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Lehrstuhl und Institut für Arbeitswissenschaft der RWTH Aachen

ABIS-Workshop 2007

Halle/Saale, September 24th 2007

RWTH AACHEN UNIVERSITY HOUSE OF PRODUCTION

Concept of an Adaptive Training System for Production

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Overview

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Concept of an Adaptive Training System for Production

- Motivation
- Training System
  - Influences on learning
  - Learning Cycle
  - Learning Styles
  - Training Units
  - Technology
  - Field of Application
  - Training System
- Summary and further steps

Motivation

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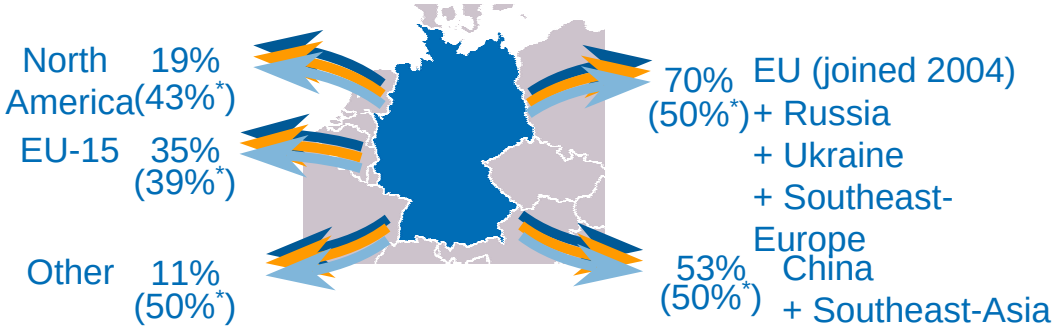
- Modest increase regarding national investments
- Dislocation of production jobs in foreign countries
  (27% of the German enterprizes reduce the number of workplaces and jobs in Germany)

40% of the German enterprizes are planning to invest in foreign countries



(*)=product related dislocation

Source: DIHK

- **Initiation of the Cluster of Excellence:**
  Integrative Production Technology for High-Wage Countries

- The objective is to answer the following question:

  Under which conditions and with which methods and measures is successful economic production in high-wage countries feasible?

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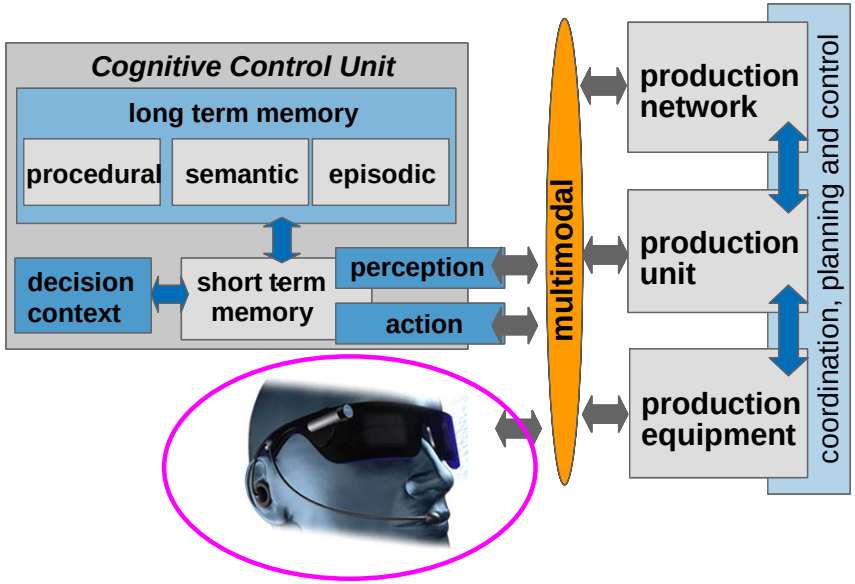
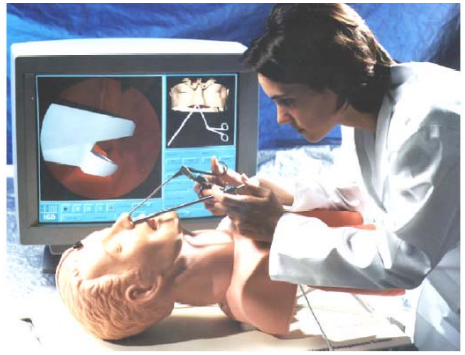
Motivation

