# "Virtual Reality CBRN Defence" (16)

*paper presentation:*

*Presenter:*

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# Overview

► **Problem & Motivation**

► **Requirements**

► **Design & Architecture**

► **Implementation**

► **User Study**

► **Conclusion & Future Work**

# Problem Statement & Motivation

► **Learning under guidance in a controlled setting**

► **Real world training requires immense resources (financial costs, equipment, participants need to travel, …)**

► **Some scenarios not possible to train in real world (wide-area contamination)**

► **Repetition of scenarios with different parameters**

► **Controllability of the scenario's characteristics**

► **Exposure to hazardous conditions**

► **After Action Review**

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# Requirements of CBRN Training

► **Three skill bundles with a high potential to be trained in VR were identified:**

  ► CBRN-defence recce

  ► Urban search and rescue

  ► Skills for aircraft rescue

► **Derived technical requirments**

  ► Movement (virtual and physical)

  ► Manipulation of objects (virtual and physical)

  ► Communication

  ► Customization of Scenario Content & Parameters

# System Design
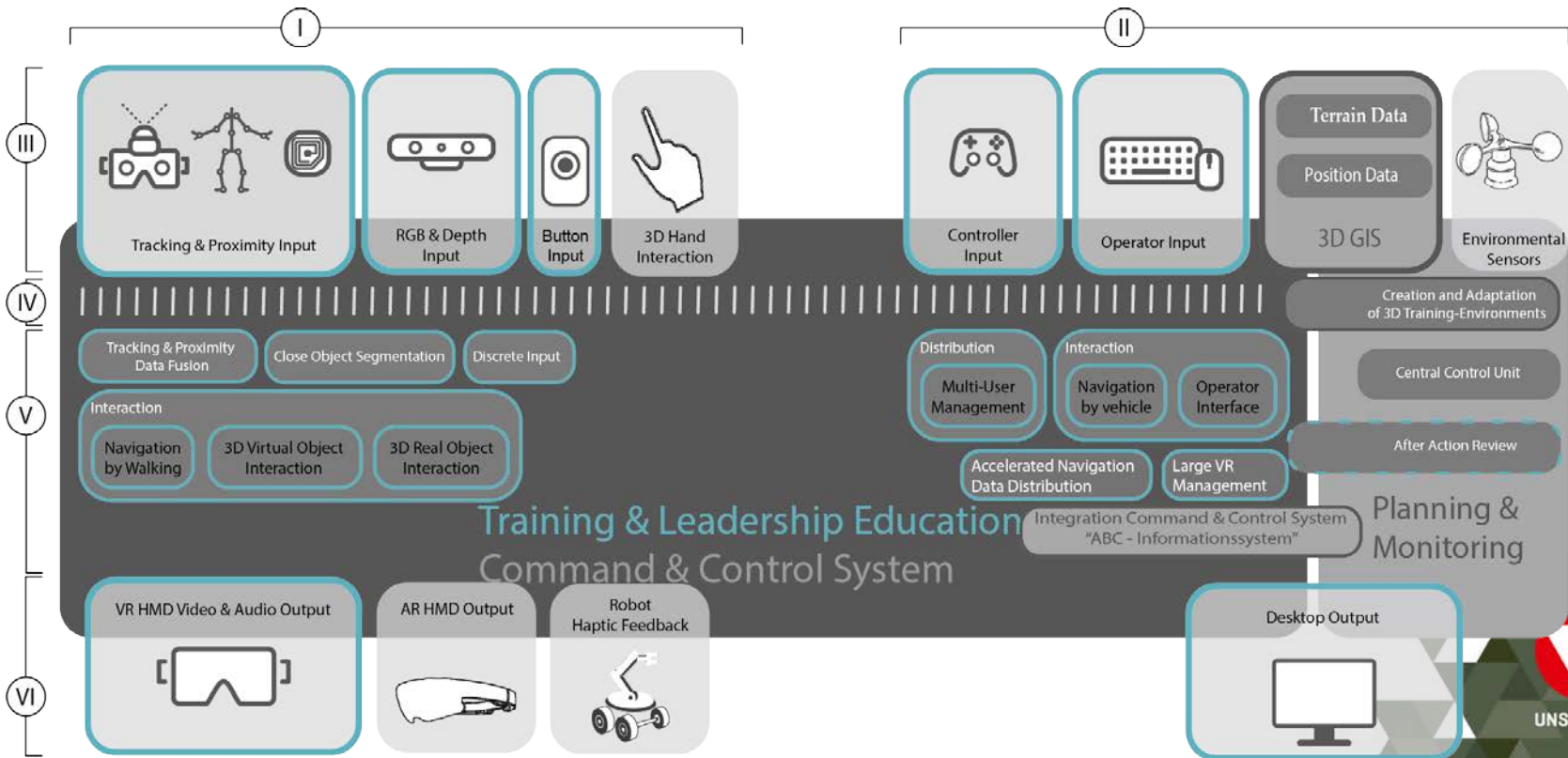
# Hardware

I.   **Virtual Reality Backpack**

▶   **Schenker XMG Walker (Intel Core i7, NVIDIA GeForce GTX 1070)**

II.  **Head Mounted Display**

▶   **Oculus Rift Consumer Version**

III. **RFID-reader**

IV.  **Motion capture suit**

▶   **Perception Neuron**

V.   **Tracking camera**

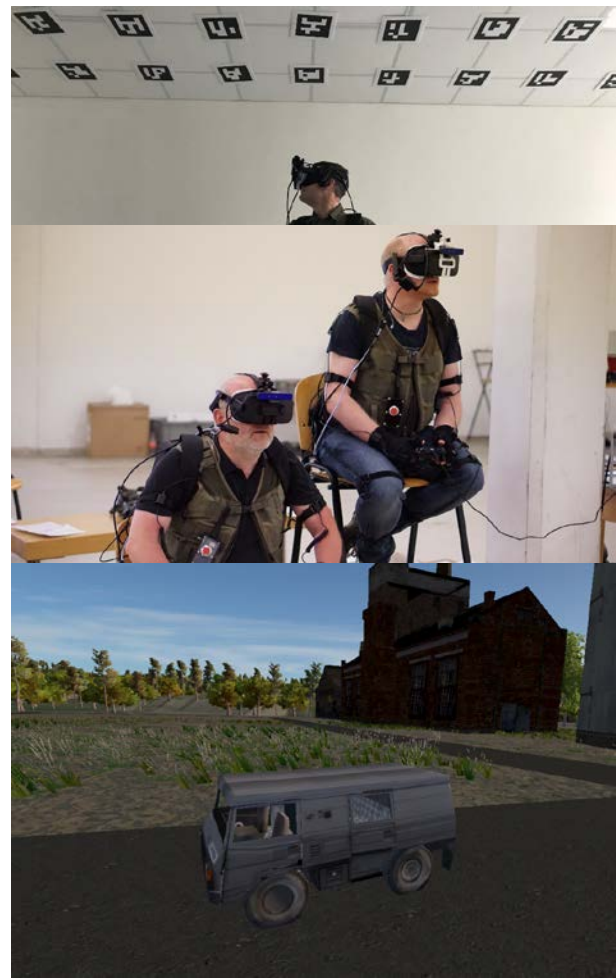VI.  **RGB-D camera**

▶   **Intel Realsense**

# Tracking and Navigation

► **Marker-based Head–tracking**

- ► Inside-out tracking
- ► Natural navigation by walking
- ► Warehouse scale tracking
- ► Efficient implementation on GPU

► **Gamepad**

- ► Navigation by virtual vehicle (Pinzgauer 710FM or Dingo)
- ► Wide-area navigation in virtual world

# Interaction with Real Equipment

► **Augmented Virtuality Approach**

► **RFID and Motion Capture Suit**

  ► Real items equipped with RFID-Tags

  ► RFID-Reader on lower arm

  ► Approximate item position in proximity of users' hands

  ► Management of object ownership in multi-user scenarios

► **Arbitrary objects**

  ► Map, ECAM, forms etc.

