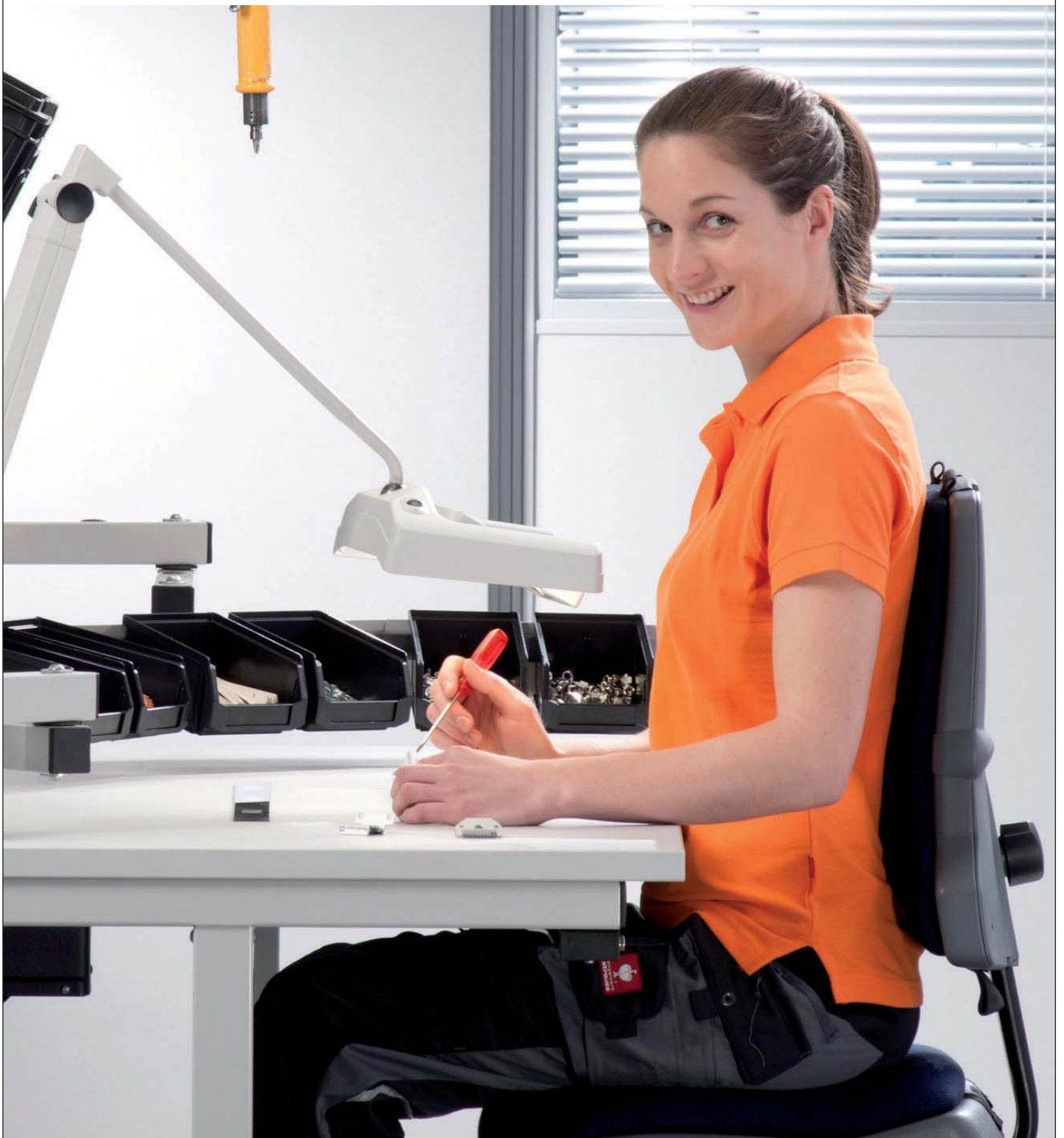


teamwork

PRACTICAL GUIDE TO ERGONOMICS



bimos



Waldmann **W**
ENGINEER OF LIGHT.

With the support of



Welcome to the teamwork network

Promoting ergonomics in the workplace

It is a shared vision which has prompted three market leaders to a cooperative project : to improve ergonomic efficiency at work, for the benefit of both employers and employees alike.

The teamwork FORUM ARBEITSPLATZ-GESTALTUNG is a workplace layout initiative started by the companies bimos, KARL and Waldmann. The innovative product line-up,

spanning desks, workbenches, chairs and lighting, forms the basis for efficient workstation ergonomics in a wide and diverse range of sectors of industry.

The three companies, which develop and manufacture their products in-house, are in tune with the market and with the requirements of employees as they go about their routine day-to-day tasks. One thing has

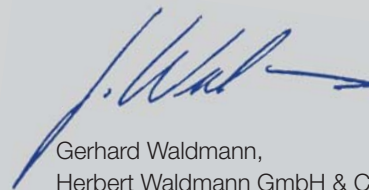
always been clear: the design and layout of working environments have a direct impact on the quality of the work and on the efficiency and productivity of the employees. Quality improvements in production and reductions in absence rates have direct economic benefits. Therefore, having recognised the sustainable value added, more and more companies are putting ergonomic theories into practice.



Helmut Link,
bimos - a brand of Interstuhl Büromöbel
GmbH & Co. KG



Andreas F. Karl,
Andreas Karl GmbH & Co. KG



Gerhard Waldmann,
Herbert Waldmann GmbH & Co. KG

Ergonomics: working to rule

For better health, more safety, added productivity and increased motivation

Ergonomics is the science of the conformity of human work. The word consists of the Greek words „ergon“ (work) and „nomos“ (laws). Ergonomics is a complex system with the ultimate aim of adapting every aspect of the workplace to the needs of the employee.

There are many different benefits: Employees are more efficient and their motivation level is higher. Their health is less likely to suffer, even if they do a job for a long time. There is also scientific research to back up the theory that ergonomic improvements to the working environment increase staff productivity and the quality of their performance on the job.

