

# CONTRASTING CULTURES: SCIENCE AND THE LAW

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*The opinions expressed in this presentation are solely those of the speaker, and do not reflect any position, pronouncement, opinion or whim attributable to either the New Mexico Judiciary or Sandia National Laboratories*

# Why Science in the Courtroom?

- ▣ There are aspects of the world around us that influence human events that occur. How they connect to the facts in a dispute requires explanation to place those facts in perspective.
- ▣ When common experience can explain perception, lay opinions are valuable.
- ▣ When knowledge beyond common understanding is required to explain things, that knowledge must be sought out and presented. Much of that knowledge is “scientific”.

# Definition by Process

## Science

- ▣ for proposing and refining theoretical explanations about the world that are subject to further testing and refinement

## Law

- ▣ for balancing propositions in dispute, and resolving them finally and expeditiously

# Definition by Objective

Science

Law

▣ Truth:

- No time limits, no final decision must be made.

▣ Justice:

- The best truth possible in a short amount of time and a closed-ended process
- Finality is a primary goal.

# The Cultures

“Science is not an encyclopedic body of knowledge about the universe. Instead, it represents a *process* for proposing and refining theoretical explanations about the world that are subject to further testing and refinement” The Supreme Court, in *Daubert v. Merrell Dow Pharmaceuticals, Inc*

## ▣ Science

- Deals with Nature
- Open ended,  
Impartial judged by  
Nature
- Organizes knowledge  
of World

## ▣ Law

- Deals with Society
- Normative process  
seeking closure
- Direct our actions in  
the World

# Science is:

- ▣ Search for “truth”? (objective reality)
- ▣ Based on an assumption of consistency of the universe
- ▣ Is about observing and objectivity
  - Knowledge comes from external observation, not by revelation
  - Derives from logic
  - Must be verifiable

*Science is the search for a consensus opinion among all competent researchers.  
John Ziman (1968) from Cromer*

# Language

- ▣ Force
- ▣ Evidence
- ▣ Theory
- ▣ Law
- ▣ Error
  - Mistake



Goodstein, Federal Reference Manual on Scientific Evidence 3d, 51 (2011)

# Law

- ▣ Regulates introduction of new science by US Constitution (Patents/Copyrights Clause).
- ▣ Regulates societal interactions and activities to benefit general population (Statutes, regulations, injunctions.)
- ▣ Judiciary acts as “gatekeeper” to assure quality of evidence offered to support theories of each case.



# Uncertainty, Error and Risk

- ▣ Continuum of proffered evidence at law (declining quality):
  - Science, “sciency”, pseudo-science, BS
- ▣ Increasing uncertainty, risk of error
- ▣ Increasing risk of wrong result

Functional MRI deception testing:  
U.S. v. Semrau, 2012 WL 3871357, 8 (6th  
Cir,2012)

# Risk of Uncertainty vs. Risk of Inaction

- ▣ “The EPA is compelled to exercise its judgment in the face of scientific uncertainty unless that uncertainty is so profound that it precludes any reasoned judgment”, *Miami-Dade County v. EPA*, 529 F.3d 1049, 1065 (11th Cir.2008)
- ▣ “The EPA's decision entailed not only an evaluation of the sufficiency of the available scientific record, but also a risk analysis of the consequences of waiting.” *Upper Blackstone Water Pollution Abatement Dist. v. U.S. E.P.A.* 2012 WL 3139578, 11 (1<sup>st</sup> Cir., 2012)(Issuing new effluent permit and new requirements for N-waste before all research is completed was proper)

# The Scientific Method (as taught in middle school)

1. Propose a hypothesis
2. Design experimental studies
3. Gather and analyze data
4. Share results

What are:

- Theories?
- Hypotheses?
- Data?
- Facts?