# Application Scenario Implementation

- ► **CBRN Defence Recce**
  - ► Observation
  - ► Detection
- ► **Configurable Events**
  - ► Artillery
  - ► Air Strike
  - ► Configurable distribution of hazard materials on ground and air
- ► **Area of 10km x 10km**
  - ► Village with residential, administrative, commercial and industrial buildings
  - ► Based on GIS data
- ► **Airspace of 2500m**
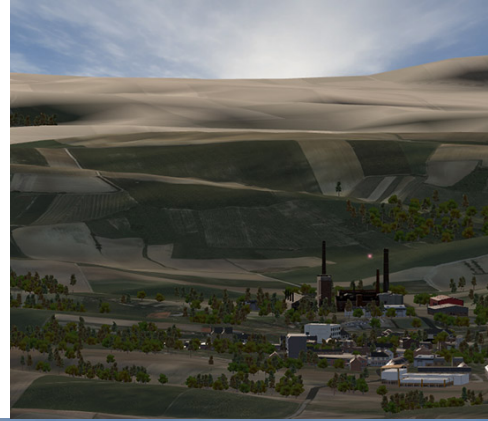
# Operator Interface

I. **Main scene view**

II. **Four different camera perspective settings**

III. **Minimap**

IV. **Function keys**

    I. Trigger Events

    II. Visualization options

    III. Movement

V. **Debug output window**

VI. **Time control and recording panel**
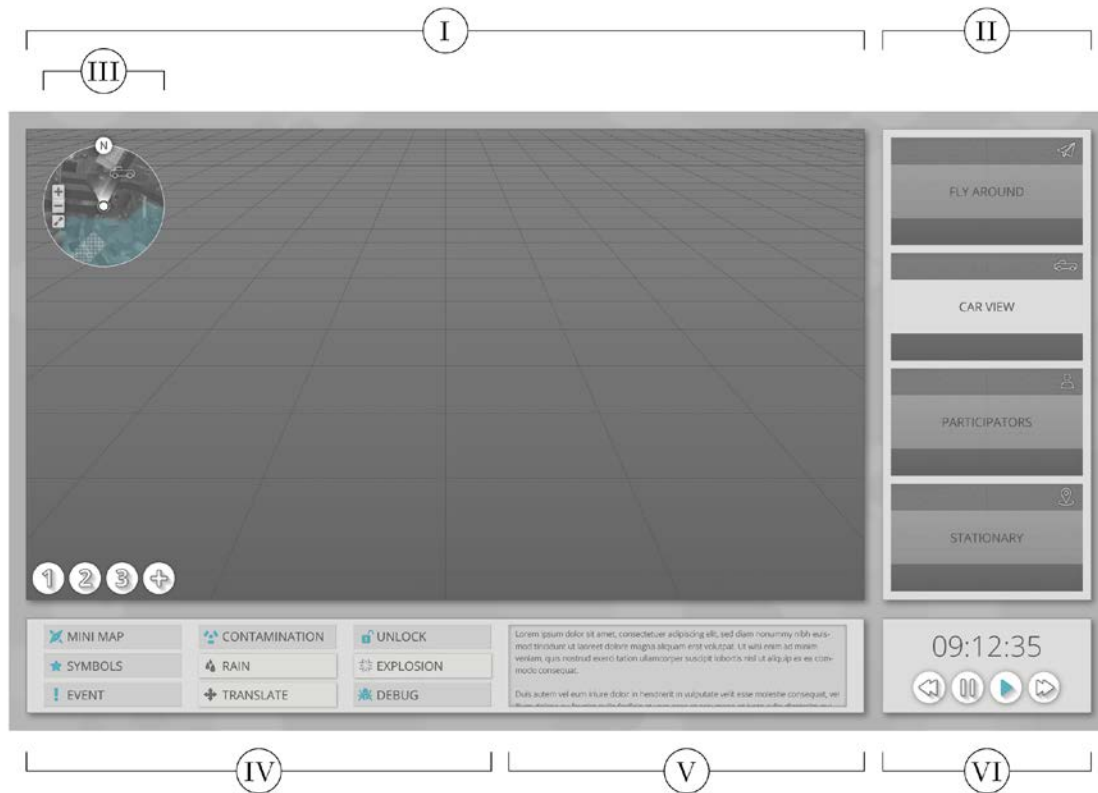
# Virtual Reality CBRN Defence

**Johannes Göllner, Andreas Peer, Christian Meurers, Gernot Wurzer**

**Christian Schönauer, Hannes Kaufmann, Chris Bösch**

# Evaluation

► **13 experts in CBRN defence**

   ► Competence Center NBC Defence of the Austrian Armed Forces (AFF)

   ► National Defence Academy

► **Two user studies during development**

