

Shaul Katzir:

Basic, applied research and
technology through the lens
of crystal frequency control

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- the relationships between basic, pure, applied and “technologically oriented” science, based on an examination of the process by which one field of “pure” physics, Piezoelectricity, became “applied.”
- piezoelectricity has many important applications
 - Quartz clocks and watches
 - Ultrasonic sonar and scanners

Brief history

- Discovered in 1880
- 35 years of pure scientific study (no applications)
- Applied for underwater detection following military request in WWI – the sonar

This episode and the “linear model”

- An example of a flow of knowledge from basic to applied, in agreement with the model
- Shortcoming: need for further basic research in areas that had not been studied
- Bi-directional rather than unidirectional influence
- No division between basic and applied research, inside “Pasteur’s quadrant”

Discovery of stable & precise resonance

- Properties of crystals discovered following the research on technological device
- Yet, not by a research aimed at a specific design
- Followed from a more general interest in the properties of crystals beyond their known utility.

Discovery of stable & precise resonance

- Academic physicists freer to pursue a “basic” study
- Unpredictable technological result

Technologically oriented science

- research on nature made with an open eye for prospective applications of the findings, tuned to pursue such applications.
- Between pure and engineering science
- Reflects continuity of applicability and of the quest of fundamental understanding

Research is inspired by:

Considerations of use?

No

Yes

Quest for
fundamental
understanding?

Yes

Pure basic
research
(Bohr)

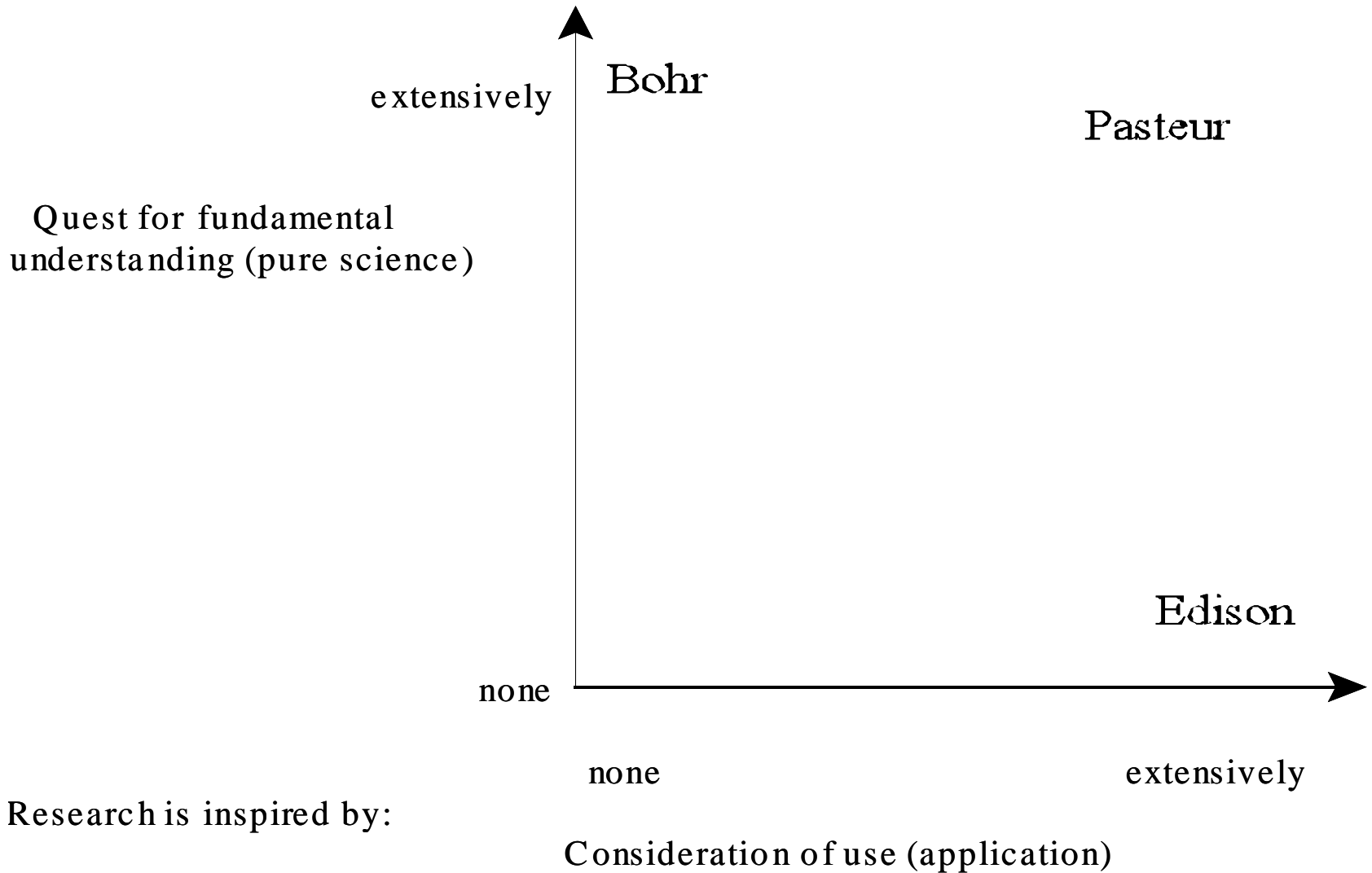
Use-inspired
basic research
(Pasteur)

No

Pure applied
research
(Edison)

(adapted from *Pasteur's Quadrant: Basic Science and Technological Innovation*, Stokes 1997).

Continuous bi-dimensional model of scientific research



Technologically oriented science and applications

- makes them more likely than “pure” science
- Provides significant advantage to its students in applying the scientific knowledge

Knowledge and problems flow in two directions from “pure” to “applied” science and back; the demarcation line between the two is not sharp; and important research is performed in so to call “theoretically oriented” science. Apparently, technological orientation to different degrees characterizes great parts of modern science, as it occupies a wide share of the continuum between “pure” science and research aimed at technological design. This perhaps makes it too wide. Still, it may help us understand the way knowledge about nature transfers into a practical means for design.