Hochschule Konstanz
Technik, Wirtschaft und Gestaltung

Future Visualization in Manufacturing - Virtual Reality and Serious Games

Application, Experience, Implementation, and Outlook

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PEOPLE

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Chair for Systems and Control Engineering at the HTWG Constance

Background: Technical Cybernetics

Profound experience in system dynamics, digitization, automation and software development

Co-founder and CEO of Modellfabrik Bodensee GmbH / Varity for industrial VR and AR applications

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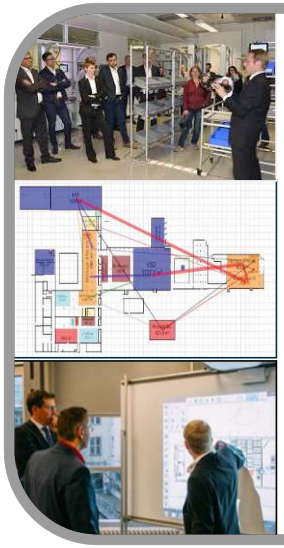
Chair for Value Creation Systems at the HTWG Constance

Background: Manufacturing Management

Profound experience in lean management, supply chain, smart manufacturing and industry 4.0

Co-founder and CEO of Modellfabrik Bodensee GmbH / Varity for industrial VR and AR applications

WHAT WE DO



CONSULTANCY

IMPLEMENT SUCCESFULLY
LEAN MANAGEMENT AND
DIGITAL TRANSFORMATION

ACADEMY

PREPARE AND ENABLE AWARENESS OF
LEAN MANGAMENT AND
DIGITAL TRANSFORMATION

VARITY

CREATE YOUR OWN VR:
VARITY SDK
VR **VARITY** APP

CUSTOMER INDIVIDUAL AR AND VR
APPLICATION DEVELOPMENT

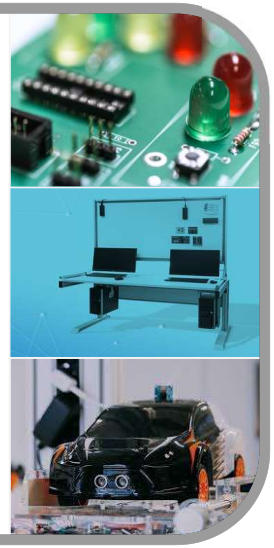
var.ity

EDBOARD

ENABLE YOUR TRAINEES AND TRAINER FOR
DIGITALIZATION:

INNOVATIVE LEARNING AND TEACHING MODULES
AND EQUIPMENT

edboard



Modellfabrik Bodensee GmbH

SPIN-OFF OF HTWG KONSTANZ

PARTNER FOR SCHOOLS, UNIVERSITIES, AND COMPANIES

HTWG

Hochschule Konstanz
Technik, Wirtschaft und Gestaltung

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The
Digital Reality
Movement

Virtual Reality –
Flash in the Pan or Long-term Development?

Metaverse

- by Meta (formerly known as Facebook)
- a kind of virtual reality Internet through which people can move as avatars*

Areas of application

- start games together or watch movies
- experience concerts or sporting events from the best seat without having to be in the stadium
- virtual conference rooms (co-operation with e.g. Slack and Dropbox)

Investment

- already 10 Billion US dollars have been invested
- 10,000 jobs shall be created alone in Europe

* The term became more widely known in the 1991 book "Snow Crash" by Neal Stephenson, which describes the metaverse as a kind of virtual reality Internet through which people can move as avatars.

Metaverse and Manufacturing Companies?

