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Research Based Education as a Necessary Infrastructure for Sustainable Development of Nuclear Energy

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Introduction (1/2)

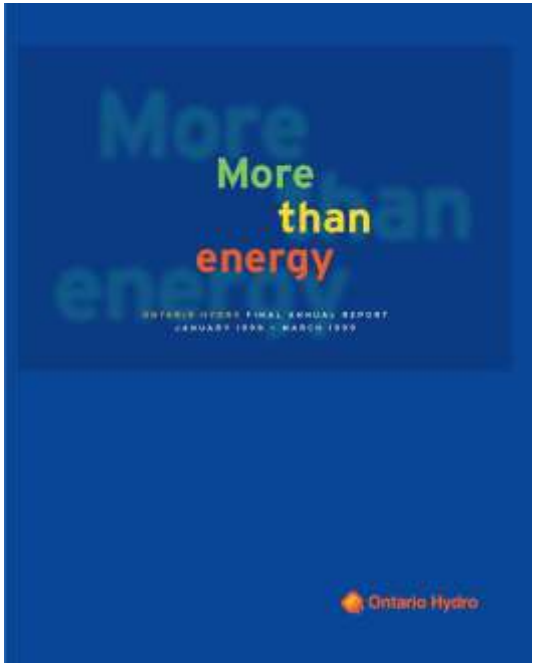
- Dwindling public acceptance: one of major challenges that face nuclear industry and sustainability of nuclear energy.
- On one hand: low impact on health and environment supported by scientific and technical knowledge.
- On the other hand: public does not acknowledge this (although most people in EU trust scientists more than regulators, government, media and industry).
- Yet: both regulatory authorities and industry in some countries losing interest for cooperation with higher education and research establishments.
- Perceptions:
  - further research cannot bring much to plant safe operation
  - higher education might be fully substituted by professional training.

Introduction (2/2)

- This perception might lead to deterioration of nuclear safety-related research and higher education (national infrastructure for nuclear safety).
- Fortunately, no nuclear incidents directly caused by deterioration of research and education *yet*.
- This paper:
  - incidents and accident caused by deteriorated infrastructures and inadequate safety cultures,
  - differences in safety cultures,
  - nuclear energy may improve public trust and safety record by stronger commitment towards research-based education and science-based decision making in industry and regulatory organizations.

Example of deteriorated infrastructure (1): Ontario Hydro "Meltdown" 1997

- **Corporate, not nuclear meltdown**
- **1997: Internal investigation at Ontario Hydro Nuclear (Canada, 19 nuclear units)**
- **Flaws found:**
  - lack of managerial leadership,
  - insufficient understanding of standards and practices ... in nuclear operations,
  - decisions dominated by production mentality,
  - serious shortages of key management, supervisory and some technical skills,
  - ...
- **Result: 7 units shut down (some permanently)**
- **Deteriorating infrastructure and safety culture**



Example of deteriorated infrastructure (2): Broken rail causing train derailment 2000

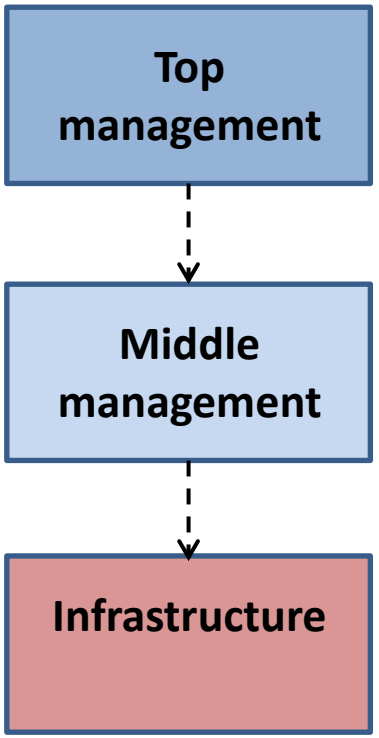
- **17 October 2000: train derailment south of Hatfield Station (UK)**
  - 4 passengers killed, 70 injured
  - Cause: rail fracture and fragmentation
- **Lack of proper maintenance of tracks by "infrastructure controler"**
  - Before accident: responsibility for safety of tracks and wheels in different business units.
  - After accident: management of wheels and tracks again under single control.
- **Development of events clearly consequence of deteriorated infrastructure and safety culture**