- Approach to a solution: Selfoptimizing Production Systems
  Development of production technologies capable to learn, which are able to attain knowledge and - in order to optimize the production process - to transfer the knowledge to new fields of production
- *Project:* Cognitive Control Systems for Production
  - Development of a cognitive control unit based on human information processing by taking the human operator into account
  - Therefore an adaptive embedded AR-based Teach/Learn/Training System shall be developed in order to support the user regarding the new requirements directly during work

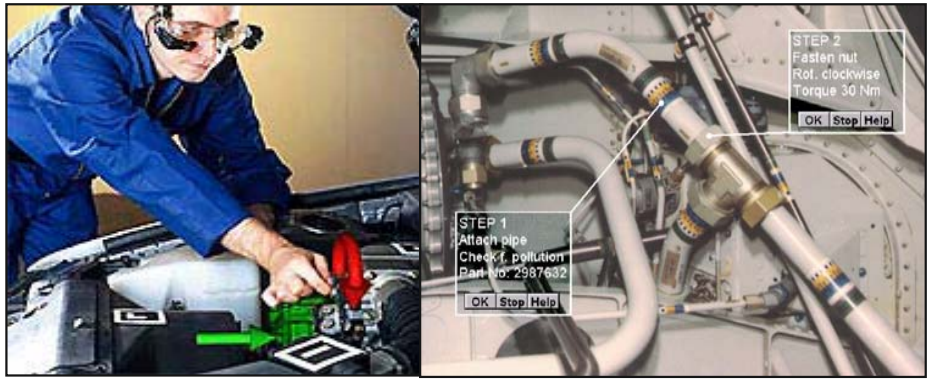


Motivation

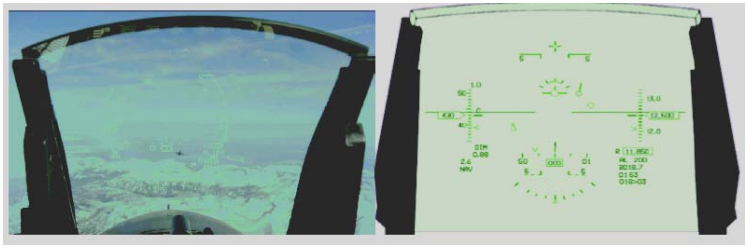
- Present applications of AR-Technologies:
  - Medicine
  - Design and Architecture
  - Military
  - Development, Production and Service



Source: Fraunhofer Institut
Graphische Datenverarbeitung, 2002



AR-Application in the production



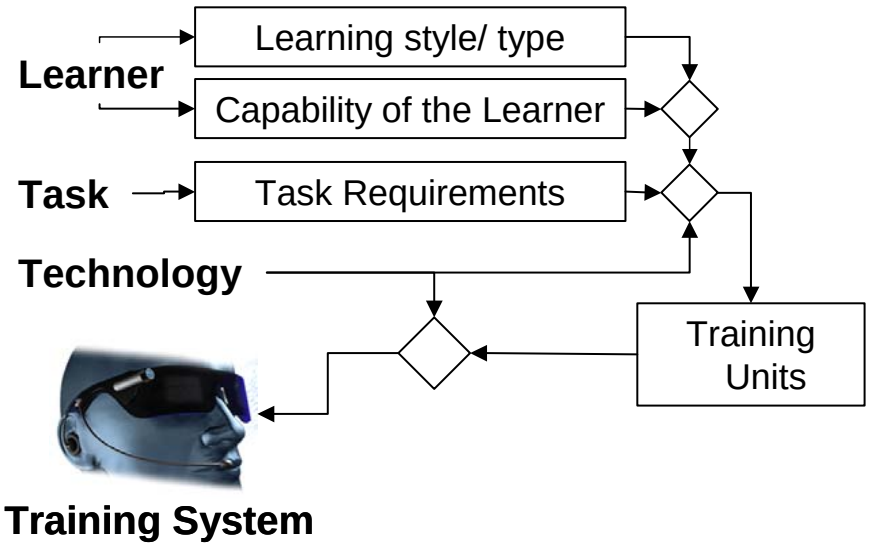
AR-Application in the aircraft cockpit (Source: Antanasov 2006)