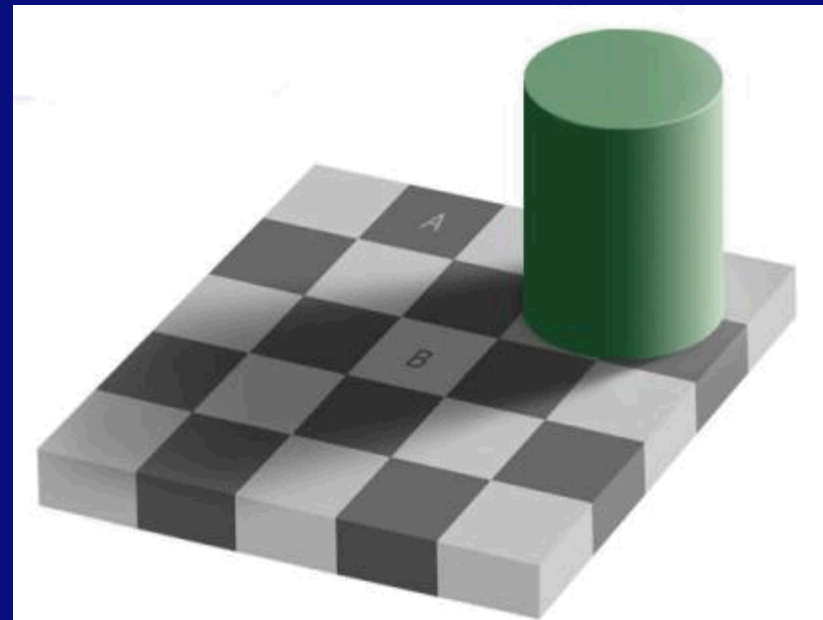
# Fact

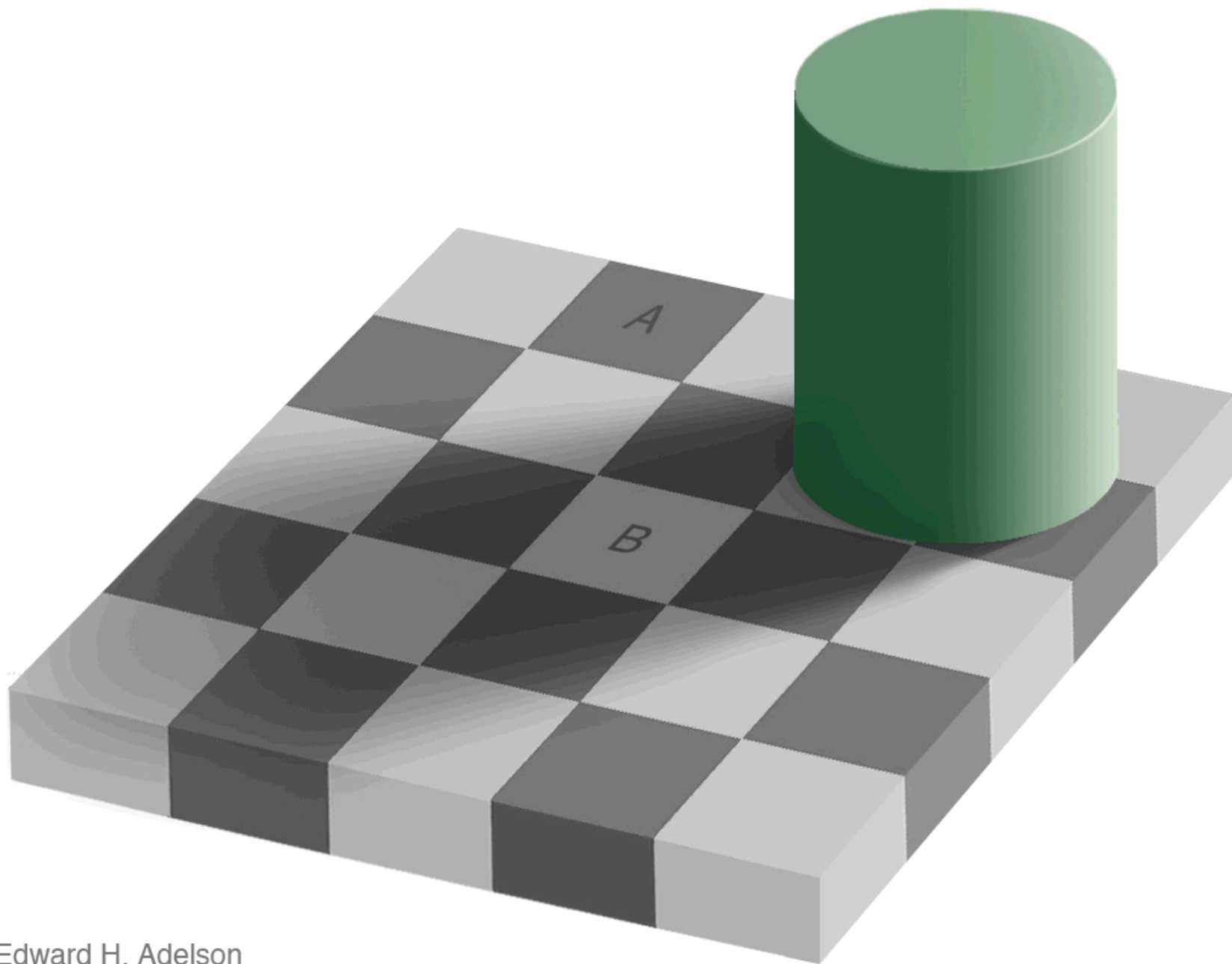
In science, "fact" can only mean "confirmed to such a degree that it would be perverse to withhold provisional assent." I suppose that apples might start to rise tomorrow, but the possibility does not merit equal time in physics classrooms.