Example of deteriorated infrastructure (3): Closure of San Onofre nuclear units 2013

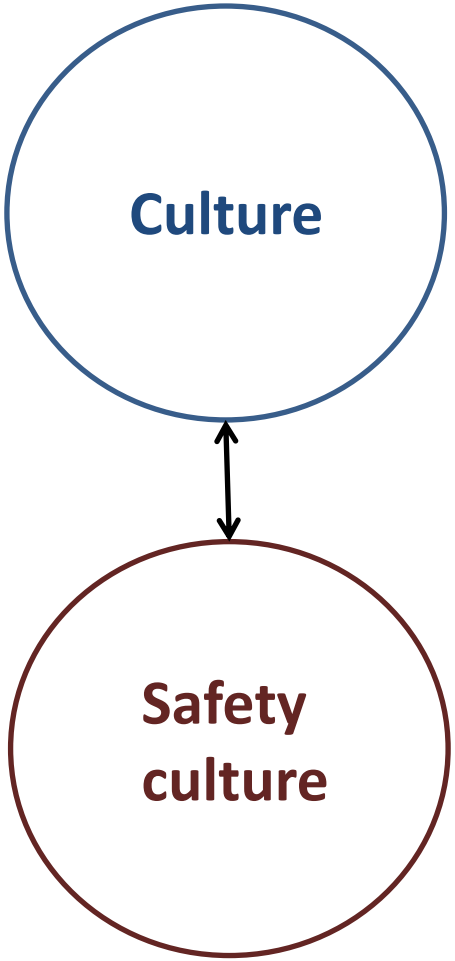
- **2 units operated by Southern California Edison**
  - Steam generators (SG) replaced 2009 and 2010
  - Tube vibrations and premature leakings
  - Permanent shutdown (economic reasons) in 2013
- **Causes**
  - Faulty design of replacement SGs
  - Poor documentation of design changes in original SGs
- **Deteriorating infrastructure: regulatory oversight and design bases**

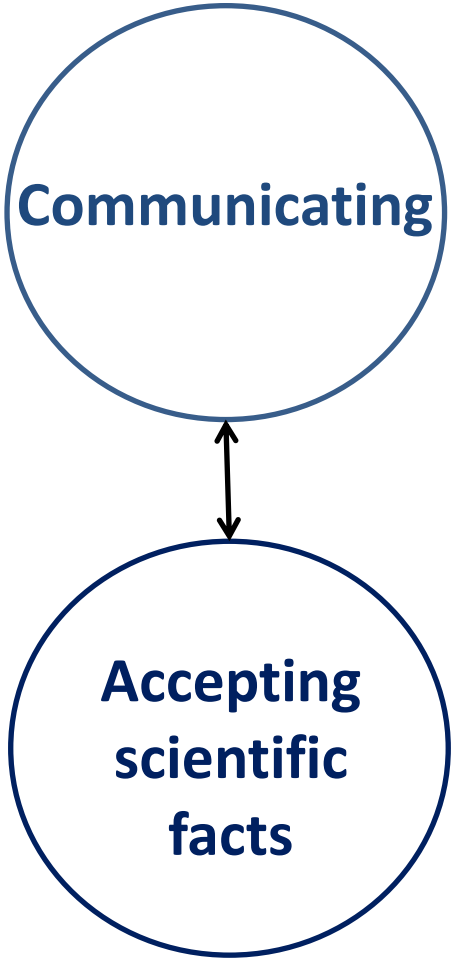
Summary of examples

- Severely deteriorated infrastructures caused severe consequences.
- Middle management responsible for the infrastructure not able to recognize and/or prevent deterioration.
- Supervisors (top management, regulators) did not provide sufficient ressources, access to knowledge and/or adequate supervision.
- Deterioration of infrastructures, if detected on time, could have been fully prevented with existing knowledge, e.g. without further research.
- Deterioration of infrastructure assisted by deteriorated safety cultures.



