Learning scenarios for the improvement of operating safety of machine tools

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HOCHSCHULE MITTWEIDA
University of Applied Sciences

Leif Goldhahn, Robert Eckardt
University of Applied Sciences Mittweida, Faculty Engineering Sciences, InnArbeit – Centre of Innovative Process Planning and Ergonomics

Abstract

Apart from a methodological approach for the development of virtual learning scenarios, two defined and developed types of learning scenarios related to the commissioning of a machine tool as well as considering different learning requirements of employee qualification are introduced in this contribution.

Introduction

The virtual learning scenarios introduced in this contribution focus on the approach of the VR-based pilot training and correspondingly transfer it to the demands for the utilization of machine tools to potentially eliminate misconduct or operating errors on the machine. Exemplary use cases on machine tools were analyzed, structured and methodologically processed. [1]

Virtual learning scenarios

On the basis of the approach according to [2] as well as the multi-stage model developed (Table 1), three types of learning scenarios with varying learning requirements were defined. These were conceptualized for the operating actions necessary for the start of a milling machine within the learning environment training factory 4.0:

Learning scenario 1:	Fully guided operating actions → visual observation without individual actions (OC1/OL1)
Learning scenario 2:	Informationally guided operating actions → visually and acoustically supported operating actions (OC2/OL2)
Learning scenario 3:	Fully autonomous operating actions → possibilities for failures and feedback for the user (OC3/OL3)

Figure 1 shows the test person while performing the second virtual learning scenario. This learning scenario comprises informationally (visually, acoustically and haptically supported) guided operating actions. In this scenario, the user navigates him-/herself through the learning environment and virtually works through the respective operating actions in a predefined order. Errors within the order of operating actions are not possible, which ensures the successful completion of the scenario.

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Table 1. Multi-stage model of VR based operating actions for the classification of learning scenarios

		OL = Operating level Increase in information provided for the respective operating action					
		level					
		1		2		3	
OC= Operating complexity Increase in degrees of freedom and number of decisions	1	OL	OC	OL	OC	OL	OC
		1	1	2	1	3	1
	2	OL	OC	OL	OC	OL	OC
		1	2	2	2	3	2
	3	OL	OC	OL	OC	OL	OC
		1	3	2	3	3	3

Within the virtual learning environment, she is depicted as an avatar and has the task to follow the footsteps shown on the floor. These provide guidance and function as navigation to the next operating action to be conducted. The figure furthermore shows information boards, which are provided for the test person and contain instructions for the operating action to be conducted (What has to be done? Why? How?).

Every learning scenario has its own advantages and disadvantages for the user as well as the instructor. For example, its an advantage in this learning scenario that the user can get used to the learning environment. As a disadvantage, learning from errors within the operating order is not included within learning scenario two.

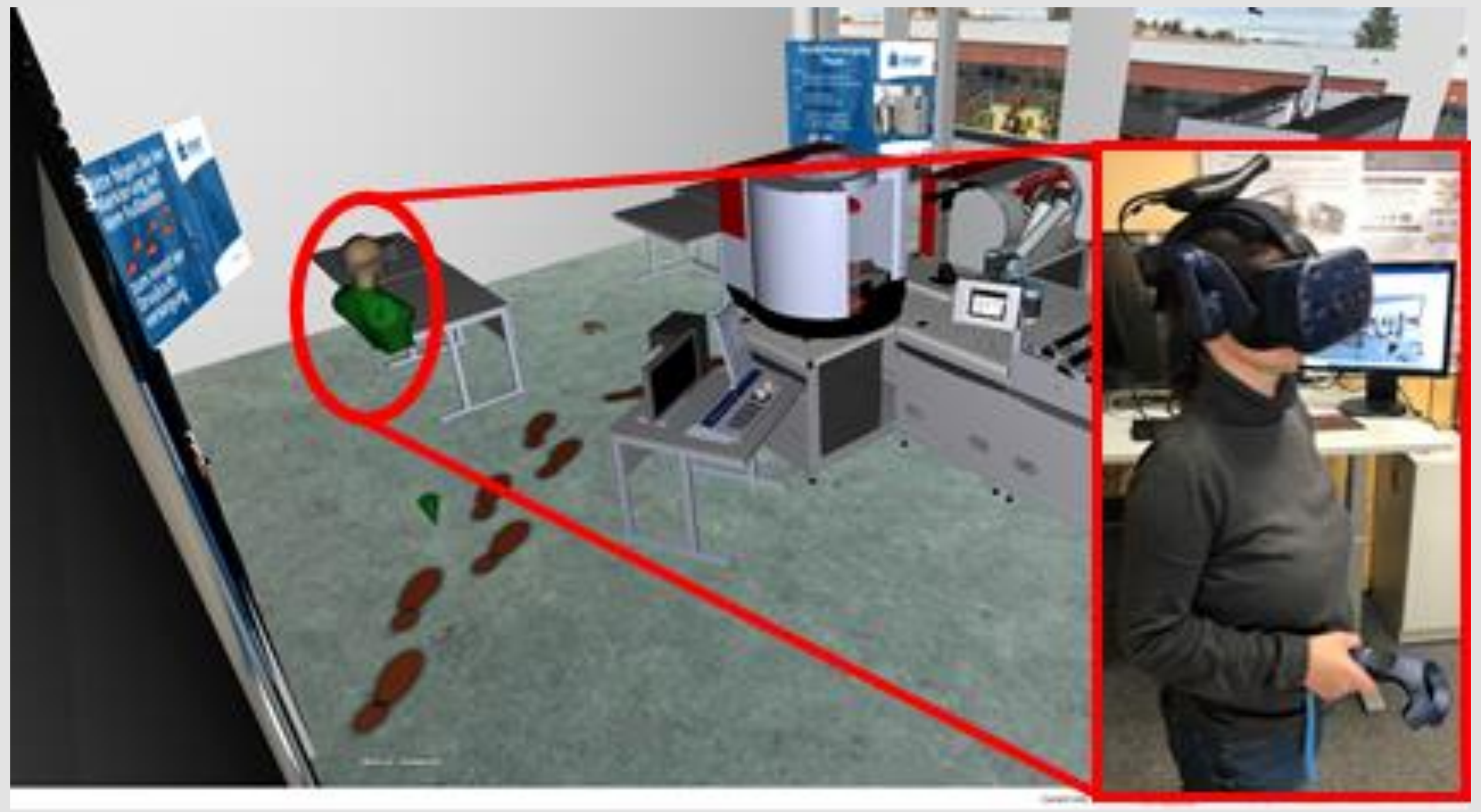

Figure 1. Scene of the VR-based learning scenario 2 – informationally guided operating actions

Summary

Virtual learning scenarios are expedient for learning essential operating actions on milling tools when using an appropriate VR technology. The „moving“ in the virtual environment, but also the implementation of operating actions were strongly impeded within the first trials, which was caused by operating errors of the VR technology. This clearly reduced the learning success desired as well as the acceptance for the technology. It can therefore be concluded, that there is a need to initially and specifically demonstrate the user handling of the HMD technology as well as inter-acting with the VR software environment.

The existing state of work in regards to the methodological approach has to be supplemented by questionnaires in the future.

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