

Improvements of Machinery and Systems Safety by Human Factors, Ergonomics and Safety in Human-System Interaction

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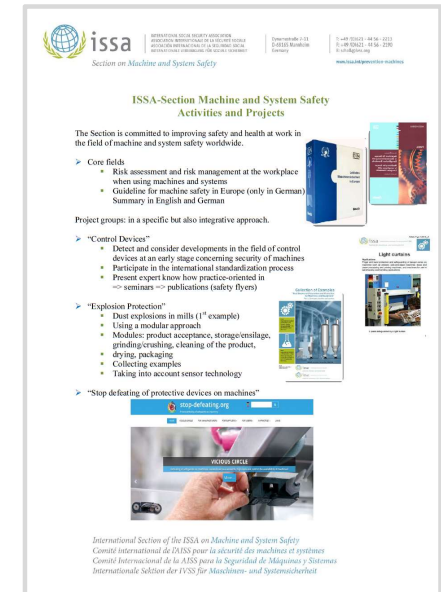


20th Congress of the IEA "Creativity in Practice", Aug 26-30, 2018, Florence, Italy
Safety & Health 06 (Safety analysis in Automotive, Manufacturing & Others)

Agenda

- ISSA Section Machine and System Safety
- Work Systems Design – Prevention through Design
- Work Systems Design – Criteria
- Work Systems Design – Internet Platform Structure
 - Design Requirements: Work Psychology Issues
 - Design Requirements: Work Equipment and Software
 - Design Requirements: Work Place
 - Design Requirements: Cyber Physical Systems

■ Conclusions



Improvements of Machinery and Systems Safety by Human Factors, Ergonomics and Safety in Human-System Interaction

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⁶ Research Centre for Applied System Safety and Industrial Medicine (ISSA), Mannheim, Germany
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Abstract. The International Social Security Association (ISSA) Section for Prevention of Occupational Risk in Machine and System Safety established a working group on Human Factors, Ergonomics and Safe Machines for reviewing, selecting and promoting design requirements and recommendations according to occupational safety and health (OSH) and human factors and ergonomics (HFE). An internet platform will inform, motivate and support machinery manufacturers, users and OSH experts to apply OSH and HFE when constructing, risk assessing, setting-up and operating machinery. Concepts like hierarchy of controls and work system design guide along relevant issues. Besides traditional approaches a special emphasis is given to smart manufacturing calling for design solutions for human-system interaction according to OSH and HFE.

Keywords. Occupational safety and health; Work system design; Design principles; Design requirements; Hierarchy of controls

List of Technical Abbreviations

- OSH: Occupational Safety and Health
- MSS: Machinery and System Safety
- HFE: Human factors and Ergonomics
- HFE/SM: Human factor, Ergonomics and Safe machines
- CPS: Cyber Physical Systems

© Springer Nature Switzerland AG 2018
 B. Bazarova et al. (Eds.), ISA 2018, ASSE 419, pp. 257–267, 2018.
https://doi.org/10.1007/978-3-319-96980-2_28



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Section on Machine and System Safety

www.issa.int/prevention-machines

ISSA Section Machine and System Safety

■ Improve OSH Worldwide

- Risk assessment and risk management at workplaces with machines and systems
- Guidelines for machinery safety in EU


■ Integrative Project Groups

- Control devices
- Explosion protection
- Stop defeating protective devices
- HF/E and safe machines [WG HFESM]

■ Project of the WG HFESM

- Support for manufacturers, designers and users (employers) of machinery and work systems via internet platform www.issa.int
- HF/E design requirements and good practice for human-system interactions
- to improve machine operator health, safety and security in analogue and/or digital environments

ISSA Section Machine and System Safety



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**ISSA-Section Machine and System Safety
Activities and Projects**

The Section is committed to improving safety and health at work in the field of machine and system safety worldwide.

➤ **Core fields**

- Risk assessment and risk management at the workplace when using machines and systems
- Guideline for machine safety in Europe (only in German) Summary in English and German

Project groups: in a specific but also integrative approach.



