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Ergonomic principles related to mental workload —

Part 2: Design principles

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Partie 2: Principes de conception

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Contents

	Page
Foreword.....	v
Introduction.....	vi
1 Scope.....	1
2 Normative references.....	1
3 Terms and definitions.....	1
4 Design principles.....	2
4.1 General principles.....	2
4.2 Design principles in relation to work organisation.....	3
4.2.1 Perform system design reviews and include prospective risk assessment.....	3
4.2.2 Individuals' and teams' related objectives.....	3
4.2.3 Extended reachability.....	4
4.2.4 Flexibility in time allocation.....	4
4.2.5 Definition of work services.....	5
4.2.6 Duration of working hours.....	5
4.2.7 Time off between successive work days or shifts.....	5
4.2.8 Time of day.....	6
4.2.9 Shift work.....	7
4.2.10 Breaks and rest pauses.....	7
4.3 Design principles in relation to working tasks.....	7
4.3.1 Operating strategies.....	7
4.3.2 Continuous time constraints.....	8
4.3.3 Flexibility of decision-making.....	8
4.3.4 Ambiguity of task goals.....	9
4.3.5 Complexity of task requirements.....	9
4.3.6 Time sharing.....	10
4.3.7 Dimensionality of motor performance.....	10
4.3.8 Mental models.....	11
4.3.9 Parallel versus serial processing.....	11
4.3.10 Decision support.....	11
4.3.11 Sustained attention.....	12
4.4 Design principles in relation to job.....	12
4.4.1 Social interaction.....	12
4.4.2 Dependencies on others' task performance.....	13
4.4.3 Identical task requirements.....	13
4.4.4 Confidential communication.....	13
4.4.5 Changes in task-related activities with different demands or kinds of mental workload.....	14
4.5 Design principles in relation to work equipment and interfaces.....	14
4.5.1 Design the socio-technical system transparent for the user.....	14
4.5.2 Re-evaluate after adopting an assistance system to an existing system.....	15
4.5.3 Time lag.....	15
4.5.4 Adequacy of information.....	15
4.5.5 Ambiguity of information.....	16
4.5.6 Signal discriminability.....	16
4.5.7 Redundancy.....	16
4.5.8 Compatibility.....	17
4.5.9 Accuracy of information processing.....	18
4.5.10 Controllability.....	18
4.5.11 Control dynamics.....	18
4.5.12 Tracking requirements.....	19
4.5.13 Error tolerance.....	19
4.5.14 Adjust system design.....	19
4.5.15 Anticipate shifts in operating states and potential consequences.....	20
4.5.16 Coupling in human-machine arrangements.....	20

ISO/FDIS 10075-2:2024(en)

4.5.17	Adaptable and adaptive human–automation interaction.....	21
5	Information and training.....	21
Annex A	(informative) Design principles and their relation to the impairing consequences of mental strain.....	22

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 1, *General ergonomics principles*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 122, *Ergonomics*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 10075-2:1996), which has been technically revised.

The main change is as follows:

- The structure is now based on working conditions and no longer on strain consequences. All design principles are formulated positively and are divided into three parts, namely justification, guidelines and examples.

A list of all parts in the ISO 10075 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document represents an extension of ISO 6385, providing design principles for work systems with special reference to mental workload as defined in ISO 10075-1.

Mental workload is the effect of a complex interaction of individual, technical, organisational and social factors. Thus, personnel, technical, organisational and social factors and the effects of their interactions are relevant for the design of work systems.

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Ergonomic principles related to mental workload —

Part 2: Design principles

1 Scope

This document gives guidance on design principles and on design of work systems, including task and equipment design (comprising robotics and intelligent autonomous systems) and design of the workplace, as well as working conditions with the inclusion of social and organisational factors, emphasising mental workload and its effects as specified in ISO 10075-1.

It applies to the design of work and use of human capacities, with the intention of providing optimal working conditions with respect to health and safety, well-being, performance and effectiveness, preventing overload as well as underload, in order to avoid impairing effects and fostering the facilitating effects described in ISO 10075-1.

This document includes the design of technical, organisational and social factors only and does not apply to problems of selection or training.

This document does not address problems of measurement of mental workload or its effects.

This document refers to all kinds of human work activities (see ISO 10075-1), not only to those which can be described as cognitive or mental tasks in a restricted sense but also to those with a primarily physical workload.

