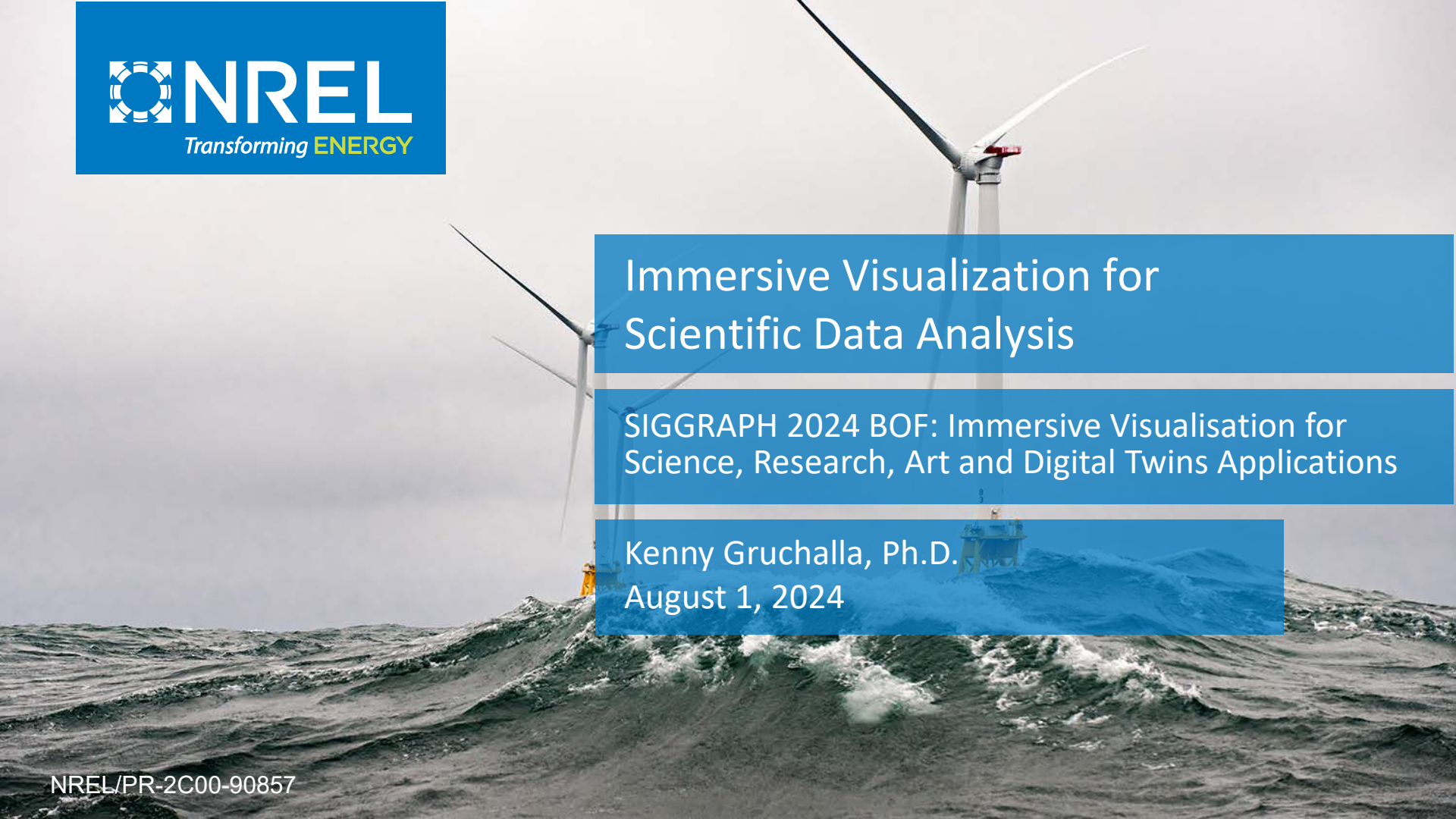


Immersive Visualization for Scientific Data Analysis

SIGGRAPH 2024 BOF: Immersive Visualisation for Science, Research, Art and Digital Twins Applications

