Big Science and Innovation: Physics Discoveries Shaping Future Societies

Shantha Liyanage, September 24-26 Meeting at Idea Square CERN,

First Meeting of the Authors

Why this book?

- How large scale physics discoveries and innovation processes offer new ways of solving future challenges – societal, education and environment?

- What are 'wicked' problems and what challenges faced by future societies?

- How the openness, knowledge sharing, integrated culture, intellectual diversity, advanced creativity and design thinking will shape future societies with beneficial impacts?

- What are successes and not so successful attempts in High Energy Physics (HEP), Astrophysics and Nuclear Science experiments and how we can learn from these successes as well as not miss opportunities in managerial and organizational innovations.

Research Challenges

- How do large fundamental physics experiments contribute to breakthrough technological innovations and what can we learn from their successes or limitations?

- What can we learn from 'big science' experiments to resolve complex social and environmental issues?

- Why is it necessary to think very carefully about scientific knowledge, about the process of scientific discoveries and the role of scientists to formulate coherent and socially acceptable solutions for future problems?

"that truth is ever to be found in simplicity, and not in the multiplicity and confusion of things" Isaac Newton

Emerging Challenges for Big Science

- Can we classify CERN research/innovation as open innovation

- Open innovation is defined as: "… the purposive use of inflows and outflows of knowledge to accelerate innovation in one's own market, and expand the use of internal knowledge in external markets, respectively. (Chesbrough,2006)

- What are the key features of inbound flow of knowledge (inbound open innovation)?

- What factors affect the external flow of knowledge (outbound open innovation)?

- How does big science collaboration is possible, if the flow of knowledge is erratic and not well manage?

Critical Analysis and Research Process

- key research observations relevant to your area and your personal insights into the innovation journey

- investigative innovation episodes – eg Trigger system, Calorimeter etc.

- case studies that explain diffusion of knowledge – eg Medipix chips etc.

- observations and ethnographic studies to refine and verify your ideas - some of European colleagues will be able to interact with you

- Future studies, knowledge creation and utilisation experience

What intrigue our minds?

- Success of the Standard Model (SM) in describing elementary particles and their interactions and how and why it fall short of all-encompassing theory of nature?

- Pilar Hernández of the University of Valencia poses some profound questions:
  - Why are the fermions arranged into three neat families?
  - Why do neutrinos have a vanishingly small but non-zero mass?
  - Why does the Higgs boson discovered fit the simplest "toy model" of itself?
  - What lies beneath the SM's 26 free parameters?
  - The mechanism of inflation;
  - the matter–antimatter asymmetry;
  - and the nature of dark energy and dark matter.

Book Chapters

Part 1 – Basic Big Science Experiments

- **Chapter 1 -** Introduction –Big Science, Breakthrough Innovation and Society: Shantha Liyanage, Markus Nordberg, Pablo Garcia Tello and Stig Johannessen

- **Chapter 2 -** Chasing the Success – ATLAS and CMS Collaboration: Peter Jenni, Tijendra (Jim) Virdee and Shantha Liyanage

- **Chapter 3** – Design and Engineering Innovation – Intricacies of Precision, Accuracy and Imagination of Creating Old and New LHC: Lyn Evans, Elisabetta Barberio and Shantha Liyanage

- **Chapter 4** - Innovating Accelerator Technologies for Society, *Authors:* Amalia Ballarino, Marilena Streit and Shantha Liyanage

Book Chapters- cont.

Part 2 - Innovations that Works

- *Chapter 5 -* Leap Frogging into Future **–** *Michael Benedikt,* Ludovico Pontecorvo and Shantha Liyanage

- **Chapter 6**: Success and Potential Failures in Innovation Landscape-Imaging and Proton Detectors: Mark Casali, Elisabetta Barberio and Shantha Liyanage

- **Chapter 7**– Human-Centered Open Science and Innovation-Lessons from Neutron Captured Enhanced Particle Therapy Tim Boyle, Mitra Safavi-Naeini and Shantha Liyanage

Book Chapters cont.

Part 3 - Organizational and Societal Implications

- *Chapter 8:*   Complex Systems and Design Thinking – CERN and European Innovation Strategy; Stig O. Johannessen, Agustí Canals, Elisabetta Barberio, Christine Thong, Anita Kocsis and Shantha Liyanage

- **Chapter 9:**   Open Science, Innovation and Social Business: Stig O. Johannessen, Beatrice Bressan, Pablo Garcia Tello and Shantha Liyanage

- **Chapter 10:**   Big Science, Learning and Social Responsibility - CERN's contribution to the Digital World: Professor Ruediger Wink, Stephen Goldfarb, Christine Kourkoumelis and Shantha Liyanage

Book Chapters

Synthesis

- **Chapter 11** - Well-ordered innovation and Commercialization: Beatrice Bressan, Faiz Shah, Pablo Garcia Tello and Shantha Liyanage

- *Chapter 12* Scientific Leadership and Collaboration –Lessons from High Energy Experiments: Christine Kourkoumelis, Viktorija Skvarciany, Grace McCarthy and Shantha Liyanage

- **Chapter 13**: Implications of Big Science, Innovation and Society *Authors: all*