This document is applicable to all those engaged in the design and use of work systems, for example system and equipment designers, employers and workers and their representatives, where they exist.

This document is applicable to the design of new work systems as well as to the redesign of existing ones undergoing substantial revision.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 6385, *Ergonomics principles in the design of work systems*

ISO 10075-1, *Ergonomic principles related to mental workload — Part 1: General issues and concepts, terms and definitions*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 6385 and ISO 10075-1 apply.

ISO and IEC maintain terminology databases for use in standardisation at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

4 Design principles

4.1 General principles

In order to avoid impairing effects and to foster facilitating effects of work system design on users, the work system must fit the user. The guidelines given in this document are recommendations concerning human-factors or ergonomics-related work design. Designing or redesigning work systems entails taking into account: people, technology, organisational and social conditions and their interactions right from the beginning, for example when planning work systems. This means that ergonomists should be integrated into the design process as early as possible. Where appropriate, stakeholders should be involved in the design process.

If there are already users, as in system redesign, their experiences and competencies should be integrated into the design or redesign process in order to achieve and verify an optimal level of design quality. This can be done by using methods of participation, by which user expectations and needs, with respect to design quality, can be incorporated into the design process. This enables user-oriented results and better acceptance on the side of the user, which contributes to the efficiency of the work system as a whole.

Furthermore, feedback mechanisms are useful to enable workers to help the designer to continuously improve the design, taking into account new situations or problems.

If the design is made for an entirely new system, the designer should take due account of the abilities, skills, experiences, expectations and needs of the prospective user population. Training should be regarded as supporting work system design, not as a replacement for system design omissions leading to sub-optimal design.

The user population must be considered from the beginning of the design process when system functions are specified. Defining system functions and subfunctions as well as function allocation between workers and technical systems and between different workers warrants consideration of the characteristics of the people involved.

In designing work systems, it should be kept in mind that work consists of a combination of tasks, which are executed with particular technical equipment in a particular work environment, in a particular organisational and social structure. Therefore, each of these components offers opportunities to influence the design of the work system with regard to mental workload.

Design principles can thus be related to different levels of the design process and the design solution in order to influence:

- a) the intensity of the workload:
 - at either the task or job level, or both;
 - at the level of technical equipment;
 - at the environmental level;
 - at the organisational and social level;
- b) the duration of the exposure to the workload:
 - at the level of the temporal organisation of work.

[Table A.1](#) in [Annex A](#) shows a matrix of the guidelines and their relation to the impairing consequences of mental strain.

Personal factors, such as abilities, performance capacities and motivation (on an inter-individual as well as on an intra-individual differences basis) influence the resulting workload. Thus, selection and training should be taken into account in the design of work systems.

Work system design starts with a function analysis of the system, followed by function allocation among worker and technical system and task analysis, and results in task design and allocation to the worker. It is proven that human factor experts are integrated into this process from the beginning in order to be able to

perform these steps with a view to the resulting design requirements, in particular with respect to mental workload. Such a procedure will reveal the appropriate requirements to be taken into account at each level of system design.

In designing work systems, it should be noted that environmental requirements, system demands, challenges and people themselves change over time. People, for example, can develop skills, abilities and expectations. This means that systems design should take into account such changes, enabling the system to adapt to these evolving needs. This can be done, for example, by dynamic task allocation, allowing the worker to allocate tasks to the technical system or to the worker, depending on the actual state of the worker.

Mental workload has different qualitative aspects leading to different qualitative effects (see ISO 10075-1). It is thus not sufficient to consider workload ranging on a unitary dimension (quantitatively) from underload to optimal load to overload. Some of the impairing effects of mental workload share common causes, although the effects are different. Monotony and saturation occur in repetitive monotonous activities. However, monotony is characterized by reduced activation and saturation by increased activation. The presentation of the following guidelines has thus been organized according to the components in work system design in ISO 6385 and with reference to impairing and fostering effects as described in ISO 10075-1. This should help the designer to take appropriate measures to avoid impairing effects and to foster facilitating effects of mental workload. Some of the guidelines are related to several consequences of mental strain. Accordingly, there are different possibilities to avoid the impairing consequences of mental strain.