Stephen Jay Gould

# Fallacies and cognitive biases

- ▣ Anchoring
- ▣ Confirmation bias
- ▣ Selective perception
- ▣ Many, many more





Edward H. Adelson

# Experiments, measurement, validation and reliability

- ▣ How do you design experiments?
- ▣ How do we gather data?
- ▣ How do we determine validity?
  - Of the experiment?
  - Of the data?
  - Of the analysis?
- ▣ How do we determine reliability?

It's all about cause and effect!

- can you reduce the problem into parts? Can you vary a single parameter?
- what would you like to do? What can you do?
- What would you like to measure? What can you measure?

*Research is what I'm doing when I don't know what I'm doing.*

Wernher von Braun

# Errors and statistics

- ▣ Measurement errors are inherent to ALL experiments
- ▣ Statistics: the collection, organization and analysis of data
  - Population sample
  - Correlation (does not imply causation)
  - Confounding variables

*Almost all aspects of experimental design, data collection and data analysis will be influenced by the theoretical paradigm*



# Competing Claims

- ▣ Science is a body of working assumptions
  - Contingent, competing claims
    - ▣ Each assumption carries with it a risk of error, because full understanding of the model under investigation is not complete
      - All possible sources of complexity may not be discerned
  - Not to proceed is not to progress.
- ▣ What does the risk of error mean for courts who use testimony of these assumptions as evidence to support a final disposition?

# “Hard” vs. “Soft” science

- ▣ “Hard” science are the physical sciences (physics, chemistry)
  - Relatively straightforward experiments
- ▣ “Soft” sciences – everything really hard!
  - Living and thinking organisms are different!
    - Experiments hard to duplicate
  - Complex
  - Interwoven
  - System dependent
  - Usually difficult to apply same tools as natural sciences
  - May not try to construct empirically falsifiable theories

# Some Issues with Experiments in the social sciences

- ▣ Population studies
- ▣ Control groups
- ▣ Double blind experiments
- ▣ Hawthorne effect
- ▣ Placebo effect
- ▣ Known Placebo effect
- ▣ Observational/Confirmational bias

# “Stone Soup”

- ▣ **Toxic Torts:** *Pharma:* Bendectin, Thalidomide; *Chemical:* Love Canal, mining waste
- ▣ **Biological:** Distillery Fungus
- ▣ **Product Liability:** Kumho Tire, Compton v. Subaru (product failure)
- ▣ **Medical:** dalkon shield, hip implants (metallosis),
- ▣ **Environmental:** Carbon limits/trading, Nitrous/Sulfur emissions, Groundwater pollution, Heavy Metal mining waste (including Uranium)

# Engineering

Must deal with the nuances of the real world, e.g.

- Materials
  - Manufacturing
  - Application
  - Degradation
  - Misuse or abuse
  - Design tradeoffs
- ▣ Makes extensive use of models and simulations
- Results will be no better than the models used, inputs, and assumptions

# Lie Detectors

“Polygraph tests are 20th-century witchcraft.”

