVATIONS DEVELOPED TO PREVENT OCCUPATIONAL CANCER

TNO has already joined forces with partners to implement various projects that put our vision into practice. Exposure, improvement potential, and examples of technological solutions are described below. Attention focuses on the carcinogenic substances encountered most frequently in the construction (respirable quartz), woodworking (hardwood dust), and metal (welding fumes containing hexavelent chromium) industries. Major health improvements can be achieved with better implementation, enforcement and information provision in place.

WELDING FUMES AND HEXAVELENT CHROMIUM

TNO has joined forces with producers to develop a number of technical solutions. These include improved tools that greatly reduce exposure to carcinogenic substances. Examples include a new generation of MIG/MAG welding torches with integrated welding fume extraction. TNO developed this tool in collaboration with a Dutch welding torch producer. The resulting welding torch extracts 90% to 95% of welding fumes at the source. The use of this type of welding torch is a great step towards achieving maximum health protection for welders. In 2015, TNO and the producer in question won a European Innovation Award. The welding torch developed facilitates a reduction in exposure by a factor of 10 to 20 (and more), which equates to a huge reduction in the risk of occupational cancer. TNO is also currently developing a multicyclone system that effectively removes dust particles from extracted air.

Welding work is necessary in various industries (the metal industry in particular) and is sometimes performed in small rooms without any extraction facilities. The large-scale use of welding torches with at-source extraction facilitates major health improvements thanks to the reduced risk of developing cancer while welding.

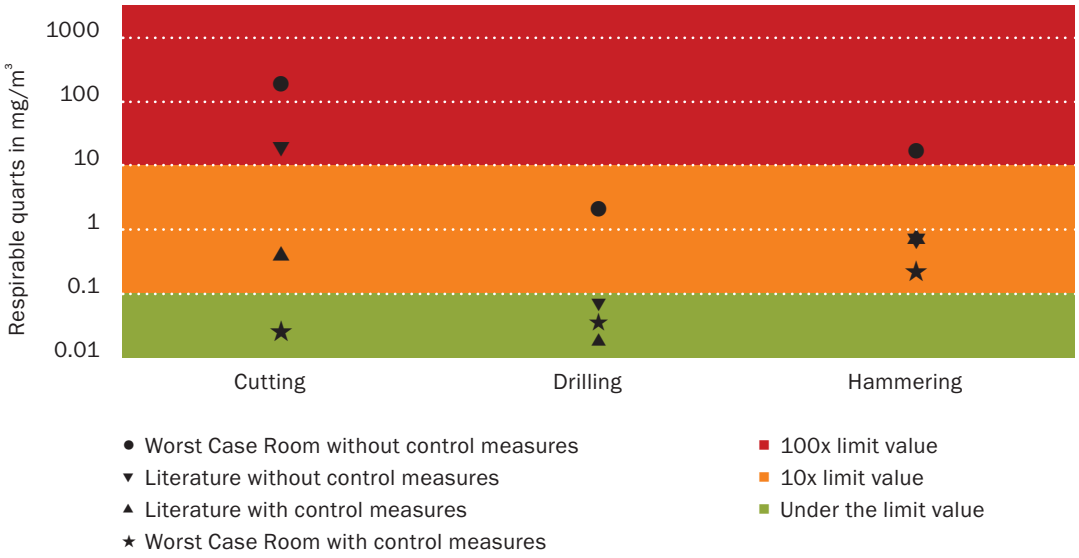
Innovative welding torch. Left: a welding torch without torch extraction. Right: a welding torch with at-source extraction.

TNO is also working with the producers of spray gun systems to develop an innovative spray gun that paves the way for a reduction in the current overspray of paint (including chromium-based paints), which damages the health of employees, damages the environment, and also creates unnecessary costs for the business sector as a result of unnecessary paint loss.