Ergonomics includes the following aspects:

- Humanity – working conditions which do not compromise safety or pose a health hazard in any way
- Productivity – quality and efficiency of output and performance
- Motivation and satisfaction – rights and aspirations of employees

The measure of all things: the human body

Solutions tailored to our anatomy

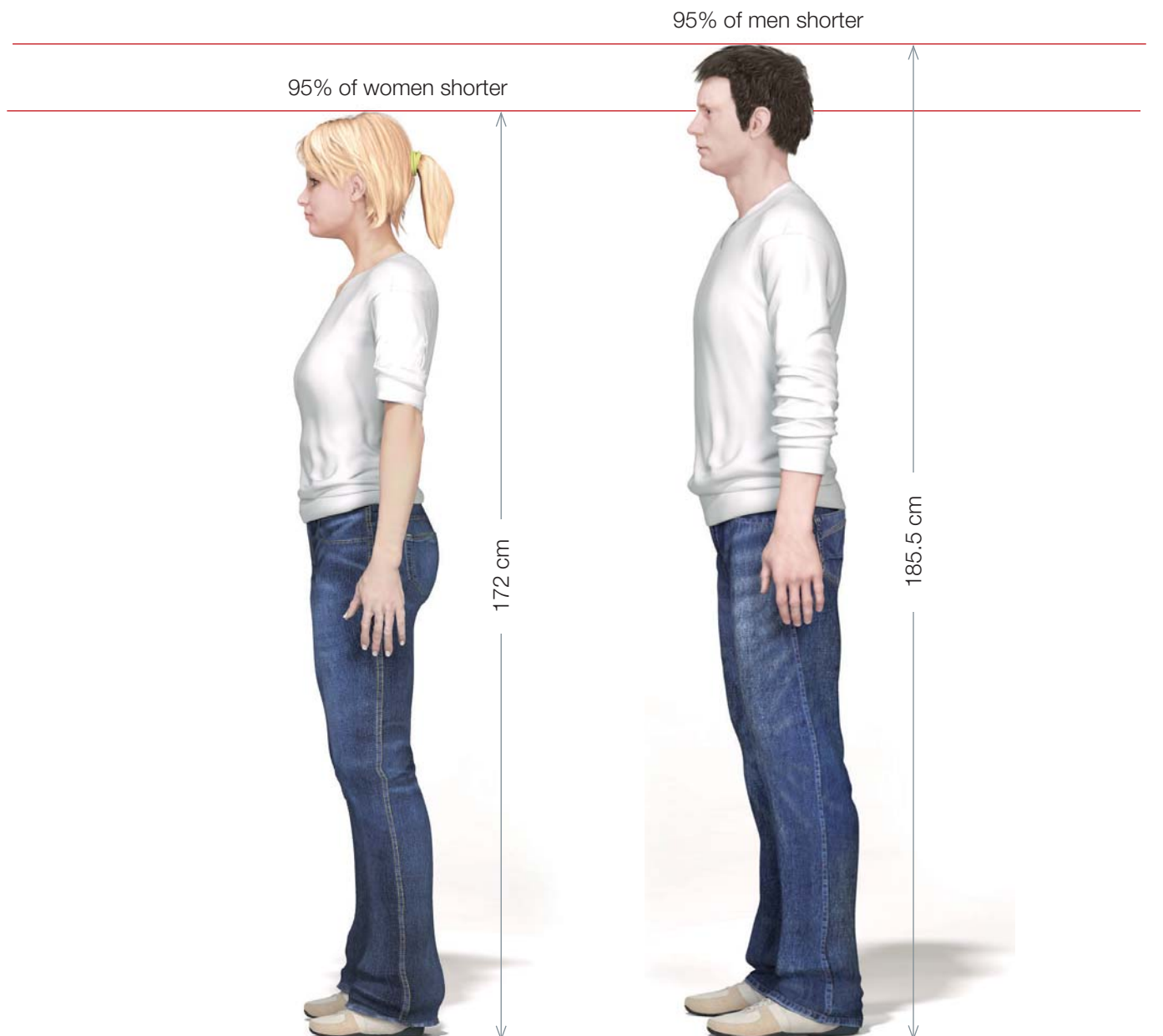


The basis for the ergonomic design of the workplace is the human body (height, weight, movements, etc.), including human perceptions (light, noise, temperature) and human intellectual abilities (e.g. processing of information, attention span, creativity).

The fundamental factors, when giving consideration to the constraints of the

anatomy in ergonomic workplace design, are the measurements and proportions of the human body (anthropometry). It would not be possible or viable, however, to design the workplace to allow for the entire population span and the full variation in size. The top 5% and the bottom 5% of the distribution are therefore disregarded. The general rule is to consider the body measurements from the 5th percentile of

women up to the 95th percentile of men. This results in a 32 cm range of variation in height and reflects 90% of the population. This „confidence interval“, as it is called, provides the data for optimum ergonomic workplace design specifications. Individual solutions are required for people who do not fall within this range.



DID YOU KNOW?

Percentile is a term from statistics where the distribution of a particular variable is divided into 1% segments. The n th percentile designates the threshold value under which $n\%$ of all the measured values falls.