*Sam Ervin*

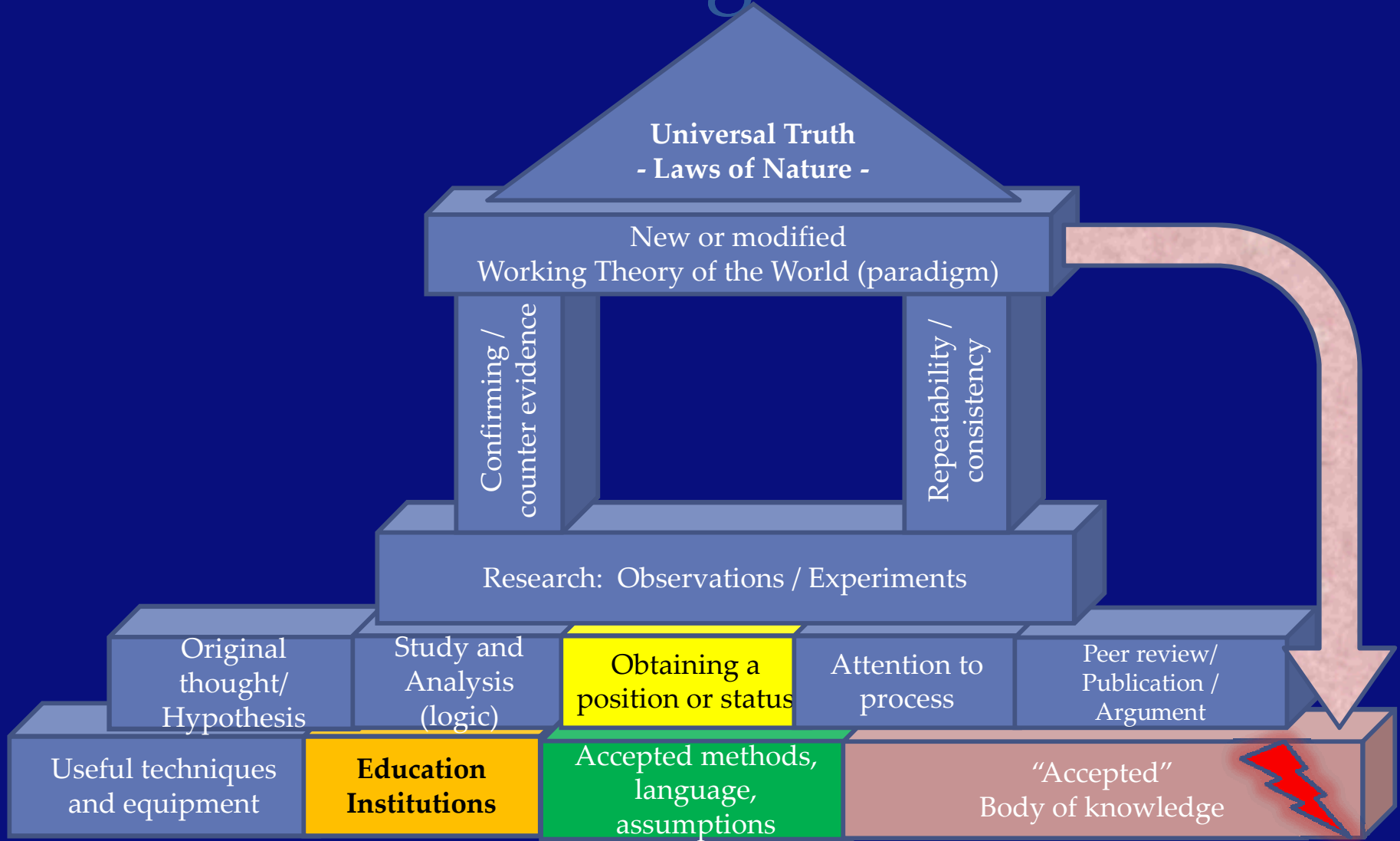
- ▣ How would you design a polygraph experiment?
- ▣ How would you apply the results?
- ▣ How do you handle the “error” rate?
  - False positives?
  - False negatives?
- ▣ Is this “science”? If not, what is it?