AR-Application in the architecture,
Source: Klinker et al. 1999

Motivation

- Problems regarding the AR-application in production:
  - Minor acceptance because of ergonomic aspects of the technology (weight, highly restricted field of view) and because of the presentation of the same information in an identical way respective e.g. the sequence
  - Information presentation without taking into account the pre-knowledge, the experiences and the individual capacity of the user

- Approach to a solution:
  Development of a training system to support the teaching and learning process of the operator of complex machines and production plants
  by adapting the system
  to the individual learning strategy



Training System

Agenda

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Concept of an Adaptive Training System for Production

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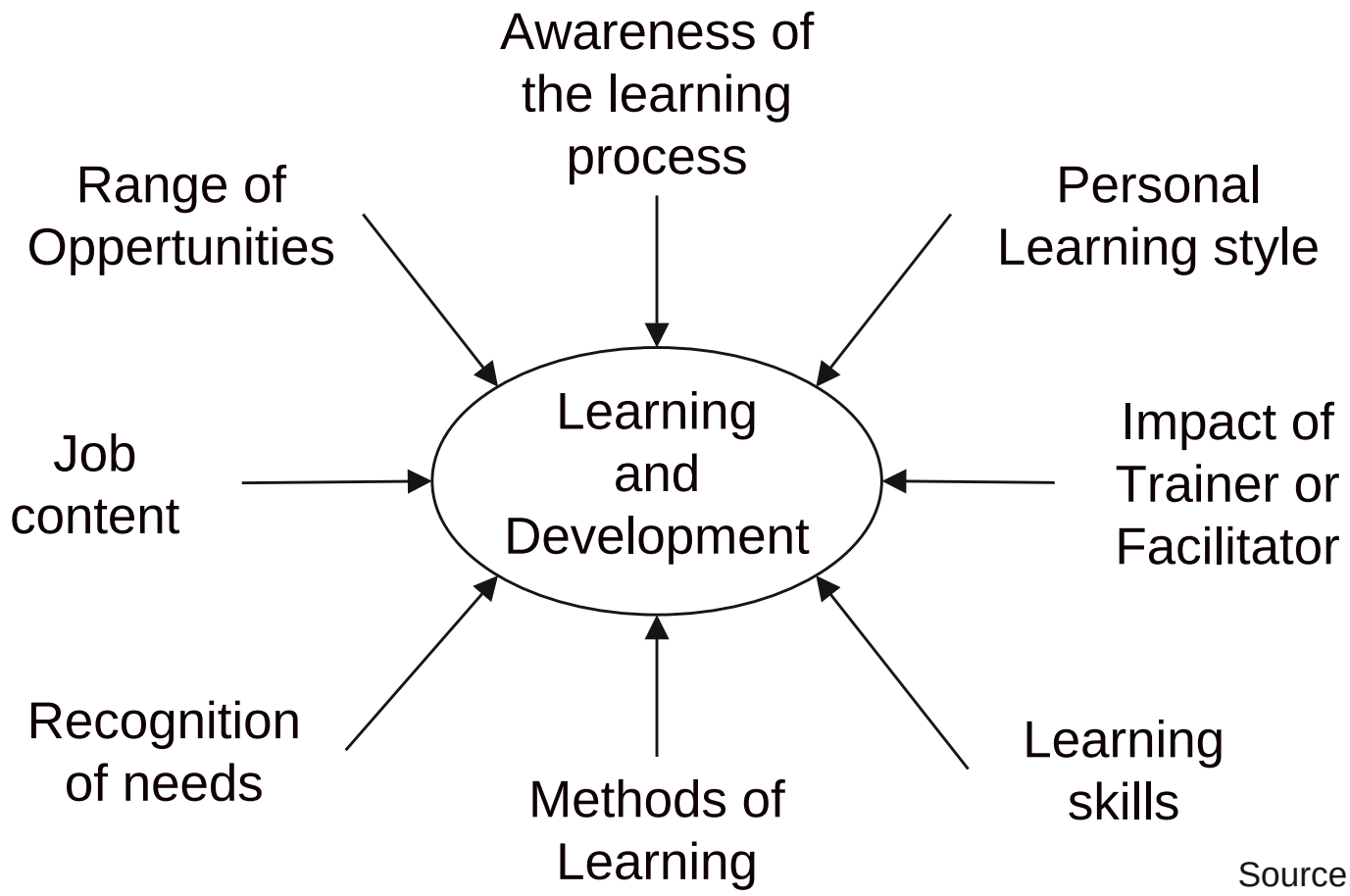
The range of influences on learning

