VIRTUAL DIMENSION CENTER

# VR / AR / MR in MRO & Service

## VDC Whitepaper

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## actual challenges e.g. in mechanical engineering

- increased product complexity, creating impact on: development, production, commissioning, operation, service
- increasing number of variants
- mass customization, highly differentiable products
- language and cultural barriers of world markets
- machine operator business models: not the machine hardware, but the output is sold (responsibility for the operation of the machine is therefore the responsibility of the manufacturer)

## application fields of VR/ AR

- service engineering (ensuring serviceability) and service planning
- service training
- service assistance

# service engineering / serviceability validation

## serviceability studies

- checking accessibility visually and manually
- check accessibility of assemblies, fasteners, lubrication points, etc
  - visually
  - with hands and
  - tools
- all variants, perspectives and positions
- check disassembly / assembly, assembly sequences
- avoidance of special tools
- memorandum, determination of default times

fig: ESI Courtesy of Extricom

Virtual disassembly: accessibility

fig: Virtalis

Installation/ disassembly inspections using haptics (and force feedback via mechanical articulated arm system)

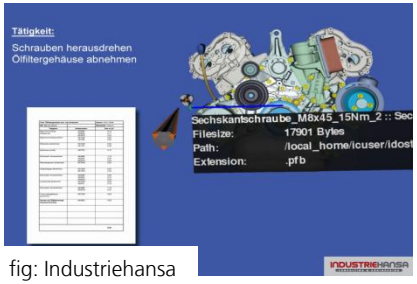



fig: Industriehansa

Documentation of the work steps: Generation of default times

# service engineering / serviceability validation

technical approaches

- user in VR environment or virtual human model
- advantage of "real user method": subjective assessment, (implicit) expert knowledge
- advantage of "human model method": objective, statements for large part of the population achievable
- evaluation results: ergonomics, strains, suitability of the process

fig: OPTIMA

Gripping space-investigations on a mixed mock-up

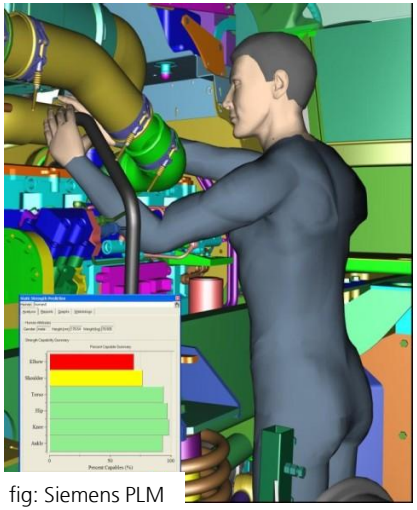


fig: Siemens PLM

Accessibility studies with a virtual human model

# service engineering / serviceability validation

fig: Virtalis

Review using a
Powerwall at CNH

# service training

possible types of knowledge to manage in virtual environments

- position knowledge
- structural knowledge
- behavioral Sciences
- procedure knowledge

Possibilities of learning in virtual environments:

- spatial exploration
- conceptual learning
- motor skills learning
- procedural learning

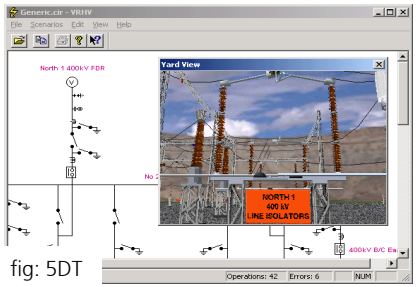



fig: 5DT

Diagram of the transformer station with spatial allocation

fig: ESI

Tool change under collision and sliding conditions

fig: ESI – IC.IDO

Virtual service review at Daimler-VRSC, Brühl

# service training

## fundamental concepts

- advantages of virtual training:
  - presentation of critical scenarios without danger to human and machine
  - location- and time-independent training, even training in non-existent future environments
  - training without occupancy (expensive, dangerous, ...) of real infrastructure

