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Section Machine and System Safety

Human-System Interaction Design Requirements to Improve Machinery and Systems Safety

Peter Nickel, Peter Bärenz, Siegfried Radandt, Michael Wichtl, Urs Kaufmann, Luigi Monica, Hans-Jürgen Bischoff, Manobhiram Nellutla

6th International Conference on Safety Management and Human Factors at AHFE 2019, July 24-28, 2019, Washington D.C., USA

Agenda

- ISSA Section Machine and System Safety
- The Design of Work Systems
- Design Issues in Human-System-Interaction
  - Work behavioural issues
  - Work place issues
  - Work equipment/software issues
  - Work with cyber physical system issues
- Conclusions

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 the EU
- **Project Groups**
  - Control devices
  - Explosion protection
  - Stop defeating protective devices
  - Human Factors, Ergonomics and Safe Machines [Human Factors]
- **Human Factors, Ergonomics, Safe Machines**
  - Support manufacturers, designers and users (employers) of machinery
  - HF/E design requirements and good practice in human-system-interaction
  - Improve machine operator health, safety and security in analogue and digital environments

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ASOCIACIÓN INTERNACIONAL DE LA SEGURIDAD SOCIAL
INTERNATIONALE VEREINIGUNG FÜR SOZIALE SICHERHEIT
Section on Machine and System Safety
Dynamostraße 7-11
D-68165 Mannheim
Germany
T: +49 /(0)621 - 44 56 - 2213
F: +49 /(0)621 - 44 56 - 2190
E: scholl@ivss.org
www.issa.int/prevention-machines

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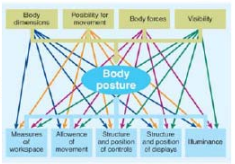
- 5 important steps each for manufacturers, dealers, users
- Practical examples
- How does digital manufacturing influence safety + security of protective devices?

- "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:
Secretariat General of the ISSA Section Machine and System Safety, Mannheim, Germany
Silke Scholl-Scheiba (scholl@ivss.org)
Phone: +49 621 4456 2213

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

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ISSA Section Machine and System Safety

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  - Support manufacturers, designers and users (employers) of machinery
  - HF/E design requirements and good practice in human-system-interaction
  - Improve machine operator health, safety and security in analogue and digital environments
  - Internet platform on HF/E and OSH (selective, simple, suitable)