RESPIRABLE QUARTZ

Much research on the subject concludes that exposure to the carcinogenic substance respirable quartz is too high when using tools and hand tools to abrade stone materials[12,13,14,15,16]. In many cases, exposure even exceeds the health limit value. To gain a better idea of the current situation and the situation envisaged, TNO has collected the values reported by field studies and done research in an experimental room at TNO. In this so called 'Worst Case Room,' (1) an unfavourable work situation is simulated in a small, poorly ventilated room on the basis of 100% tool activation time, without any preventive control measures in place. The same test is repeated (2) in a favourable situation, using dust-free tools and working methods. It was found that the limit value for respirable quartz is exceeded by a factor varying from 15 to 4,600 in the test room simulating unfavourable conditions and involving the use of ten processes, like drilling, sharpening, sawing, and hammering without any prevention measures in place (see below). This level of exposure is reduced dramatically if the tests are carried out using innovative technological solutions (see the figure and table below). A reduction in exposure by more than a factor 50 to 8,000 in comparison with the unfavourable situation in which these technological solutions were not used is possible by choosing the right tools and using these tools correctly. This is called the prevention factor. The level of these factors confirms the huge potential to improve the work situation and the health of employees in the construction industry in particular.

Limit value exceeded for the processing of stone materials, measured while work is being carried out in an unfavourable situation and without any preventive control measures, and the reduction possible through the use of innovative working methods or tools and with the appropriate prevention control measures in place.



Working activities	Exceedance factor*	Prevention factor
Trench sawing (dry)	4,600x	5,000 - 8,300x
Sawing (dry)	2,500 - 5,000x	750 - 5,500x
Cutting (dry)	1,500 - 2,400x	600 - 5,700x
Grinding (dry)	1,600x	600 - 8,700x
Hammering (dry)	120x	35 – 300x
Sweeping (dry)	60x	500x
Drilling (wet)	25 – 100x	200x
Drilling (dry)	25 – 100x	50 – 200x

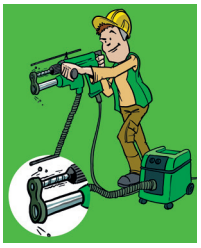
** The exposure levels measured in the Worst Case Room are a factor of 2-3 higher than the exposure levels established in day-to-day workplace practice in the construction industry, on the basis of intensive tool use.*

The figure below shows in more detail the controlmeasures possible while drilling and the effect of these measures.

Reduction of exposure when various prevention control measures are used while drilling

