

Ergonomics does not stop at the edge of the desk.

Identify physical demands, assess them professionally and design working conditions systematically.

The kaiserkraft white paper.



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Executive Summary

Ergonomic work design starts with the task and the conditions in which it is performed. Visible movements, postures or manual handling activities are initially observations. Only professional classification and consideration of working conditions show where changes can usefully be made.

Five design areas are central:

1. **Reach and travel distances:** Frequently required material, tools and controls should be reachable without unnecessary additional movements.
2. **Working height:** The actual point of work is what matters – not just the height of the work surface.
3. **Force and load handling:** Weight is only one factor. Grip, distance from the body, start and destination height, frequency and route conditions also shape the demand.
4. **Changes of posture:** Workstations should allow different working positions where the task permits.
5. **Workstation and material flow:** Relief must cover the entire process – from provision through to onward transfer.

The user perspective is equally important. Body dimensions and the task-spectrum jointly determine the required reach, clearance and adjustment options. With changing users, it also matters whether required adjustments can be made easily in everyday work.

For implementation in the business, the route leads from observation through professional classification and prioritisation to suitable measures. The next step is to verify whether the physical demand considered has actually changed.

Important: Wider claims about sickness absence, error rates or productivity require their own data and robust evidence.

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1. Introduction

People are remarkably adaptable. And that can quickly become a problem at work. So the question is: when we look at physical demands in the workplace, do we focus first on the employee – or on the conditions in which they work? That question determines where companies look for improvements. It is the starting point of this white paper.

Physical work is indispensable in many businesses. Materials are provided, workpieces are processed, loads moved, products assembled or consignments packed. Physical demands do not arise only from individual heavy tasks. Everyday processes can also place demands on the body when movements are repeated frequently, require awkward postures or involve additional force.

The European Working Conditions Telephone Survey 2021 shows how widespread such demands are: 71 per cent of respondents reported repetitive hand and arm movements at work. The survey covered more than 70,000 employees in 36 European countries. It does not allow conclusions to be drawn about the ergonomic quality of individual workplaces, but it does show how widespread repetitive physical demands are in European working life.

Ergonomics is more than workplace equipment.

An adjustable-height table, a suitable work chair or a lifting aid can be part of an ergonomic solution. Whether they actually provide relief depends on the specific task:

Where is material provided? At what height is the work performed? What loads are moved? How often is an operation repeated? And who uses the workstation?

This is where the white paper starts. It is aimed at people responsible for production, intralogistics, occupational safety and workplace design, as well as decision-makers who plan or develop workstations and processes.

It shows how physical demands in everyday work can be identified and classified professionally, which features of the work offer starting points for design, and how an observation can become a verifiable change. Different body dimensions and tasks are also considered as planning parameters.

This white paper provides professional guidance. It does not replace a risk assessment or a review of the applicable legal requirements.

**So the key question is not: Is the employee working correctly?
It is: Which conditions cause the task to be carried out in this way?**

2. Do not consider behaviour in isolation.

During a repeated work step, an employee reaches a long way to the side for material. A component is picked up from a low position. A load has to be lifted from the floor onto a work surface. Or a work step is carried out differently from the intended method.

In everyday work, an explanation can quickly seem obvious: awkward movement, lack of attention or an incorrect way of working. But this initially describes only **what** happens – not **why** the work is carried out in this way.

From behaviour to working conditions.

Material position, working height, work equipment, workflow and required movements help determine an employee's scope for action. So the question **Why does the employee work this way?** becomes a different one: **Which conditions cause the work to be carried out in this way?**

This change of perspective is one of the basic ideas of ergonomics. ISO 6385 describes ergonomic design as the integrated design of work systems. The focus is on the interaction of the work task, work equipment, workspace, work environment, work organisation and the person. The International Labour Organization also understands Human Factors and Ergonomics as a systemic approach in which people, tasks, tools and technologies, organisation and the work environment interact.

Ergonomic design therefore focuses on the **work system**.

The visible action is not the cause.

A simple example shows the difference: an employee regularly removes material from a container next to the workstation. To do so, they twist the upper body and reach down to the side. The movement is visible. Its cause still has to be identified.

This leads to different questions:

- Why is the container positioned there?
- Does the workflow dictate this position?
- How often is the material accessed?
- What alternatives does the available work area allow?