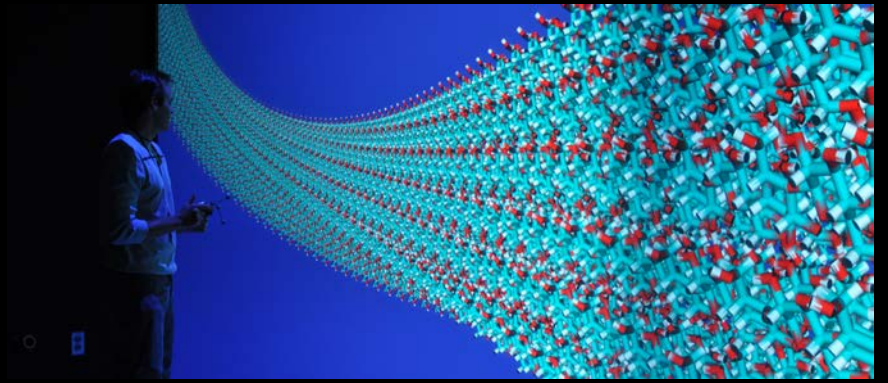
Kenny Gruchalla, Ph.D.

August 1, 2024

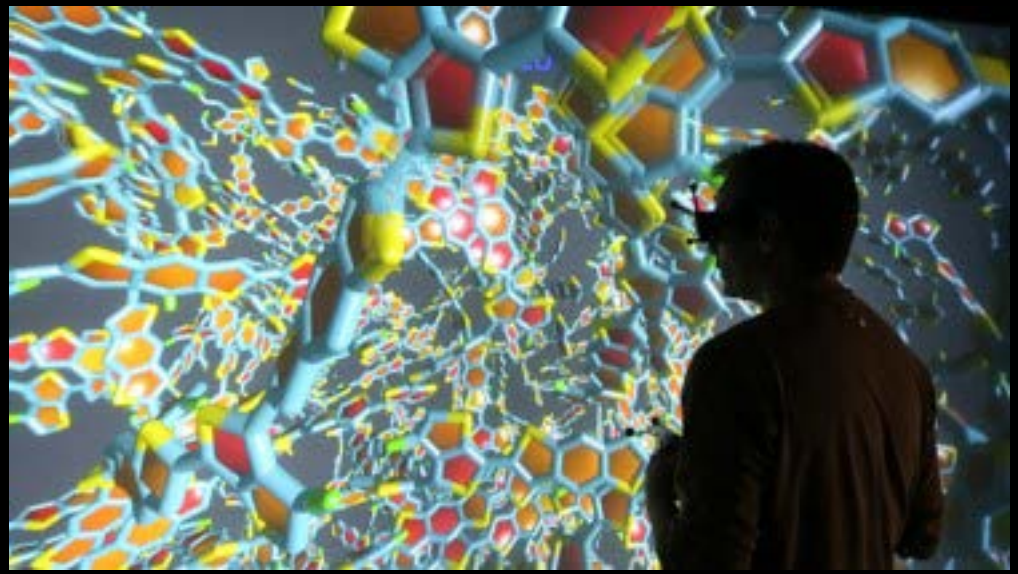
NREL/PR-2C00-90857


Improved Spatial Judgments
Direct 3D Interaction
High-Dimensional Data
Collaboration