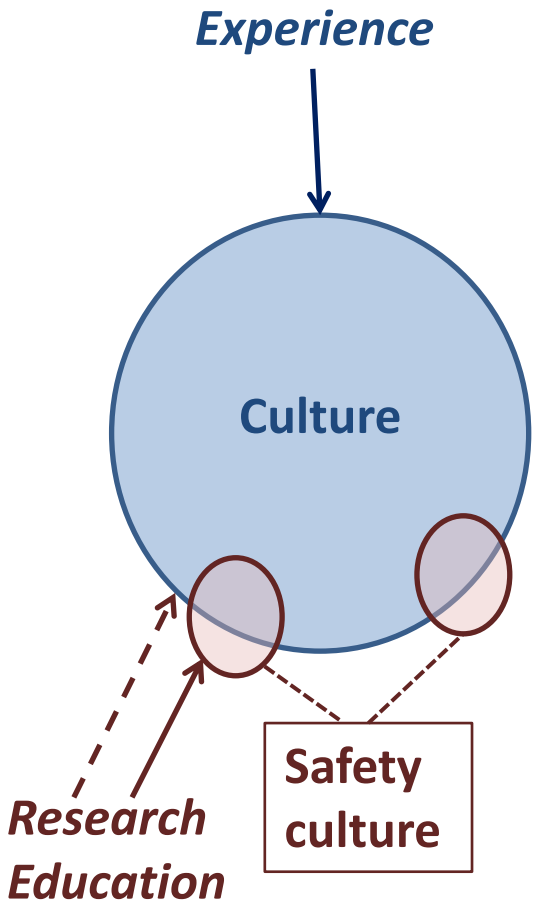
Interplay of different cultures





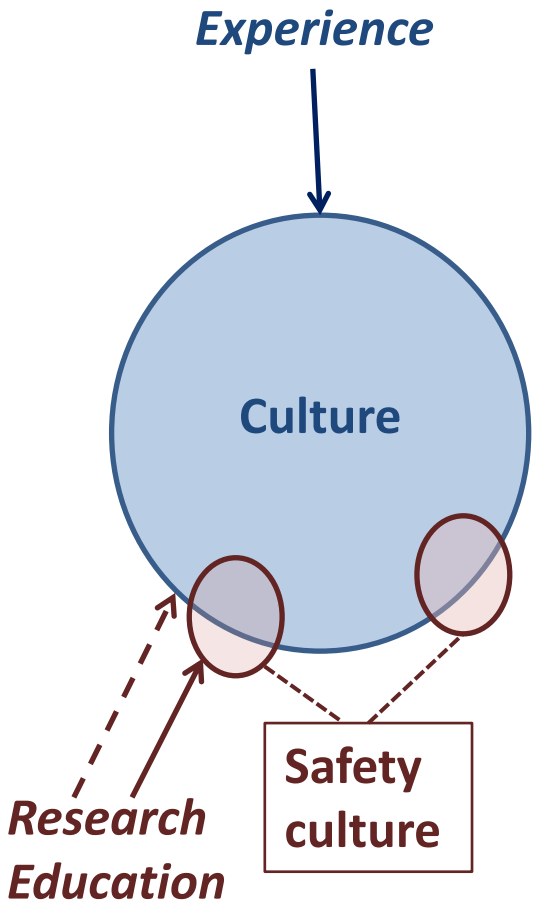
Culture & safety culture (1/2)

- Safety culture of every individual important for detection and neutralization of known and potential threats.
- Safety culture influenced by assumptions, beliefs, education, ability for critical thinking, etc.
- Interplay between safety culture and culture of society:
  - Culture of society developed mostly on experience of preceding generations and slowly takes influences from research and education.
  - Safety culture designed through research and education and progresses fast with influences from experience and also further research and education.
- Consequence: there could be many successful safety cultures within a single culture of a society.