Individual behaviour remains part of the work system. Employees make decisions, use work equipment and influence workflows. However, they operate within conditions that enable or limit possible actions.

A clear sequence therefore helps with the next steps:

- ▶ **Observation:** What happens during the task?
- ▶ **Classification:** What physical demands arise?
- ▶ **Cause analysis:** Which conditions contribute?
- ▶ **Design:** Which of these conditions can be changed?

This distinction prevents premature solutions. Before measures are discussed, it must first be clear what actually happens during the work and how the physical demands should be classified professionally.

3. Classifying physical demands professionally.

Walking, reaching, lifting, holding and repetitive movements are part of many tasks in production and intralogistics. For assessment purposes, it is useful to distinguish between **physical demand**, **individual response** and **exposure**.

Physical demand, individual response and exposure.

Physical demand refers to physical requirements acting on a person during work. Examples include manual handling of loads, forceful or repetitive movements and prolonged postures.

Individual response describes how these requirements affect the individual employee. Body dimensions, physical characteristics, abilities and skills influence how people experience and manage the same working conditions.

Exposure describes the extent to which a demand occurs – particularly in terms of duration and frequency.

For professional classification, these levels need to be considered together. When moving a load, for example, its weight is not the only factor. Grip options, distance from the body, start and destination positions, frequency and duration are also relevant.

Several factors act together.

Physical demands rarely arise from a single factor. Relevant physical and biomechanical factors include:

- manual handling of loads
- forceful or repetitive movements
- awkward or static postures
- prolonged sitting or standing
- pulling and pushing trolleys, containers or transport equipment

Several of these factors may occur at the same time. Repeatedly repositioning a workpiece, for example, may involve force, an awkward posture and a high repetition rate.

Physical demand does not equal harm.

Physical demand is part of many tasks and is not inherently negative. What matters is its type, level and exposure.

Depending on the level, physical demands can contribute to fatigue, for example. This does not automatically imply illness, errors or changes in performance.

Such wider claims require their own data basis. For ergonomic assessment, a different question therefore comes first: **Which physical demands occur during the task – and to what extent?**

4. Identifying physical demands in everyday work.

Before causes are analysed or measures developed, observation comes first. Three areas help with an initial review: **a) reach and posture, b) force and loads, and c) duration and repetition.**

The aim is to describe how the task is performed as specifically as possible – not yet to assess its cause or anticipate a solution.

a. Reach and posture.

Frequent bending or twisting.	Repeated long reaches.	Working in high or low positions.
Workpieces are picked up from the side, material is removed from containers or objects are reached in low positions. The upper body bends or twists in the process. Observe: ▶ What movement occurs? ▶ How pronounced is it? ▶ How often and for how long does it occur?	During a work sequence, an employee repeatedly reaches a long way forwards or to the side. Observe: ▶ How far does the person reach? ▶ In which direction? ▶ How often does the movement occur?	The actual working height may differ from the height of the work surface. The work-piece, tool, container or machine also determines where the point of work is located. Observe: ▶ Where is the point of work? ▶ What posture results? ▶ How often or for how long is work carried out in this position?

b. Force and loads.

Lifting, holding and carrying.	Pulling and pushing.
Material is removed from containers, workpieces are repositioned, packages are lifted or objects are transported between work areas. Observe: ▶ What is being moved? ▶ From where to where? ▶ How often does the operation occur? ▶ In what body position? ▶ How far is the load from the body?	Trolleys, containers or other transport equipment are started, moved, braked and redirected. Observe: ▶ Where is pulling or pushing performed? ▶ When is increased force visibly required? ▶ What distances and changes of direction occur? ▶ What are the route conditions?

c. Duration and repetition.

Repetitive manual tasks.	Prolonged postures.
Gripping, turning, joining, inserting, cutting or packing can be repeated many times within a workflow. Each individual movement shows only part of the picture. Observe: ▶ Which movements are repeated? ▶ How often? ▶ Over what period?	Tasks with little visible movement can also require the same position to be maintained for a long time. Observe: ▶ Which posture does the task require? ▶ How long is it maintained? ▶ When does a change occur?

Practical check: make notable work steps visible.

The following check provides initial guidance. It replaces neither a risk assessment nor a professional evaluation. The first aim is to record observations and identify conditions that should then be examined more closely.