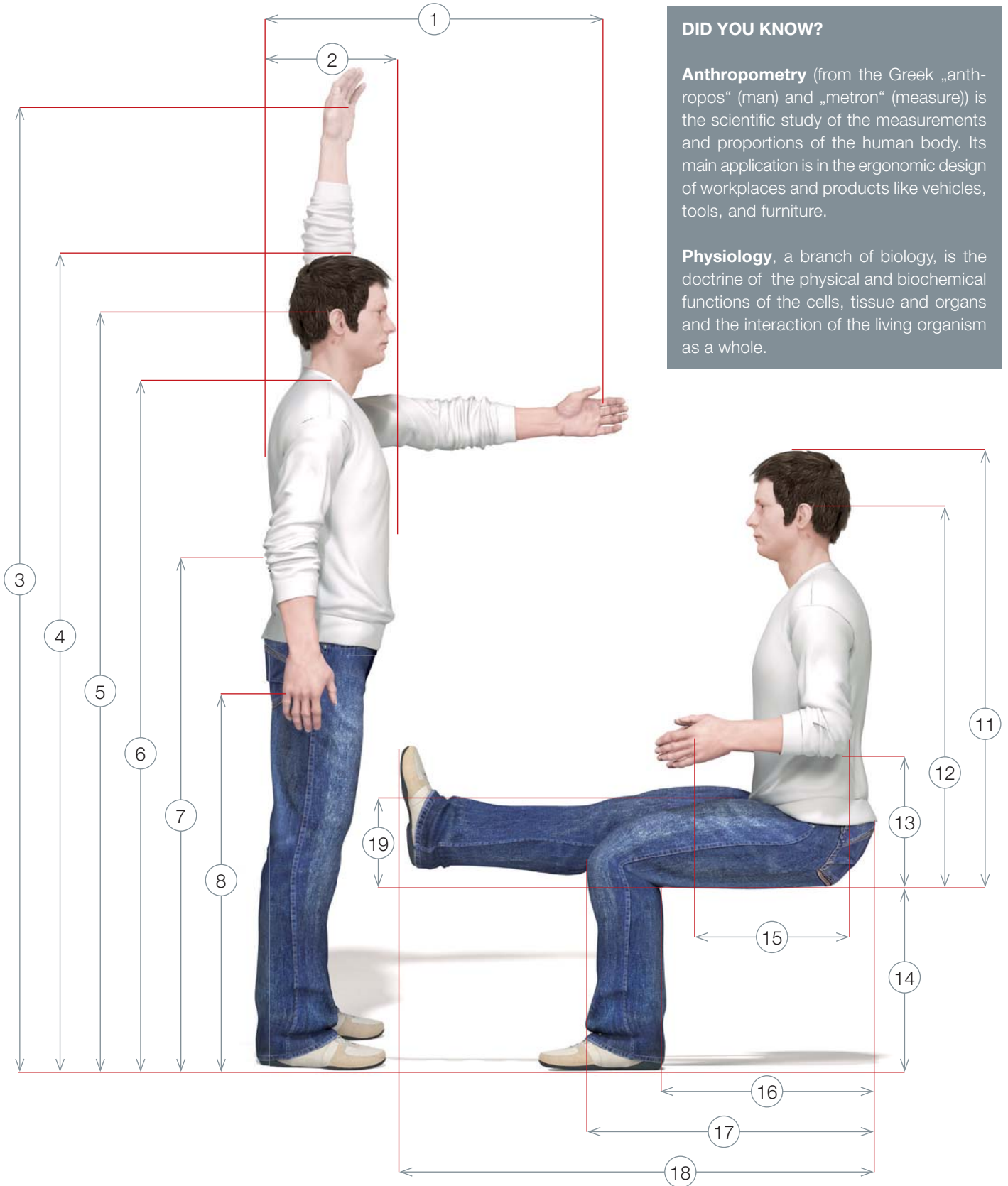
For example, the 5th percentile means that 5% of all the values are below this level. The 95th percentile means that 95% of all the values are below this level; therefore 5% are over this level.

In respect of the principle of normal distribution, this means that just 25% of the full range of variation in heights covers 90% of the population.

All measurements apply without clothing. The relevant amounts need to be added to allow for work wear and protective clothing.

Upsizing or downsizing for the right fit

Made-to-measure solutions for individual proportions



DID YOU KNOW?

Anthropometry (from the Greek „anthropos“ (man) and „metron“ (measure)) is the scientific study of the measurements and proportions of the human body. Its main application is in the ergonomic design of workplaces and products like vehicles, tools, and furniture.

Physiology, a branch of biology, is the doctrine of the physical and biochemical functions of the cells, tissue and organs and the interaction of the living organism as a whole.

The body measurements, especially the height measurements, are used to work out the required layout in areas used for sitting, standing, looking or reaching out for items.

Workstations on assembly and production lines are generally used by different people (e.g. on shifts, job rotation systems or one-piece flow systems), therefore they need to be adjustable. Indeed, heights can vary tremendously - and people of the same or similar height can actually have

very different proportions. If production processes do not dictate otherwise, the dimensioning and positioning of items at the workstation should be based on the principles of anthropometry and physiology. Wherever possible, the aim should be to use equipment which can be adjusted to different heights and proportions.

If the workstation and equipment are not optimised to suit the dimensions and activity of the employee, this will lead to bad posture in the long run. This, in turn,

causes stresses and strains, which may cause one-sided abrasions of the body. This can affect the tendons, muscles, nerves, tissue, heart and circulation. Possible side effects include tension pains, muscle and tendon contraction, and cardiovascular diseases. The impact is felt not just by the employees – it also reduces the potential of value-added performance.

Human body dimensions

As set out in DIN 33402, Part 2 (measurements in cm)

	5 %		50 %		95 %	
	♀	♂	♀	♂	♀	♂
1. Forward reach	62.5	68.5	69.0	74.0	75.0	81.5
2. Depth of body	24.5	26.0	29.0	28.5	34.5	38.0
3. Vertical reach	184.0	197.5	194.5	207.5	202.5	220.5
4. Body height	153.5	165.0	162.5	175.0	172.0	185.5
5. Eye height	143.0	153.0	151.5	163.0	160.5	173.5
6. Shoulder height	126.0	134.5	134.5	145.0	142.5	155.0
7. Height of elbow from ground	96.0	102.5	102.0	110.0	108.0	117.5
8. Height of hand from ground	67.0	73.0	71.5	76.5	76.0	82.5
9. Hip width standing	34.0	34.0	36.5	36.0	40.0	38.5
10. Shoulder width	39.5	44.0	43.5	48.0	48.5	52.5
11. Height sitting	81.0	85.5	86.0	91.0	91.0	96.5
12. Eye height sitting	70.5	74.0	75.5	79.5	80.5	85.5
13. Height of elbow above seat	18.5	21.0	23.0	24.0	27.5	28.5
14. Length of lower leg including foot (seat height)	37.5	41.0	41.5	45.0	45.0	49.0
15. Distance from elbow to hand	29.5	32.5	31.5	35.0	35.0	39.0
16. Depth when seated	43.5	45.0	48.5	49.5	53.0	54.0
17. Buttock-knee length	54.5	56.5	59.0	61.0	64.0	65.5
18. Buttock-leg length	92.5	96.5	99.0	104.5	105.5	114.0
19. Thigh height	12.5	13.0	14.5	15.0	17.5	18.0
20. Width above elbow	39.5	41.5	48.5	48.0	55.5	55.5
21. Hip width sitting	36.0	35.0	39.0	37.5	46.0	42.0

All measurements apply without clothing. The relevant amounts need to be added to allow for work wear and protective clothing. When applying measurements to workstation design, the measurements of the tallest man should be taken for inside measurements (e.g. legroom) and the measurements of the smallest woman should be taken for outside measurements.

Discover the work zone with your hands

Everything to hand within easy reach

The layout of parts, tools and materials is key to boosting efficiency, avoiding time-wasting motion sequences, preventing physical strain and avoiding movements which strain the arms. The reaching distance and working height are important factors when it comes to positioning equipment.