No protection measure
Excess factor:
50 – 100 times

Hollow drill Prevention factor (PF): 100 – 140 times

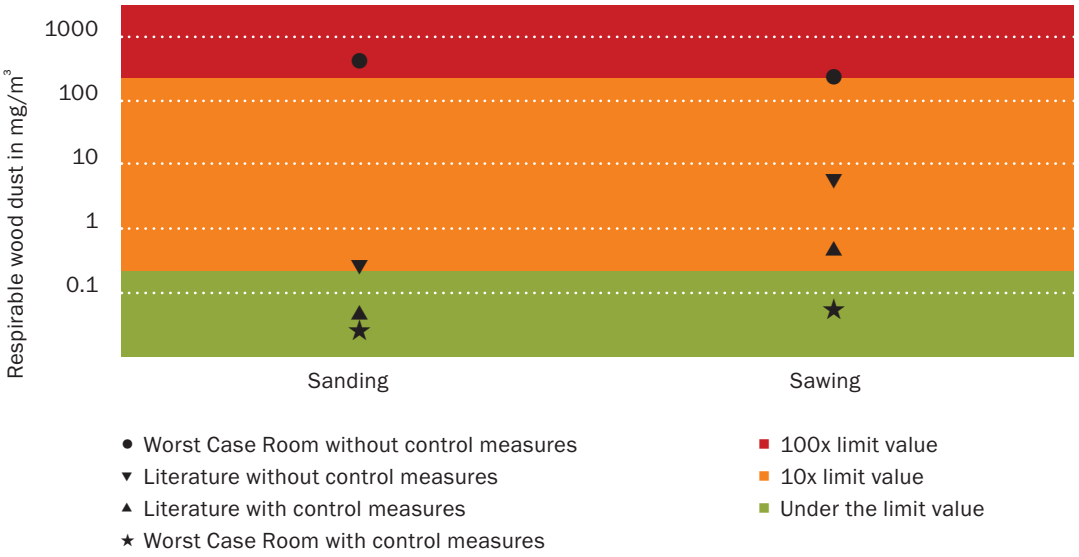


Extraction telescope
Prevention factor (PF):
60 – 200 times

Extraction ring
Prevention factor (PF):
50 – 75 times

HARDWOOD DUST

When using tools and hand tools to process wooden materials, the risk of exposure to carcinogenic hardwood dust is very high too and exceeds the limit value (see the figure and table below). Measured in the Worst Case Room under unfavourable conditions without any prevention control measures in place, the occupational exposure limit value for hardwood is exceeded by a factor of 15 to 140. If the same tests are then carried out using innovative technological solutions, exposure decreases significantly.



Work activities	Exceedance factor*	Prevention factor
Sanding (Excenter)	140x	150 – 300x
Sawing (circular saw)	100x	150 – 500x
Belt sanding	80x	120 - 1,400x
Sawing (circular saw)	80x	10 – 80x
Sanding (flat)	65x	200 – 1,400x
Planing	55x	130 - 1,300x
Sawing (crosscut saw)	40x	10 – 130x
Sawing (saw bench)	40x	20 – 200x
Sawing (jigsaw)	15x	15 – 50x
Milling	15x	15 – 200x

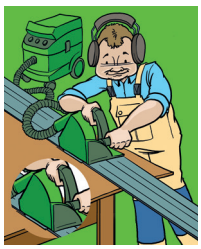
** The exposure levels measured in the Worst Case Room are a factor of approximately 2-3 higher than the exposure levels established in day-to-day workplace practice in the construction industry, based on intensive tool use.*

A reduction in exposure by a factor of more than 1,000 in comparison with the unfavourable situation without prevention control measures can be achieved by choosing the right tools and ensuring that these tools are used correctly (see the illustration below). So, here too, there is a huge potential to improve the work situation of workers in the woodworking industry.

Sanding (Excenter)
No control measure
Excess factor: 140 times

Sanding (Excenter)
With extraction
Prevention factor (PF)
150 – 300 times

Circular saw
No control measure
Excess factor: 100 times



Circular saw with extraction
Prevention factor (PF):
150 – 500 times

See the TNO website (www.stofvrijwerken.tno.nl) for more information about a wide range of tools and measures that reduce exposure to these substances.

EFFECTIVE BEHAVIOURAL CHANGE

The introduction of the right tools for workers in situations in which they are at risk of developing occupational cancer will require them to change the way they work; familiar practices will make way for new ones. In this situation, workers will need to change their behaviour, which will also involve processing certain information. This is achieved via two systems: the conscious and the subconscious systems[17].
The conscious system is rational and reflective and focuses on the long term. It also balances the costs and benefits before arriving at a decision. The subconscious system – by contrast – is fast, intuitive, and automatic. It uses rules of thumb to arrive at decisions, because of which there is a risk of flawed thinking.

THE CONSCIOUS SYSTEM

Anyone who is not aware that he is at risk will not be able to protect himself against these risks. For this reason, many initiatives focus on creating awareness among workers about the risks of exposure to hazardous substances. The most popular behavioural change models18 say that behavioural change based on the creation of awareness is achieved in five stages, during which workers gain an increasing awareness of the risk they have of developing cancer as a result of exposure to hazardous substances.

Behavioural change relies on awareness that there is a risk. However, not only must employees and their employers be willing to embrace change, but employees themselves must be in a position to exhibit the desired behaviour. This means that the technological solution, in the form of dust-free tools, must be within reach, and that employees must have the skills necessary to use the tools correctly. Therefore, ‘knowing’, ‘wanting’ and ‘doing’ are all keywords for behavioural change via the conscious system. Good examples of initiatives that focus on ‘knowing’, ‘wanting,’ and ‘doing’ are the campaigns launched by the European Agency for Safety and Health at Work, in which TNO is involved as part of the Dutch Focal Point (https://www.arboineuropa.nl/campagnes). The Stofvrij werken in de bouw project (a project about dust-free working conditions in the construction industry), which has reduced exposure to quartz dust, is another good example of the successful achievement of behavioural change via the conscious system (see the frame). Other good initiatives launched in various industries are responsible for the creation of a healthy working environment and awareness.