Observation	Condition requiring closer review
Frequent long reaches for materials, tools or controls Repeated bending or twisting of the upper body Picking up or setting down at very low or high positions Repeated lifting, holding or carrying Visibly increased force when pulling or pushing Frequently repeated hand or arm movements Prolonged maintenance of the same body position	Position, distance and access frequency Location of pick-up, work and set-down points Height of pick-up, destination and work points Load, grip, distance from the body, frequency and route Transport operation, distance, changes of direction and route conditions Movement pattern, cycle and repetition volume Duration of posture and available changes within the workflow

If several observations apply to the same work section, this is a reason for closer professional review – not a final assessment of the workstation.

5. Designing physical relief: five key levers.

Observation shows where physical demands occur. The next design question is: Which working conditions can be changed?

a. Reduce travel and reach distances.

The position of materials, tools and controls helps determine which movements are required. The key factors are **position, access frequency and required movement**.

Frequently used materials and work equipment should, wherever possible, be within easy reach close to the body and without unnecessary extra movements. Less frequently used items can be positioned farther away, provided this does not create new awkward movements.

Typical starting points:

- provide material closer to where it is used
- arrange containers, tools and controls by access frequency
- reduce unnecessary travel between pick-up, processing and set-down
- check the effects of a change on the entire process

b. Adapt working height to the task.

The key factor is the **point of work** – the point or area where the actual task takes place. It may differ significantly from the height of the work surface.

The appropriate height depends on the task. Tasks with high visual demands may require different working heights from force-intensive tasks. There is therefore no universal ideal height.

The main planning factors are **point of work, task, posture and user group**.

Typical starting points:

- adjust the height of the work surface
- position the workpiece or container differently
- coordinate pick-up, processing and set-down heights
- provide suitable adjustment options for different users or tasks

c. Change force requirements and load handling.

For manual handling of loads, weight is only part of the picture. The shape and centre of gravity of a load, grip options, distance from the body, start and destination height, as well as frequency and duration, all affect the physical demand.

For pulling and pushing, relevant factors also include starting, braking, changes of direction, distance and route conditions.

The entire handling process should therefore be considered: **provision, pick-up, transport, transfer and set-down**.

Typical starting points:

- provide or transfer material at a suitable height
- avoid unnecessary manual repositioning
- shorten or reroute transport routes
- position the load and body more favourably relative to one another
- use suitable work or transport equipment

EU Directive 90/269/EEC on the manual handling of loads follows the principle of avoiding manual handling where possible and reducing the remaining risks.

d. Enable changes of posture.

A particular problem can arise when a workflow dictates the same posture for a long period and allows little variation.

Depending on the task, different working positions, alternating between sitting and standing, or breaks from prolonged one-sided postures may be possible.

What matters is not maximum adjustability, but whether the design supports a meaningful change of position for the specific task.

e. Consider workstation and material flow together.

Physical demands arise not only at the processing point. Material is delivered, provided, picked up, processed, set down and moved on. Additional reaches, lifting operations or transfers can occur at each of these interfaces.

An adjustable-height packing table therefore solves only part of the problem if material still has to be picked up from the floor or finished packages are then moved at an unsuitable height.

Work surfaces, material provision, containers and transport equipment should be considered across the entire process. In other words: **Ergonomics does not stop at the edge of the desk.**

6. Who are we planning for? User group and adjustment ranges.

The five design levers show which conditions can be changed. For detailed planning, a second question is needed: **Who does the workstation need to work for, and for which tasks?**

Stature, reach and body proportions vary. At shared workstations or across changing shifts, this range becomes a specific planning parameter.

Do not design for the average.

Anthropometric data describe the dimensions and proportions of the human body. They support the planning of reach, clearance and movement spaces for a defined user group. A single average value, however, does not represent the full range.

Before planning, clarify:

- Who will use the workstation?
- Which tasks will be performed there?
- Which body dimensions are relevant to the specific design task?

ISO 7250-1 describes basic body dimensions for technological design. ISO 14738 addresses anthropometric requirements for the design of workstations at machinery. Which dimensions and ranges should be applied depends on the user group and design task.

Think differently about reach and clearance.

For **reach**, shorter reaches must be taken into account. A tool or control that is easy for a taller person to reach may already be too far away for a shorter person.

For **clearance**, the perspective is reversed. Legroom, passageways and movement spaces must also be large enough for larger body dimensions.