Reaching distance

The reaching distance is the area around a person within reach, i.e. the person can reach something by hand without moving out of position. A distinction is drawn between the inner reaching distance (things

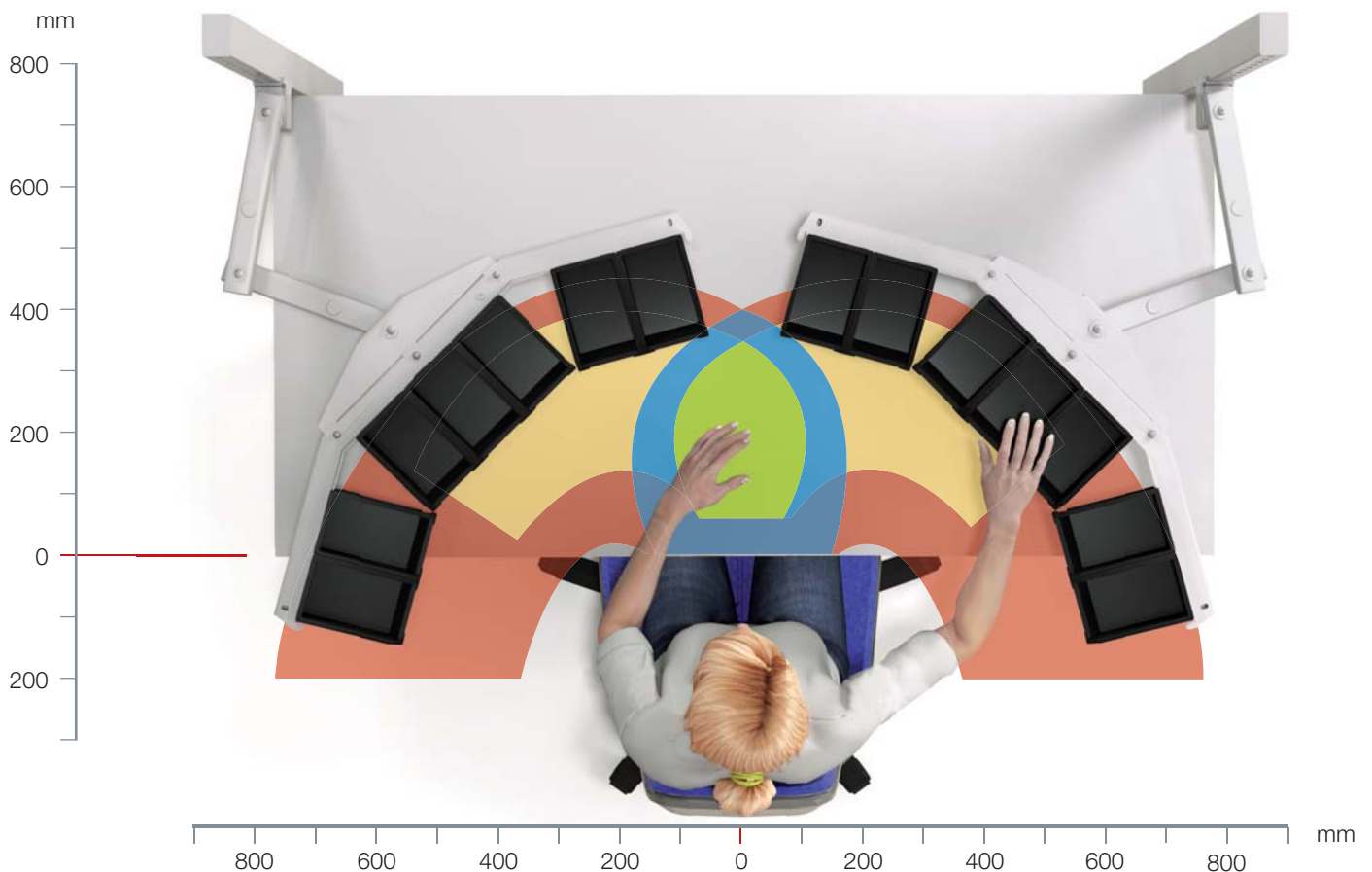
can easily be reached with arms bent) and outer reaching distance (things can be reached with outstretched arms).

When positioning materials having ergonomic efficiency in mind, frequently needed items are placed within the inner reaching distance and parts needed less frequently are placed within the outer reaching distance. All the necessary containers, equipment and controls are arranged in such a way as to encourage a flowing movement away from the body with the arms arching upwards. This pre-

vents having to twist the upper part of the body – avoiding unnecessary shoulder movements, one-sided actions and repetitive movements.

Comfortable working height

Prolonged or frequent bending can lead to musculoskeletal complaints, as much as twisting the head and upper body, holding the head in an awkward stretched position or lifting the shoulders. Equipment should therefore be laid out so as to enable the employees to adopt an upright and natural posture.