Materials Design



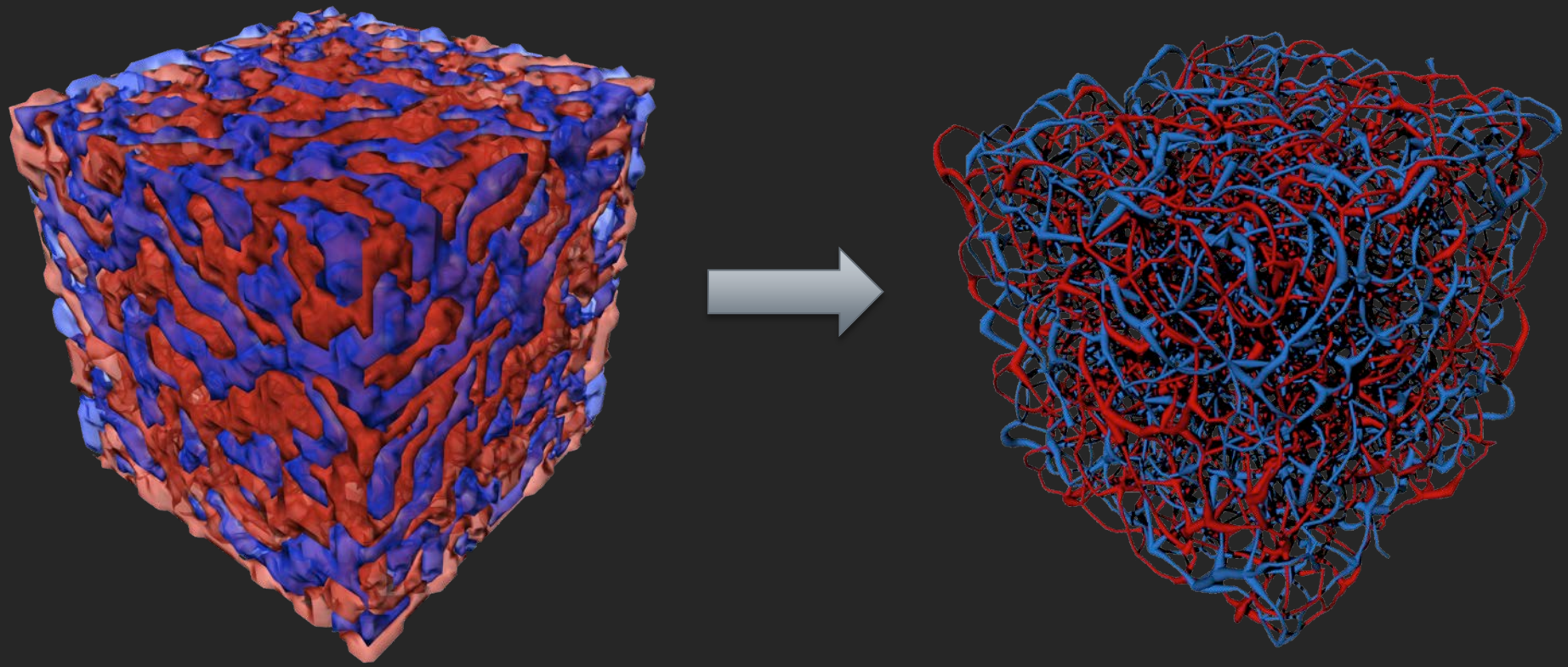
Investigating the molecular and morphological properties of materials (e.g., organic photovoltaics, biomass catalysts, batteries, …)



- Immersive Particle Advection through the Scales of Renewable Energy (Brunhart-Lupo & Gruchalla 2023)
- The Utility of Virtual Reality for Science and Engineering. (Gruchalla & Bruhart-Lupo 2019)
- Immersive Examination of the Qualitative Structure of Biomolecules (Gruchalla, et al. 2008)

Improved Spatial Judgments

OPV Morphology



CFD Analysis

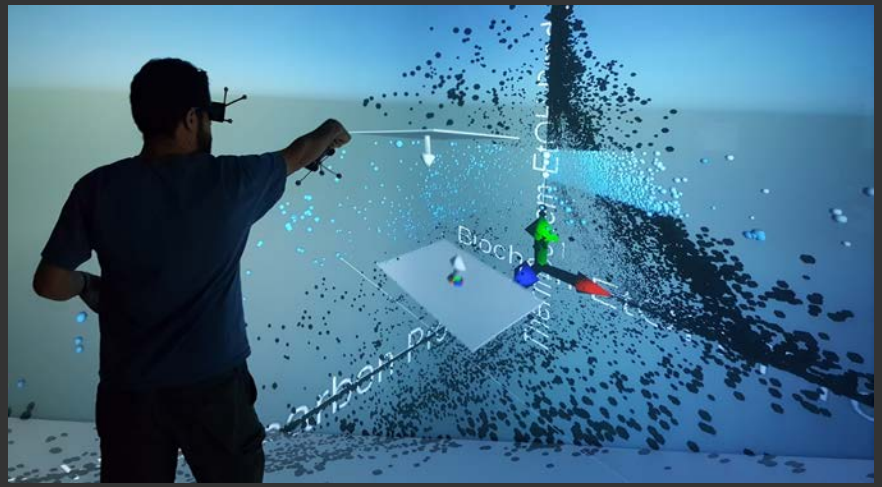
Visual analytics to support the understanding of computational fluid dynamics data.