1. https://de.beincrypto.com/the-zuck-77-der-menschen-wollen-nicht-dass-facebook-ein-metaverse-aufbaut/ 08.03.2022
2. https://eehd.gmbh/blackstone-resources-will-ab-2021-batterien-in-sachsen-drucken-solarserver/ 08.03.2022
3. https://www.produktion.de/wirtschaft/autobauer-fuehren-bei-investitionen-in-smart-factories-112.html 08.03.2022

Real Industry Use Case by varity.me
NSK Germany

Trainee from NSK Germany production department in the setting process using the Virtual Reality training module

- Learning how to **set up grinding machines** at **NSK** can take a long time and cause delays on the shop floor. Employees who need to learn this process require supervision from a more experienced employee.
- With VR setup training, inexperienced employees can learn the work environment and **train the complex process** in a realistic way. The user is guided step-by-step through the process via voice instruction and can **complete the entire training independently without a supervisor**.
- When purchasing a machine, **setters can already be trained** before the machine has been physically set up in the factory. As soon as the machine arrives, it can **immediately be used productively without long training period** for the setters.
- Thanks to the support of three languages, the training can be carried out at many locations.
- **Gamification** elements motivate the trainees.

Real Industry Use Case by varity.me
Audi

Trainees from the Ingolstadt plant logistics department in the so-called pick-by-light process using the Virtual Reality training module

- **Audi AG engaged varity** to develop a VR training for the **logistics department**
- **New logistics concepts**, like pick-by-X (-light, -voice, -tablet) **require complex hard-and software mock-ups**t o ensure realistic training effects
- **VR is seen by Audi AG as a promising tool** to enable a flexible and realistic **training environment without high CAPEX** and large space requirements for mock-ups
- Additionally, the training helps to **increase process reliability** and **reduce number of errors** when workers step into reality (and it is fun for them, through embedded gamification elements)
- The **VR training is now an integral part of curriculum**

Real Industry Use Case by varity.me
Audi

Training of the E-Training department of the Audi AG, in the battery change process of an Audi e-tron using the Virtual Reality training module

- To support **Audi** authorized workshops, we have developed a virtual training course for the introduction of the **Audi Aftersales Support** to support the introduction of the new **e-tron** module replacement.
- This allows employees to **practice on the high-voltage system** without the high-voltage system **without any risk** and from any location.
- The e-tron thus not only **saves** fuel, but also **business trips** and **training infrastructure**. A new addition is thethe multiplayer version.
- This **enables workshop** foremen **around the world** to work on the e-tron and receive external support and training **instructions** from an **Audi trainer from Germany**.

Real Industry Use Case by varity.me
Thüga Energienetze and Schwaben Netz

Trainee doing functional test of a house pressure regulator and setting activities of a gas station using the Virtual Reality training module

- The **basis** is the **real hands-on training** in the training room with specific device set-up. **Transfer** of the whole concept **into VR**.
- **Runs on VR glasses as well as on PCs, tablets, smartphones and e-learning platforms**. A WiFi connection is required for the **multiplayer version**.
- Employees can **train the relevant work steps as often as they like**, regardless of location and language.
- Automated analysis of the individual performance of trainees

Training is structured through different levels (difficulty levels)**:**

- **Level 1:** Automated trainers support through standardised processes and guidance of the players through highlights and voice instructions (flexible language, multiplayer and remote trainers)
- **Level 2:** Verification of learning content through competition of the player with himself (or, if desired, through ranking)
- **Level 3:** Targeted training of the unexpected through random error scenarios.

The Alix Partners Future Factory:
Hands-on Experience in Operational Excellence and Digital Manufacturing