Planning task	Planning perspective
► Reachability of tools and controls ► Legroom, passageways and movement spaces	► allow for shorter reaches ► allow for larger body dimensions

The user and the task jointly determine the adjustment range.

Body dimensions are only one side of the planning equation. The other is the task. The required adjustment range therefore results from **two ranges: the user group and the task spectrum**. If a workstation is to cover different combinations of these, adjustability may be required. But adjustability is not an end in itself.

Adjustability must be usable.

With changing users or tasks, what matters is whether the required settings can be adjusted easily in everyday work.

Four questions help with planning:

1. Which settings need to change between users or tasks?
2. Are the adjustment controls easy to reach?
3. Can employees make the adjustments themselves easily?
4. Is it clear which setting is required?

Not every component needs to be adjustable. Some requirements can be covered by a suitable fixed arrangement; others require adjustable work surfaces, tool positions, material provision, or sitting and standing options.

The aim is not maximum adjustability. The aim is a workstation that works for the defined user group and the actual range of tasks.

7. From observation to verified change.

There is a systematic process between noticing an unusual work situation and implementing a justified measure:



a. Define the task scope.

First define the section of work to be considered: Where does the sequence start and end? Which work steps and variants are included? This creates a clearly defined scope for review.

b. Observe the actual process.

Next, record how the task is performed under real conditions. This includes movements and postures, load handling, duration and repetition, material positions, routes and transfers. The aim is a specific description of the current state.

c. Classify the physical demands.

The observations are organised professionally. What demands occur? For example, do they involve manual handling of loads, pulling and pushing, repetitive movements or prolonged postures?

d. Determine the need for assessment.

Depending on the type of demand, a more detailed assessment may be required. Duration, frequency, force, posture, movement sequence and other conditions may be considered. Which methods are suitable or mandatory depends on the task and location.

e. Prioritise the need for action.

Where several physical demands occur at the same time, prioritisation can take account of factors such as professional relevance, frequency and duration, the work steps affected, and technical and organisational opportunities for influence.

f. Design and implement suitable measures.

Only now is it decided where the change should be made. The central question is: Which observed physical demand should be influenced by which change? The design levers from Chapter 4 provide guidance. A measure is not ergonomic simply because a particular product is used. What matters is which condition of the task is changed as a result.

g. Verify the change.

After implementation, the task is reviewed again.

For example, the following can be verified:

- Have manual lifting operations been eliminated?
- Have reach or transport distances changed?
- Do certain postures occur less often?
- Can users actually make the required adjustments?
- Have new demands arisen elsewhere?

Where suitable assessment methods have been used, results before and after the change can be compared.

h. Make only claims that have been verified.

Success checks should initially focus on variables directly linked to the measure. If a manual lifting operation is eliminated, that can be verified directly. Statements about sickness absence, error rates or productivity, by contrast, require their own data and robust evidence.

The logic therefore remains deliberately narrow:



If verification shows that a demand remains or a new one has arisen elsewhere, the process starts again.

This approach supports structured ergonomic work design. It does not replace a workplace risk assessment. For companies in the European Union, Directive 89/391/EEC provides the fundamental framework for safety and health at work; specific requirements arise from the applicable national legislation.

8. Ergonomic work design in practice.

Two kaiserkraft projects show how different design approaches can be.

Vallorbe Swiss: changing a manual handling step.



Initial situation:

Usines Métallurgiques de Vallorbe SA manufactures precision files and round files for chainsaws. At least eight tonnes of round chainsaw files have to be transported between production stations every day.

According to the project documentation, this adds up to around 2.4 million kilograms and approximately 447 kilometres of transport over a working year. The boxes used weigh 65 kilograms each. They have to be transported and positioned for the next work step.