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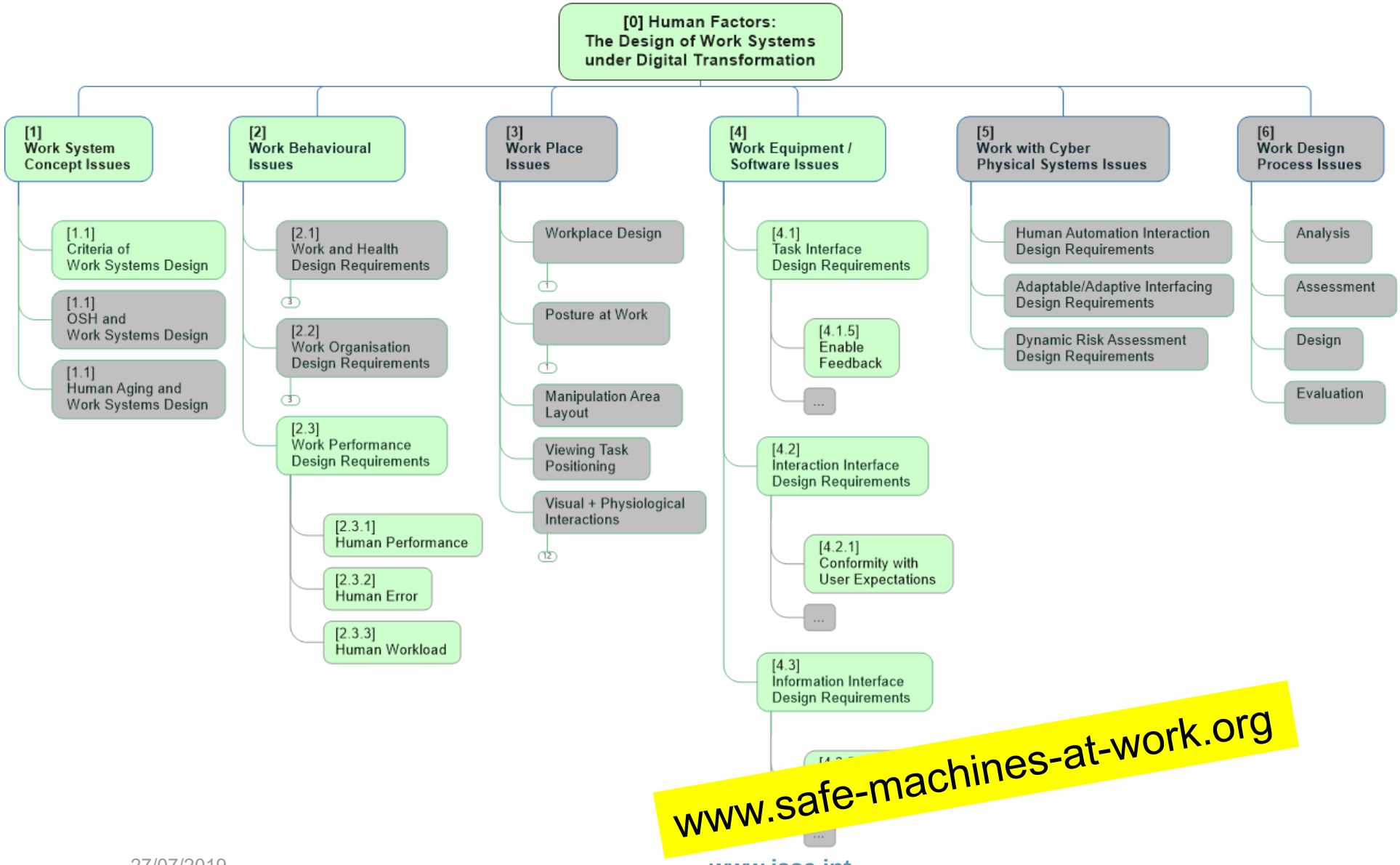
ISSA Section Machine and System Safety – HF Structure



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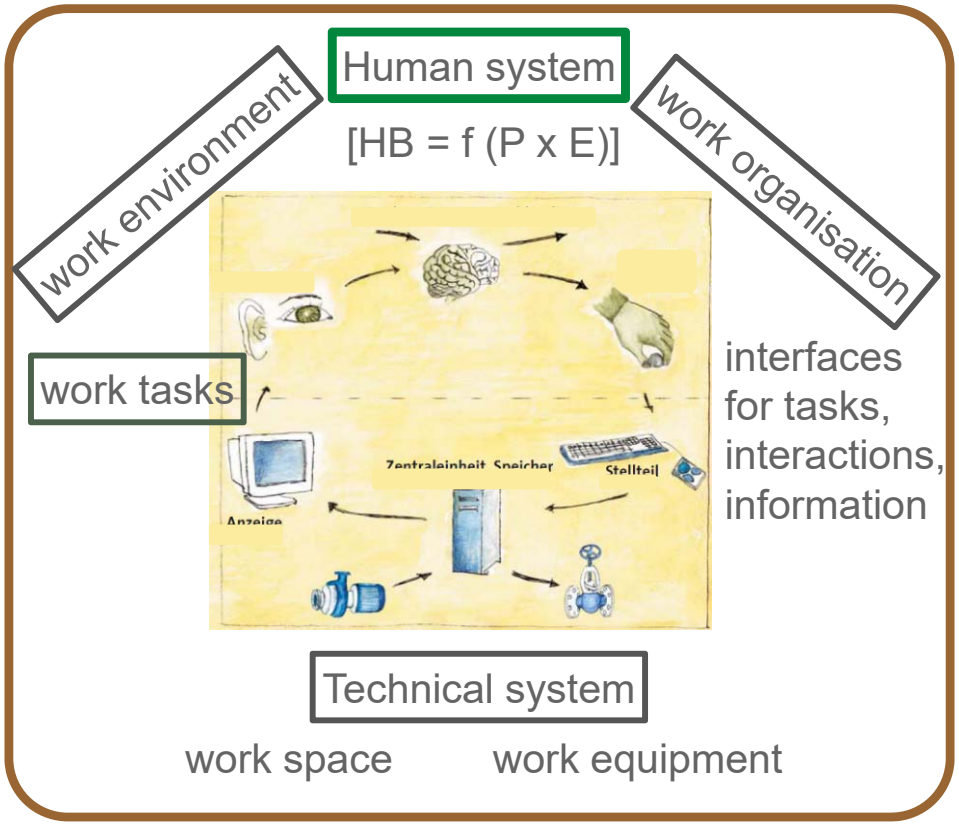
The Design of Work Systems – The Concept

