Application of Digital Twins to Large-Scale Complex Systems
Institute for Mathematical and Statistical Innovation (IMSI)
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OHSL
OPEN HEALTH SYSTEMS
LABORATORY

OpenStack ƒ Digital Twins

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- ## Why I Am Here?

  - **Modelling human health and physiology is of global interest and value.** Eric Stahlberg

  - IMSI workshop confirmed my belief that Virtual Human requires understanding the approach to digital twins in other fields

- ## Who am I? and Rishika Sharma

- ## Thanks to Dr. Caroline Chung and IMSI for the opportunity

- ## My purpose today is to discuss and gather ideas
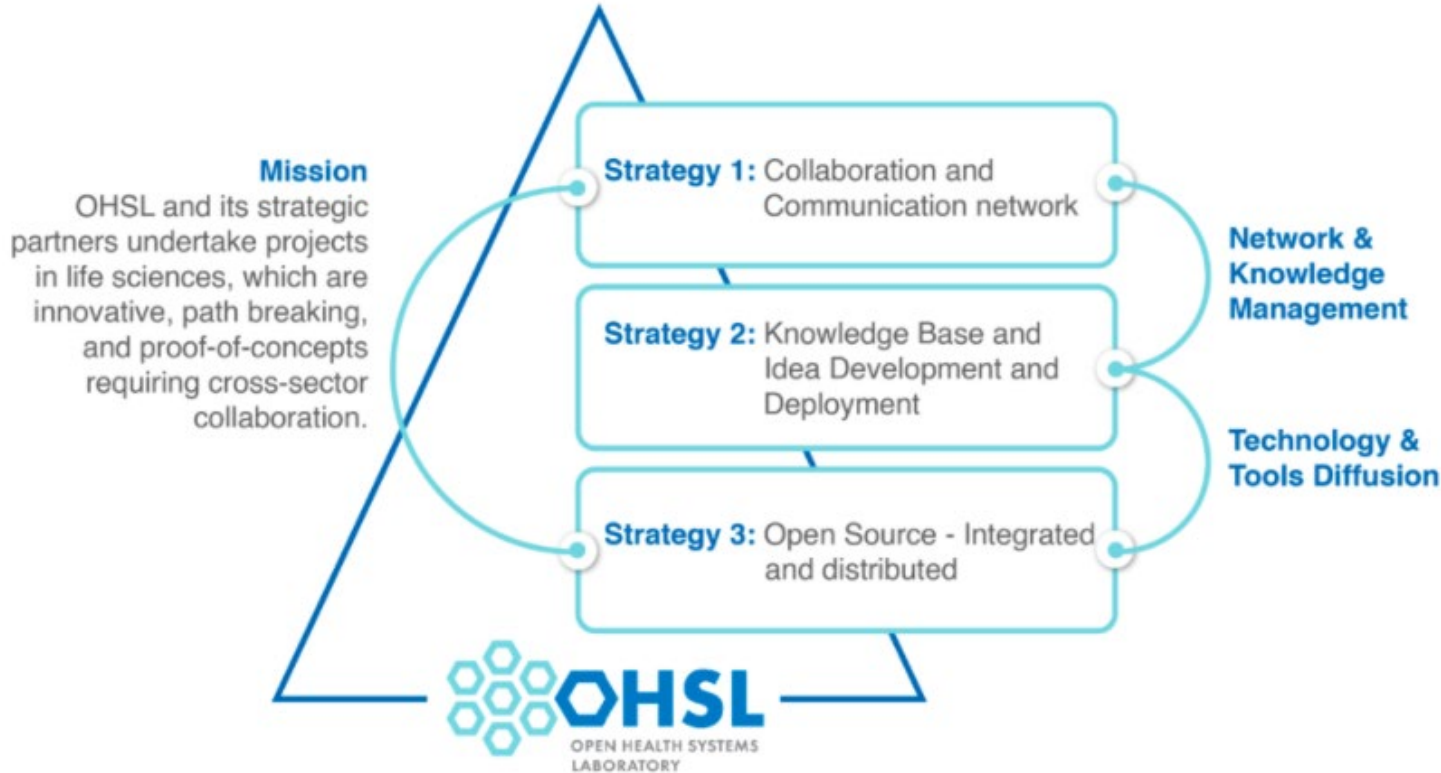
We look for, and find, life scientist from across the world through literature search and conference attendance.

Bring them together to collaborate on a scientific research of common interest and find funding and resources for them to pursue their research.

Where it started?