- some of many influences on the learning and development process

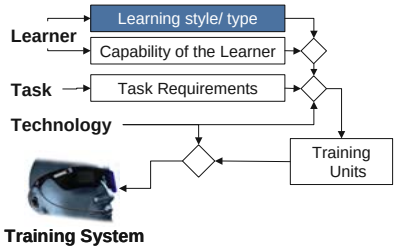


Source: Honey, Mumford

Learning Cycle

- Learning is a life-long process.
- It can be described as a never-ending spiral.
- Each loop of the spiral has four distinct stages.

Collection of data and information from tests and personal experiences



Stage 1
Having an experience

Stage 2
Reviewing the experience

Stage 3
Concluding from the experience

Stage 4
Planning the next steps

Observation and reflection lead to an analysis of the meaning of the collected data

Executing new operations, maximizing desired effects, proofing models, planning further steps

Abstract formation of concepts generates abstract models and mental patterns

Source: according to Kolb and Honey & Mumfort

Learning process oriented classification of learning styles

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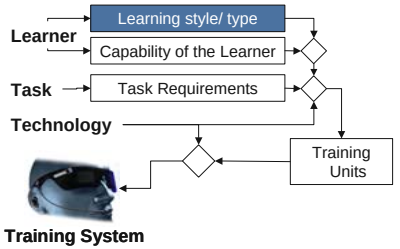

Activists:
- Involve themselves fully
- Are open-minded, not sceptical
- Their days are filled with activities

ACTIVIST
Stage1:
Having an experience

REFLECTOR
Stage 2
Reviewing the experience

THEORIST
Stage 3
Concluding from the experience

PRAGMATIST
Stage 4
Planning the next steps

Pragmatists:
- Are keen on trying out ideas, theories and techniques
- Take the first opportunity to experiment with applications

Reflectors:
- Like to stand back to ponder experiences
- Observe from many different perspectives
- Consider all possible angles and implications
- Are cautious

Theorists:
- Adapt and integrate observations into complex but logically sound theories
- Like to analyse and synthesise
- Are dedicated to rational objectivity

Source: according to Honey & Mumfort, 1992

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Training Unit - Activist

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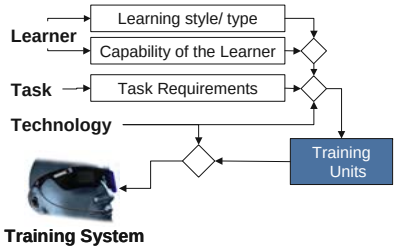
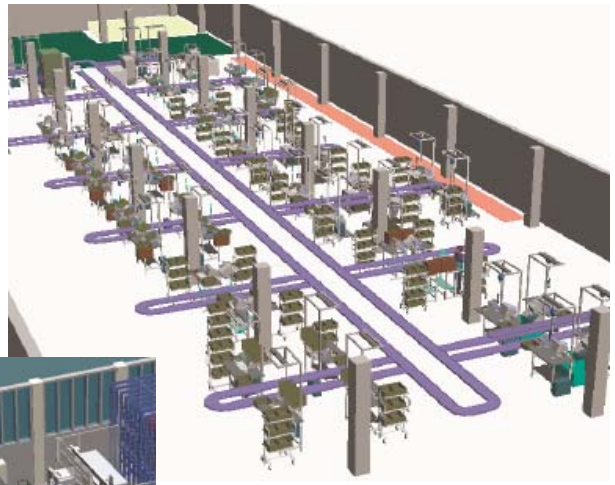


