

Occupational Safety in Collaborative Robot Applications

(Extract)

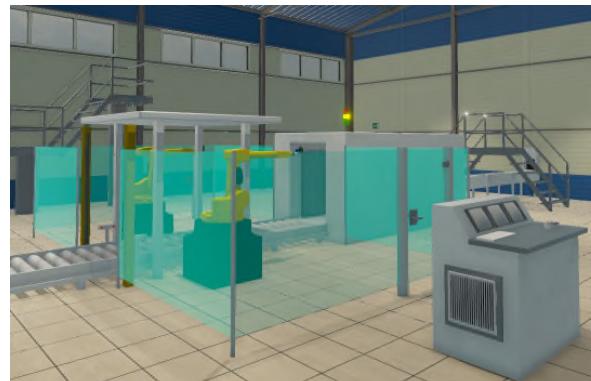
Digital manufacturing
Research results from
occupational safety and health

Jan.Zimmermann@dguv.de

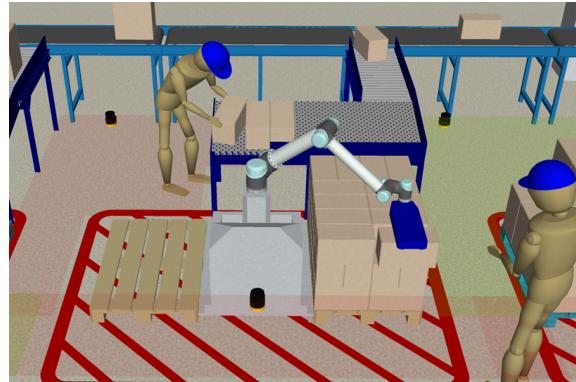
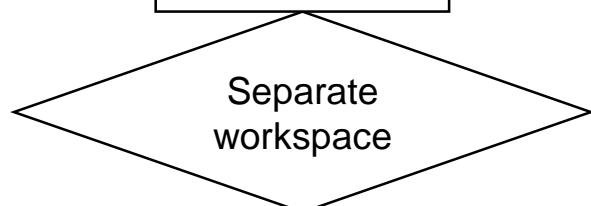
Webinar ISSA, 24.06.2024



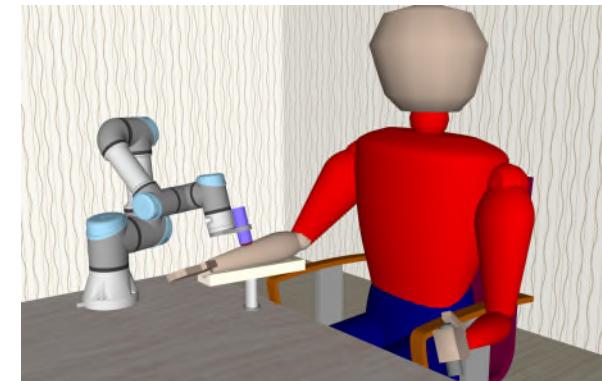
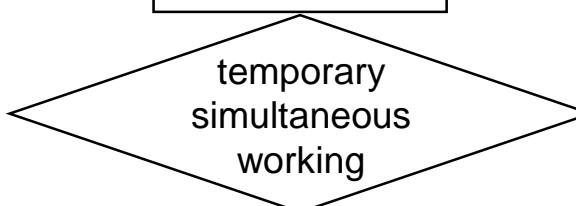
Forms of a HRC and compliant safety principles



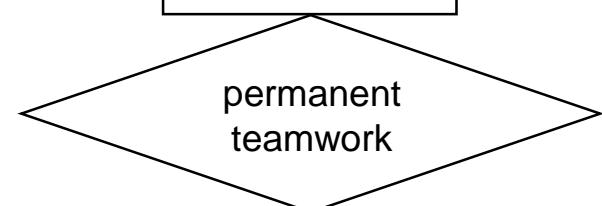
Coexistence



Cooperation



Collaboration



Examples of protection principles according to ISO 10218-2:

Fence*

(may be possible)

Speed and Separation Monitoring

Hand guidance

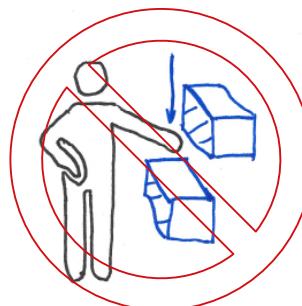
Safeguard Stop

?