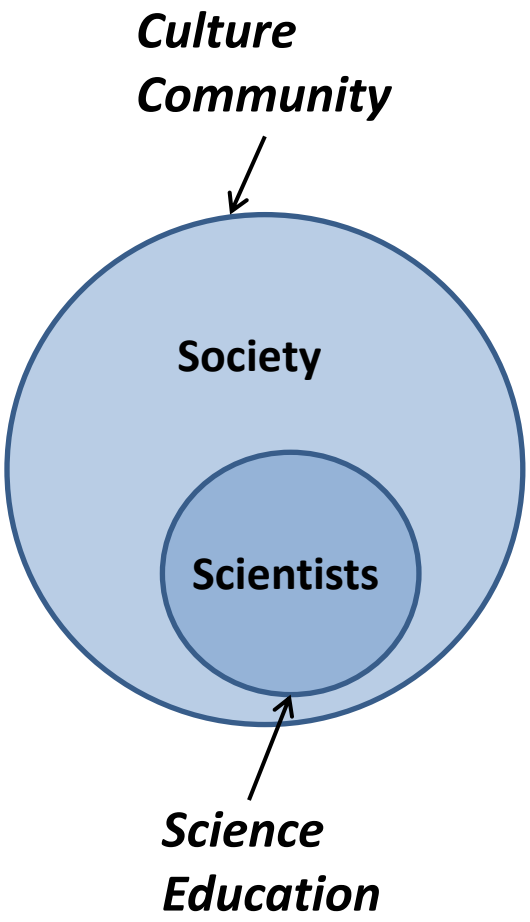
Culture & safety culture (2/2)

- An individual typically raised to live in a culture must continuously adapt to the changes in such culture.
- An individual educated and trained to perform within safety or corporate culture must continuously be educated and trained to adapt to changes.
- Learning from experience shall be systematically accompanied with learning from best available scientific knowledge and operational experience.



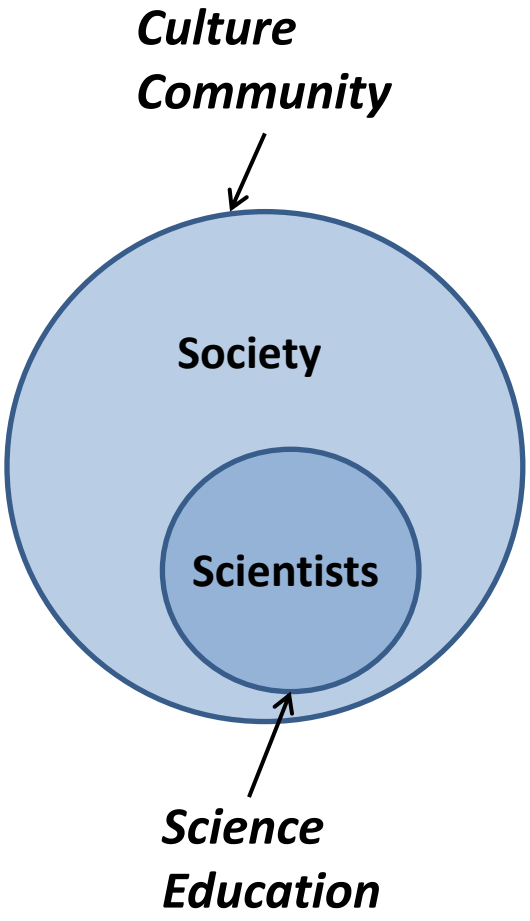
Communicating & accepting scientific facts (1/2)

- Many facts accepted by scientific community may not be accepted by society at large (egg. nuclear having lowest impacts on public health; climate change threats).
- *"The "beliefs" individuals form about a societal risk such as climate change are not of a piece; rather they reflect the distinct clusters of inferences that individuals draw as they engage information for two distinct ends:*
  - *to gain access to the collective knowledge furnished by science,*
  - *and to enjoy the sense of identity enabled by membership in a community defined by particular cultural commitments."* (D.M.Kahan, 2014)



Communicating & accepting scientific facts (2/2)

- Individuals give priority to beliefs rooted in community or culture rather than to knowledge acquired from science (and education).
- Communication between "nuclear" and "non-nuclear" communities or cultures easily dominated by affiliations and beliefs over scientific facts.
- "Communication barrier" probably among fundamental causes leading to conflicts between cultures.
- Similar communication barriers *probably* exist between members of different nuclear safety and/or corporate cultures, e.g. industry, academia, regulators.



Conclusions

- Presented incidents and accident in general enabled or caused by interplay of different corporate and safety cultures.
- Communication of available knowledge did not penetrate between different levels of management within company or between different organizations.
- Successful communication between members of different communities or cultures may put much stronger trust to affiliations of communicators than scientific relevance of information.
- Similar communication barriers possibly exist between nuclear stakeholders and general public.
- To start changing this situation: reaching to science and higher education organizations in corporate safety cultures.

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