# Applied vs Basic Science

Most court cases involved applied science, not basic science

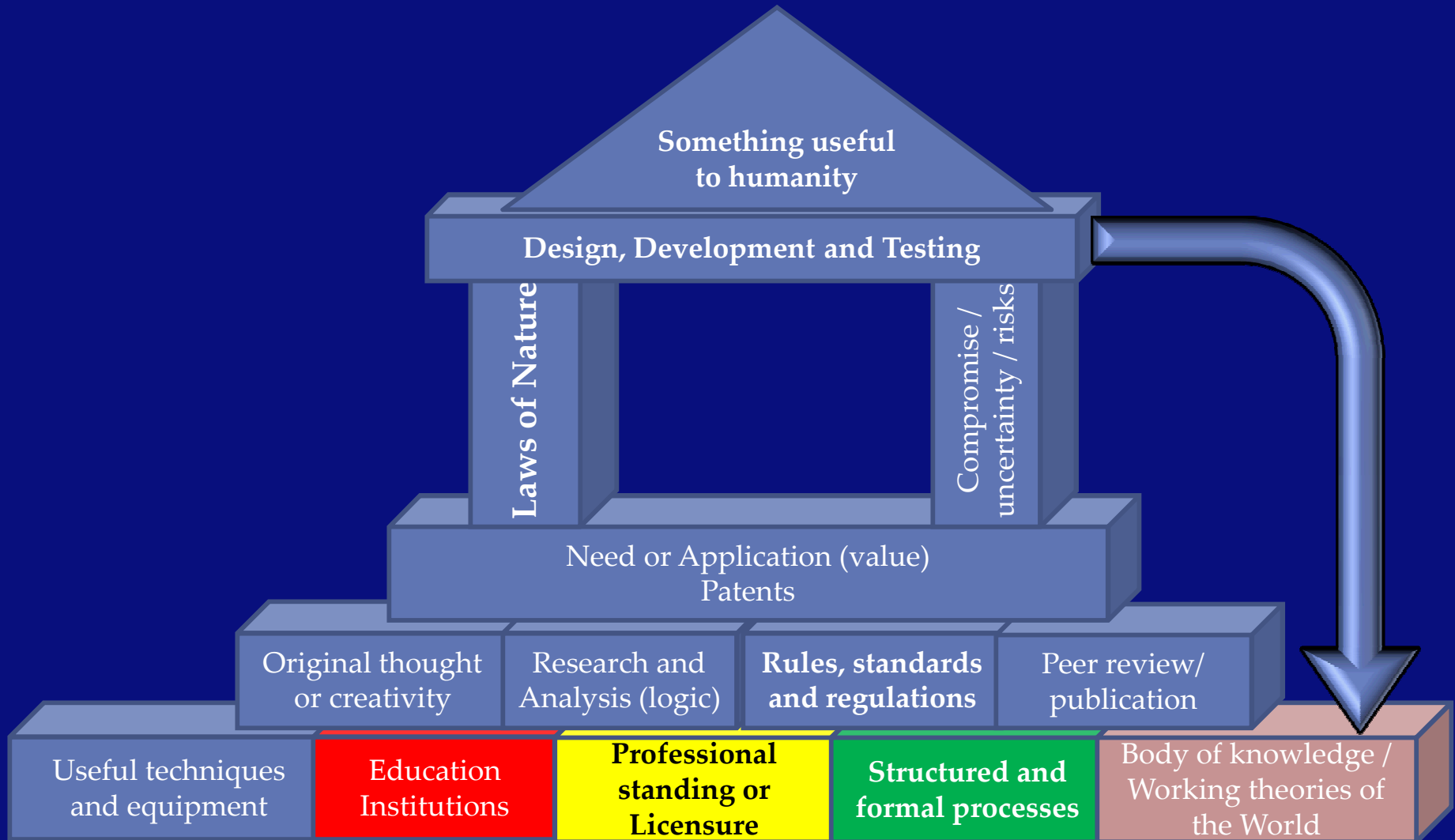
# Basic Science

## Building blocks





# Engineering/ Technology / Applied Science Building blocks



*In all science, error precedes the truth, and it is  
better it should go first than last.*

Hugh Walpole

# Quotes

No amount of experimentation can ever prove me right; a single experiment can prove me wrong.

Albert Einstein

Science is a way of thinking much more than it is a body of knowledge.

Carl Sagan