► **Questionnaires with a five point Likert scale (1-5)**

► **Feedback implemented in demonstrator**

# Results Trainees

► **All participants agreed that the virtual environment can support training CBRN Defence**

► **All participants liked training with multiple users in VR**

  ► Speed and quality of collaboration ok

► **Interaction speed and visual quality of real items good, but can be improved**

► **Text down to 10pt recognizable**

► **Interaction with virtual equipment**

  ► Compass, height angle protractor very good

  ► Others (ECAM, Menu) ok, but improved in latest version
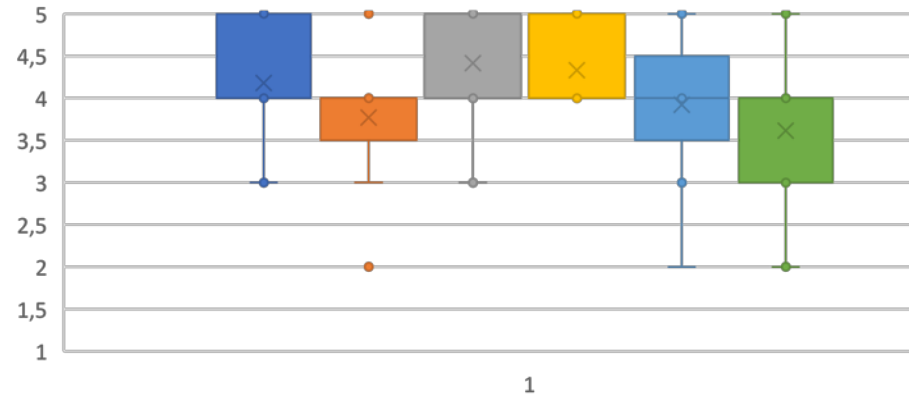


■ Navigation Gamepad Easy

■ Navigation Wide-Area Tracking easy

■ Interaction Real Devices Easy

■ Interaction Virtual Compass

■ Visual Quality Sufficient for Observation

■ Visual Quality Sufficient for Detection

# Results Trainer

► **Very positive feedback regarding usability**

- ► Intuitive – little learning effort
- ► Low complexity
- ► Well integrated

► **All participants agreed that the operator interface can support training CBRN Defence**
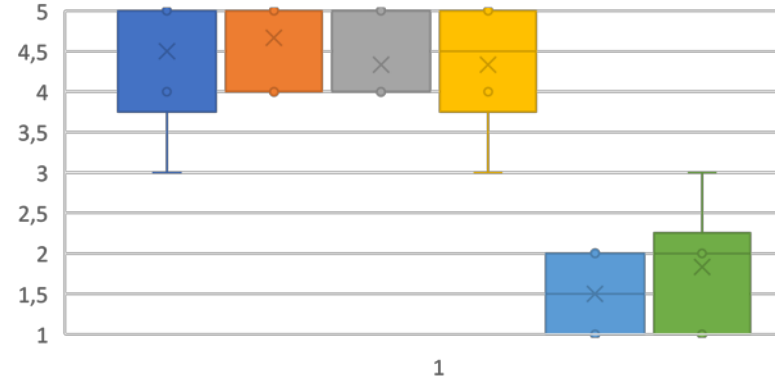


