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Section Machine and System Safety

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

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AUVA Soziale Unfallversicherung

IFA Institut für Arbeitsschutz der Deutschen Gesetzlichen Unfallversicherung

suva

FSA

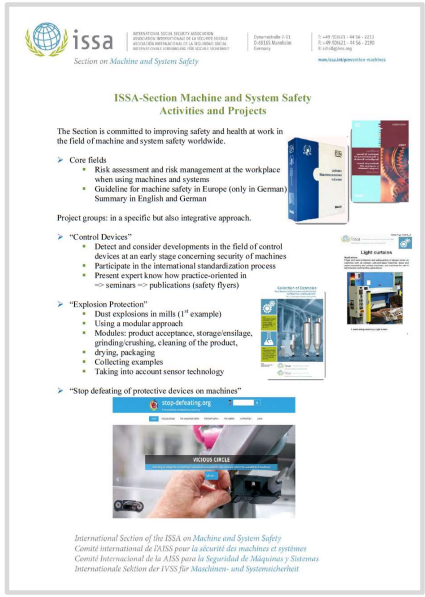
INAIL ISTITUTO NAZIONALE PER L'ASSICURAZIONE CONTRO GLI INFORTUNI SUL LAVORO

manufacturing Safety Alliance of BC

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



[Proc, vol II, 257-267]

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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

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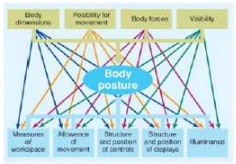
- 5 important steps each for manufacturers, dealers, users
- Practical examples
- How does digital manufacturing influence safety + security of protective devices?

