

# Focus on IFA's work

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## How should workplaces involving collaborative robots be designed?

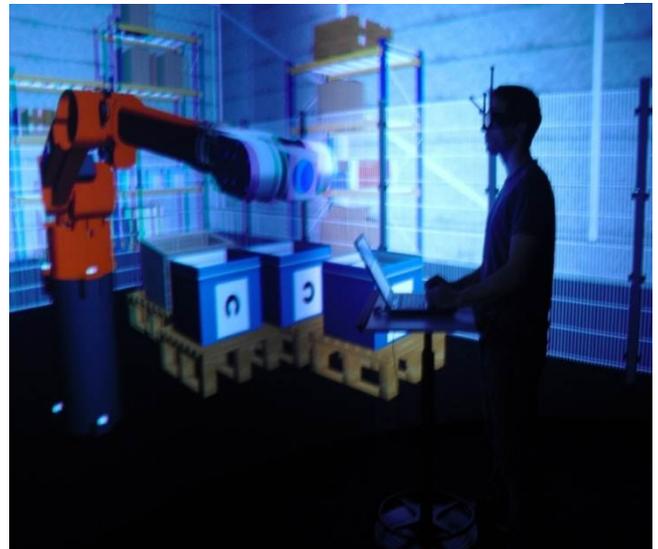
### Problem

In future, workplaces will increasingly be created at which human beings and robots work closely together. The term "collaborative robots" is used for robots which share a common workspace with human beings. This combination has numerous advantages: human beings have strong decision-making abilities and judgement; robots work fast and precisely. However, this arrangement is permissible only when safety requirements are satisfied. This raises the question as to what characteristics the robot must possess in order for cooperation to be smooth yet at the same time safe and pleasant for the human being. How should the exterior of the robot be designed, for example? What speeds and travel patterns are reasonable?

Existing standards and provisions acknowledge the relevance of these questions but do not provide specific design guidance, owing to the lack of empirical findings.

### Activities

Two studies were performed into the effects of different design properties of collaborative robots upon human beings. Work environments can be simulated in the IFA's SUTAVE virtual reality laboratory. Test subjects receive a three-dimensional impression of the scenario and are able to interact with the environment.



A test subject working with a virtual collaborative robot in the IFA's SUTAVE laboratory

For the studies into collaboration between a human being and a robot, a robot workplace was modelled in the laboratory (see image). Effects upon the user of the motion speed of the robot, the distance between the subject and the robot and the predictability of the movement path were studied. For this purpose, test subjects performed tasks in conjunction with the virtual industrial robot. The subjects' performance was recorded during completion of the tasks, and they completed questionnaires into the task load, sense of anxiety, and other measures of strain. Their heart rates during completion of the tasks were also measured.

## Results and Application

The results show that very fast robot movements can lead to elevated task load and to a stronger sense of anxiety. This suggests that high robot speeds should be avoided. At the same time, the performance in completion of the task deteriorates when the robot movements are too slow. The sense of anxiety increases when the distance between the human being and the robot is small. Unpredictable robot movements also have an impact upon the performance during completion of the task; in particular, rapid **and** unpredictable robot movements are perceived as being dangerous.

The results can be used to support standards governing collaborative robots; they represent a first step towards the formulation of design recommendations. Companies considering the introduction of collaborative robots can use such studies as a source of information on the risks to their employees, in order to take precautions.

## Area of Application

Standards committees, manufacturers of industrial robots, parties involved in the health and safety of workers at work

## Additional Information

- Information on the IFA's SUTAVE laboratory can be found at: [www.dguv.de/ifa/sutave](http://www.dguv.de/ifa/sutave)
- Koppenborg, M.; Naber, B.; Lungfiel, A.; Nickel, P.: Auswirkung von Autonomie und Geschwindigkeit in der virtuellen Mensch-Roboter-Kollaboration. In: Gesellschaft für Arbeitswissenschaft e.V. (Eds.): Chancen durch Arbeits-, Produkt- und Systemgestaltung, 59th conference of the Gesellschaft für Arbeitswissenschaft. Dortmund 2013, pp. 417-420
- Naber, B.; Lungfiel, A.; Nickel, P.; Huelke, M.: Human Factors zu Robotergeschwindigkeit und -distanz in der virtuellen Mensch-Roboter-Kollaboration. In: Gesellschaft für Arbeitswissenschaft e.V. (Eds.): Chancen durch Arbeits-, Produkt- und Systemgestaltung, 59th conference of the Gesellschaft für Arbeitswissenschaft. Dortmund 2013, pp. 421-424

## Expert Assistance

IFA, Division 5: Accident prevention, Product safety

## Literature Requests

IFA, Central Division