- ■ Training easy to follow
- ■ Interaction with Training easy
- ■ Trainer View visually appealing
- ■ Trainer view easy to handle
- ■ Compexity of Trainer View
- ■ Technician needed for Operation

# Conclusion & Future Work (I)

► **Demonstrator for immersive multi-user VR training**

- ► Navigation
- ► Interaction with virtual and real equipment
- ► Collaborative training with multiple users
- ► Wide-area training environment
- ► Trainee evaluation and education in CBRN Defence *(After Action Review)*

► **Scenario CBRN Defence recce**

► **Evaluation**
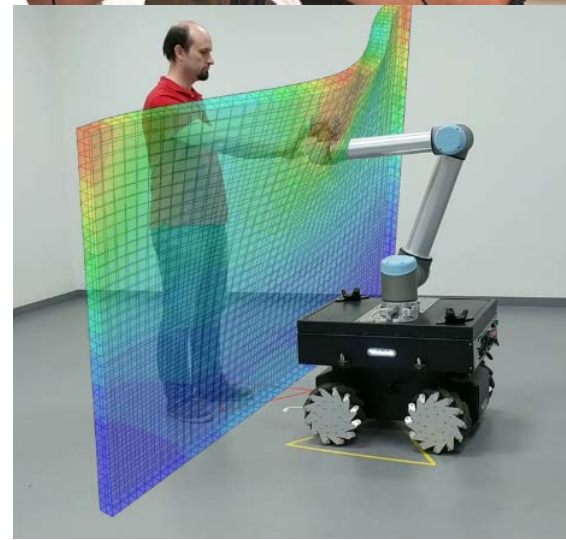
# Conclusion & Future Work (II)

► **Future Prototype**

  ► Extensions towards MR, with integration of an AR HMD and gesture interaction targeting requirements of a command and control system

  ► Integration of mobile robot platform for haptic feedback

  ► Integration of 3D GIS, "ABC *(CBRN)*-Informations-system" and a separate planning and monitoring module.

  ► Wider area of training scenarios in group-size

  ► Continuation within Austria's FORTE defence research program and more long term with funding from the European Defence Agency.
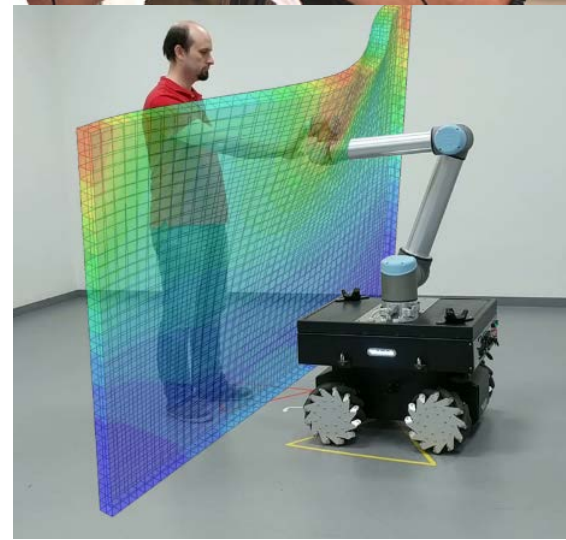
# Conclusion & Future Work (III.1)