Proof-of-concept presented at Bio IT 2022

In 2021 OHSL, working with All India Institute of Medical Sciences (AIIMS) Delhi, undertook a proof-of-concept for Digital Twin in Neuro Oncology for Precision Medicine in partnership with:

- Arizona State University
- Indian Institute of Technology Delhi
- C3.ai
- Microsoft Research
- Frederick National Laboratory for Cancer Research (FNLCR)
- NIH STRIDES (Science and Technology Research Infrastructure for Discovery, Experimentation, and Sustainability)

This has continued to several partnerships with

- **Indian Institute of Technology Kharagpur** partnering with OHSL and Digital twin Consortium (DTC) to establish **an international centre of excellence on digital twin**
- AIIMS (All India Institute of Medicine) Delhi to develop a full scale deployment of **digital twin in a clinical situation for neuro-oncology and precision medicine**
- January 2025 lecture tour of Peter Coveney has led to **Apollo Group of Hospitals** deciding to develop and deploy digital twins across all of their hospitals in India and abroad
- **Accelerating Biology 2024-25 Symposium** digital twin sessions at the C-DAC (**Centre for Development of Advanced Computin**g) and India's **National Supercomputing Mission** creating access to digital twin tools and compute for medical researchers
- Eric Stahlberg, (**MD Anderson Institute of Data Science** (MDA/ISDO), to collaborate to develop and deploy digital twins in their hospitals
- Partnership with **Digital Twin Consortium** of the Object Management Group

The INDUS Group

- Indian Institute of Technology Kharagpur
- Indian Institute of Technology Gandhinagar
- Indraprastha Institute of Information Technology
- All India Institute of Medical Sciences Delhi
- All India Institute of Medical Sciences Kalyani
- Tata Medical Centre Kolkata
- Centre for Development of Advanced Technology
- Apollo Research Academy
- Apollo Group of Hospitals
- Apollo AyurVAID
- All India Institute of Ayurveda
- Digital Twin Consortium, Object Management Group
- Institute for Data Science in Oncology, UT MD Anderson Cancer Center
- Duke University
- Open Health Systems Laboratory
- Amity University

Peter Coveney, Eric Stahlberg & Dan Isaacs
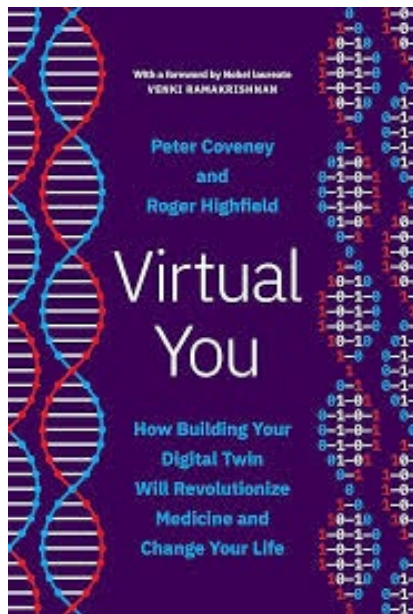
- Over 2024-25 Peter Coveney (UCL), Eric Stahlberg (MDA/IDSO) and Dan Isaacs (DTC) made visits to India
- **Peter Coveney** delivered a series of talks in January 2025 which persuaded Apollo Group of Hospitals to work towards implementing digital twin for diagnostic and treatment across their 82 hospitals in India
- **Sangam Digital Twin** program in India has more than 150 corporations and educational institutions working on digital twin across several sectors

International Centre of Excellence for Digital Twins

- Collaboration between the **Indian Institute of Technology Kharagpur**, **Open Health Systems Laboratory** and **Digital Twin Consortium**
- **Indian Institute of Technology Kharagpur** is establishing (as we speak) a campus in Houston, Texas
- Houston, Texas campus will be connected to the Kharagpur campus through broadband Research and Education Network in two countries (Internet2 to India's National Knowledge Network)
- **OpenStackƒDigital Twin** will reside on supercomputing facility at Kharagpur which is part of India's National Supercomputing Mission.