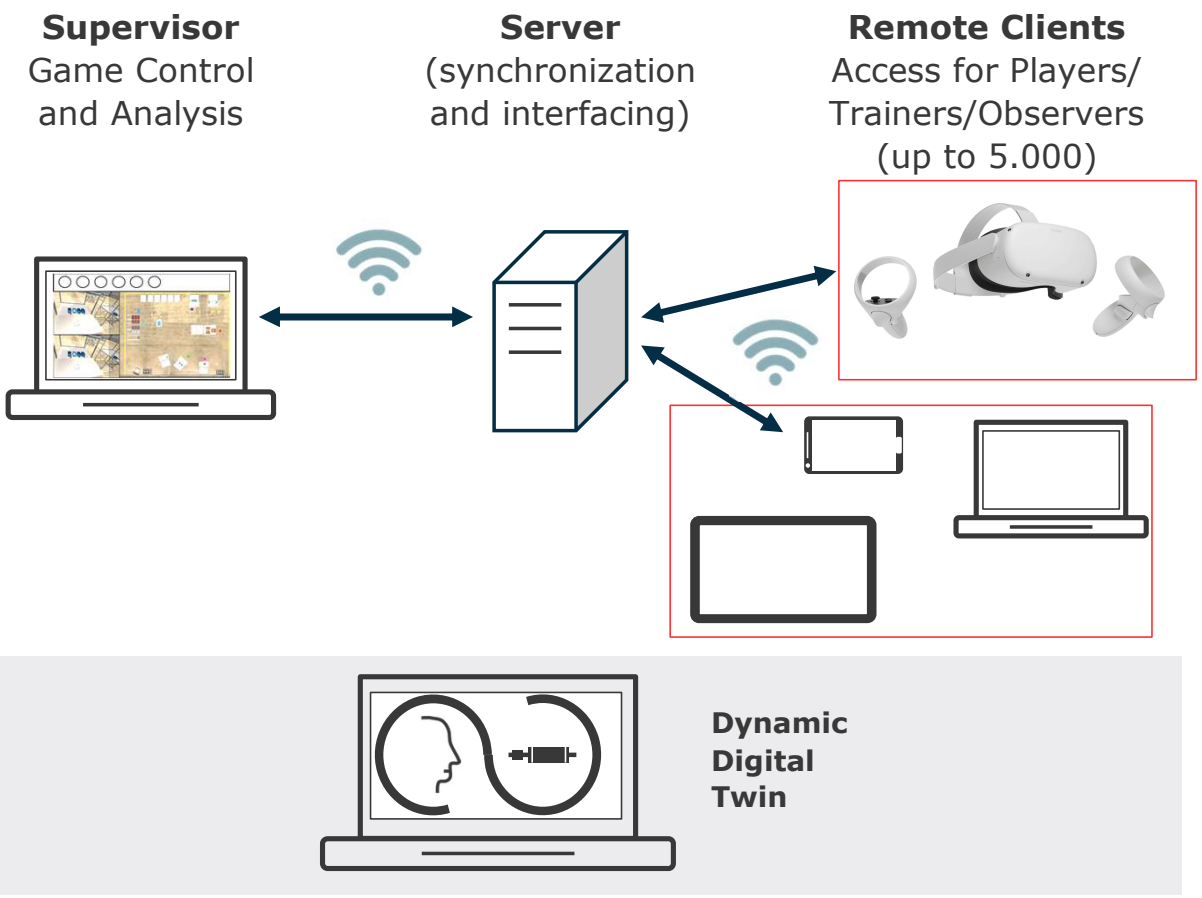
The REALITY (operational today)

- Digital Manufacturing Transformation in a simulation game consisting of three rounds
- Application of operational excellence and pragmatic digital tools (MES, RFID, pick-by-light, etc.)
- Participants "feel" the efficiency improvements firsthand in an authentic assembly line

The VIRTUAL REALITY (in development)

- Transfer the entire concept into a digital world to enable fully virtual workshop environment
- VR headset and a WiFi-connection is the only equipment required
- Fully independent from participants physical location even if in different countries / continents

The Future Factory Training as a Virtual Reality Multiplayer Game based on a Dynamic Digital Twin



- Interoperation of 3 applications - core stored stand-alone on client platform (e.g. VR headset)
- Communication via inter-/intranet in real-time via UDP (User Datagram Protocol)
- Multi-client (real / simulated player)
- Multi-platform (VR headset, PC, tablet, HTML)
- Fully independent of location
- Audio-visual interaction of clients
- Motion-control and physics embedded
- Interactions between objects / participants
- Recordings and simulations of players possible
- Highly scalable in terms of objects and scope