➤ **“Control Devices”**

- Detect and consider developments in the field of control devices at an early stage concerning security of machines
- Participate in the international standardization process
- Present expert know how practice-oriented in ⇒ seminars ⇒ publications (safety flyers)


➤ **“Explosion Protection”**

- Dust explosions in mills (1st example)
- Using a modular approach
- Modules: product acceptance, storage/ensilage, grinding/crushing, cleaning of the product, drying, packaging
- Collecting examples
- Taking into account sensor technology

➤ **“Stop defeating of protective devices on machines”**

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Comité Internacional de la AISS para la Seguridad de Máquinas y Sistemas
Internationale Sektion der IVSS für Maschinen- und Systemsicherheit



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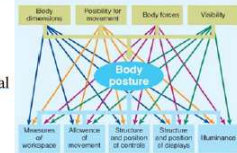
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Section on Machine and System Safety

- 5 important steps each for manufacturers, dealers, users
- Practical examples
- How does digital manufacturing influence safety + security of protective devices?

➤ **“Human factor, ergonomics and safe machines”**

- Tasks and requirements from engineering for safe machines and healthy users
- 1st part: ergonomic requirements for design of an ergonomic workplace with displays and control actuators
- Next parts:
 - Software ergonomics
 - Work psychology – engineering psychology
 - Technological developments towards cyber physical systems (tasks and functions in process chain, machine (user) interface)



➤ **“Digital Manufacturing”**

Each individual element of the system Man - Machine - Environment may be the cause of system failure and thus lead to risks.

- Digitization: chances + risks for safety and security, health at work
- Classical risk assessment be extended => cyber risks
- Develop practical examples from industry
- Training for engineers, employees, prevention and IT-experts




Photo: www.issa.int

Contact data:

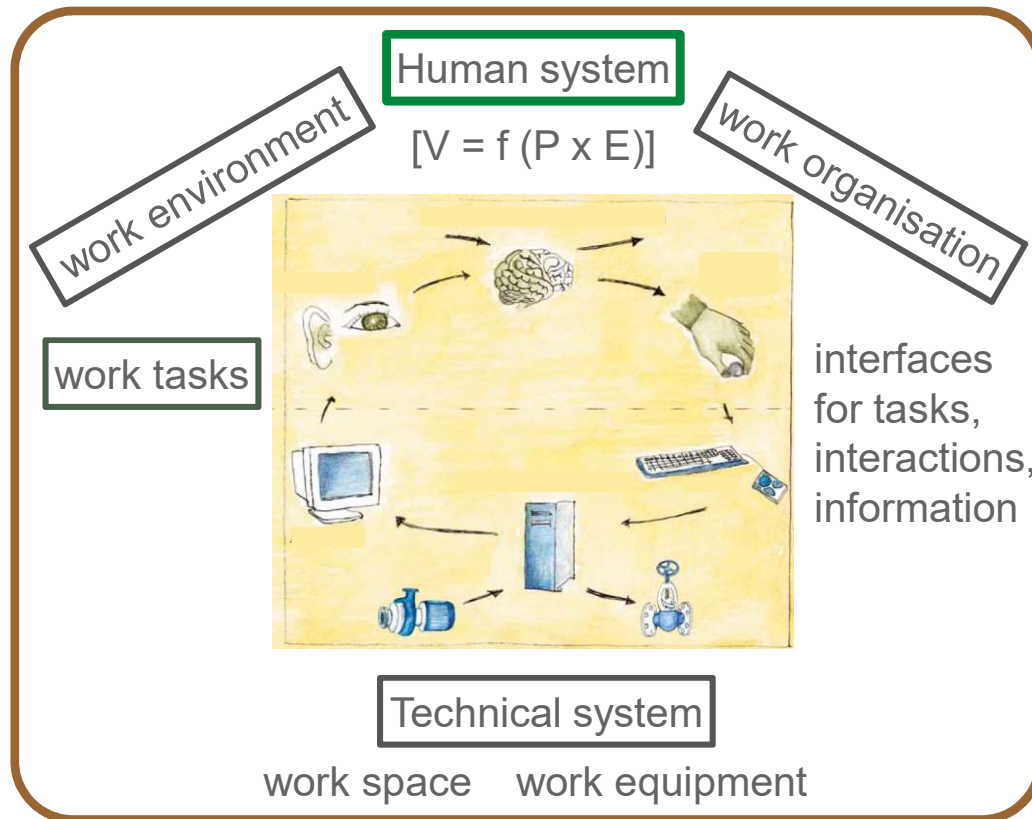
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Further information:
<http://www.issa.int/de/web/prevention-machines/about>