- "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

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

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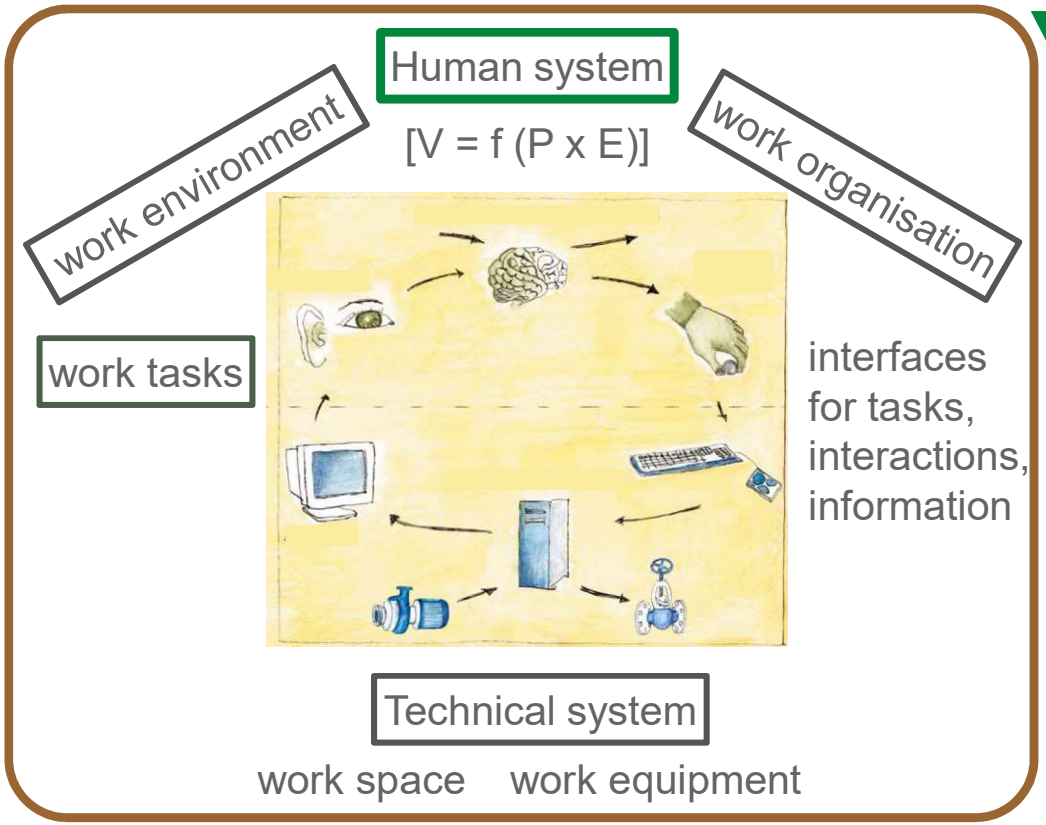
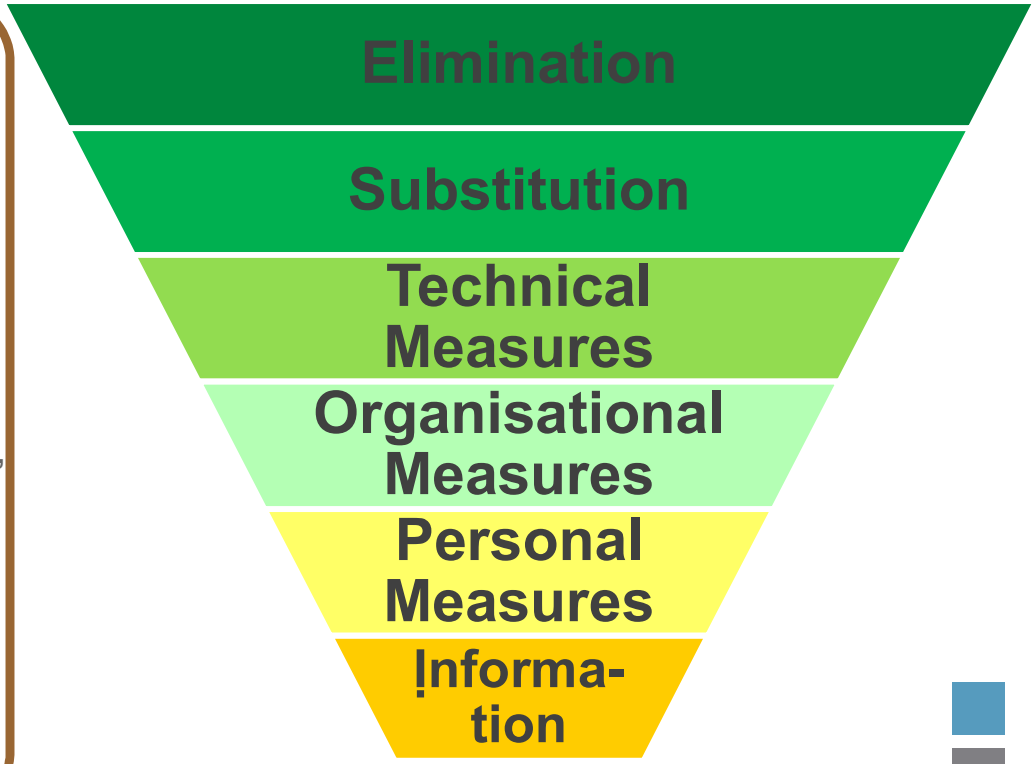
Work Systems Design – Prevention through Design