- learning concept in 3 stages:
  - demonstrate
  - accompany
  - assess

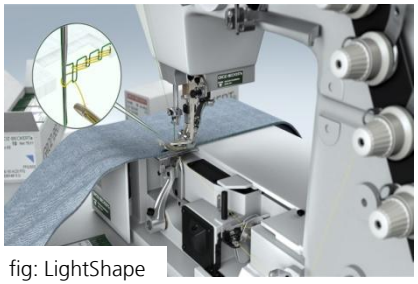


fig: LightShape

Transfer process knowledge: Stitch types at Groz-Beckert

fig: ESI – IC.IDO

Removing engine from forklift


fig: Volkswagen

AR front projection on physical vehicle

# service training

## fundamental concepts

- processes, process knowledge
- risk of damage
- resource / tool use
- all variants
- all perspectives
- incorporating documentation
- incorporating simulators
- visualization of hidden elements
- [animated] AR front projection
  (e.g. obscured installations) on real objects

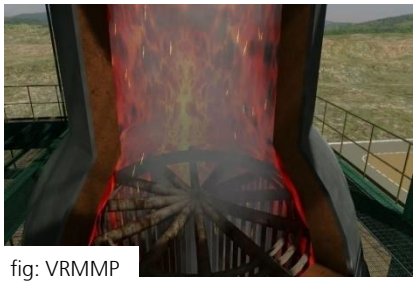


fig: VRMMP

How a process works

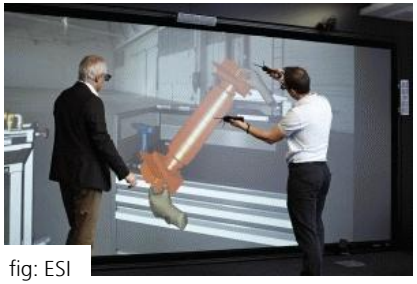


fig: ESI

Ambidextrous removal simulation

fig: Daimler

Virtual service review at Daimler-VRSC, Brühl

# service training

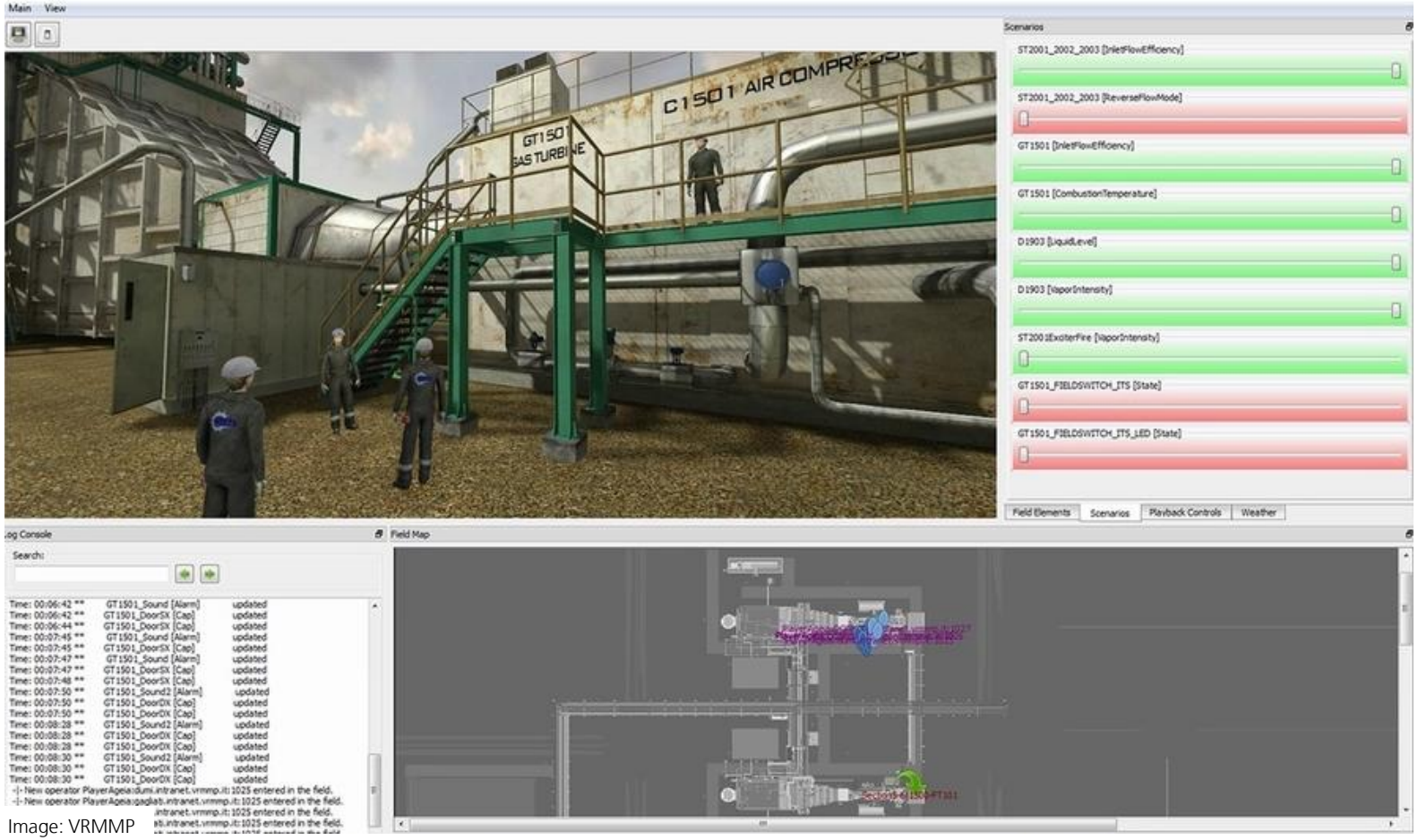



Image: VRMMP

Screenshot of a distributed, cooperative training simulator of the Virtual Reality & Multimedia Park Turin for Total: a group of employees - each with their own avatar - has joint tasks to solve the fault diagnosis and repair.

# service assistance

## fundamental concepts

- display on mobile device:
  - next steps
  - process places
  - necessary tools
  - process parameters in the field of view of the observer
- illustration correctly superimposed with camera image of the real object
