Test-Ban Verification at the Intersection of Basic and Applied Science and Innovation

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CTBTO

- An organization created to detect clandestine nuclear tests
- Generates massive amounts of data and latest technologies
- Seismic, hydro acoustic, infrasound, and radionuclide
- Need to develop and use onsite inspection technologies
- This makes CTBTO both a user and a supplier of innovation and science
Traditional thinking on innovation is linear

- Process starts with basic curiosity driven research
- Followed by applied science and engineering studies
- In some cases to creation of patents and spinoff companies
- In some cases the application to processes and manufacturing
- With good luck to wide spread adoption
But innovation is typically non linear

Sometimes divided into supply side and demand side

Basic research is the supply side

Public policy or private need represent the demand side

Smart procurement to meet public need can be instrumental
We know the impact of the physics revolution of the 1920s/30s.

Some estimate that this is responsible for as much as 50% of the GDP of today’s US.

“Where Good Ideas Come From – the Natural History of Innovation” a recent book

- This book uses evolution as a model for the process of innovation
- First chapter – Reef, City, Web capture the idea of vibrant life and interactions
○ Last chapter outlines innovations of the past two centuries

○ Focus is the move from individual innovation to networked innovation

○ Hubs of interacting complexity resemble the web itself

○ Analogy to evolution is that networking and communication are drivers of both
There are many examples in the earth sciences showing the results of interaction between supply and demand...

- Which came first?
  - The technology of new instruments or technologies?
    - A public or a military need?
      - A scientific breakthrough?
The planetary revolution that followed the Apollo missions to the moon

- The Apollo missions were designed for a well determined public purpose
- Demonstrate the US superiority in technology
- Science was a byproduct but fortunately was supported
- But the surface experiments and the returned lunar samples documented the nature and evolution of a sister planetary body
- Provided information about a period in solar system history not previously available

- Documented the early volcanism and an intense bombardment period

- Determined the chemical composition, magnetic field and internal structure
  - First extraterrestrial seismic network established

- Using bombardment history timetable provided a method of dating other planetary surfaces
● Led to the extensive rewriting of the history of the solar system

● Led to deeply increased interest in the study of meteorites

● Provided a great deal of information about the origin of the solar system

● The public objective of the Apollo mission clearly led to very rapid development of solar system science and a revolution in planetary science
Earth System Science and the Plate Tectonics Revolution

- Much networking and communication was key to the plate tectonics revolution

- Consider the magnetometer

- First developed by the oil industry before WW11 for geologic mapping

- Adopted by the US Navy for submarine detection

- Manufactured by Texas Instruments as its first government contract
- Modified after the war for use again for geologic mapping
- Adopted for mapping of the sea floor
- Put into widespread mapping of the Atlantic to find suitable places to hide submarines
- Symmetrical magnetic stripes found on both sides of the mid Atlantic ridge
- These stripes coincided in distance from the ridge to the time sequence of the Earth’s magnetic field reversals
- A key plank in the evolving story of spreading centers
The Distribution and Mechanism of Earthquakes

- Intense earthquake studies were focused on earthquake prediction.
- This led to the creation of global networks of ever better detector technology.
- Then came the need to monitor for clandestine nuclear explosions.
- Scientific understanding of earthquake mechanisms were elaborated.
- CTBTO produces remarkable information on the distribution and mechanism of earthquakes.
This understanding of earthquakes was a central plank in the plate tectonics revolution.

CTBTO continues to provide a basis for outstanding science.

This outstanding science is crucial to their mission of nuclear monitoring.

Innovation and scientific breakthroughs result from networks and communications.

New technologies often derive from basic science.

Basic science often comes from new technologies and from meeting public or private need.
○ CTBTO has the need for onsite inspection when an explosion has been detected

○ There is a long record of geophysical and geochemical exploration techniques in the search for mineral deposits

○ CTBTO is the beneficiary of these

○ CTBTO will be able to adapt and improve many of these techniques including the use of modern drone technology

○ This will in turn improve approaches to near surface geologic mapping technology
Innovation is much like evolution and depends on the fact that supply and demand interact with each other.