Zone 1: Central working zone

Both hands work closely together – assembly point

Zone 2: Wider central working zone

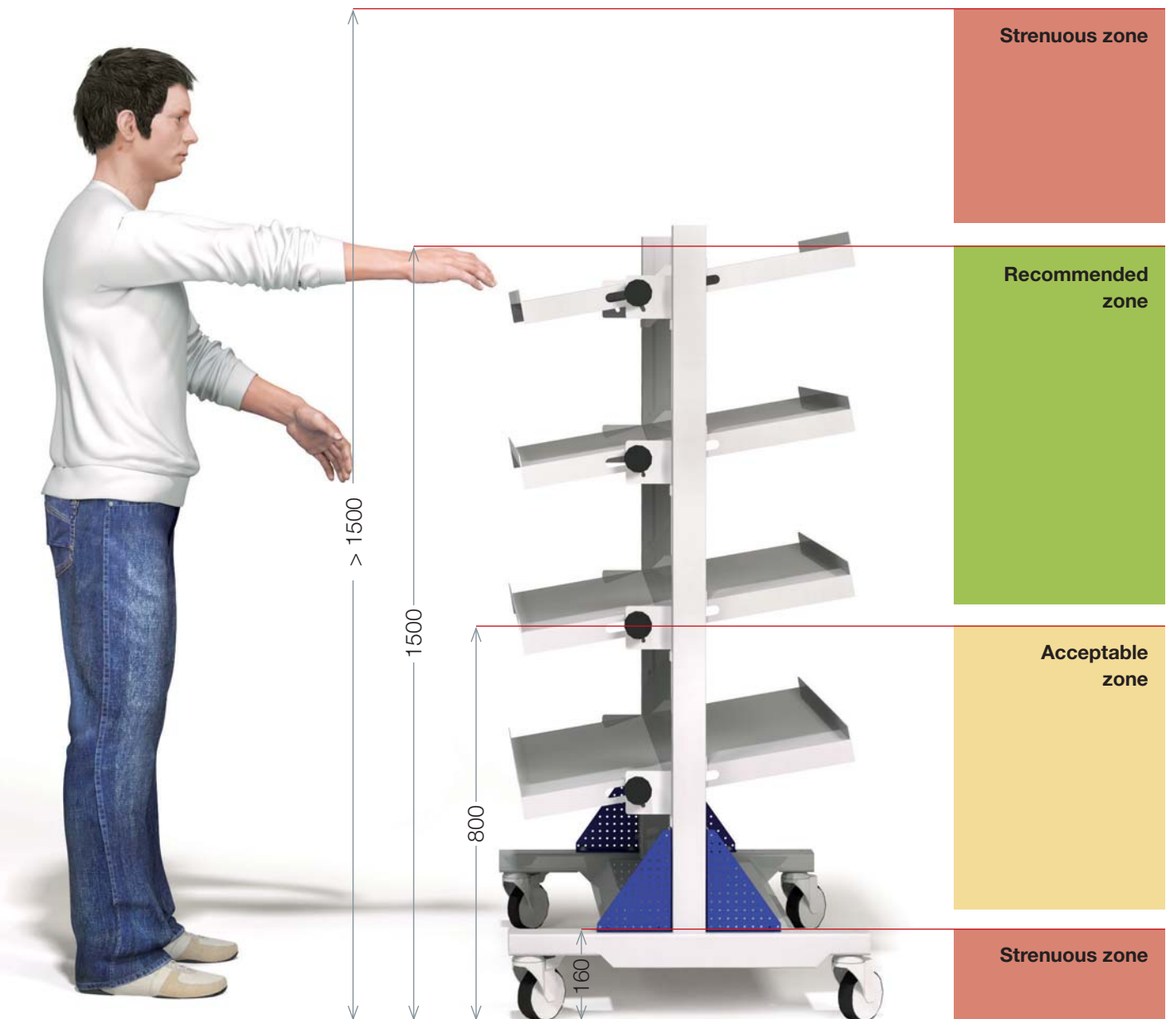
All parts of this zone are within reach of both hands

Zone 3: Single-handed access zone

Storage location for parts and tools which are often picked up with one hand

Zone 4: Wider single-handed access zone

Outermost zone which might be used for containers



Measurements in mm

DID YOU KNOW?

The ideal working height is between 800 mm and 1500 mm. Activities above heart level (over 1500 mm) diminish the

circulation of the blood and the oxygen supply to the muscles. Jobs which require bending below 800 mm also put

the body under disproportionate strain and should be avoided.

Sitting pretty takes practice

All the necessary information about the best chair and how to use it

The same principle applies to workplace chairs. The chair needs to adapt to the workplace situation and the person, both equally well and it needs to be extremely comfortable. Despite being perfectly adapted for purposes in the industry, a good workplace chair will make no concessions when it comes to ergonomic qualities. What used to be reserved for office desks is now also a must in production: offering the best support for the body, excellent breathing properties and top-level comfort.

The jobs carried out at manufacturing workstations may involve force, fine motor skills and repetitive movements, and it is not always possible to adopt an ideal

position in relation to the work piece. A workplace chair must adapt perfectly to the working environment and to the person, in order to enable necessary actions when seated - without adopting unhealthy positions or unnatural postures and without affecting productive efficiency.

There is a choice of two mechanisms for active-dynamic sitting: The permanent contact backrest and the synchronous mechanism. The permanent contact backrest follows the person's movements and guarantees that the back is always fully supported. The weight adjustment facility ensures that the balance is maintained between backrest resistance and

body weight. The permanent contact backrest is particularly suitable for close-up jobs where the employee spends most of the time leaning forwards over the work surface (e.g. precision engineering or laboratory work). The synchronous mechanism provides an active-dynamic sitting experience including weight adjustment. The seat and backrest synchronise with the movements of the body. This induces a feeling which is probably best described as a sense of "weightless floating". The synchronous mechanism is ideal for office-type activities, and for jobs which involve working at a monitor and frequent changes of seating position.

A good workplace chair

Backrest

Maximum freedom of movement is always the key criterion for chairs which are used to work in settings other than offices. This is met by a backrest which is broader at the base and narrower at the top.

Upholstery

It is important in terms of hygiene and economic efficiency to be able to change the upholstery. Different employees can use different upholsteries at the same workstation (e.g. if operating multiple shifts). If they are subject to high rates of wear, they can simply be replaced without the expense of buying a new chair.

Seat height and backrest height adjustment

The seat height adjustment serves to match the body height to the workstation height. The backrest height adjustment is designed to provide the ideal support - especially in the lumbar region - regardless of the person's size or height.

Weight adjustment

The resistance of the backrest can be adjusted to enable the correct sitting position for both light and heavy people.

Seat depth adjustment

The seat depth adjustment matches the depth of the seat to the size of the body, therefore allowing optimum support for the thighs.

Seat tilt adjustment

A slightly raised and bent forwards position is required for many jobs in production. The correct incline can guarantee a seat angle of at least 90° while still maintaining contact with the backrest.



DID YOU KNOW?

Simple production jobs are increasingly being replaced by more complex and more exacting tasks. The demands placed on the employees are also increasing in line with this trend. A company which wants to recruit and retain skilled employees must provide ideal working conditions – beginning with the correct workplace chair. The latest research shows that future production systems will give rise to new demands in terms of work

resources and equipment like machines, instruments, workbenches and also chairs. This means that the performance features will be required to meet higher specifications, as will the design quality. Companies which require highly motivated staff working at top levels of productivity must ensure that all the components of the operational system are conducive to this outcome. Research shows that up to 36% improvement can be realised

through high-end design and high-quality fittings. Moreover, a good workplace chair prevents fatigue, improves performance and boosts concentration.

(More information on this can be found in the Fraunhofer IAO publication on the post-2015 world of work „Arbeitswelt 2015 plus“)

The correct position

Adjust the backrest height!

Adjust the backrest so that its curvature supports the spine in the area of the 3rd and 4th lumbar vertebrae (approximately belt height).

Use the entire surface of the seat!

The bottom should be right at the back of the seat to fit its anatomically shaped contours. Only this posture ensures a contact with the backrest so that the user benefits of its support. The seat should slightly be inclined forwards for jobs involving fine motor skills. Ideally, the chair will have a seat depth adjustment mechanism allowing the optimum setting for the length of the thighs.