Design approach:

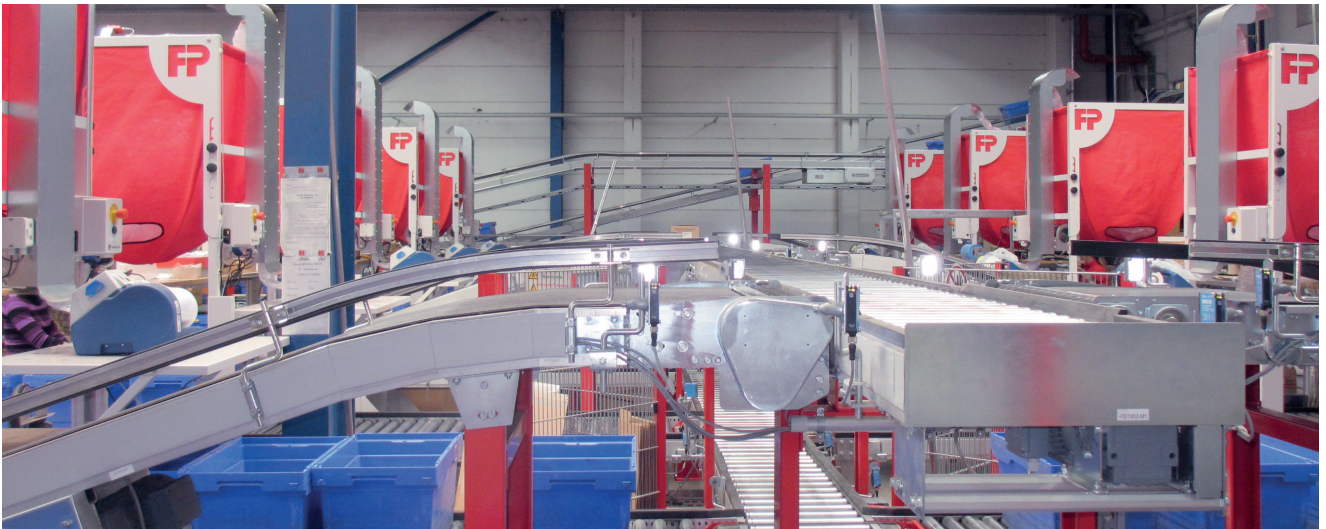
The key question was: **How can transport and positioning be designed so that the boxes do not have to be lifted manually again and again?**

kaiserkraft developed a conveyor system comprising 14 rows of roller conveyors. Five ball transfer tables were added across ten rows. The roller conveyors transport the boxes from the lathes to the press. At the ball transfer tables, the 65 kg boxes can be positioned for the next work step.

Directly verifiable change:

The boxes can be positioned without having to be lifted again, the load is significantly reduced and the transport distance is much shorter. The design approach therefore combines transport, transfer and positioning.

FEGA & Schmitt: provide material where it is needed



Initial situation:

FEGA & Schmitt originally operated two air-cushion machines in its packing area. Some of the void-fill material was stored on the floor or in large boxes. The required material was therefore not directly where it was used in the packing process.

Design approach:

Material provision was integrated into the packing process. The solution comprises 24 Mini-Pak'r machines with corresponding Automatic Delivery systems for 24 packing stations on four packing lines. The machine and frame were positioned directly above the conveyor belt.

The produced void-fill material is delivered into silo containers directly at the packing stations. A sensor controls their filling.

Directly verifiable change:

These changes significantly shortened walking distances. At the same time, employees no longer had to bend down to remove void-fill material from the boxes used previously.

Two projects, the same design logic.

	Vallorbe Swiss	FEGA & Schmitt
Observed operation	Transport and positioning of heavy boxes	Removal and provision of void-fill material
Design approach	Change transport and transfer	Integrate material provision into the process
Implementation	Roller conveyors and ball transfer tables	automatic supply via silo containers at the packing station
Directly verifiable change	Positioning without lifting again	shorter walking distances and no bending to remove material

The examples do not show which product is generally an ergonomic solution. They show how a design approach can be derived from a specific work situation. A suitable solution for another business must be derived from its task, material flow, user group and spatial conditions.

This is precisely where kaiserkraft starts when planning and implementing customised projects: Different requirements are considered in their specific operational context in order to develop an appropriate solution for the ergonomic design of workplaces, material flows and processes.

9. Conclusion: Good work needs good conditions.

Ergonomic work design starts with understanding the work. A visible movement is initially an observation. Only when considered together with the task, work equipment, material flow, organisation and user group does it become clear where design changes can usefully be made.

Three principles follow from this:

1. Consider the work system

Do not assess an employee's behaviour in isolation; examine the conditions under which the task is performed.

2. Design around the specific demand

Reach, working heights, load handling, changes of posture and material flow require different solutions. The user group and task spectrum also determine which design works.

3. Verify changes

What matters is not that a measure has been implemented, but what has actually changed in the work-flow as a result.

