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Ergonomics of human-system interaction - Part 810: Robotic, intelligent and autonomous systems (ISO/TR 9241-810:2020)

Ergonomie de l'interaction homme-système - Partie 810: Titre manque (ISO/TR 9241-810:2020)

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Ergonomie de l'interaction homme-système - Partie 810: Titre manque (ISO/TR 9241-810:2020)

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European foreword

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Part 810: Robotic, intelligent and autonomous systems

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 documents 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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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 4, *Ergonomics of human-system interaction*.

A list of all parts in the ISO 9241 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

Product development of systems with robot, intelligent and autonomous characteristics is rapidly progressing. Given the human-system issues of such systems, timely guidance covering these issues is necessary to help all sectors of industry to design, field and operate first-time quality robotic, intelligent, autonomous (RIA) systems, and build appropriate trust in products and services that use these systems.

There is an urgent need for a Technical Report from ISO explaining the existing, emerging and potential human-system issues and consequences for use and users associated with systems that have robot, intelligent and autonomous characteristics. This document explains the existing, emerging and potential human-system issues and consequences for use and users associated with systems that have RIA characteristics. It identifies the potential risks and priorities for standardization to address these issues. Solutions will be the subject of future standards.

This document reviews the ergonomics for a range of RIA systems. It describes the human-system issues that should be considered in the application of these technologies and identification of priorities for future standardization work. The purpose of this study is to identify and explore the ramifications of a categories of issues involving RIA systems that suggest a need to reset the boundaries of what is called ergonomics. The conclusion is that to make an ergonomic RIA system, the practice of ergonomics will need to do more, working together with new disciplines, and can require new tools, methods and approaches to support the design and integration of these types of systems into working environments and organizations. Ergonomics will also need to identify relevant research from a wide variety of scientific disciplines, as well as conducting our own research to ensure we have a robust evidence base to guide the development of these systems.

The paradigm behind human-systems interaction standards so far has been that of tool use. The ISO 9241 series is for interactive tools and the physical environment within which they are used. RIA systems necessitate a new paradigm. Agents developed using these technologies will be more connected, complex, probabilistic and non-deterministic, social, and augment human capabilities well beyond merely replacing physical work. Interaction with these agents can become a relationship, their interface a personality, and users and agents can form complex human-machine teams, working together towards a shared goal.

The evolution of RIA systems will significantly alter the nature of tasks users perform. The design of work will likewise be altered. Applications of RIA systems represent a significantly more complete and impactful replacement of human activity than has been seen with any other form of technological labour-saving device. For example, when working with another person on a common task, how do you diagnose a failure state in your interactions? How are you to interpret the off-nominal behaviour of a team member? How are you to interpret and predict the behaviour of other people who are operating within the same environment as you are but are otherwise not directly coordinating activity? What is the safe state you can fall back on in the event of a failure in your interaction with another person? Now, replace that person or team member with an RIA system. The changes in the nature of tasks and the design of work to accommodate the complex, social human-machine interaction of an RIA system is fundamental for ergonomics, but will require that the ergonomics community adapt its best practices and expand into areas of psychology and sociology that few ergonomists deal with on a regular basis.

The focus of this document is breadth not depth, and issues not answers. The emphasis is on describing general issues and the consequences of not addressing them, even though not all will/can be relevant to all types or applications of RIA systems covered by this document. But be sure that this is the case for your application, and that you take account of the categories of issue and context that do apply.

Ergonomics of human-system interaction —

Part 810: Robotic, intelligent and autonomous systems

1 Scope

This document addresses:

— physically embodied RIA systems, such as robots and autonomous vehicles with which users will physically interact;

— systems embedded within the physical environment with which users do not consciously interact, but which collect data and/or modify the environment within which people live or work such as smart building and, mood-detection;

— intelligent software tools and agents with which users actively interact through some form of user interface;

— intelligent software agents which act without active user input to modify or tailor the systems to the user's behaviour, task or some other purpose, including providing context specific content/ information, tailoring adverts to a user based on information about them, user interfaces that adapt to the cognitive or physiological state, "ambient intelligence";

— the effect on users resulting from the combined interaction of several RIA systems such as conflicting behaviours between the RIA systems under the same circumstances;

— the complex system-of-systems and sociotechnical impacts of the use of RIA systems, particularly on society and government.

