

Using VR and simulation to enable agile processes for safety-critical environments

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Virtual Reality

"Virtual Reality: A computer system used to create an artificial world in which the user has the impression of being in that world and the ability to navigate through the world and manipulate objects in the world."

C. Manetta and R. Blade in "Glossary of Virtual Reality Terminology" International Journal of Virtual Reality, Vol.1 Nr.2 1995.

The Essence of VR

• Immersive experience

- Puts user inside a virtual environment
 - Physical multi-sensory perceptual immersion

• Results in a sense of presence

- User feels located in the virtual environment
 - Psychological immersion

• The whole experience becomes real for the user

State of the art of VR





Gaming PC, HTC VIVE Pro, hand controllers, and optical position tracking in IFE's VR Lab (2018)

Using a rapid virtual prototyping approach to support agile thinking

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Control Centre – Conceptual Design - ISO 11064

- Space allocations
- Functional links/task zones
- Control suite arrangement
- Control room layout
- Workstation layout and dimensions
- Displays and controls
- Information and data flows
- Special security and access controls
- Environmental conditions
- Operation and management systems

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Immersive interfaces for rapid prototyping & simulation

- Enable stakeholders to enter a design together and experience it full-scale
 - Leverage our visual perception capabilities to get a rapid feeling of the space and layout our a design
- Shared experience, even when using head-mounted displays
 - Multiple people in the shared space simultaneously while in the same physical (or remote) room
 - One or two people immersed and the rest of the team discussing with them as they function as «guides» showing the models (everyone watches on monitors)







Value of virtual prototyping for designing/optimising environments and work procedures

- Faster iterations, rapid feedback & learning, more time to reflect
 Quick to fail in order to eventually succeed
- Common holistic understanding between stakeholders and the design team
 Stakeholder involvement
- Prototype relatively easy to understand and can support role-play exercises
- Challenge in most digitalization projects is that existing end-users are not experts in new way of working that the new systems are intended to support
 - Role-play especially useful to bring user stories to life and clarify requirements
- Work remotely stakeholders often inconveniently located for regular discussion, complex projects typically have teams spread across continents

Semantic Data Models & Smart Testing

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Focus on producing great (innovative) solutions rather than conformant (conservative) "solutions".

- Safety-critical systems are commonly found in highly-regulated industries
 - Some stakeholders used to communicating through formal documents only
 - Formal documentation often a legal requirement for permission to operate
- Need to avoid too much effort on conformance, and maintain focus on producing a great overall solution
- Smart testing and simulation are essential to being able to iterate rapidly
- Depends on enough semantic data in the model
 - Combining virtual prototype and semantic data model enables automated testing
 - Use to maintain holistic overview of conformance with regulations and requirements while reducing risk and identifying better ways of working



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VR in a Lifecycle Perspective

Digital Twins, Training, Optimisation, Decommissioning

- Digital design ightarrow digital twin
- Provide a platform for continuous improvement of complex processes
- VR and AR can enable powerful 3D interfaces to spatial data and processes using a digital twin
 - Digital twins are challenging as they should not only be able to mirror the state of a real system but also enable simulation of alternative futures
 - Enable user to adjust parameters and evaluate consequences of potential optimisations
 - Use a digital twin to try to balance improved production output and system reliability
- Continuous Improvement after implementation implies that a framework that support agile thinking is in place if changes are to be done quickly
- Not just for operation but also through dismantling/recycling



Training

- Human-centred system design and human factors are essential for effective digitalisation VR is great for presenting spatial information efficiently
 - Digitalisation often implies more automation
 - But humans expected to solve problems when something unexpected happens and understand the limits of automation (e.g. an automated suggestions for decision-support)
- Training is important to drive change in work processes and cultures
 - Adapting to new operational mindset
 - New forms of teamwork and inter-disciplinary teams
 - Project management, scheduling, coordination, risk management
- Role-play in VR useful as training tool for work in inaccessible areas or to prepare for new ways of working before physical facilities exist
 - Engagement, gamification, accidents & emergencies, etc.



Wrapping up...

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Some challenges affecting usability of VR (and AR) today

- Interaction design; efficiency, frustration
- Audio important but computer processing-intensive to do accurately
- Tactile and haptic feedback limited
- Workflow using iteratively updated 3D models; optimization, visual quality
- Simulator sickness; minimize system lag
- Field of view; optics, multi-resolution
- Vergence-Accommodation Conflict
 - eye strain, headaches, limits duration of comfortable use

Vergence-Accommodation Conflict



Ref: Hoffman et al (2008) Vergence-accommodation conflicts hinder visual performance and cause visual fatigue, Journal of Vision, Vol.8, 33

Summary

- To achieve agility when designing & optimising safety-critical systems then need good tools to prevent getting lost in documentation requirements
 - Rapid testing, quick to fail, ability to innovate important to success
- Good result requires understanding the stakeholders actual needs
 - Using multi-user VR to simulate behaviour of socio-technical system is a great tool for evaluating complex systems to ensure that the right solution is delivered
- It's possible to achieve many of the traits of a physical prototype using a virtual prototype but can rapidly modify and evaluate changes more quickly
 - Physical and virtual prototypes in combination work well no need to stick to just one of them
 - For large environments, virtual prototypes are really the only practical option
- Digital models are an asset that should continue to be updated and used to optimise the design/process (digital design → digital twin)



Extra Slides

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Control Centre Design Process - ISO 11064



Based on ISO 11064, as applied in CRIOP

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Control Room Design – Conceptual Design

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Human-Centred Control Room Design Process in Practice



Adapted from ISO 9241-210- Human-centred design processes for interactive systems