(may be possible)

Power and Force Limitation

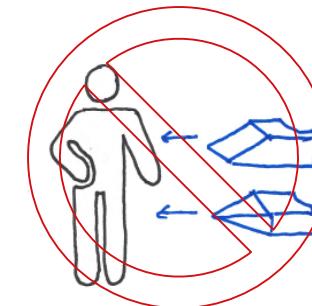
Mechanical Hazards



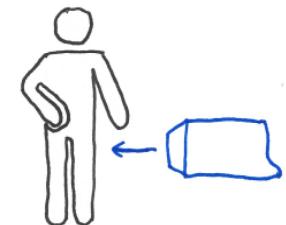
Shear point



Crush point



Puncture point



Impact point

load limit based on 75th percentile
of pain threshold



S1

Minor injuries
(usually reversible)

S2

Serious injuries
(usually irreversible)

Examples:

Pain

Bruise

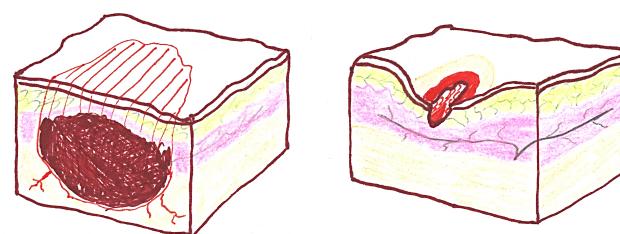
Laceration

Fracture

Paralysis

Amputation

reasonable load



Avoid pointed or sharp contours

Background Biomechanical Thresholds

Research projects:

- FP317: Experimental assessment of pain thresholds in major parts of the human body due to mechanical exposure in human-machine interface (2011-2014)
- FP411: Follow-up tests to the BGHM Study "Collaborative Robots: Determination of Pain Thresholds at the Human-Machine Interface" (2015-2018)
- FP430: Human-robot collaboration – supplementary suitability tests of recent results for incorporating them into white papers of the DGUV and standards (2019)

Literatur:

- Melia et. al. 2019: Pressure pain thresholds: Subject factors and the meaning of peak pressures DOI: 10.1002/ejp.1298
- Melia et. al. 2014: Measuring mechanical pain: The refinement and standardization of pressure pain threshold measurements DOI:10.3758/s13428-014-0453-3
- Ottersbach, H.J.; Huelke, M.: Requirements for hazard analyses referring to mechanical exposure in workplace applications with collaborative robots. 6th International Conference on Safety of Industrial Automated Systems – SIAS 2010. 14.-15. Juni 2010, Tampere/Finnland
- Behrens et al. 2022: A Statistical Model to Determine Biomechanical Limits for Physically Safe Interactions With Collaborative Robots DOI: 10.3389/frobt.2021.667818

Development and evaluation of a metrological concept for collaborative robots

IFA-Project No.: 5160

Commissioner:

- Expert Committee Woodworking and Metalworking of the German Insurance Association (BGHM)

Research institutions:

- Fraunhofer Institute for Factory Operation and Automation (IFF)
- Institute for Occupational Safety and Health of the German Social Accident Insurance (IFA)

Background:

- new research results are to be considered in standardization



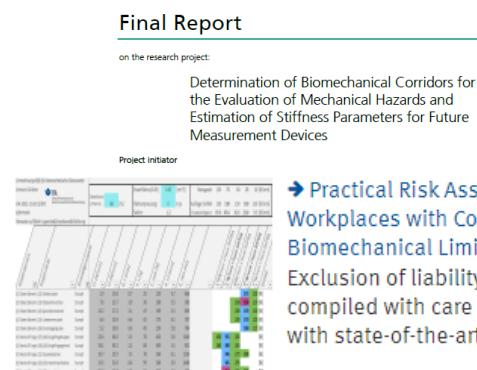
Determination of biomechanical corridors