Human-System Interaction



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Work Behavioural Issues – Human Workload

Definition

- Physical and mental stress is the total of all influences having an effect on a human being. Influences should be assessable from external sources and may affect physically or mentally.
- Physical and mental strain is the immediate effect of stress within the individual; moderated by their current condition.

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.

Example

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

References

- EN ISO 10075-1:2017. Ergonomic principles related to mental workload - Part 1. CEN.
- Hacker (1998). Mental workload. ILO Encyclopaedia of OSH.

Work Behavioural Issues – Human Workload

Human Workload

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 and work 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.

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- Hacker (2011). Mental workload. In: Stellmann, J.M. (ed.) ILO Encyclopaedia of Occupational Health and Safety (vol. 1, 29.41-43). International Labour Office (ILO), Geneva.

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Work Place Issues – Field of Vision

Definition

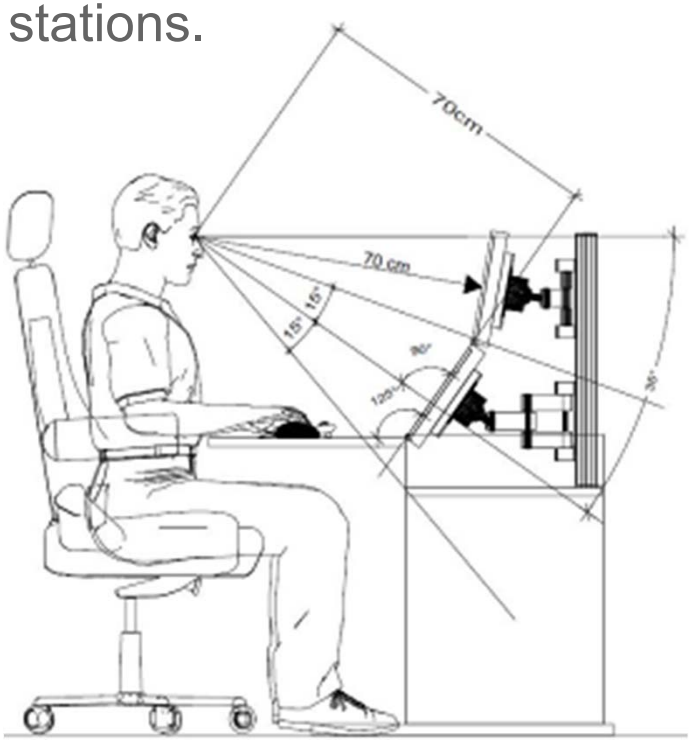
- Field of vision or line of sight is the location for displays and controls during task performance.

Explanation

- Displays and hand control actuators shall be placed at comfortable levels below the line of sight in order to reduce fatigue and to maintain high level of task performance (e.g. when operating machines).

Example

- Field of vision at sitting work stations.



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

References

- EN 894 Series (ISO 9355 Series): Safety of machinery – Ergonomics requirements for the design of displays and control actuators – Parts 1-4. CEN, Brussels (2010).