Human-System Interaction

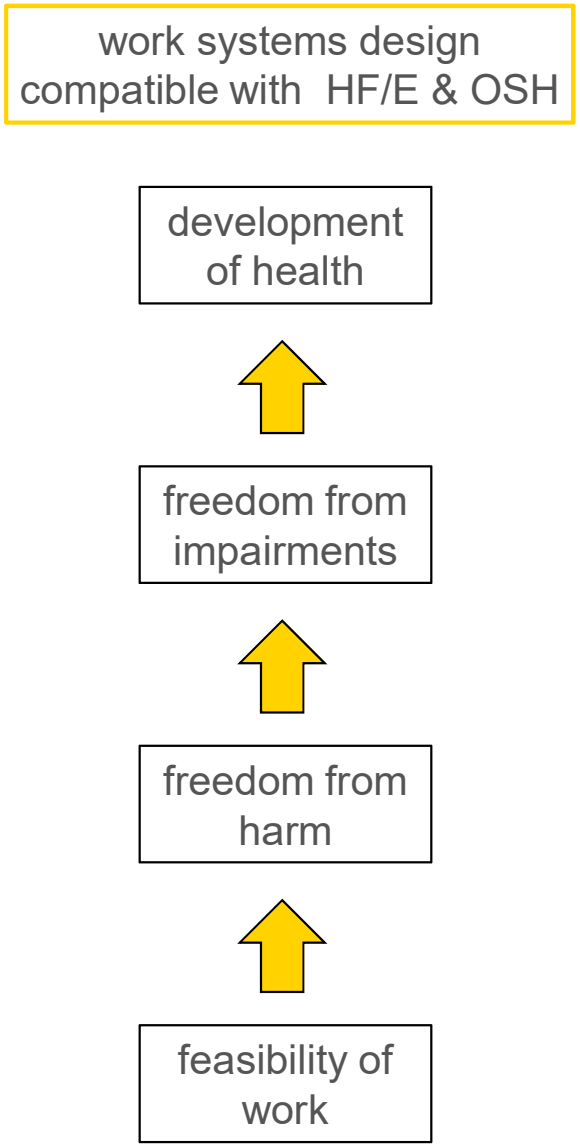


Hierarchy of Controls – E STOP !