- recording the current status (disassembly, control, ...)
- remote service experts may join via tele conferencing

fig: Volkswagen

AR-based maintenance & repair assistant "Marta" on tablet PC

fig: Fraunhofer IPA

AR-supported machine operation

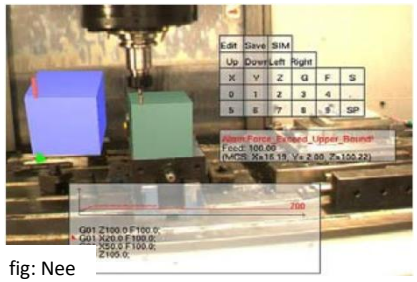


fig: Nee

Crossfade online process data on workpiece

# service assistance

fig: Re‘flekt

tele support with augmented reality: operator in central receives view of the worker and his problem definition. worker receives instructions from the operator with correct assignment

# service assistance

## documentation & proof

- documentation within the 3D model
- AR annotations for mobile devices
- recording (digitizing) new knowledge about mobile devices (camera recording, sensor data acquisition, etc.); Filing for documentation and sharing with others (such as knowledge management systems and social media) [Knowledge types in virtual environments: position, structural, behavioral and procedural knowledge]

fig: Fh-IPA

demonstrator "Service Tools": documentation in the interactive 3D model

fig: Volkswagen

AR-based, mobile workshop information system data browser

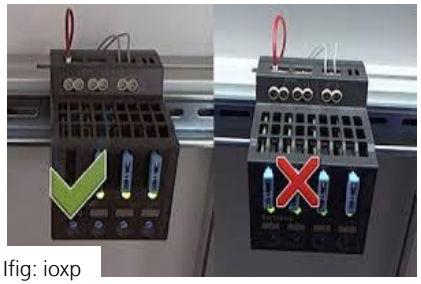
fig: ProGlove

data glove for industrial context with CPU, display, scanner, sensors (inter alia, voltage, temperature) Detection of manual activities, and wireless connection