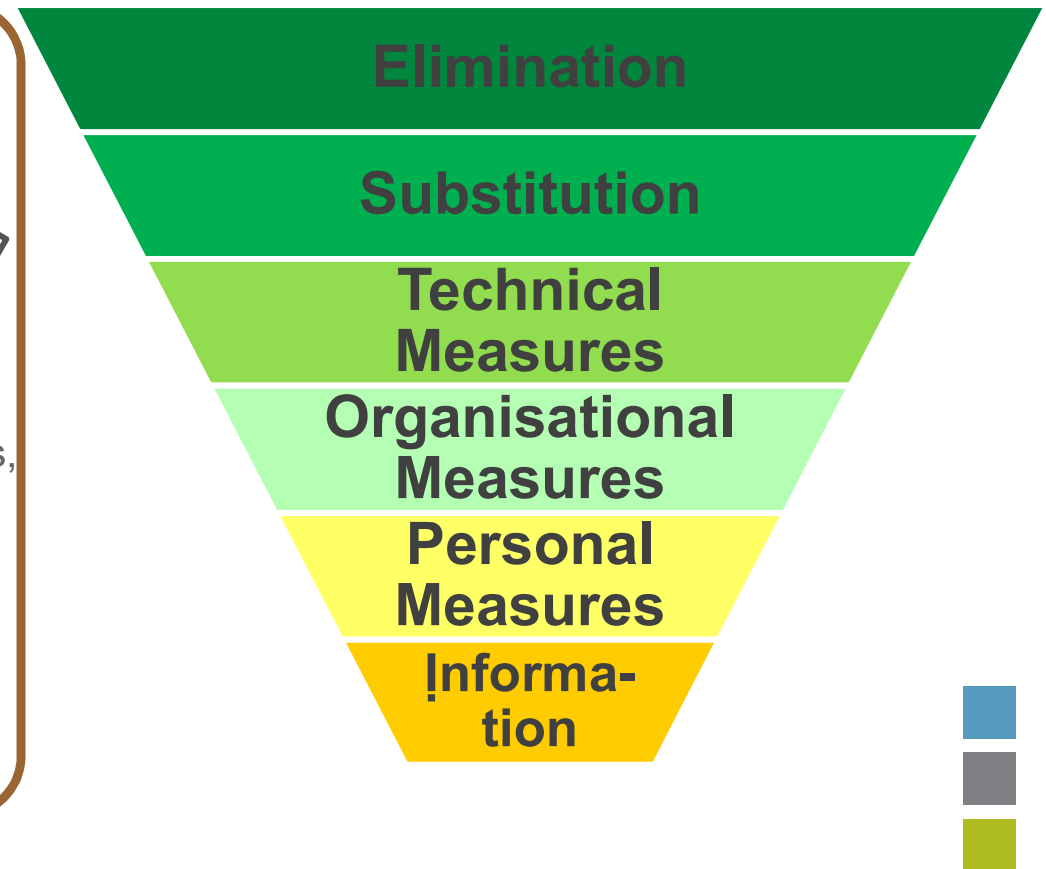
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Work Systems Design – Prevention through Design

Human-System Interaction



Hierarchy of Controls – E STOP !



