Virtual, Immersive and Augmented Reality – Feasibility Study On The Applications Of The HVRC VRdose Planner

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Agenda

- National Nuclear Laboratory
- Project Scope
- HVRC VRdose Planner
- Design Simulation
- Potential Applications
- Summary
National Nuclear Laboratory

Universities | NNL | Industry

Basic Science | Research, Development and Testing | Technology Deployment

1 | Technology Readiness Levels | 9

Small scale, low rad | Full scale, high rad

Independent, Authoritative, Subject Matter Experts
Nuclear industry is generally resistant when using new technology for the purposes of design and development.

IR&D project focused on developing NNL’s immersive and augmented modelling capabilities.

Vision – To develop a state of the art capability applicable to nuclear design and decommissioning.

Two strands:

- Virtual Glovebox
- HVRC VRdose Planner
Virtual Glovebox
HVRC VRdose Planner

- Developed by Institute for Energy Technology at the Halden Virtual Reality Centre (HVRC)

- Simulate and mitigate radiological risks in a 3D virtual environment

- Provide an interactive virtual representation of an active area with all associated radiological risks

- Feasibility study testing software capabilities in an NNL industrial application
Design Scope

• To develop a radiological assessment of installing a Pneumatic Transfer System (PTS)

• Three studies:
  
  • PTS Design
    
    • Optimum shielding material with respect to dose
    
    • Optimum pipe thickness with respect to dose
  
  • Operator Activities
  
  • Blockage
Simulation
Simulation Design
Optimum Pipe Specification

Three common piping materials:

- PVC – simulated by no shielding properties
- Stainless Steel – simulated by Iron
- Lead – simulated by Lead
Optimum Pipe Specification - PVC

Graph showing radiation levels over time for different operators.
Simulation

Operator 1
Operator 2
Operator 3
Operator 4
Optimum Pipe Specification - Iron

Graph showing radiation levels over time for Operators 1 to 4.

- Green: Operator 1
- Yellow: Operator 2
- Blue: Operator 3
- Red: Operator 4
Optimum Pipe Specification - Lead
Optimum Pipe Specification

- Three thicknesses:
  - 25 mm
  - 15 mm
  - 10 mm
## Optimum Pipe Specification

<table>
<thead>
<tr>
<th>Pipe Thickness (mm)</th>
<th>Dose Rate (mSv/h)</th>
<th>Dose Rate (mSv/y)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>7.00E-07</td>
<td>6.13E-03</td>
</tr>
<tr>
<td>15</td>
<td>2.40E-06</td>
<td>2.10E-02</td>
</tr>
<tr>
<td>10</td>
<td>5.50E-06</td>
<td>4.82E-02</td>
</tr>
</tbody>
</table>
Simulation

Operator 1

Operator 2

Operator 3

Operator 4

- Operator 1
- Operator 2
- Operator 3
- Operator 4
Operator Activities

- Operators have been programmed to simulate maintenance work in PTS vicinity
- Present accident scenario whereby sources travel during maintenance

![Graph showing mSv over time for Operators 1 to 4](image)
Mal-Operation

![Diagram of a nuclear reactor with an operator highlighted]

![Graph showing radiation levels over time for operators 1 to 4]

- Operator 1
- Operator 2
- Operator 3
- Operator 4
Potential Future Design Process
Potential Applications

Design

• Most engineering drawings are 2D isometric drawings which are not ideal for representing complex structures

• Operators and engineers rely on past experience and complex dose calculations during the design process which may be overly pessimistic

• Simulating the experiments and analyse ergonomic/ dose effects in a 3D virtual environment enables assessors from any discipline or background to interface with the virtual design and identify areas of concern with ease
Potential Applications

Safety Case

• Developing a safety case relies on the HAZOP process and multi-disciplinary teams sharing a common understanding of the designers vision for the process.

• Most HAZOPs are undertaken with 2D technical drawings, complex calculations and operator experience input which can be subject to pessimistic assumptions and overinflated figures which need to be scaled down.

• Inclusion of advanced simulation software has been ‘proven’ to speed up the process as the models make a system easier to understand, which speeds up safety case work and reduces scope for human error.
Decommissioning

- Ability to map out radiation and simulate dose uptake to an operator in dynamic conditions is particularly beneficial in decommissioning existing facilities.

- Current practice involves the use of pessimistic assumptions and previous experience which often lead to inflated dose uptake values.

- The software’s ability to simulate dose in a 3D virtual twin of an active facility, place sources in the correct positions and simulate an operator route whilst recording dose uptake data is a powerful...
Summary

• IR&D project focused on developing NNL’s immersive and augmented modelling capabilities

• Allows NNL to accurately analyse the risks & constraints involved with working with radioactive material and develop effective safety procedures in a safe environment

• NNL can use the capabilities of the software to reduce costs, improve safety, streamline the design process and enhance public awareness

• Future applications of the programme requires building up NNL’s capabilities via use on other projects (such as decommissioning)
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ANY QUESTIONS?

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