Adjust the seat to the correct height!

The seat is at the correct height when the upper arms and forearms form a right angle and the forearms are level with the working surface. At the same time, the angle between the thighs and lower legs should be at least 90°. The feet should be flat on the floor or on a footrest.



Sit down or stand up?

It's about the right mix

There is a steady decrease in the number of workstations on production and assembly lines which are either purely for sitting down or standing up. Standing up or sitting down on a job for the whole time is not good for the human body and therefore has a negative effect on output and performance because of pain, fatigue, lapses of concentration and loss of motivation.

Standing up demands considerably more energy than sitting down, exerting strain on the musculoskeletal system and reducing the stability of the upper part of the body.

Sitting down permanently, especially in a static way, is bad for the muscles and the locomotor system, and puts an additional strain on the cardiovascular system.

Alternating between standing up and sitting down

The ideal workstation enables the employee to alternate between sitting and standing up.

The action involved in moving from standing to sitting position and vice versa, and in changing position while working, exercises different muscle groups. It introduces a degree of movement which reduces muscle inactivity, relieves muscular tension, breaks the monotony of sitting or standing in one single position, and activates the cardiovascular system and the autonomic nervous system. This encourages an energetic and efficient working style.

Ideal seated position for working:

- Upper body upright
- Upper arms vertical
- Forearms horizontal
- Thighs horizontal
- Lower legs vertical
- Feet flat on floor
- Sufficient room to move the arms and legs



DID YOU KNOW?

Absence rates among assembly line workers are among the highest due to musculo-skeletal complaints (approx. 25%).

Simple measures can be put in place to reduce many of the stresses and strains on the assembly line.

Combined workstations with flexible height settings for sitting down or standing up

Height-adjustable workstations can be adjusted to individual body sizes and to accommodate the product being assembled. The height adjustment facility should be simple and quick to operate – electric height adjustment mechanisms have proved their efficiency. If height-adjustable workbenches are not available, then the height of the working surface should be selected for jobs performed in a standing position – in this case high chairs, standing rests or appropriate footrests should be provided.

Optimum dynamics:

- Avoid inactive sitting down & standing up
- Do not stand up for more than 20 minutes at a time
- Change position two to four times an hour

Ideal division of the working day:

- Sitting down on the job for approx. 60% of the day
- Standing up on the job for approx. 30% of the day
- Walking around for specific purposes for approx. 10% of the day

Ideal standing position for working:

- Upright posture
- Upper arms vertical
- Elbow at an angle of at least 90°



Insights into our field of vision

How to maintain an overview

If a job involves frequent head movements and the eyes constantly have to refocus on objects in the working zone, this will eventually lead to fatigue, headaches or tenseness. It is therefore necessary to factor the field and distance of view into the ergonomic design of assembly workstations.

All the essentials in view

A distinction is drawn between peripheral and central vision.

The peripheral field of vision is the area which is in view – but not in focus – without moving the eyes and head. The field of central vision is the area in which, with the

head kept still, objects can only be located and seen in focus by moving the eyes.

When arranging materials at a workstation, the general ergonomic principles are not to place them outside the maximum range of peripheral vision and to place frequently used items within the field of central vision. Jobs which require frequent eye contact are carried out in the optimum field of central vision.

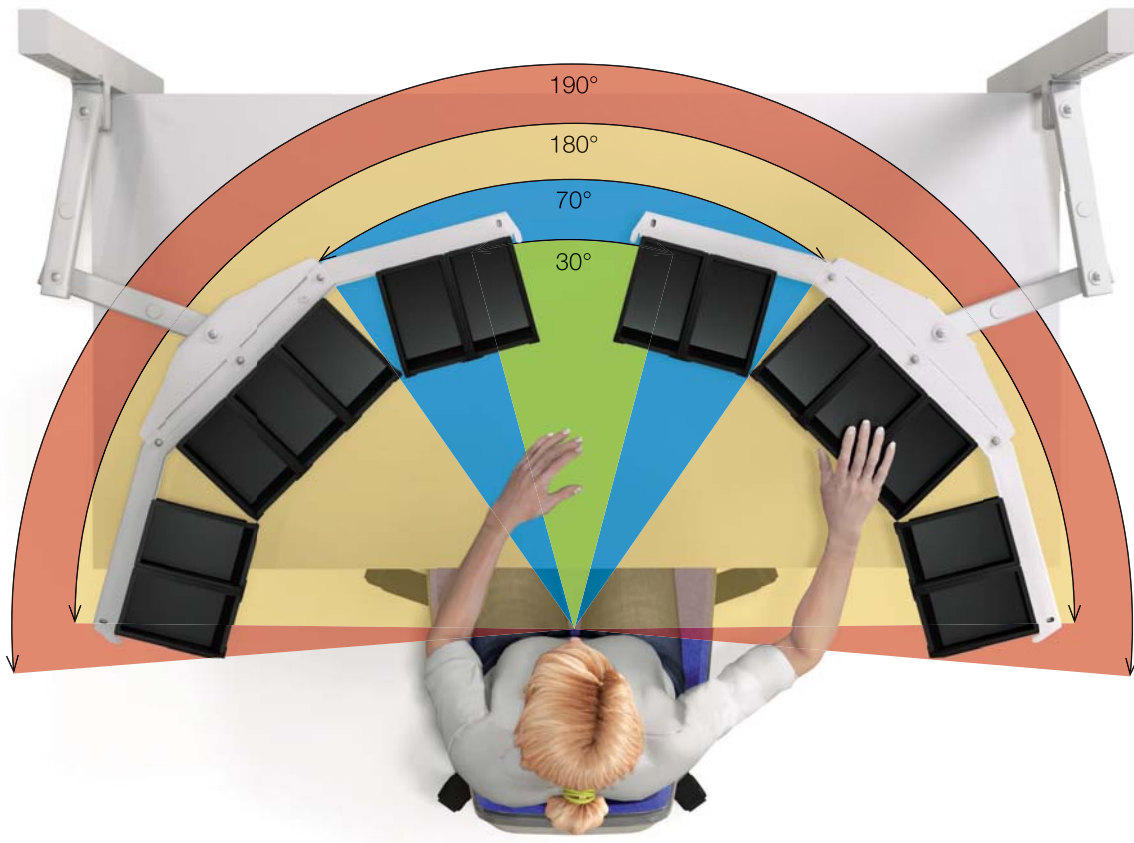
The ideal inclination angle of head and vision when standing up is 15° for the head and 30° for the eyes – relative to the horizontal plane. The ideal angles when

sitting down are a 35° head incline and a 40° angle of vision.