Work Systems Design – Criteria

■ Design should enable

- development of learning, health and personality to improve general competences, capacities and experiences
- freedom from physical and mental impairment through task variations (e.g. monitoring limits to avoid low vigilance)
- freedom from harm by OSH classics (e.g. obstacle-free floor for trip reduction)
- feasibility of work compatible with generic human physical and mental abilities (e.g. hand grip and force, colour discrimination)

work systems design
compatible with HF/E & OSH

development
of health



freedom from
impairments



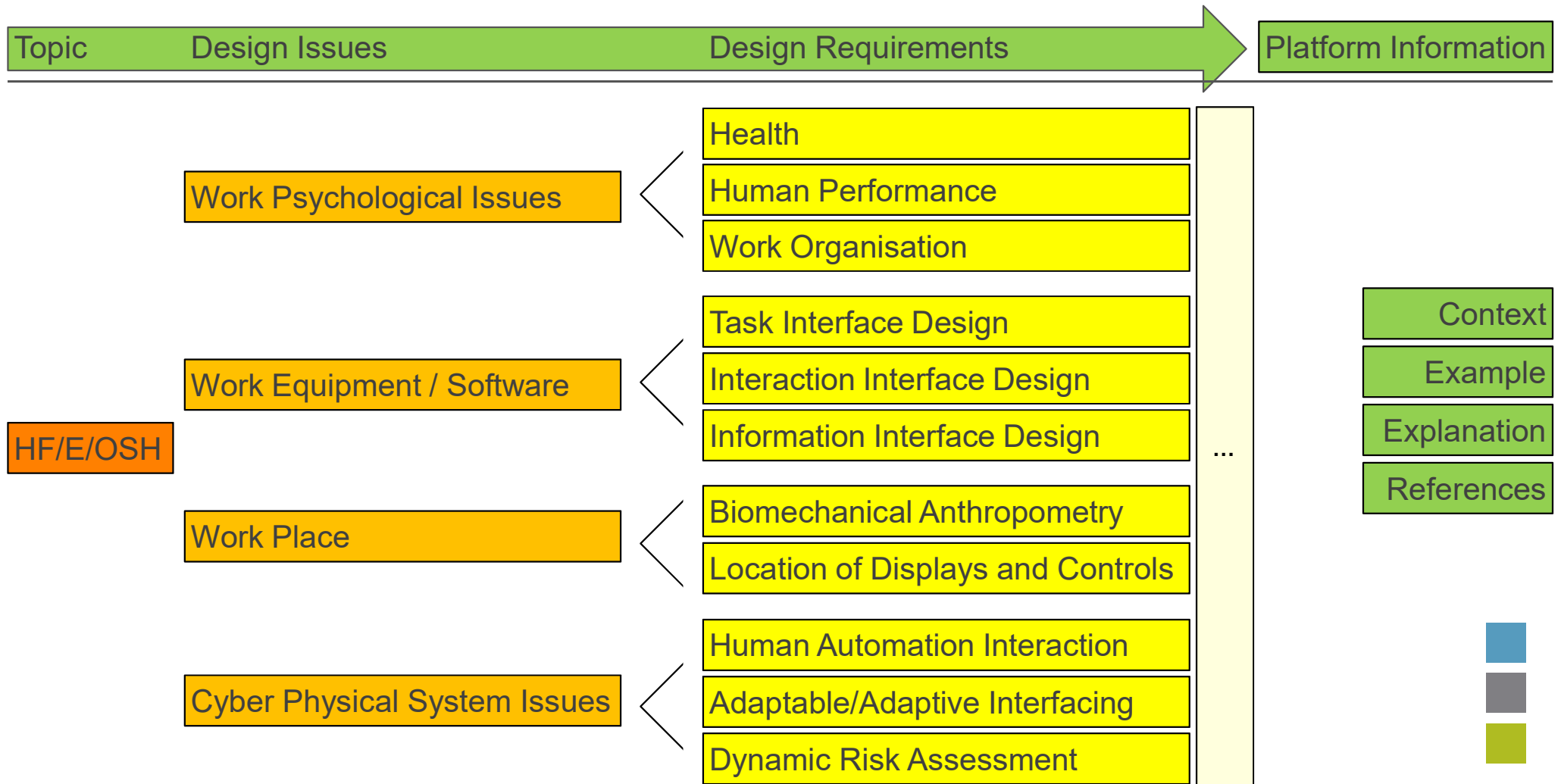
freedom from
harm



feasibility of
work



Work Systems Design – Internet Platform Structure



Design Requirements: Work Psychology Issues

Platform Information

HF/E/OSH

Work Psychological Issues

Human Performance

Workload

Menu Context

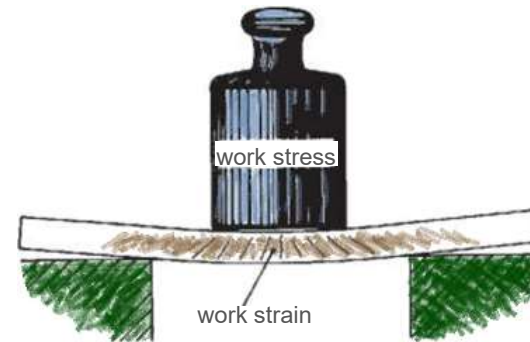