# service documentation

## digital capture of a service process

- purpose
  - quality assurance
  - conflict resolution
  - basis for invoicing
  - valuable content for entreprise social network (information back channel)
- technologies
  - cameras
  - 3D depth sensors
  - gesture recognition
  - tracking technologies
  - machine sensor data
  - measurement devices



Ifig: ioxp

photo documentation

fig: VDI-Nachrichten

3D hand capture

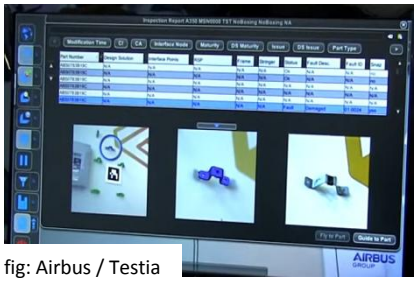


fig: Airbus / Testia

photo comparison and documentation

# AR assistance systems discussion

- fundamental concepts: motivation for AR use

figPicavi

fig: BMW

fig: Volvo

**logistics**

- faster
- flawless commissions

**maintenance, Repair, Service**

- lower qualification requirements
- focus experts in strategic projects
- reduce travel costs
- offer solutions ad-hoc
- documentation process

**manufacturing**

- accelerate training
- increase quality
- control customized products
- documentation process

- what is the desired result of the data glasses usage?
- what are indicators for success? How to measure?

# AR assistance systems discussion

## fundamental concepts: basic functions of an AR system

- tele conference

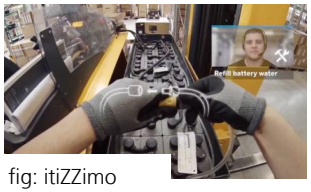


fig: itiZZimo

- assistance, X-ray, consistency check real-digital with augmented reality

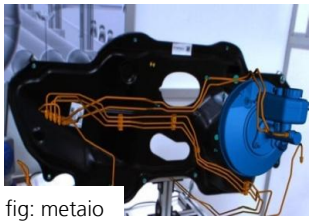
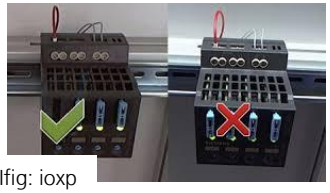


fig: metaio

- simple information display

fig: all-electronics.de

- documentation


Ifig: ioxp

- training


fig: ioxp

- real-time tracking and tracing for big data analysis, such as process improvements


fig: VDI-Nachrichten

# AR assistance systems discussion

## conditions of use - 1

- under which conditions are the data glasses used?
  - dirt, narrowness, temperatures, humidity, dust, noise, explosive environment, ...

fig: Microsoft

fig: KNAPP

fig: www. v3.co.uk

# AR assistance systems discussion

## conditions of use - 2

- who uses the smart device?
  - qualifcation, overall tasks, glasses, other handicaps with impact on smart device operation, usual task during smart device usage
- what are respective knowledge and experiences?
  - knowledge of actual work task, IT knowledge, wearables knowledge
- what the individual user's advantages out of smart glasses use?
  - service business model
  - job description, performance assessment

fig: Ii's OWL

fig: Ubimax

fig: 123RF

# Summary

- main application fields of virtual techniques in the field of service:
  - serviceability validation
  - service training
  - service assistance
  - service documentation
- sensuring serviceability and service training
  - local and cooperative through projections
  - distributed or individually via HMDs
- service assistance
  - through tablet PCs, smartphones and smart glasses
  - small display size requires customized content (pictograms, symbols, little text, ...)
    => efficient content supply chain crucial
  - develop efficient and robust interaction concepts for use in a variety of environments


CAD

3D content supply chain

# VDC members in this topic

# Thanks for your interest

**You are interested in the topic and are you looking for contact persons? Talk to us.**

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