Evaluation of the human subject studies according to the stiffness curves

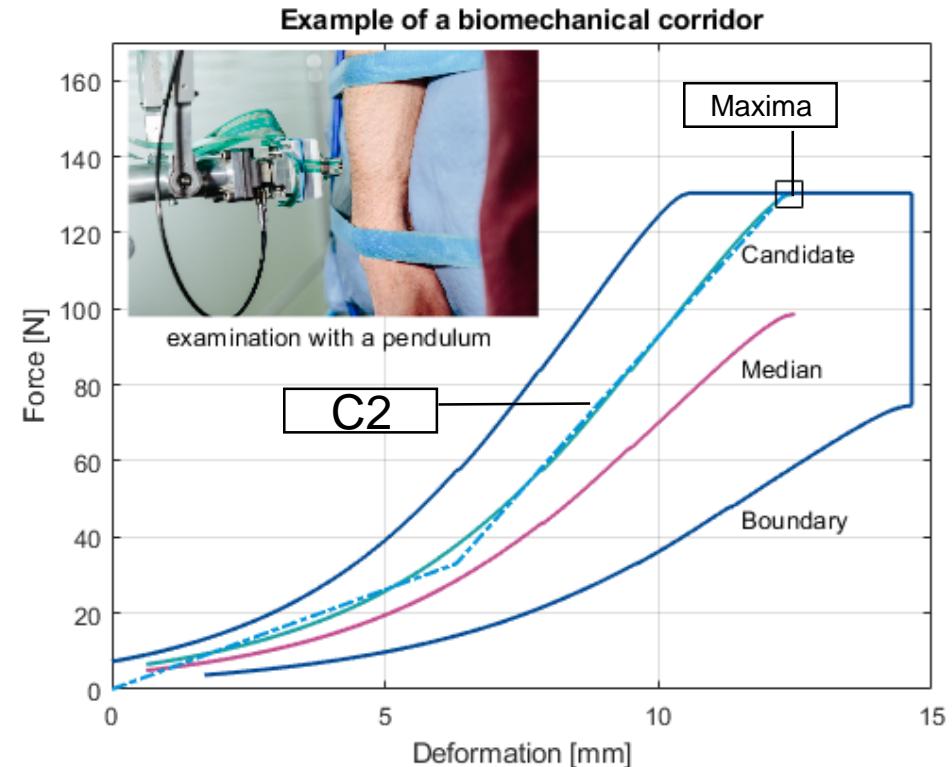
- Force-deformation analysis

Determination of biomechanical corridors incl. a percentile-dependent **candidate** line and **clustering** of similar body parts

- [Final Report](#)



- [Practical Solution](#)



Standards & co

- EN ISO 10218: Robots for industrial environments - Safety requirements - Part 1&2
- TS 15066: Robots and robotic devices - Collaborative robots
- DGUV-Information FB-HM-080
- new: ISO PAS 5672 Collaborative robotic devices – Test methods
- new: [Final Report](#) & [Practical Solution](#) & [SIAS2024](#)

DIN EN ISO 10218-1 DIN

ICS 25.040.30 Ersatz für DIN EN ISO 10218-1:2009-07

DIN ISO/TS 15066 DIN SPEC 5306

ICS 25.040.30

Industrieroboter – Sicherheitanforderungen – Teil 1: Roboter (ISO 10218-1:2011); Deutsche Fassung EN ISO 10218-1:2011

Robots and robotic devices – Safety requirements for industrial robots – Part 1: Robots (ISO 10218-1:2011); German version EN ISO 10218-1:2011

Robots et dispositifs robotiques – Exigences de sécurité pour les robots industriels – Partie 1: Robots (ISO 10218-1:2011); Version allemande EN ISO 10218-1:2011

2/2022 IFA Report NEW

Final Report

on the research project:

Determination of Biomechanical Corridors for the Evaluation of Mechanical Hazards and Estimation of Stiffness Parameters for Future Measurement Devices

Project initiator:  IFA Institut für Arbeitsschutz der Deutschen Gesetzlichen Unfallversicherung Institute for Occupational Safety and Health (IFA), Alte Heerstr. 111, 53757 Sankt Augustin, Germany

Project contractor:  Fraunhofer IFF Fraunhofer IFF, Sandtorstr. 22, 39106 Magdeburg, Germany

ISO/PAS 5672

PUBLICLY AVAILABLE SPECIFICATION NEW

The 11th International Conference on Safety of Industrial Automated Systems

Application example: Evaluation of mechanical collisions at workplaces with collaborative robots

Zimmermann J.¹, Clermont M.¹, Nischalke-Fehn G.