- Physical and mental stress is the total of all assessable influences impinging upon a human being from external sources and affecting that person physically and mentally.
- Physical and mental strain is the immediate effect of physical and mental stress within the individual; with their current condition potentially having a moderating effect.

Explanation

- Work stress and strain are crucial for assessments of work systems design quality. Multidimensional measurement and differentiation with regard to type, level and dynamics of work stress may be required.

- Work stress (physical and mental) is synonymously used with the term external workload. The figure illustrates the stress-strain relationship

Example



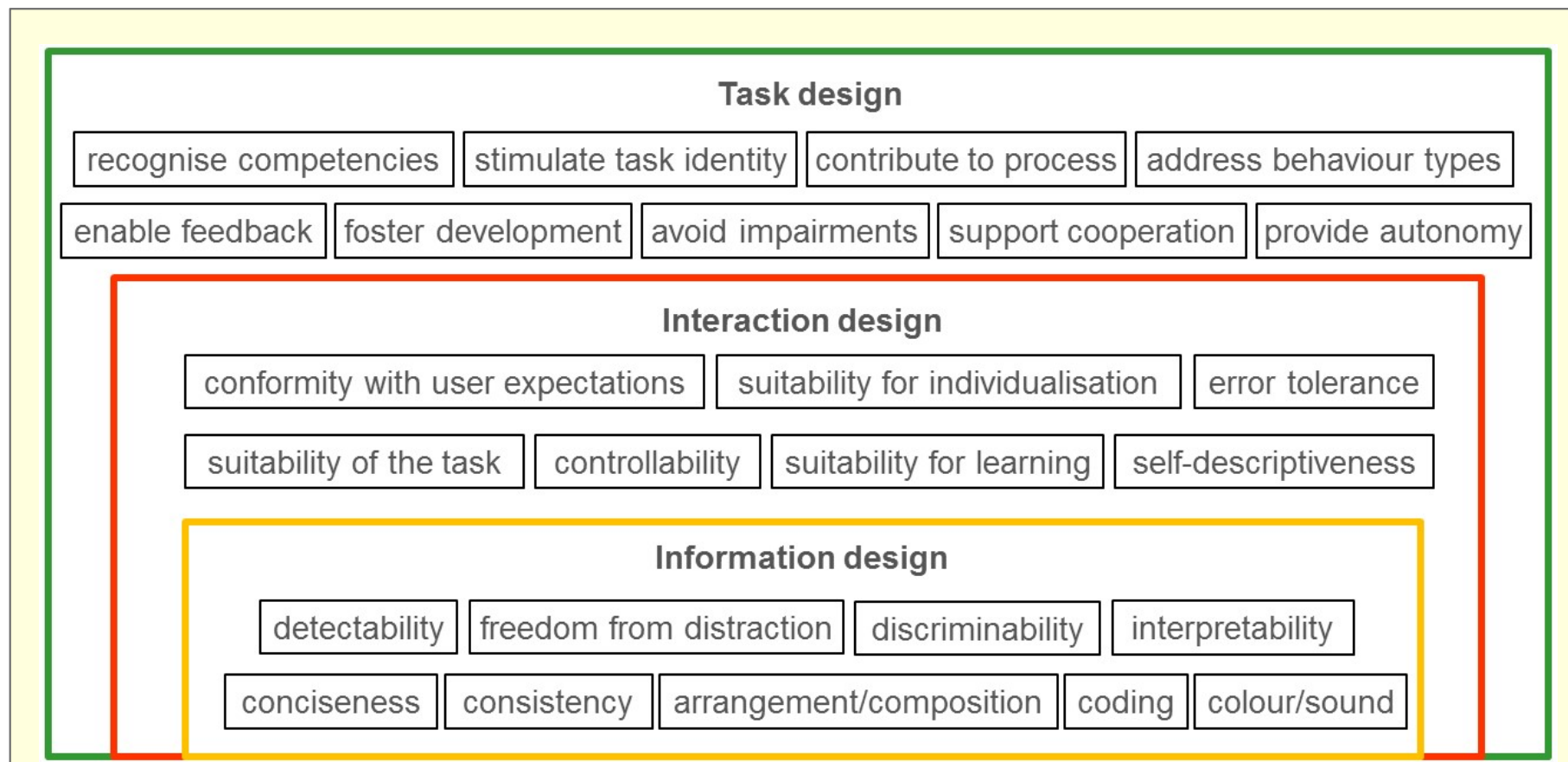
- EN ISO 10075-1:2017. Ergonomic principles related to mental workload - Part 1: General issues and concepts, terms and definitions. Brussels: CEN
- Hacker (1998). Mental workload. ILO Encyclopaedia of OSH