With the optimum peripheral field of vision and the head at a comfortable angle, the neck and eye muscles are not under strain.

The ideal focusing distance

The focusing distance depends on the current task. The objects to reach for should be closer if they require a high vision grade. Containers should always be kept the same distance away from the eyes so that the eyes do not need to refocus very often.



ZONE 1:

Optimum field of central vision

ZONE 2:

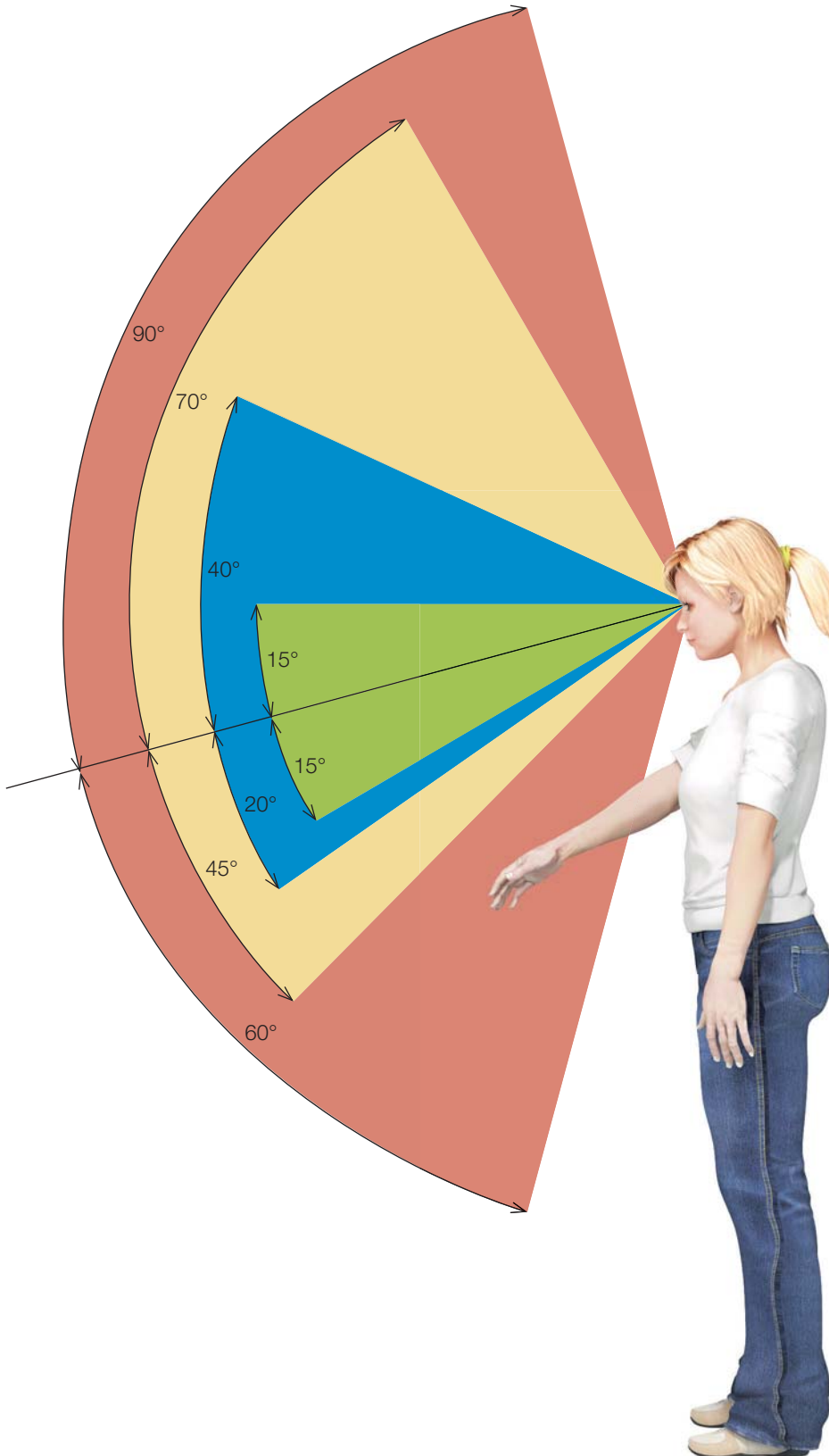
Maximum field of central vision

ZONE 3:

Maximum field of peripheral vision

ZONE 4:

Extended field of vision which comes into view by moving the head



Five exercises for the eyes

Blink more often

Blinking causes the fluid to be distributed over the eye to keep the eyes from becoming too dry.

Allow your gaze to wander

Select at least three focal points inside the room and a few outside, such as a picture on the wall or the light switch, a tree in front of the window or a building on the other side of the road. Every now and again, allow your gaze to skip from one focal point inside the room to one outside, then back to one inside and back again to one outside, and so on. This prevents one-sided strain of the eye muscles.

Take a short break

Take a very slow look in a far distance and move your eyes upwards without turning your head. Take a deep breath and then look downwards as far as possible. Take another deep breath and repeat the whole exercise five times. Then do the exercise another five times, pivoting the eyes to the right and left.

Roll your eyes

First roll your eyes, clockwise for one minute. Then close your eyes for 10 seconds and then roll the eyes anticlockwise for a minute.

Particularly effective

It is very relaxing for your eyes if you just close them for 10 seconds every now and again.

Don't forget to drink plenty! A lack of liquid may cause stinging and dry eyes. Make sure that you drink enough and at regular intervals – it is good for you in general, not just for the eyes!

Setting things in the right light

Optimum anti-fatigue lighting conditions

Lighting conditions at industrial workstations are very important and should take account of working times, tasks and individual requirements in order to facilitate jobs with high demands upon eyesight. The main factors are the correct incidence of the light source and the optimum light intensity. This is particularly important when there are changes, such as working in shifts, alternating between intricate close-up jobs and less intricate jobs, or if a workstation is occupied by several people of different ages.

A comprehensive lighting concept takes account of all the light sources in the room, including daylight, room lighting, and the shadow-free illumination of the actual work surface.

The level of illumination should increase, from the basic room lighting right through to the illumination of the area for close-up work.