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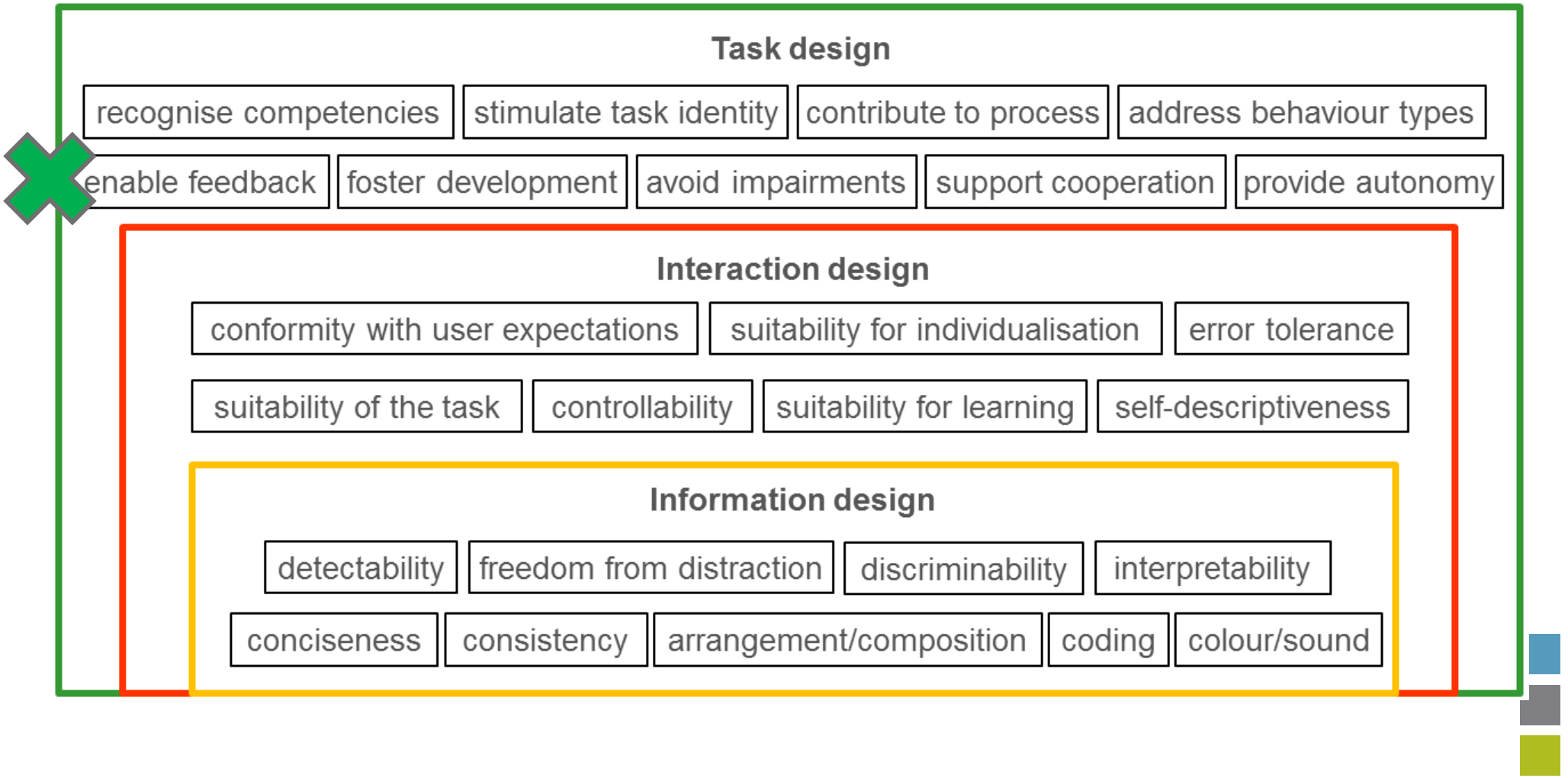
Work Equipment Issues – Interface Design Hierarchy



Work Equipment Issues – Task Interface Design

Definition

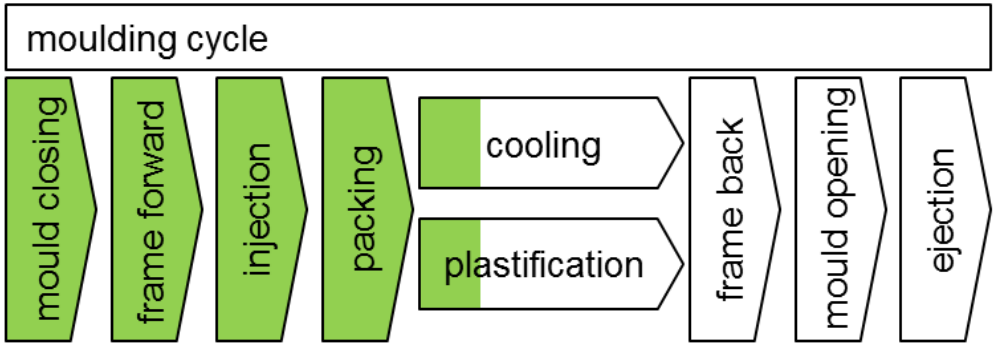
- Machinery should inform operator about operations available and provide feedback about operations currently applied in the work process.
- Operator decides whether systems task goals have been achieved and whether adjustments are required.