SIAS 2024

Kollaborierende Robotersysteme

Planung von Anlagen mit der Funktion „Leistungs- und Kraftbegrenzung“

Ausgabe 08/2017 FB HM-080

Inhaltsverzeichnis

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Practical Risk Assessment Guide for Workplaces with Cobots: Conversion of Biomechanical Limit Values

New standard published +++ News +++

The new standard ISO/PAS 5672 was published at the end of 2023. It is a practical guide for risk assessments of cobots measuring forces and pressures in human-robot contacts.

Conversion Tool

Conversion Table Interface

Zoom Image

The DGUV has funded several research projects (e.g. FP430) in which the IFA, together with other partners, has identified certain biomechanical limit values.

Contact

NEW

Bild 1: Hinweisschild Kollaborierendes Robotersystem

Outlook

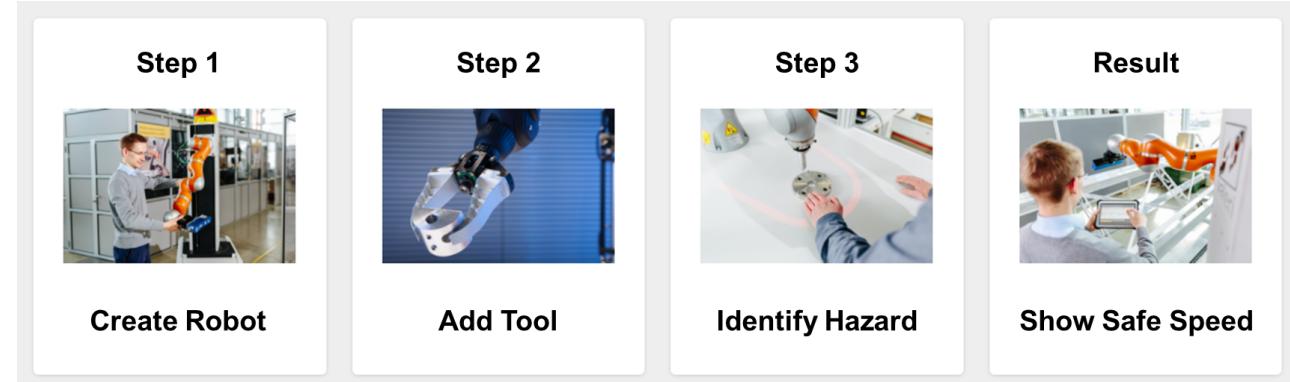
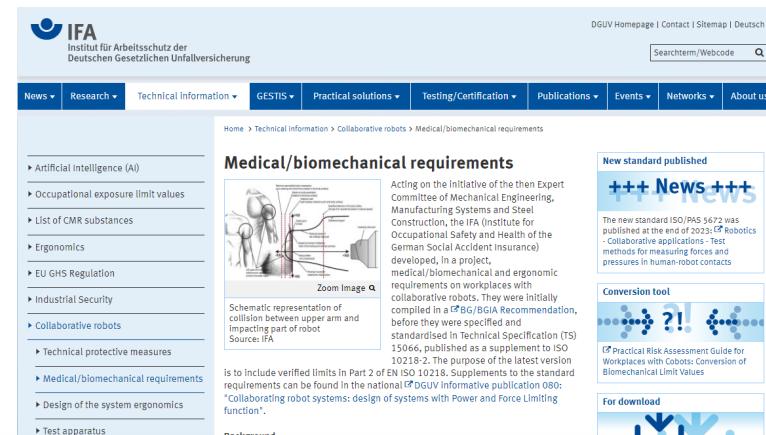
Use of scientific findings for simplified applicability (special case vs. standard applications)

Richness of variants in digital models (accuracy) vs. simplifications for measurement practice (controllability, comparability)

Digital planning tool:

www.cobotplaner.com

more information→

The screenshot shows the IFA website's navigation bar with links like News, Research, Technical Information, GESTIS, Practical solutions, Testing/Certification, Publications, Events, Networks, and About us. The main content area is titled 'Medical/biomechanical requirements' and discusses the publication of ISO/PAS 5672. It includes a schematic diagram of a collision between a human arm and a robot arm, and a 'Zoom Image' button.

www.dguv.de/ifa
Technical information -> Collaborative robots ->
Medical/biomechanical requirements

Thank you very much!