Lighting quality matters

Brightness is an important factor and quality properties also play a key role, such as colour rendition, colour temperature, absence of flicker and absence of glare. If colour recognition is important, the light source should have a colour rendering index of $R_a \geq 90$. For a good contrast, the ideal colour temperature is over 5300K (daylight white). Direct glare and glare by reflection on high-gloss surfaces can be countenanced by the correct positioning of the lights and the right choice of light shades and louvres. Flicker can be eliminated by installing lights with electronic control gear or LED lights.



DID YOU KNOW?**Light prevents fatigue and promotes concentration**

Light stimulates the metabolism of the employees in suppressing the production of melatonin (sleep hormone) and in encouraging the release of „happy hormones“ like serotonin – important factors in eradicating human error in shift work. Fatigue can be prevented by increasing light intensity levels. It also has long-term health benefits, especially for elderly workers and people who work nights or in shifts. The relative light requirement increases from the age of about 30 onwards. The dioptric media lose their permeability, and the average pupil width in the same light intensity decreases – so 60-year-old employees need twice as much light as their 20-year-old colleagues.

Average light intensity levels for assembly workstations

As specified in DIN EN 12464-1:2011-08

Type of job	Branch of industry*	Close-up work zone	Area immediately surrounding the close-up zone	Background
Not very intricate	M	200 lx	150 lx	50 lx
	E	300 lx	200 lx	70 lx
Of average intricacy	M	300 lx	200 lx	70 lx
	E	500 lx	300 lx	100 lx
Intricate	M	500 lx	300 lx	100 lx
	E	750 lx	500 lx	170 lx
Very intricate	M	750 lx	500 lx	170 lx
	E	1000 lx	500 lx	170 lx

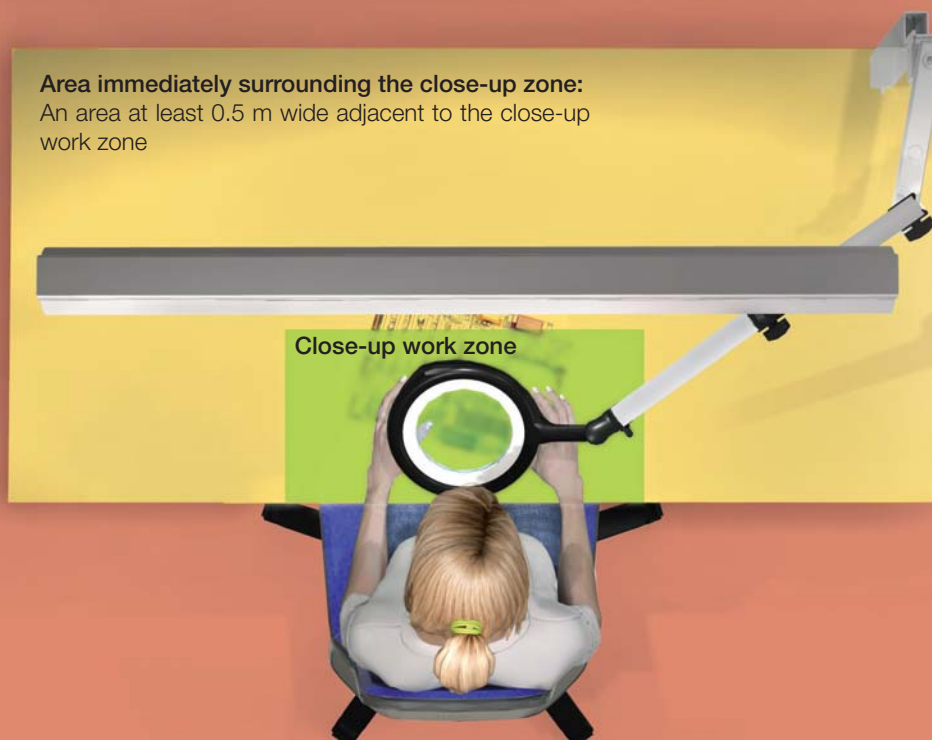
* M: Metalworking | E: Electric and electronics industry

Background:

An area at least 3 m wide, bordering on the area immediately adjacent to the close-up zone

Area immediately surrounding the close-up zone:

An area at least 0.5 m wide adjacent to the close-up work zone



Health management

Key contribution to success

As a health insurance specialist with a market share of over 40 %, the „AOK Bayern“ has an active involvement in the health care system in the Free State of Bavaria. Over four million people trust in our services. It is therefore a matter of particular urgency to us to get the message across to companies at senior level that they have a direct influence on the physical well-being and mental health of their staff. Modern corporate strategies favour improvements which promote health and safety in the workplace through the introduction of better systems and changes designed to optimise the working environment.

Company health management systems aim to put strategies and systems in place which keep the workforce healthy and encourage health-conscious practi-

ces among employees. The end results are higher levels of job satisfaction, less sickness-related absence and a lower sick pay bill. The impetus for ergonomic improvements comes from the senior management level. The correlation between management and health is therefore an indispensable perspective in a company health management system.

A knowledge of the ergonomic factors allows companies to cut costs and improve the quality of output, simply by optimising workstations and processes. The effectiveness of ergonomic changes is proven, and in many cases the changes are relatively minor and only involve little outlay. The initiative “teamwork FORUM ARBEITSPLATZGESTALTUNG is therefore a welcome move in every way. It sheds light on the ergonomic factors from dif-

ferent perspectives, allowing everyone to benefit.

For these reasons, the AOK Bayern has also agreed to endorse the PRACTICAL GUIDE TO ERGONOMICS. Indeed, as a health insurance fund, we are aware of the importance of education and prevention.

We wish the teamwork FORUM ARBEITSPLATZGESTALTUNG every success in the future and hope that many people will read this practical guide with interest.

Heinrich Hecht, Director of the AOK Bayern, Freising Headquarters



teamwork

www.teamwork-arbeitsplatzgestaltung.de

A joint initiative of:

bimos

A brand of Interstuhl Büromöbel GmbH & Co. KG
Brühlstraße 21 · 72469 Meßstetten-Tieringen
Germany | www.bimos.de



Andreas KARL GmbH & Co. KG Arbeitsplatzsysteme
Hauptstraße 26 · 85777 Fahrenzhausen
Germany | www.karl.eu

Waldmann 
ENGINEER OF LIGHT.

Herbert Waldmann GmbH & Co. KG
Peter-Henlein-Straße 5 · 78056 Villingen-Schwenningen
Germany | www.waldmann.com