References

Design Requirements: Work Equipment / Software

HF/E/OSH

Work Equipment / Software



Design Requirements: Work Equipment / Software

Platform Information

HF/E/OSH

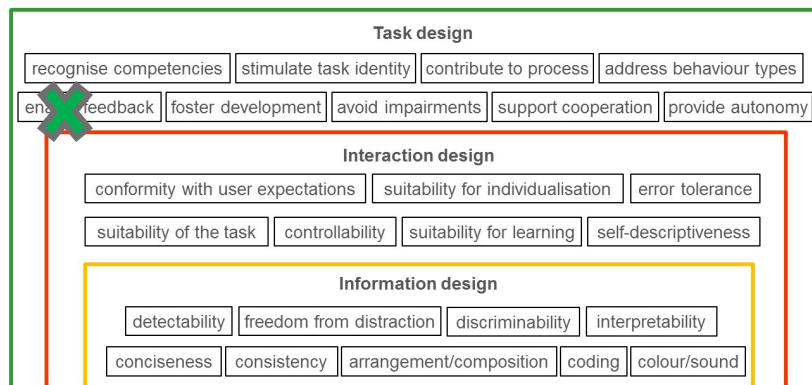
Work Equipment / Software

Task Interface Design

Enable Feedback

Menu Context

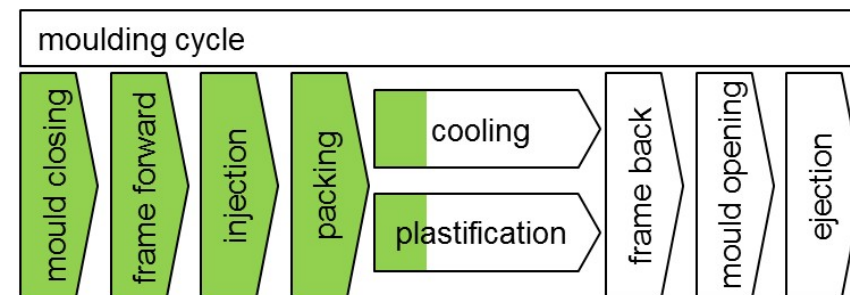
- Machinery should inform operator about operations available and provide feedback about operations currently applied in the work process
- Operator decides whether systems task goals have been achieved and whether adjustments are required