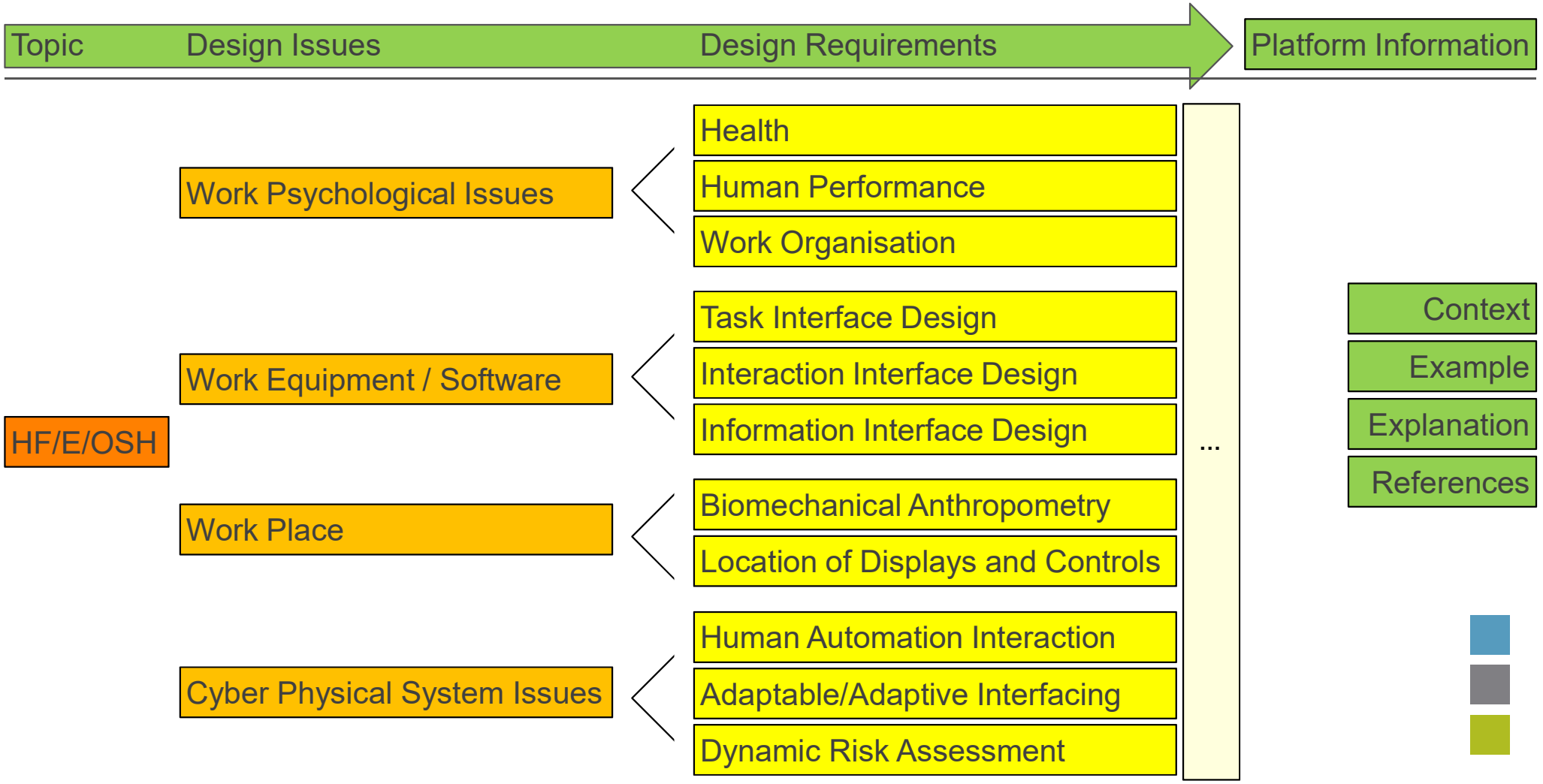


Work Systems Design – Criteria

- **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 – Internet Platform Structure



Design Requirements: Work Psychology Issues

Platform Information

Menu Context

HF/E/OSH | Work Psychological Issues | Human Performance | Workload

Example

- 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.

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

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.