THE PROJECT FOCUSING ON THE ACHIEVEMENT OF DUST-FREE WORKING CONDITIONS IN THE CONSTRUCTION INDUSTRY: 25% DECREASE

The objective of this project is to reduce exposure to quartz dust in the construction industry by promoting the use of technological solutions, encouraging employees to work dust-free and removing organizational barriers. As part of the project, eight construction companies were randomly allocated to either an intervention or a control group. A programme was then developed for the four intervention companies in collaboration with workers. This programme consisted of two meetings, one with employers and the other with employees, with contributions from researchers, a lung specialist, and a health and safety inspector. An informational video was also played. Alongside this, employees were advised on the correct use of the technological solutions available. Employers were given more information about existing technological solutions. Exposure to quartz dust before and after the programme was then compared. The decrease observed following attendance of the intervention programme was more than 25% higher than the reduction achieved by the companies in the control group. In the intervention companies with a high level of exposure, the percentage that exceeded the limit value decreased from 75 to 40. The use of measures increased, too, including the use of water suppression techniques by concrete drillers and pneumatic drills. Knowledge about which measures needed to be taken also improved.

THE SUBCONSCIOUS SYSTEM

To date, it has not been possible to fully achieve the desired behavioural change when working with carcinogenic substances via the conscious system. It would seem that 'knowing,' 'wanting,' and 'doing' are not enough. Given this fact, TNO is also doing research to ascertain how behaviour can be influenced via the subconscious system. Different techniques can be used to tap the subconscious to persuade workers to display healthy and safe behaviour; the effectiveness of these techniques is still to be established in many cases. A well-known technique is 'nudging,' which involves making changes to the environment that are such that the person in question only displays the desired behaviour. For example, the annoying sound a vehicle makes when a driver forgets to put his seatbelt on.

Other techniques designed to achieve certain desired behaviour rely on the social environment and interaction between people (who could be colleagues, but also partners or children, for example). Another approach involves the use of role models on the work floor who set a good example. This could be formal leaders (managers) or informal leaders (colleagues with the most influence). The exchange principle[19] could be utilized better, too, by ensuring that displaying the desired behaviour yields instant benefits, rather than just the deferred reward ensuing from the use of technological solutions (being a reduced risk of developing occupational cancer). TNO is currently doing research to establish how the subconscious system can be triggered to promote safe working practices when working with hazardous substances (see the frame).

THE PREVENTION OF OCCUPATIONAL DISEASES PROJECT: NEW INSIGHTS

The Dutch Ministry of Social Affairs and Employment is setting up a multiannual programme (2018-2021) on the prevention of occupational diseases; TNO is responsible for preparing the programme. In the first two years, the programme will focus on the prevention of exposure to hazardous substances. Preparations in 2017: – An overview will be produced of the use of hazardous substances in different industries in the Netherlands and also of the possibilities available for the reduction of exposure (technological, behaviour). – Relevant parties that could be involved in the roll-out of the programme will be identified. – Needs and problem areas will be identified and also the preconditions necessary for a successful approach.

THE EFFECTIVE USE OF TECHNOLOGICAL SOLUTIONS

Why are the number of cases of occupational cancer still so high, despite the availability of technological solutions and the possibility of new innovations that would benefit both employers and employees? Why are these solutions successful with some employees, sectors, or suppliers and not with others? The most important limiting and facilitating factors are described below

LIMITING AND FACILITATING FACTORS AT AN INDIVIDUAL LEVEL

Occupational cancer develops after a cycle of continuous exposure. Because it often takes a long time for the disease to manifest itself - only after an individual has retired in many cases – workers usually underestimate their risk of exposure to carcinogenic substances. As such, the chance of falling is considered to be a far greater risk, whereas fewer construction workers actually die as the result of a fall from a height than from occupational cancer.