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 an injection moulding machine provides visual feedback to an operator about the production process.



References

- EN 614-2 Safety of Machinery – Ergonomic design principles – Part 2 – Task design. CEN.
- Kantowitz & Sorkin (1983). Human factors: Understanding people-system relationship.

Work Equipment Issues – Task Interface Design

Task Interface Design Requirements – Enable Feedback

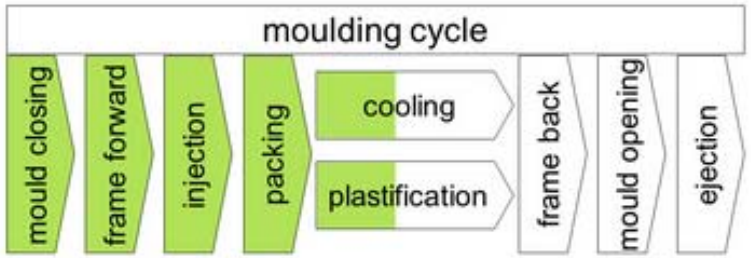
Among the task interface design requirements "Enable Feedback" is important to allow the operator to perform his/her task.

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.

Figure shows batch procedure of injection moulding machine that provides visual feedback to operator about production process.



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- EN 614-2:2008. Safety of Machinery – Ergonomic design principles – Part 2: Interactions between the design of machinery and work tasks – Task design. Brussels: CEN
- Kantowitz, B.H., Sorkin, R.D. (1983). Human factors: Understanding people-system relationships. Wiley, New York.
- Wickens, C.D., Hollands, J.G., Banbury, S., Parasuraman, R. (2013). Engineering Psychology and Human Performance. Pearson, Upper Saddle River.

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Cyber Physical Systems Issues – Adaptable Dynamics

Definition

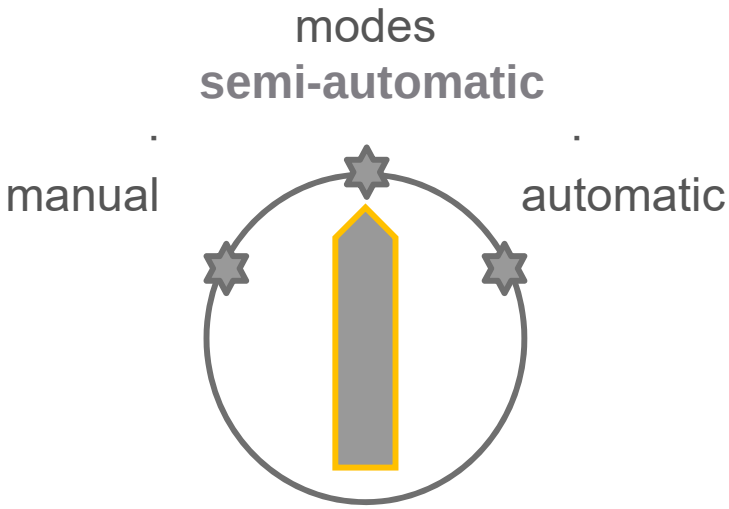
- Function allocation is dynamic when (various) functions (to different degrees) can flexibly be allocated to humans and to machines.
- Adaptable and adaptive automation provide solutions for interaction challenges.

Explanation

- Technology-centred design leads to unintended uses.
- changes and errors in automation are difficult to identify and impossible to compensate for by operators, due to high automation and insufficient information.

Example

- Adaptable automation mode switching keeps human operator in the loop.



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Conclusions

- **Internet platform available**
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- **Organisational issues**
  - add information
  - design, structure and layout
  - editorial office
- **Invitation to participate**
  - by reading
  - by comments
  - as a member of the ISSA MSS
- **Contact and information**
  - scholl@ivss.org