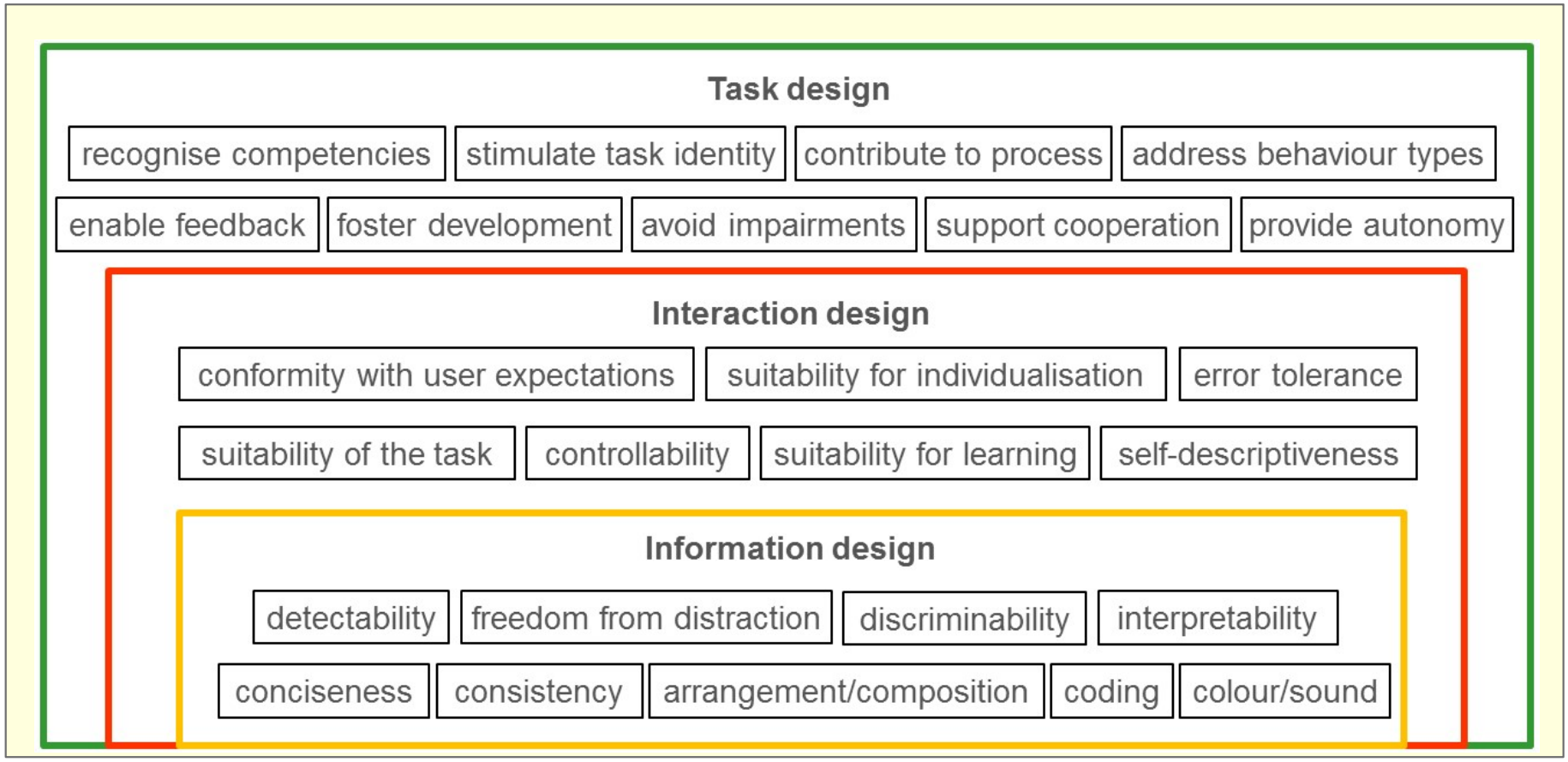
References

- 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

Design Requirements: Work Equipment / Software

HF/E/OSH

Work Equipment / Software



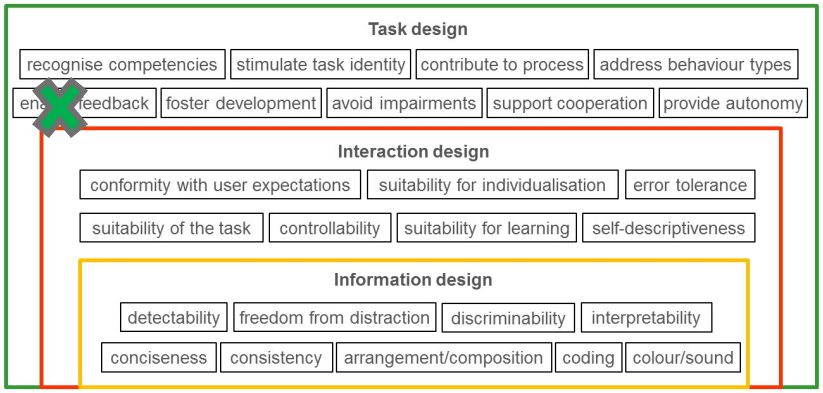
Design Requirements: Work Equipment / Software