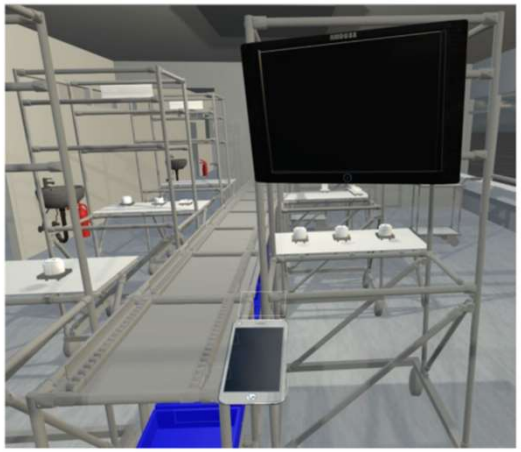
Virtual Reality Training
Structure of Study

500 Picking Orders, 30 subjects, 3 comparison groups

RT-Group	VRT-Group	WRT-Group
10 Persons	10 Persons	10 Persons
10 POs per Person	10 POs per Person	10 POs per Person
Real Training	VR-Training	Without Training
⬇	⬇	⬇
Real Picking	Real Picking	Real Picking

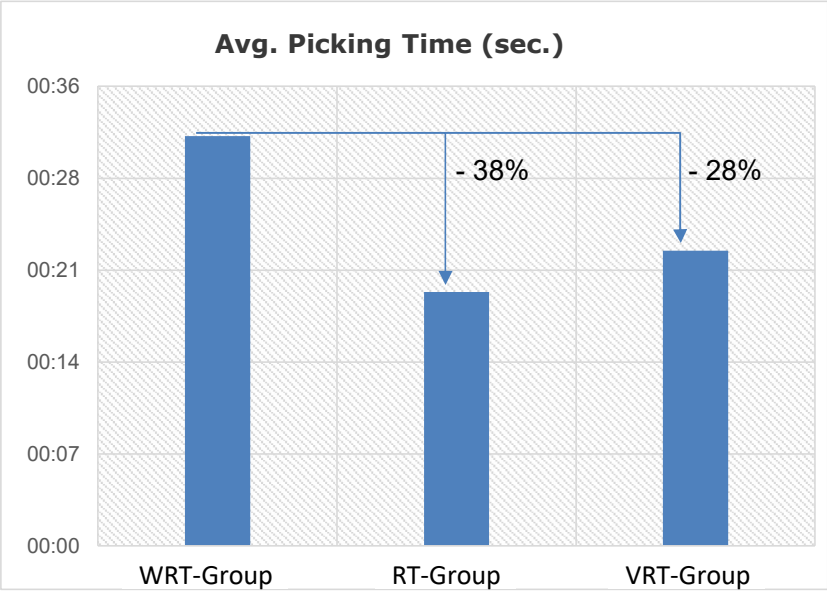
Reality Lean Dojo*

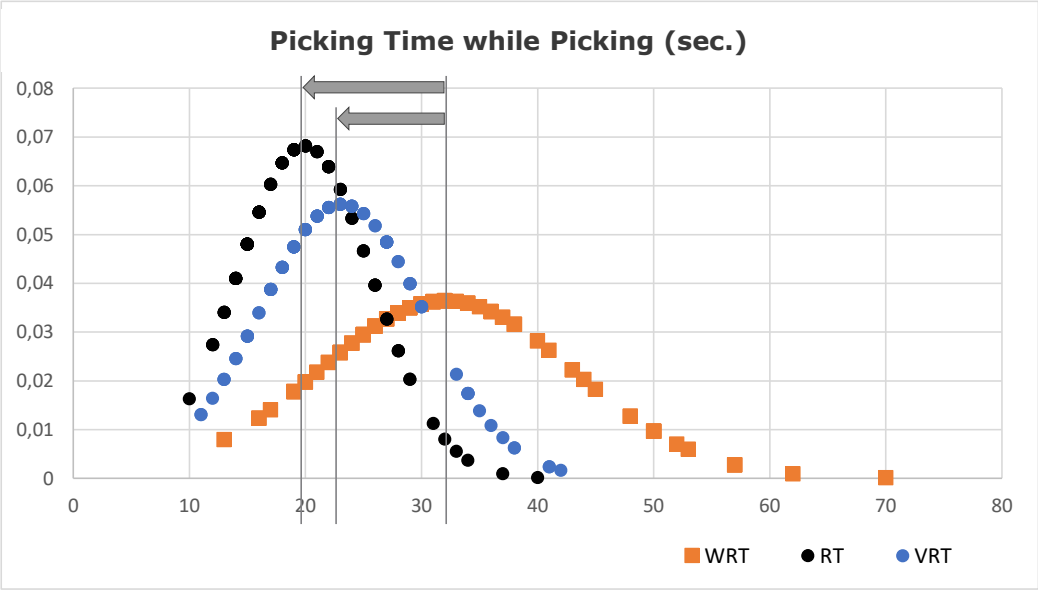
Virtual Reality Lean Dojo*



*(jap. 道場): place for immersive learning. The term literally means "place of the Way" in Japanese.

Analysis of the Efficiency of VR Training





Efficiency: picking time (per PO)

- efficiency increases by **real training** by **ca. 38%**
- efficiency increases by **VR training** by **ca. 28%**

- time for corrective actions (in case of faulty picking) have not been taken into account
  → favourable for VR training

Efficiency: Normal distribution of picking time (per PO)