The approach can therefore be condensed into a simple sequence:



Ergonomics thus shifts from a question of equipment to a specific design task. **And that is precisely why it does not stop at the edge of the desk.**

Every workplace combines different tasks, material flows, users and spatial conditions. The requirements for workplace design, material provision and work equipment therefore vary accordingly.

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10. Appendix

Glossary

Anthropometry: The study of the dimensions and proportions of the human body. Anthropometric data support the planning of reach, clearance and movement spaces for defined user groups.

Work system: The interaction of the person, work task, work equipment, workspace, work environment and work organisation within which work is carried out.

Physical demand: In the context of this white paper: physical demands acting on a person during work. These may include manual handling of loads, repetitive or forceful movements and prolonged postures.

Individual response: In the context of this white paper: the individual effect of physical demands on an employee. In addition to the type and level of demand, individual characteristics may also play a role.

Ergonomics: A scientific discipline and design approach concerned with interactions between people and other elements of a system. Ergonomic knowledge is used, among other things, to design work systems.

Exposure: In the context of this white paper: the extent to which a physical demand occurs, particularly in terms of duration and frequency.

Physical demands: Physical demands arising from a task and the conditions under which it is performed. These may include manual handling of loads, forceful or repetitive movements and prolonged or awkward postures.

Material flow: The movement of materials, workpieces or products within an operational process – for example from provision through processing to onward transfer.

User group: The group of people for whom a workstation or work equipment is planned. Their body dimensions and the range of those dimensions, together with the task spectrum, are important planning parameters.

Repetitive task: A task in which the same or similar movements or work sequences recur regularly.

Point of work: Term used in this white paper for the point or area where the actual task is performed. Its height may differ from the height of the work surface, for example because of workpieces, containers, tools or machines.

Standards

ISO 6385:2016 – Ergonomics principles in the design of work systems: Describes fundamental ergonomic principles for the design of work systems and an integrated design approach. It provides the main normative basis for the systemic perspective in Chapter 1.

The edition was last reviewed and confirmed in 2021 and remains current.

ISO 7250-1:2017 – Basic human body measurements for technological design – Part 1: Body measurement definitions and landmarks: Describes basic anthropometric body dimensions, reference points and measurement principles. It provides a basis, among other things, for defining and comparing user groups and for anthropometric design tasks.

In this white paper, it provides the basis for the anthropometric terminology in Chapter 5. How anthropometric data are applied to reach, clearance and adjustment ranges depends on the relevant user group and design task.

The edition was last reviewed and confirmed in 2023 and remains current.

ISO 14738:2002 – Safety of machinery – Anthropometric requirements for the design of workstations at machinery: Describes how dimensions are derived from anthropometric measurements and applied to the design of workstations at non-mobile machinery.

The standard therefore supports individual planning aspects in Chapter 5. Its scope is narrower than that of this white paper and does not generally cover all production, logistics or packing workstations.

The edition was last reviewed and confirmed in 2023 and remains current.

Legal framework

Directive 89/391/EEC – Safety and health at work: The European framework directive on occupational safety and health sets out fundamental prevention principles for safety and health at work. These include avoiding risks, evaluating unavoidable risks, combating risks at source and adapting work to the individual. It forms the overarching European legal framework for the prevention logic described in Chapter 6.

Directive 90/269/EEC – Manual handling of loads: The Directive addresses the manual handling of loads, particularly where the characteristics of the load or unfavourable ergonomic conditions may create risks for workers.

Employers should avoid manual handling of loads where possible through suitable organisational measures or appropriate means. Where it cannot be avoided, measures must be taken to reduce the associated risks.

This source provides the legal reference for the section on force and load handling in Chapter 4.

Note on legal classification: The EU directives mentioned form a common European legal framework and are transposed into national law. Specific legal requirements may therefore differ between Member States. For sites outside the European Union, the relevant national legislation applies.

This white paper provides professional guidance. It does not replace a review of the legal requirements applicable at the relevant site or any required workplace risk assessment.

Technical foundations

European Agency for Safety and Health at Work – EU-OSHA

EU-OSHA describes relevant physical and biomechanical factors associated with work-related musculoskeletal disorders. These include:

- manual handling of loads,
- forceful or repetitive movements,
- awkward or static postures,
- prolonged sitting or standing.