IMSI's Application of Digital Twins to Large-Scale Complex Systems Workshop 2025 has further confirmed that

- Many people are building many pieces of digital twin
- Most of them are open source and can be freely shared
- Interoperability of computational models
- Need to create a robust and versatile Applications Program Interface environment
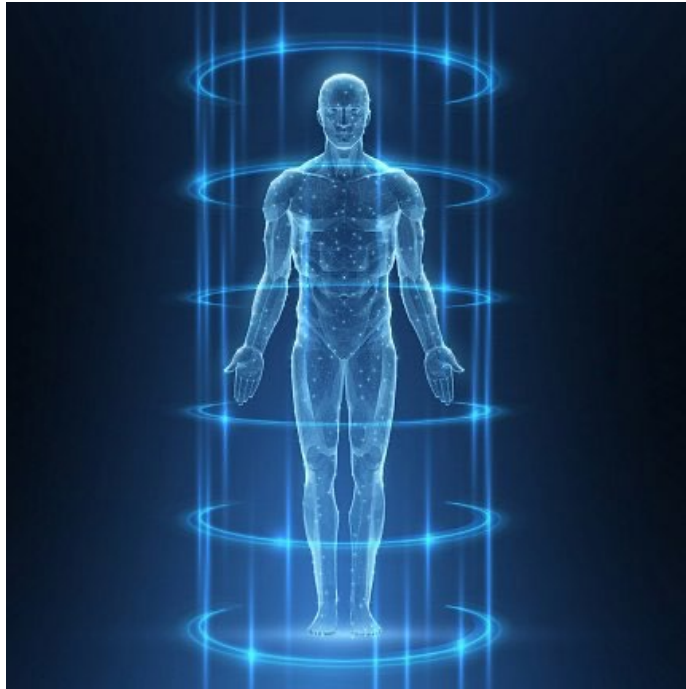
Fluid Dynamics

Anatomy and Geometry

Patient-Specific Data

Mechanical Properties

Cellular and Molecular Properties

NIH Launches Project on Whole-Person Health

NIH has launched a landmark effort to advance research on whole-person health and create an integrated knowledge network of healthy physiological function.

Whole-person health involves looking at the whole person—not just separate organs or body systems—and considering multiple factors that promote health. For example, a multicomponent lifestyle intervention including healthy diet, physical activity and stress management may improve multiple and interconnected aspects of health including cardiovascular (e.g. blood pressure), metabolic (e.g. glucose metabolism) and musculoskeletal function (e.g. muscle strength).

- **International Physiome** initiative, focusing on establishing a methodological and technological framework, enabling the collaborative investigation of the human body as a single complex system.

- **NIH Multiscale Modelling of Virtual Physiological Patient**

OpenStack

- OpenStack Infrastructure is a software framework that virtualizes a data center's resources, giving users control through a web-based dashboard or APIs

- "If AWS, Azure, and GCP are restaurants, OpenStack is the full kitchen software so I can cook my own cloud."

Virtual Human OpenStack

Biomedical scientists are not happy working with proprietary models because of their inherent need to look 'under the hood' at the algorithm in the model

Several research groups around the world are working on digital twin software and models which are mostly open source or where the software creator is willing to allow the medical researcher to have access to the necessary internals

The cost of **commercial digital twin solution is often unaffordable for medical researchers**

OHSL and DTC working with the Indian Institute of Technology Kharagpur, Apollo Research Academy (ARA) and several members of **Virtual Human Global Alliance** have started an ongoing research program to develop the **Virtual Human Open Stack.** This is being designed as an international open science effort every interested Individual/institution would be able to fully engage

OneSciencePlace

https://onescienceplace.org/

Science Gateway
to provide access to data, tools and compute

Funding

…work in progress, several promising ongoing discussions

1. **EU Horizon – US NIH Collaboration**

https://research-and-innovation.ec.europa.eu/strategy/strategy-research-and-innovation/europe-world/international-cooperation/

Supports joint EU–U.S. projects in health, data science, and biomedical research. Enables NIH-linked teams to join Horizon Europe consortia and share data standards and infrastructure.

1. **India–U.S. Joint Funding (NSF–DBT–DST–MeitY)**

https://usiai.iusstf.org/building-collaborations

Each country funds its own researchers on jointly reviewed proposals in AI, biotech, materials, and data science. Ideal for large-scale collaborative digital twin projects.

1. **UKRI – International Science Partnerships Fund (ISPF)**

https://www.ukri.org/what-we-do/browse-our-areas-of-investment-and-support/international-science-partnerships-fund/

Funds global research collaborations in health, technology, and sustainability. Designed to build international networks and tackle major societal challenges.

4. Wellcome Discovery Awards & DBT/Wellcome India Alliance

https://www.indiaalliance.org/

Wellcome supports bold health research with global co-investigators, while India Alliance funds teams and fellowships within India. Both emphasize interdisciplinary and international collaboration.

5. India–U.S. iCET + INDUS-X Programs

https://iusstf.org/u-s-india-science-technology-endowment-fund/

Strategic initiatives funding joint work in critical technologies like AI, biotech, semiconductors, and defense innovation. Supports commercialization and cross-country R&D ecosystems.

6. India Megascience Project

...and more

Thank You

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