Activist:

- Aspects, which have influence on the learning success:

  + Varying tasks
  + Development of new ideas
  + Team work
  + Trying out

  - Passive and inactive role
  - No participation
  - To much emphasis on theory
  - Repeated exercises



➢ Example: simulation based operational production game

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Training Unit - Reflector

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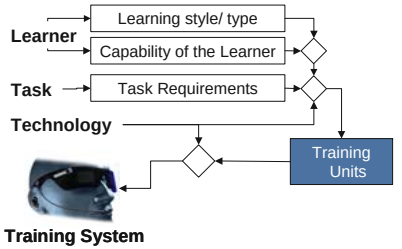

Reflector:

- Aspects, which have influence on the learning success:

  \+ Listening impersonally
  \+ Enough time for decision making
  \+ Repeating the learning content

  \- Operation without planning
  \- Rigid work instructions

➢ Example: Presentation of the learning content in a film

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Training Unit - Theorist

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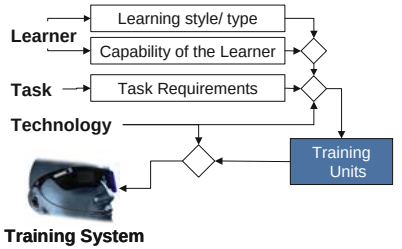
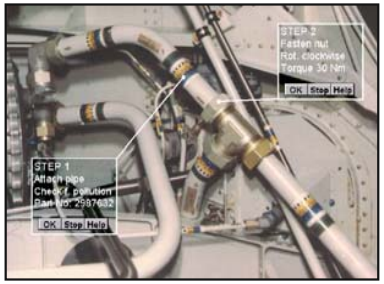
Theorist:



- Aspects, which have influence on the learning success:
  - \+ Enough time
  - \+ Possibility to verify and to check for inconsistencies
  - \+ Further questions possible
  - \- Intention and context not visible and identifiable
  - \- Not structured

➢ Example: Presentation of the learning content in textual mode in order to provide the opportunity to learn in the individual speed, offering questions to repeat the new content, tests



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Training Unit - Pragmatist

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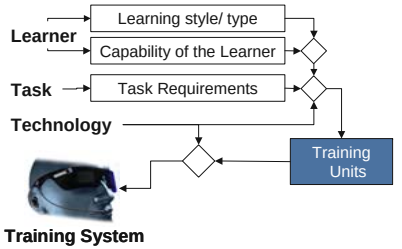
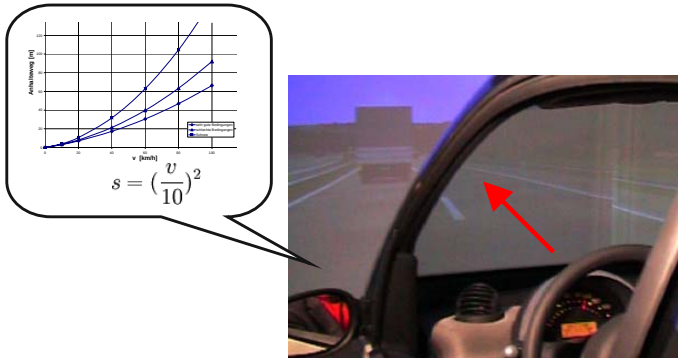
Pragmatist:



- Aspects, which have influence on the learning success:
  - \+ Clear connection between the subject matter and the problem
  - \+ Implementation and practice of the what was learned
  - \+ Immediate possiblity to apply what was learned
  - \- Without visible and practical advantage and benefit
  - \- No practical exercises

- Example: game (simulation) with basic and further instructions/information which offers the possibilty to execute and realize the learned steps directly



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Technology

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- Requirements regarding the Augmented Reality system:
  - Integrating the learning process in the working process
  - Offering the possibility to work simultaneously
  - Not distracting the user‘s attention from the object of interest when additional virtual information is supplemented in the field of view
  - Providing the right information at just the right time at just the right location
  - Useable in the field of production
  - No restrictions regarding place/location

➢ The technology which meets the special requirements, is the augmented reality technology in the appearance of a head-mounted-display (HMD)