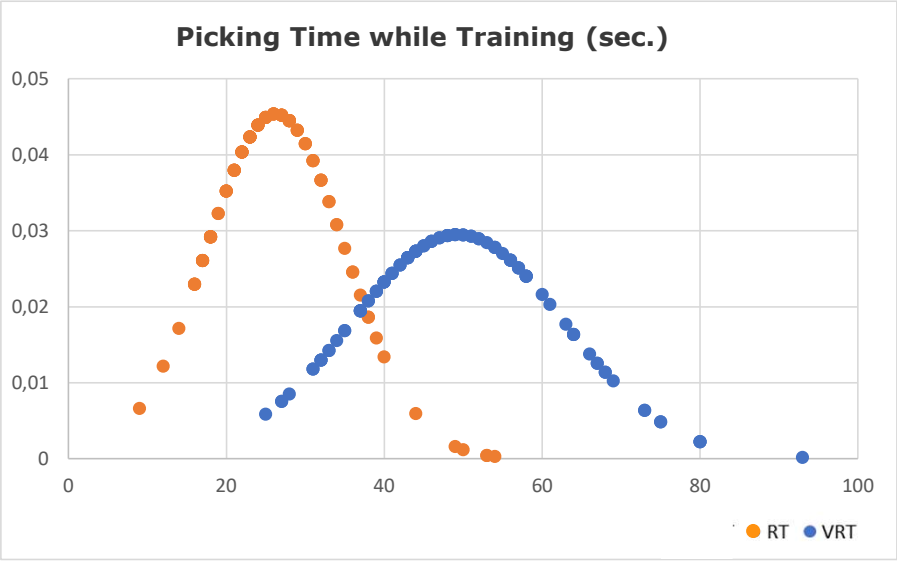
- picking times (RT) / picking times (VRT) have a more narrow and more symmetric normal distribution than those of WRT group
  → picking **process** is more homogeneous and **stable and therefore more reliable**

- **VRT** group is **close** to the performance of the **RT group**

Analysis of the Effectiveness of VR Training

Effectiveness: **number of mistakes**

- VRT group has only 3 picking mistakes vs. 5 picking mistakes done by RT group



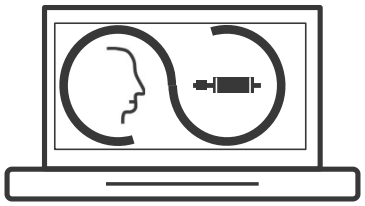
Analysis of Training Behaviour

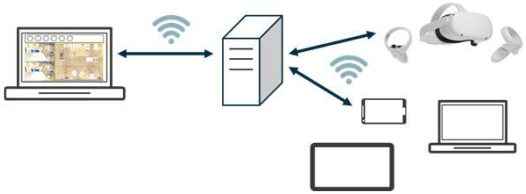
- trainees spend more time to learn new skills (normal distribution is shifted to the right): **try out and test things**
- do mistakes and see what happens
- each trainee decides, how much time he individually needs to do the training (normal distribution is flat and wide): **individual training time** (defined by the trainee)