- **ExaWind at NREL: Upping the Ante (Brunhart-Lupo & Sharma 2023)**
- **Immersive Particle Advection through the Scales of Renewable Energy (Brunhart-Lupo & Gruchalla 2023)**
- **Blade-Resolved, Single-Turbine Simulations Under Atmospheric Flow (Lawson, et al. 2019)**
- **A simulation study demonstrating the importance of large-scale trailing vortices in wake steering (Fleming, et al, 2018)**

Improved Spatial Judgments

Direct 3D Interaction

Immersive Analytics



Facilitate the exploration of high-dimensional or multivariate data, uncovering patterns, correlations, and trends that might be obscured in traditional 2D representations.

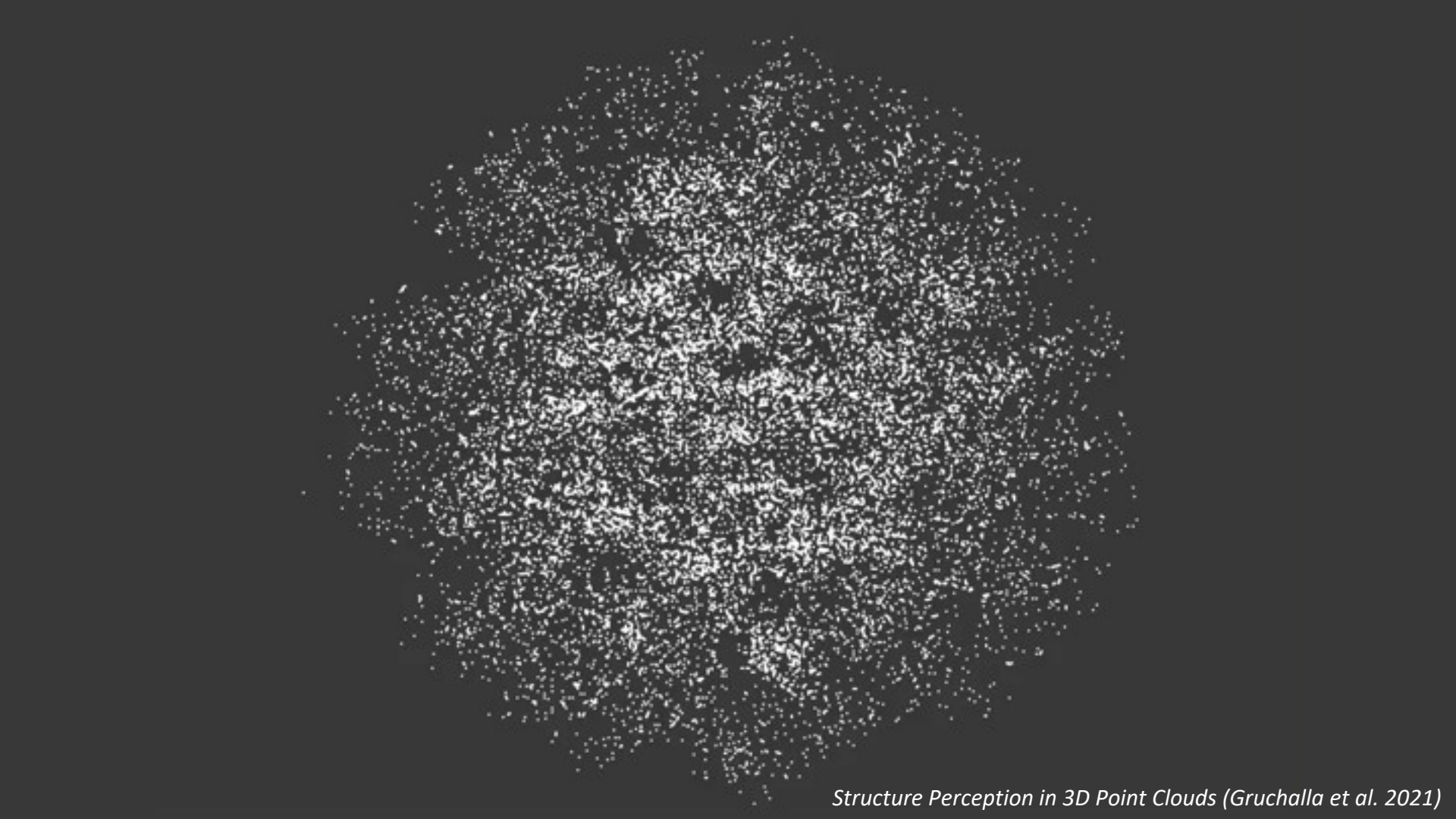
- Collaborative Exploration of Scientific Datasets using Immersive and Statistical Visualization (Brunhart-Lupo, et al. 2020)
- The Utility of Virtual Reality for Science and Engineering (Gruchalla & Brunhart-Lupo 2019)
- Enabling Immersive Engagement in Energy System Models with Deep Learning (Bugbee, et al. 2019)
- Simulation Exploration through Immersive Parallel Planes (Brunhart-Lupo, et al. 2016)