Research has also shown that workers underestimate their susceptibility to the disease ("that won't happen to me") and its consequences ("If I do get ill, I'll definitely manage to recover"). New behaviour is more likely to become a routine if it is fun and easy and if advantages are immediate (whether or not in the form of an immediate benefit to an employee's health)20. So, if we want to ensure that workers really do change their behaviour, we have to make sure that the new behaviour is just as fun and easy as the old behaviour and also yields immediate results. With this in mind, maximum consideration was given to the ease of use and weight of the innovative welding torch developed, to ensure that anyone working with it actually enjoys using it. The success of interventions requires the development of industry-specific knowledge about perceptions in collaboration with the occupational groups, the identification of what makes an intervention fun and easy and also the advantages of the desired behaviour. Besides rewarding healthy behaviour, it is, of course, also important for government to exert the pressure necessary to ensure the enforcement of regulations designed to avoid unhealthy situations. Social pressure on workers not to accept unhealthy work situations is vital too.

LIMITING AND FACILITATING FACTORS AT ORGANISATION LEVEL

In a report to the Dutch Social and Economic Council (Sociaal-Economische Raad (SER))[21], TNO described the reasons why employers decide for or against the introduction of measures that have proven to effectively protect or promote the health of their workers. The report identified a number of general measures, often required by law, and specific ones too, such as ergonomic, safety-related, and psycho-social measures. Based on interviews with employers and the employees of 40 companies, the reasons for and against the introduction of measures were broken down as follows: obligations, statutory obligations, intrinsic motives, and financial motives. Reasons in favour of introducing measures were the statutory obligation to do so, certification, collective labour agreements, or the regulations issued by a parent company. Good employment practices or image improvement were also cited as reasons to introduce measures, as well as the expectation of lower staff costs and higher productivity by introducing the measure in question.
Reasons not to introduce measures were a lack of control over or enforcement of the measures. Companies that circumvent statutory obligations can sell their product or services at a lower price, which creates an uneven playing field and puts compliant companies at a disadvantage.
Organizations sometimes also decide against introducing measures because of a lack of intrinsic motivation: the subject is experienced as difficult or sensitive and the culture of the organization is not such that steps would be taken to tackle the issue. Thirdly, financial considerations play a role when deciding whether or not to introduce measures. For example, the employer would not stand to benefit from the measures, or it is not known whether the measures in question would be cost effective at all. Organizations often lack the resources necessary (time, money, and/or expertise) or do not have the knowledge and skills needed to be able to introduce the measure in question. Another incentive could involve increasing checks, particularly those in relation to the general measures that are required by law. Finally, effective communication[22] could also be used to promote compliance. Initial research would seem to show that compliance with the rules may improve if physical checks remain at the current level or decrease in number[23].

CONCLUSION: ELIMINATION

The preconditions for many of the measures introduced in this paper would seem to be favourable. This is due to the existence of a legal necessity: compliance with the limit value. Compliance helps to achieve good employment practices; the resources required are largely already available; purchase costs are limited, and savings can be made on the cost of materials and thanks to a reduction in cleaning costs. Added to this, a number of good initiatives have already been launched, making it seem possible to achieve a real difference[3,4]. Having said this, some extra effort will be necessary to actually reduce the risks that give rise to occupational cancer. The innovative technical solutions and working methods described for the industries in question in this document are already available and, if applied across the board, we as a society can strive to eliminate occupational cancer from these industries. We would like to invite government, the suppliers of tools, industrial associations, employers, and employees to join forces with us to eliminate occupational cancer.

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TNO CONNECTS PEOPLE AND KNOWLEDGE TO CREATE INNOVATIONS THAT BOOST THE COMPETITIVE STRENGTH OF INDUSTRY AND THE WELL-BEING OF SOCIETY IN A SUSTAINABLE WAY.

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17-9256 oktober 2017