Effects of Training Behaviour

- VR effect: „**it is ok to do mistakes**"
- potential explanation:
  - just try it → it's a game
  - learn from mistakes → no harm, no negative consequences
  - no fear to do mistakes → **open to do mistakes**
- each mistake done in training, will help you to avoid to do it in reality, **finally better training results**

How to Create VR Trainings Fast?
Varity Software Developer Kit (SDK)





Graphical Programming

HMI Design

Platforms Handling

unity

varity SDK - Module

Multiplayer

360° Tours

Avatar/NPC*

Voice Commands

Gamification

Worker Guidance

State Engine

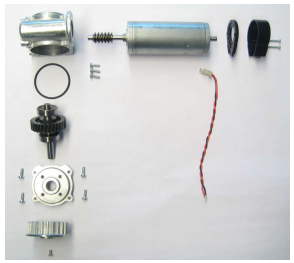
Recordings

Teach-In

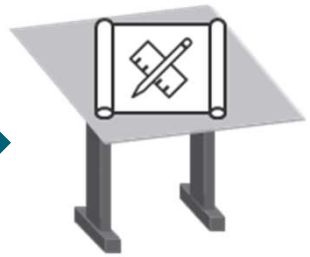
- Core development is done in Unity game engine module Varity SDK
- Varity SDK was created to enhance digital twins by dynamics
- The SDK offers a highly automated approach to
  - Apply motion and physics
  - Add link to work instructions
  - Make objects interactable
- The SDK can be applied to a large variety of industrial applications
- Apps created from SDK are standalone and allow user-based modifications
- Varity offers also solutions to automate the work flow from CAD to digital twin

* NPC = Non-Player Character (simulated player)

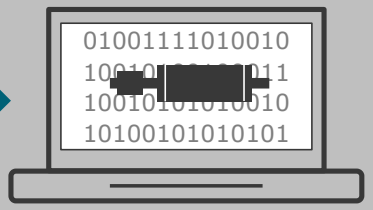
Work Flow for an Integrated Digitalisation



Product

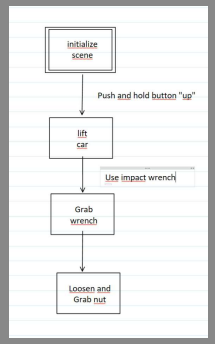


CAD/CAE

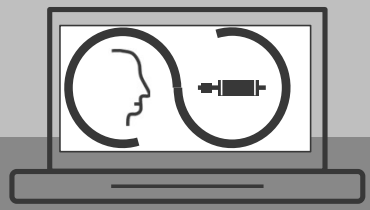


Digital Twin
e.g. for VR/AR/HMI Usage

~75% automatisation by Varity Graphic Support



Work Instructions



Dynamic Digital Twin

~90% automatisation by Varity SDK

Manufacturing Companies and Metaverse?

1. https://de.beincrypto.com/the-zuck-77-der-menschen-wollen-nicht-dass-facebook-ein-metaverse-aufbaut/ 08.03.2022
2. https://eehd.gmbh/blackstone-resources-will-ab-2021-batterien-in-sachsen-drucken-solarserver/ 08.03.2022
3. https://www.produktion.de/wirtschaft/autobauer-fuehren-bei-investitionen-in-smart-factories-112.html 08.03.2022

Summary

- VR training delivery the best result in effectiveness; VR training is reaching similar results in efficiency
- Self-motivation through serious gaming approach
- Virtual goggles do not replace the real "training activity", however, the work steps already learned through training can be trained as often as desired and independent of location
- Savings in training hardware and materials
- VR training is easily scalable, nearly free of investment
- VR training can already be used in the planning and ramp-up phase
- VR training is easily tailored to meets local needs (language etc.)
- High coverage through use in e-learning platforms
- Non-specialist employees get an impression of what the skilled employees do
- Analysis of error-prone processes through automatic evaluation of frequent errors in the training process
- Standardization and optimization of work processes

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The
Digital Reality
Movement

www.varity.me