This document is not an exploration of the philosophical, ethical or political issues surrounding robotics, artificial intelligence, machine learning, and intelligent machines or environments. For matters of ethics and political issues, see standards such as BS 8611 and IEC P7000. However, this document does identify where and why ethical issues need to be taken into account for a wide range of systems and contexts, and as such it provides information relevant to the broader debate regarding RIA systems.

This document has a broader focus than much of the early work on autonomy that relates to the automation of control tasks and mechanization of repetitive physical or cognitive tasks, and centres on levels of automation.

Although this document addresses a wide range of technology applications, and sector and stakeholder views on the issues, the treatment of each can be incomplete due to the diverse and increasingly varied applications of RIA systems.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

4 Symbols and abbreviated terms

AI	artificial intelligence
CRM	crew resource management
DM	decision making
GPS	global positioning system
HCD	human-centred design
HCI	human-computer interaction
HCQ	human-centred quality (see ISO 9241-220)
HF	human factors
IA	intelligent agent
ICT	information and communications technology
IVR	interactive voice response
ML	machine learning
OODA	observe–orient–decide–act
RIA	robotic, intelligent, autonomous
RPA	robotic process automation
UxV	unmanned (where x = space, air, ground, surface, sub-surface) vehicle
UI	user interface
UX	user experience

5 Report contents and structure

The target audience for this document is decision-makers, designers and engineers who would benefit from the consideration of human-systems issues of RIA systems. Futurists, researchers, technology developers, regulators and legislators can also find this document useful.

The target audience for this document is the standards development community and ergonomists involved in developing, acquiring and/or commissioning RIA systems.

This document is based on an analysis that projects forwards from current applications of technology to more connected, complex, probabilistic and non-deterministic, social systems/entities/agents, and human augmentation. Social in this context also includes physical interaction. Applications considered include robots, intelligent systems and environments such as smart buildings that control or otherwise influence an environment, and autonomous agents/systems. The analysis considers views and concerns of: RIA system users and stakeholders from various industry sectors regarding the impact on future job roles, human tasks and organizational structures, safety, system trust, rights and culture. The

limits for ergonomics are considered together with an initial identification of potential areas of change. A broad range of published sources and expertise was drawn on during the creation of this document. It includes the futurology literature, regulatory work, input from astute observers and reports of current and planned products. Extensive discussion and analysis by the project team is also included.

— Clause 6 discusses relevant concepts in AI and ergonomics.

— Clause 7 describes the groups of identified issues.

— Clause 8 describes the hazards and possible harm that can result if Ergonomics is not applied.

— Clause 9 describing how various existing ergonomics standards address the issues.

— Clause 10 describes the changes in ergonomics standards required to better address RIA systems technology.

Annexes A to E are written for:

— the ergonomics community — to give their input to RIA system projects/discussions face validity, provide food for thought regarding how ergonomics can be applied/should evolve/needs to be supported, gives a framework for issues to raise if involved with such projects;

— those developing, acquiring, commissioning or approving RIA systems — providing a set of considerations and potential issues to think about for those in any executive, project, design or legal and regulatory role;

— developers and users of standards who need to understand how the ergonomics aspects of RIA systems affect their activities — alerting those who have not so far included human or ergonomic requirements in relation to RIA systems in their domains to new or emergent human-system issues or needs.

Annex A elaborates the human-system issues within each category. Annex B presents examples of RIA systems, illustrating the issues, hazards, and ergonomics considerations. Annex C provides a two-stage review of the areas in which ergonomics needs to develop to address these issues. Annex D contains a more detailed description of the analysis and notes on the necessary extensions to ergonomics and standards. Annex E describes the analysis on which this document is based.

6 Concepts

6.1 General

There are many technologies used to implement RIA systems, various combinations of which are employed across a huge range of applications with which humans will interact. This has led to a general lack of agreement and precision in definitions and terminology, including those within standards where RIA system technologies and applications are defined in various ways according to specific requirements of the given context. As it is not possible to fully predict the different ways in which such technologies will be developed and applied in the future, this document does not refer to existing definitions from other standards. Instead, this document uses generic and commonly used terms because, although these can still invoke different individual interpretations and opinions, they are more generally and widely understood.

This document uses the most common generic terms in the title (robotic, intelligent, autonomous) with the understanding that they can trigger a range of associations and differences of opinion. These are not conceptually independent. Furthermore, this document focusses on their use by humans as collective descriptions for characteristics of types of intelligent agent. These agents are often qualified as to type or context of use (for example, autonomous car, intelligent building, care robot).