Improved Spatial Judgments

Direct 3D Interaction

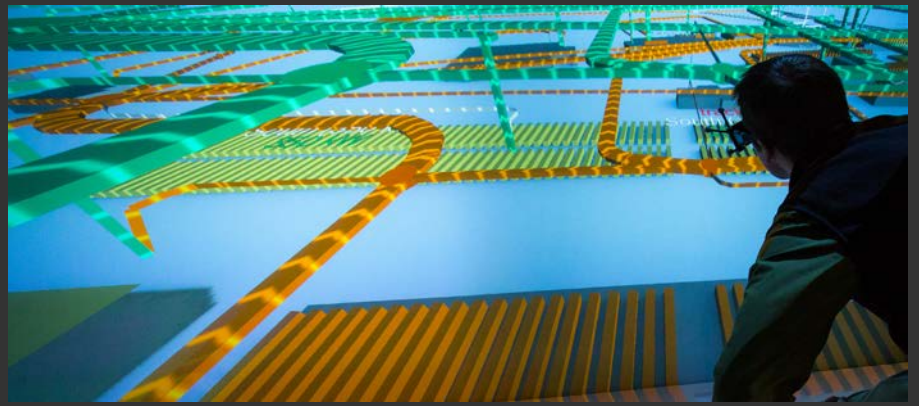
High-Dimensional Data

Collaboration

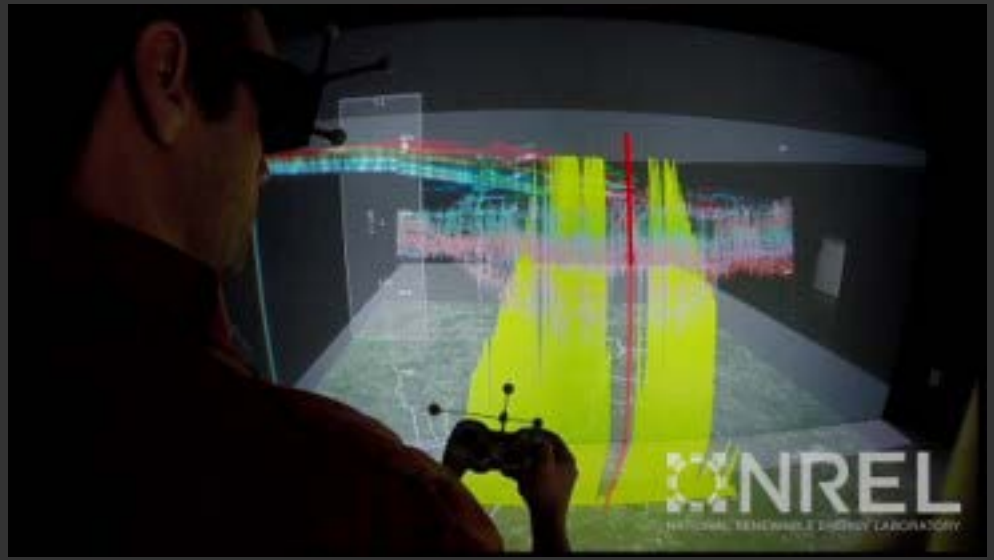


Structure Perception in 3D Point Clouds (Gruchalla et al. 2021)

Grid Modernization



Development and evaluation of novel interface for power-systems data, supporting analysis of high levels of renewable penetration.



- Feeder Voltage Regulation with High-Penetration PV Using Advanced Inverters and a Distribution Management System (Palmintier, et al. 2016)
- Peña Station NEXT: Visualizing a net-zero energy district (Symko-Davies, et al. 2018)
- City Scale Modeling with OpenStudio (Macumber, et al. 2016)

High-Dimensional Data

Collaboration

Immersive Digital Twins

Immersive representations of physical systems, providing users with interactive and realistic experiences for enhanced understanding, monitoring, and decision-making.