*(related to After Action Review)*

► **Competence  & skill profiling and**

**After Action Review Measuring**

- ► **Leadership competences**
- ► **Social competences**
- ► **Personal competences**
- ► **Professional competences**
- ► **Methods competences**
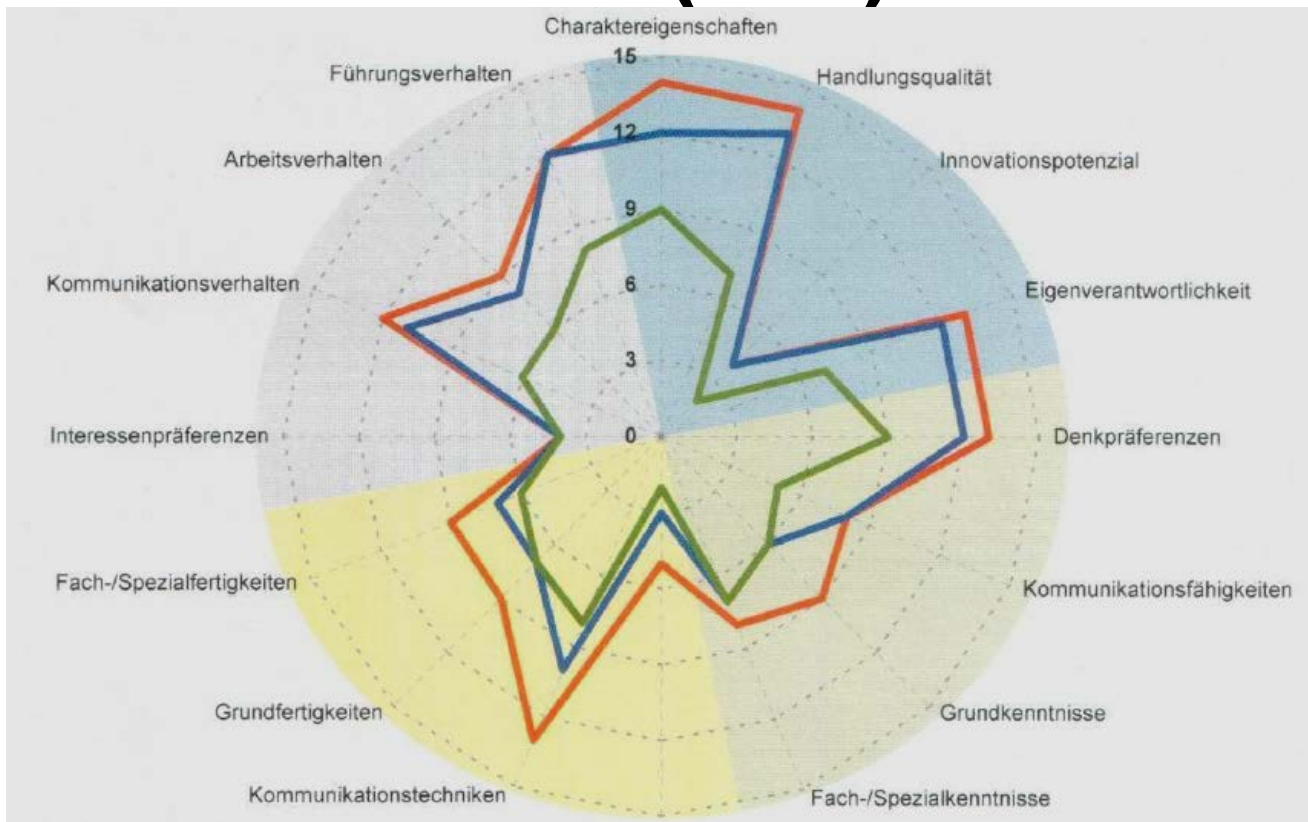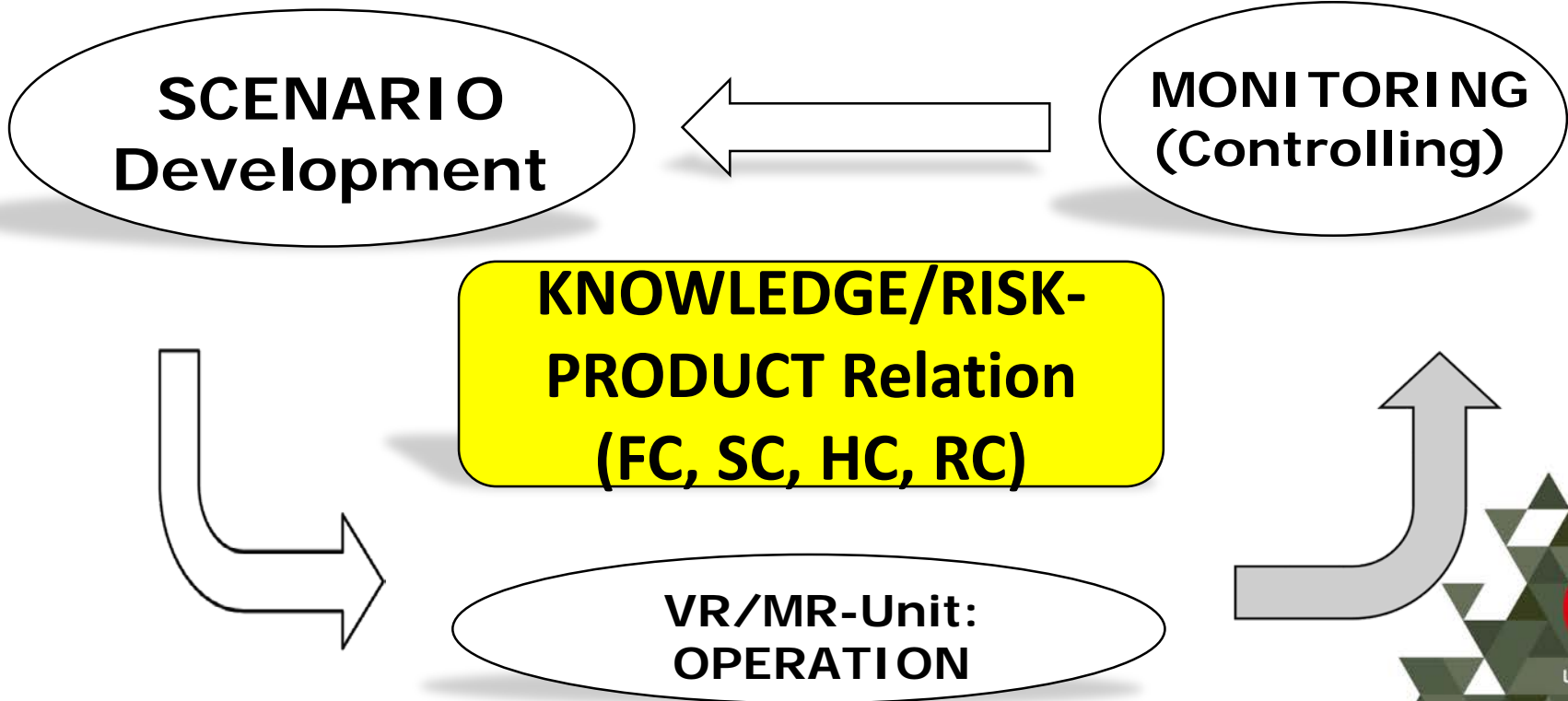
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# Conclusion & Future Work (III.2)