The source provides a technical basis for classifying physical demands in Chapter 2 and for the observation areas in Chapter 3.

International Labour Organization – ILO / International Ergonomics Association – IEA

The joint ILO and IEA guidelines treat Human Factors and Ergonomics as a systemic design approach. People, tasks, tools and technologies, work organisation and the work environment are considered interconnected components of the work system.

The guidelines complement ISO 6385 as a technical basis for the systemic perspective in Chapter 1.

Survey

European Working Conditions Telephone Survey 2021 – EWCTS

Survey by the European Foundation for the Improvement of Living and Working Conditions – Eurofound – among more than 70,000 employees in 36 European countries.

The following figure is used in the white paper:

71 per cent of respondents reported repetitive hand and arm movements at work.

The figure is used solely to put the prevalence of physical demands in the European world of work into context.

The survey does not allow conclusions to be drawn about the ergonomic quality of individual workplaces or demonstrate a health effect of repetitive movements at a specific workplace.

Project sources

Vallorbe Swiss – Usines Métallurgiques de Vallorbe SA

kaiserkraft project reference on the design of material transport between production stations.

It forms the basis for the case study in Chapter 7. The documented details include:

- at least eight tonnes of round chainsaw files to be transported per day,
- around 2.4 million kilograms of transport volume per working year,
- around 447 kilometres of transport distance,
- boxes weighing 65 kilograms each,
- 14 rows of roller conveyors,
- five ball transfer tables on ten of the roller-conveyor rows,
- the option of positioning the boxes on the ball transfer table without having to lift them again.

The figures and changes described relate exclusively to this specific project.

FEGA & Schmitt Elektrogroßhandel GmbH

ratioform project reference on integrating the supply of void-fill material into the packing process.

It forms the basis for the second case study in Chapter 7. The documented details include:

- 24 Mini-Pak'r machines with Automatic Delivery systems,
- 24 packing stations,
- four packing lines,
- silo containers directly at the packing stations,
- sensor-controlled filling of the silo containers.

The project reference also describes shorter walking distances and the elimination of bending to remove void-fill material from the boxes previously used.

These statements relate to the specific project. They do not constitute general proof of effectiveness for comparable solutions at other workplaces.

References

European Agency for Safety and Health at Work – EU-OSHA: Musculoskeletal disorders. Thematic information on physical and biomechanical factors associated with work-related musculoskeletal disorders.

Eurofound: Working conditions in the time of COVID-19: Implications for the future. European Working Conditions Telephone Survey 2021 series. Publications Office of the European Union, Luxembourg, 2022.

European Union:

Council Directive 89/391/EEC of 12 June 1989 on the introduction of measures to encourage improvements in the safety and health of workers at work.

European Union: Council Directive 90/269/EEC of 29 May 1990 on the minimum health and safety requirements for the manual handling of loads.

International Labour Organization – ILO; International Ergonomics Association – IEA: Principles and guidelines for human factors/ergonomics (HFE) design and management of work systems. Geneva: ILO, 2021.

International Organization for Standardization – ISO: ISO 6385:2016 – Ergonomics principles in the design of work systems. The current ISO page confirms that the edition remains valid.

International Organization for Standardization – ISO: ISO 7250-1:2017 – Basic human body measurements for technological design – Part 1: Body measurement definitions and landmarks. The current ISO page confirms that the edition remains valid.

International Organization for Standardization – ISO: ISO 14738:2002 – Safety of machinery – Anthropometric requirements for the design of workstations at machinery. The current ISO page confirms that the edition remains valid and limits the scope to workstations at non-mobile machinery.

kaiserkraft:

Project reference Usines Métallurgiques de Vallorbe SA – custom-made conveyor systems.

<https://www.kaiserkraft.de/company/projekte-und-referenzen-2/usines-metallurgiques/w/references-usines-metallurgiques/>

ratioform:

Project reference on FEGA & Schmitt Elektrogroßhandel GmbH and the integration of void-fill supply into the packing stations.

KAISER+KRAFT GmbH (ed.) (2025): Einfach effizienter mit Maschinenlösungen. Verpackungsprozesse ganzheitlich gedacht. Maschinenbusiness Brochure.

Note on the use of AI support.

This white paper was created using AI-assisted tools and was reviewed, revised and finalised editorially by kaiserkraft. kaiserkraft is responsible for the content, statements and professional assessments.