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

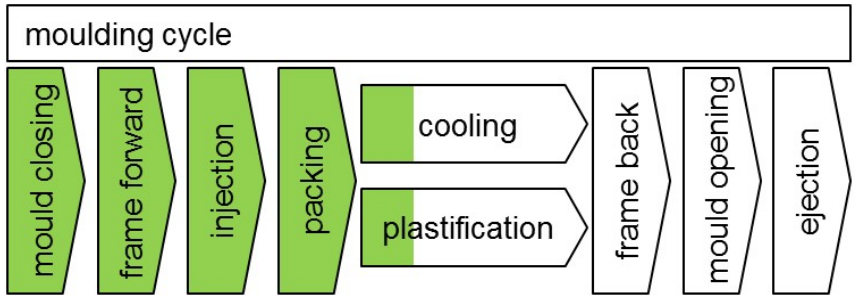


Explanation

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

Example

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



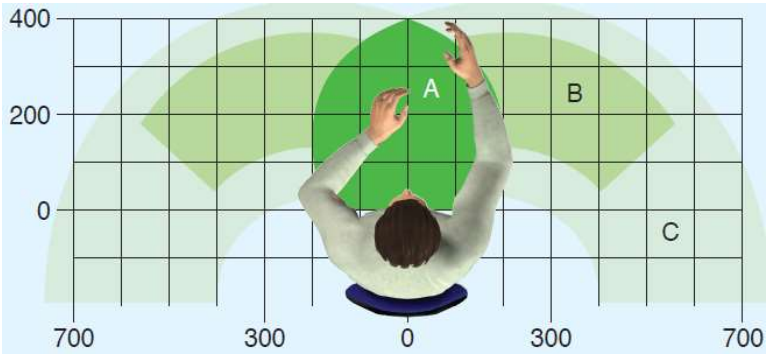
References

- 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

Design Requirements: Work Place

- 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.

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



- 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.

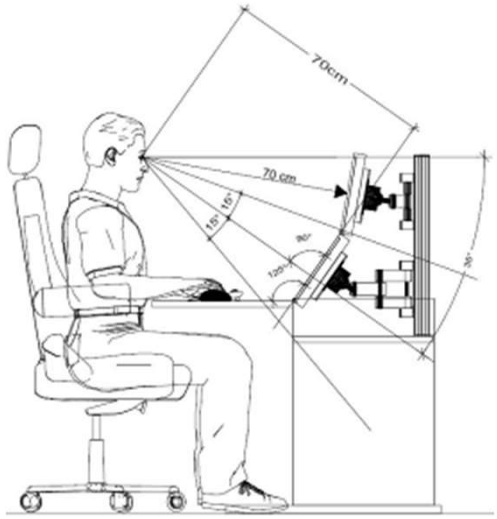
- EN 894 Series (ISO 9355 Series): Safety of machinery – Ergonomics requirements for the design of displays and control actuators – Part 1: General principles for human interactions with displays and control actuators, Part 2: Displays, Part 3: Control actuators, Part 4: Location and arrangement of displays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

Design Requirements: Work Place

- 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).

Example

- Field of vision at sitting work stations



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

- 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).

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).

Design Requirements: Cyber Physical System Issues

Platform Information

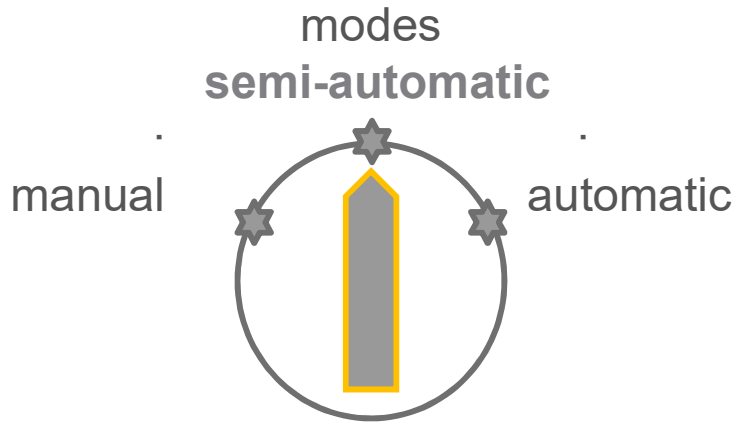
Menu Context

HF/E/OSH | Cyber Physical System Issues | Adaptable/Adaptive Interfacing | Modes of Adaptation

- 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

Example

- Adaptable automation mode switching keeps human operator in the loop



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

References

- 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

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**
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  - design, structure and layout of presentation of information
  - editorial office
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