- Operators require feedback about their own and the systems task to maintain job control, to coordinate interactions and to optimise workload

Explanation

- Batch procedure of injection moulding machine provides visual feedback to operator about production process



- EN 614-2 Safety of Machinery – Ergonomic design principles – Part 2: Interactions between the design of machinery and work tasks – Task design. Brussels: CEN
- Kantowitz & Sorkin (1983). Human factors: Understanding people-system relationship

Example

References

Design Requirements: Work Place

Platform Information

HF/E/OSH

Work Place

Biomechanical Anthropometry

Areas of Grasp

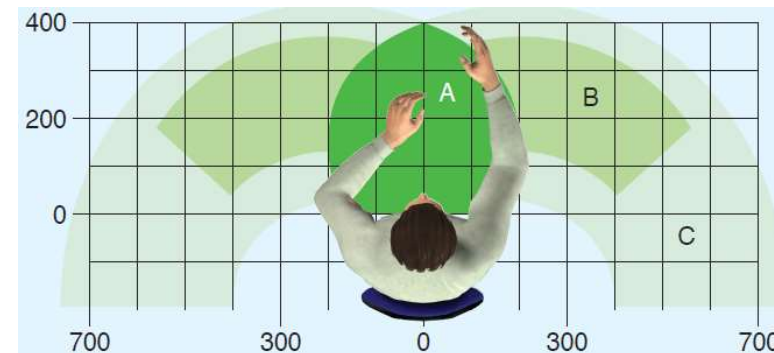
Menu Context

The layout of manipulation areas at industrial work places is chosen with regard to the given task. Areas for main, frequent, and occasional grasp activities in sitting and standing postures should be selected accordingly.

The layout of the industrial work place is adjusted to the given tasks when areas of grasp are chosen with regard to the frequency of manipulation movements. Operator physical fatigue is kept at relatively lower levels and/or may be maintained for longer work periods.

Explanation

Areas for (A) main, (B) frequent, and (C) occasional grasp at sitting work stations.



EN 894 Series (ISO 9355 Series): Safety of machinery – Ergonomics requirements for the design of displays and control actuators – Part 1: General principles for human interactions with displays and control actuators, Part 2: Displays, Part 3: Control actuators, Part 4: Location and arrangement of displays and control actuators. CEN, Brussels (2010).

Example

References

Design Requirements: Work Place

Platform Information

HF/E/OSH

Work Place

Location of Displays and Controls

Field of Vision

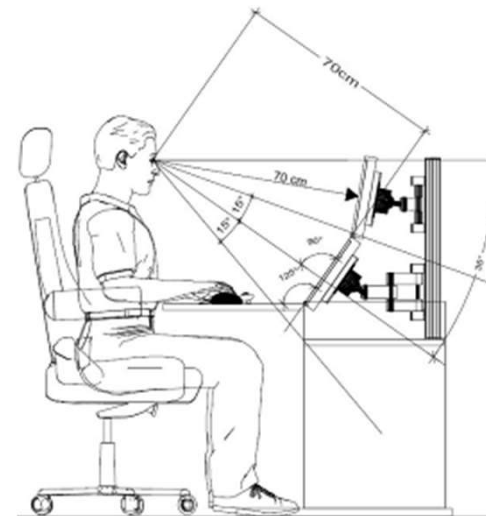
Menu Context

- Fields of vision for locating visual displays when performing detection and monitoring tasks in order to avoid impairments (e.g. neck pain and detection/monitoring errors).

Explanation

- Displays and hand control actuators shall be placed at comfortable levels below line of sight in order to reduce fatigue and/or enable maintaining task performance relatively longer (e.g. when operating machines).