- Immersive Industrialized Construction Environments for Energy Efficiency Construction Workforce (Podder, et al. 2022)
- Enabling Immersive Engagement in Energy System Models with Deep Learning (Bugbee, et al. 2019)
- Coupling Visualization, Simulation, and Deep Learning for Ensemble Steering of Complex Energy Models (Bush, et al. 2016)

Improved Spatial Judgments

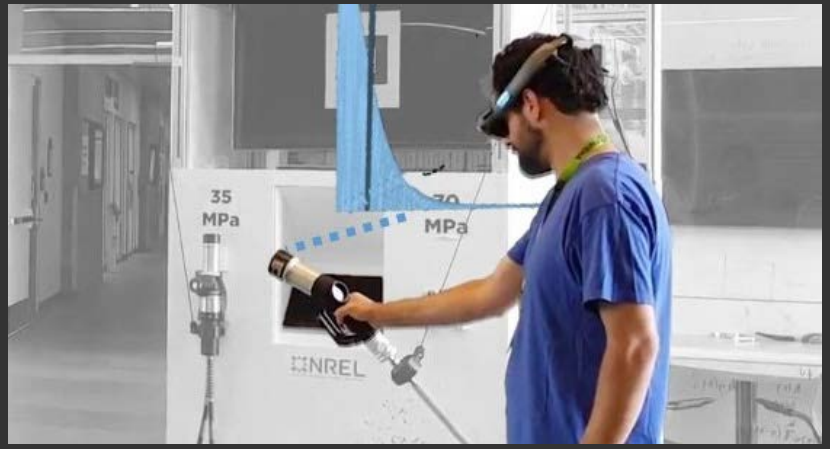
Direct 3D Interaction

High-Dimensional Data

Collaboration

Situated Visualization

Data visualizations situated in the physical environment, enabling users to interact with and interpret visualized information in context, enhancing real-time decision-making and understanding.

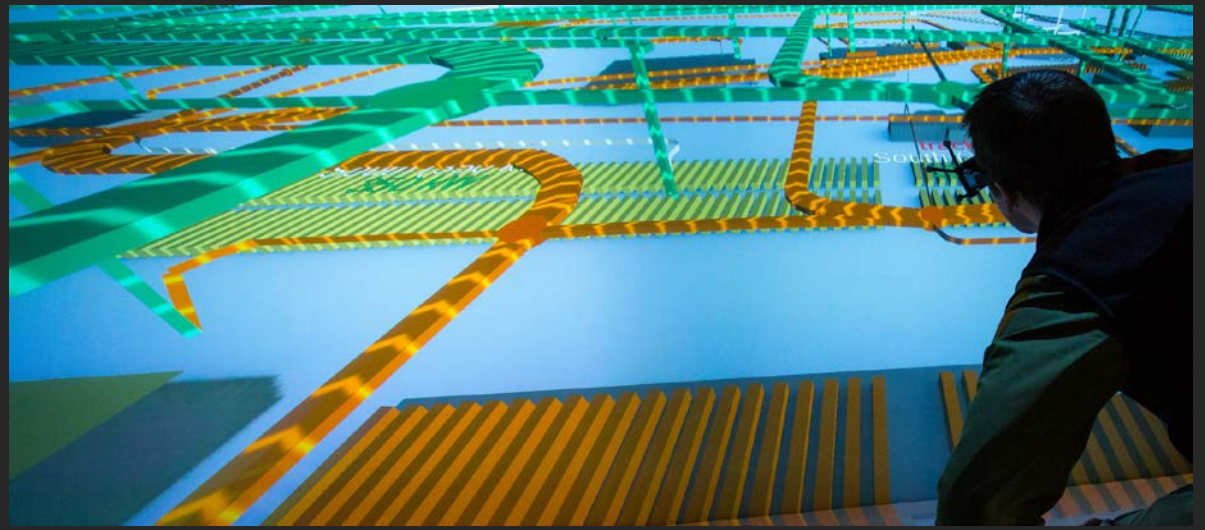


- Machine Learning for Advanced Building Construction (Eagan, et al. 2023)
- Situated Visualization of Photovoltaic Module Performance for Workforce Development (Brunhart-Lupo, et al. 2024)
- HydrogenAR: Interactive Data-Driven Presentation of Dispenser Reliability (Whitlock, et al. 2020)

Improved Spatial Judgments

Direct 3D Interaction

Further Reading



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