4.2 Design principles in relation to work organisation

4.2.1 Perform system design reviews and include prospective risk assessment

4.2.1.1 Justification

The evaluation of work processes at various stages of development allows for adjustments. The focus should always be human-centred, since latent or occasional impairments due to working conditions can result in reasonably foreseeable misuse, mental fatigue and stress responses during worker task performance.

4.2.1.2 Guidelines

The designer should:

- perform system design reviews;
- assess dynamics and the variability of health and safety risks during system design;
- include, in design reviews, the system life cycle, potential system states, system performance, contexts of use, risks by system wear and tear, and reasonably foreseeable misuses.

4.2.1.3 Example

A building originally designed as a production site is planned to be used as an office or coworking space. Offices and production sites have different illumination requirements. Illumination for office use is suboptimal with regard to natural illumination and artificial illumination design.

4.2.2 Individuals' and teams' related objectives

4.2.2.1 Justification

Objectives should be attainable within regular working hours, otherwise the worker can experience mental fatigue, stress response or burnout.

4.2.2.2 Guidelines

The designer should:

- define individuals' and teams' work-related objectives consistently and attainably;
- enable worker participation in setting objectives and giving support for achieving these if necessary.

NOTE A commonly used criteria is SMARTER (specific-measurable-achievable-reasonable-timely-ethical).

4.2.2.3 Examples

A nursing goal following the SMARTER criteria can possibly be that a particular patient consumes at least 1,5 litres of fluid every day starting on a certain date, and that this goal is reviewed daily.

At a financial bank, the workers task is to finish a fixed number of financial transactions (e.g. funds) monthly. Every month, the attainability of this objective is reviewed by the worker and employer.

4.2.3 Extended reachability

4.2.3.1 Justification

If workers are available outside working hours, mental fatigue and burnout can occur.

4.2.3.2 Guideline

The designer should provide rules for extended reachability which are agreed upon and clearly communicated and documented.

4.2.3.3 Examples

Rules can include the definition of time of non-availability, the ignoring of certain calls, the separation of mail accounts into private and professional, the automation of mail sorting or the switch-off of notification functions.

4.2.4 Flexibility in time allocation

4.2.4.1 Justification

In interaction work, working conditions should allow the worker to satisfy the needs of the interaction partner (e.g. patients, and clients) in the given situation; otherwise, mental fatigue or burnout can occur.

4.2.4.2 Guideline

The designer should ensure that work systems allow flexibility in the time allocated to any task, especially those requiring social interaction.

4.2.4.3 Example

A certain proportion of the daily working time can be set aside for disposable, as well as demand-oriented interaction times.

4.2.5 Definition of work services

4.2.5.1 Justification

If there are no definitions and clear descriptions of roles, the expectations between workers, clients and management can differ and result in unnecessary work for the persons involved, leading to stress response and mental satiation.

4.2.5.2 Guideline

The designer should define and document the scope and character of work or services and inherent tasks as well as the roles and responsibilities.

4.2.5.3 Example

The description of a service can include, for example, information on the service objective, the period of service provision and quality assurance measures.

4.2.6 Duration of working hours

4.2.6.1 Justification

The duration of working time influences the mental fatigue of workers. Mental fatigue can affect health, safety and performance. The duration of working time should therefore be designed to prevent mental fatigue.

4.2.6.2 Guidelines

The designer should:

- ensure that the duration of daily working time does not exceed 8 hours; however, an increase in the duration of daily working time to 10 hours is acceptable if the average daily working time does not exceed 8 hours within a defined period;
- ensure that the duration of weekly working time does not exceed 48 hours; however, an increase in the duration of weekly working time to 60 hours is acceptable if the average weekly working time does not exceed 48 hours within a defined period;
- ensure that the duration of working time is reliable for the worker;
- involve workers in the planning of working time.

These are recommendations which the designer can apply in arranging working hours, taking the applicable legal and regulatory requirements into consideration.

4.2.6.3 Examples

The designer can consider the introduction of working time accounts with time limits.

The designer can also consider compensation for overtime and extra work done in free time (rest time) in the course of an agreed time period.

4.2.7 Time off between successive work days or shifts

4.2.7.1 Justification

The purpose of the time off between successive workdays or shifts (rest periods) is to allow workers to recover. The rest period between successive shifts should be sufficient to allow full recovery from the mental