Head-Mounted-Display (HMD)

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Fields of Application in Production

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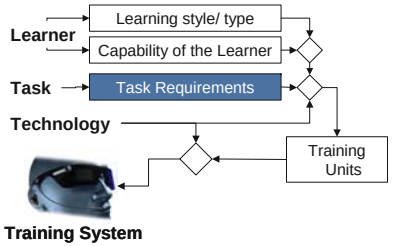
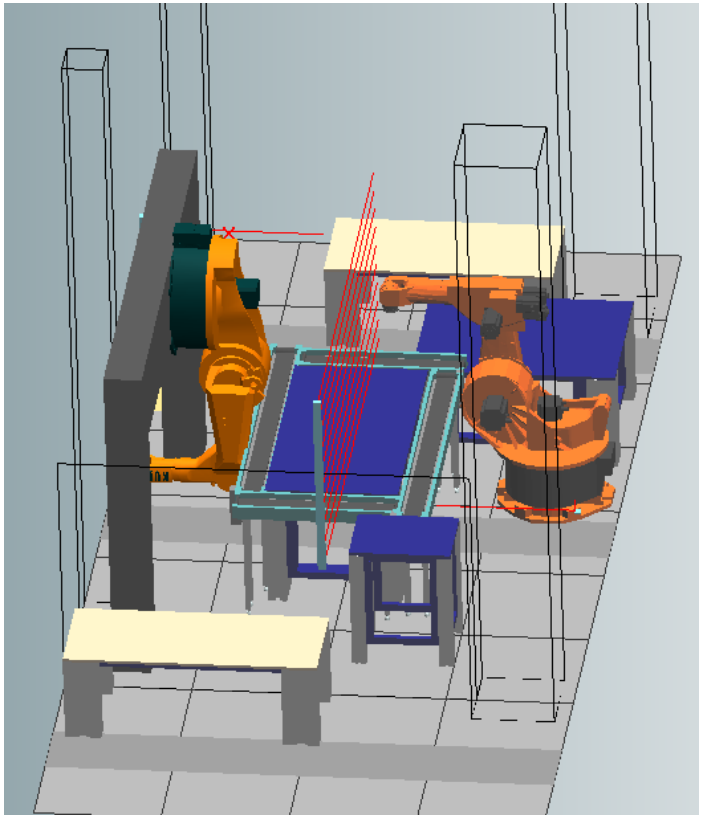
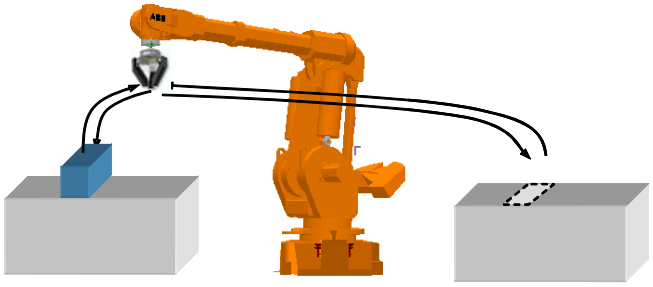
- Requirements:
  - Handling of complex plants and machines
  - Period of vocational adjustment as short as possible
  - training-on-the-job, embedded in the working process (embedded Tarining)



- Work tasks in an industrial environment:
  - initial start-up of the system
  - monitoring system's operation
  - intervention in the case of system errors
  - Respectively Assembly:
    e.g. robot-human-interaction





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Training System

- Modular construction of the system which offers the possibility to choose automatically the training units for the user individual strategy of learning
- The learning modules must be adapted to the learning process for each work task
- In order to evaluate the system, laboratory tests will be executed.
- The aim is to compare the success of the learning process supported by the developed system to conventional learning in order to make a statement how the success of learning can be increased effectively.

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Summary and Further Steps

Summary:

- Presentation of a concept for the development of an Augmented-Reality based training system
  - which provides the possibility to learn/train new and unknown performances and operations embedded in the working process during the work.
  - which adapts to individual way of learning based on a classification of learning style according to Honey and Mumford.

Further Steps:

- Realization of the training and learning units respectively to a special application
- Executing of experiments to validate the system

Thank you
for your attention

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