► Competence

Radar:

# Conclusion & Future Work (III.3)

**SCENARIO Development**

**MONITORING (Controlling)**

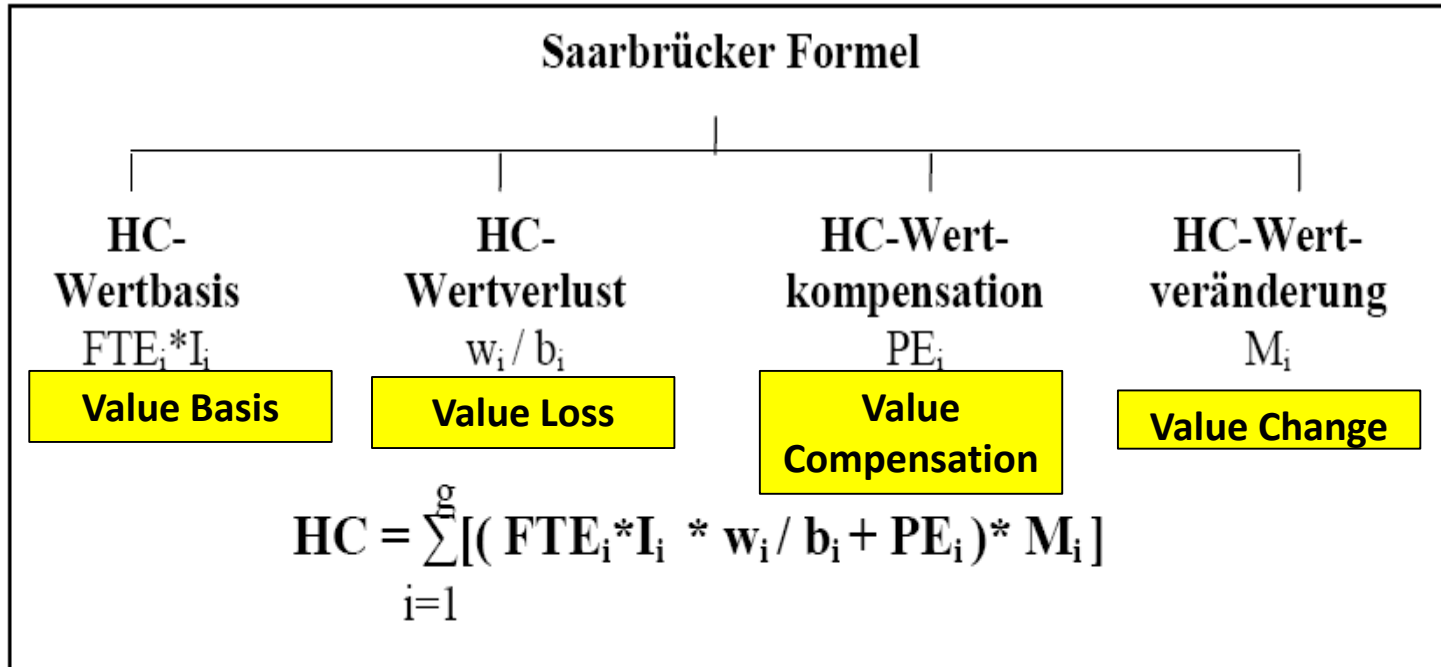**KNOWLEDGE/RISK-PRODUCT Relation (FC, SC, HC, RC)**

**VR/MR-Unit: OPERATION**

# Conclusion & Future Work (III.4)

## Human Capital – Measuring Models:

► **Input Models:** value of the HC = in employee invested sum of money

► **Output Models:** value of the HC = from employee earned profits

► **Comparison Value Models:** value of the HC = difference between at the employment market potentially achievable value and the transacted investments

► **Indicator Models:**

  ► often only listings of indices

  ► mostly approximations

# Conclusion & Future Work (III.5)

▶

**Saarbrücker Formel**

HC-
Wertbasis
$FTE_i * I_i$

**Value Basis**

HC-
Wertverlust
$w_i / b_i$

**Value Loss**

HC-Wert-
kompensation
$PE_i$

**Value Compensation**

HC-Wert-
veränderung
$M_i$

**Value Change**

$$HC = \sum_{i=1}^{g} [( FTE_i * I_i \ * \ w_i / b_i + PE_i )* M_i ]$$

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# Thank you for your Attention !

# Questions ?

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