- Field of vision at sitting work stations



- EN 894 Series (ISO 9355 Series): Safety of machinery – Ergonomics requirements for the design of displays and control actuators – Part 1: General principles for human interactions with displays and control actuators, Part 2: Displays, Part 3: Control actuators, Part 4: Location and arrangement of displays and control actuators. CEN, Brussels (2010).

Example

[Picture: © GAWO e.V. + Jungmann Systemtechnik GmbH]

References

Design Requirements: Cyber Physical System Issues

Platform Information

HF/E/OSH

Cyber Physical System Issues

Adaptable/Adaptive Interfacing

Modes of Adaptation

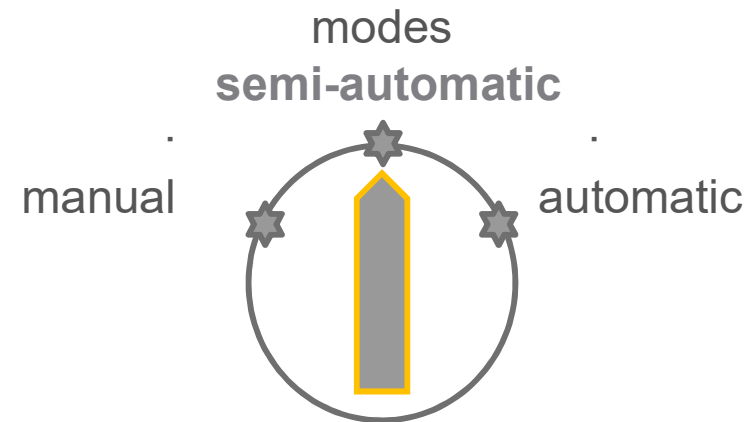
Menu Context

- CPS rely on human system interaction during setting-up, monitoring, maintaining, repairing, cleaning etc.
- Adaptable and adaptive human automation interaction may provide solutions when facing challenges from feedback, human task and interaction structures

Explanation

- Technology-centred design of automation leads to unintended uses by operators
- Due to high automation and insufficient information for human participation, operators find changes and errors in automation difficult to identify and impossible to compensate for

- Adaptable automation mode switching keeps human operator in the loop



Example

- EN 614-2 Safety of Machinery – Ergonomic design principles – Part 2: Interactions between the design of machinery and work tasks – Task design. Brussels: CEN
- Wickens et al. (2013). Engineering Psychology and Human Performance. Pearson

References

Conclusions

- **Internet platform is going to be established**
 - www.issa.int/
 - <https://www.issa.int/en/web/prevention-machines/about>
 - www.safety-work.org

- **Organisational issues**
 - integration of information
 - design, structure and layout of presentation of information
 - editorial office
- **Contact and information**
 - scholl@ivss.org



The screenshot shows the ISSA website interface. At the top, there is a navigation bar with language options (English, Français, Español, Deutsch, Русский, العربية) and links for 'Join us', 'Media', 'Contact', and 'Member Directories'. A 'My ISSA member login' button is on the right. Below the navigation bar is the ISSA logo and the text 'INTERNATIONAL SOCIAL SECURITY ASSOCIATION'. A search bar with 'Google Benutzerdefinierte Suche' is also present. The main navigation menu includes 'THE ISSA', 'NEWS', 'EVENTS', 'COUNTRY PROFILES', 'TOPICS', 'COMMUNITIES' (highlighted), 'REGIONS', 'RESOURCES', and 'CENTRE FOR EXCELLENCE'. The 'PREVENTION SECTION' is active, displaying the title 'International Section of the ISSA on Machine and System Safety' and a paragraph: 'The ISSA Section for the Prevention of Occupational Risks in Machine and System Safety is committed to improving safety and health at work in the field of machine and system safety worldwide.' Below this text is a banner image of industrial machinery. At the bottom of the page, there is a footer menu with 'About', 'News', 'Section Events', 'External Events', 'Resources', and 'Membership'.