

Science Society and Risk

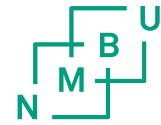
MNSES9100

deborah.oughton@nmbu.no



Trinity, July 16 1945 (Berlyn Brixner)

Ethics, Science and Society



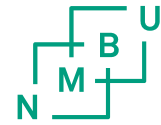
- What responsibility do scientists have for the possible negative consequences of their research?
- What are the relevant issues for evaluating a potentially harmful research project?
- How should we best evaluate and balance the harms and benefits of potentially harmful research and technologies?



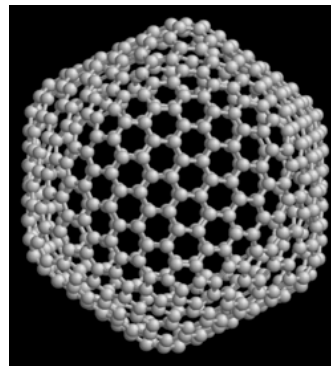
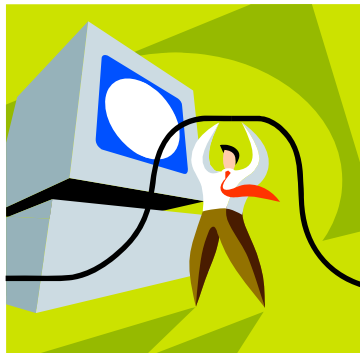
genengnews.com



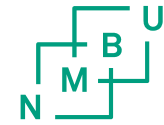
All knowledge has the potential to be
abused or misused; all knowledge has
the potential to be beneficial to society;
all technologies carry risks



Is this part of Research Ethics??

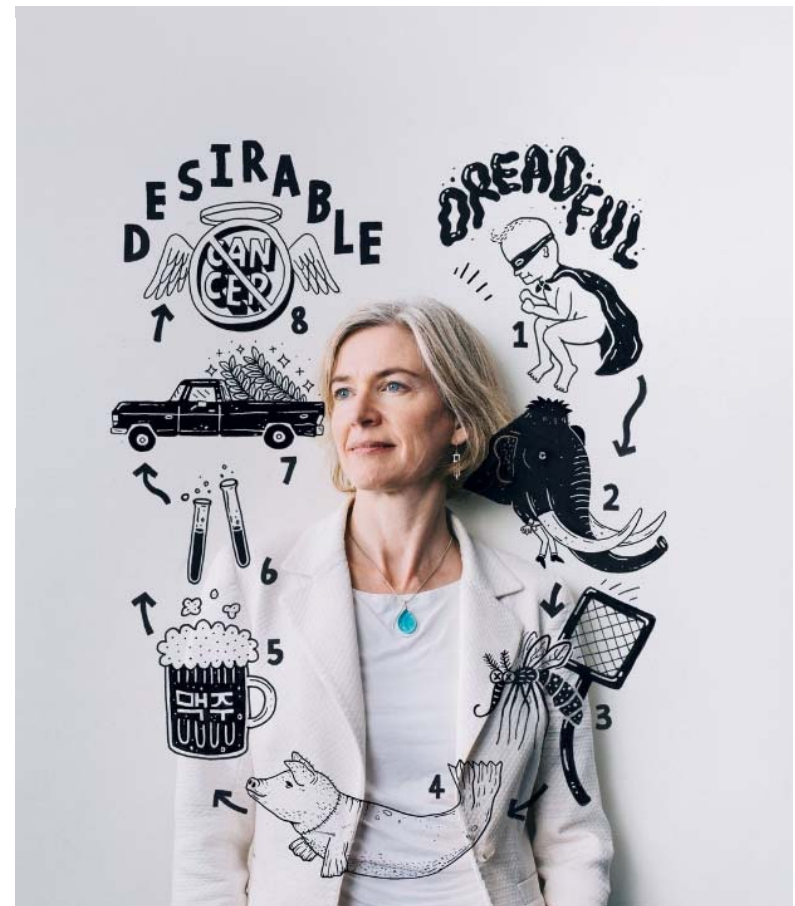


Biotechnology



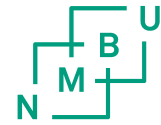
ANNA VLASITS SCIENCE 05.18.17 11:00 AM

CRISPR CREATOR JENNIFER DOUDNA ON THE PROMISES—AND PITFALLS—OF EASY GENETIC MODIFICATION



www.wired.com/2017/05/jennifer-doudna-what-crispr-can-do/

National Security and Edward Snowden



Mathematicians Discuss the Snowden Revelations

The Mathematical Community and the National Security Agency

Andrew Odlyzko

NSA and the Snowden Issues

Richard George

Letter to the Editor: “AMS Should Sever Ties with the NSA”, by Alexander Beilinson (December 2013)

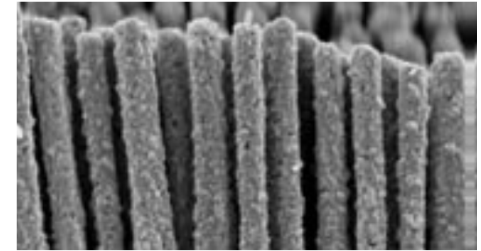
Opinion: “Dear NSA: Long-Term Security Depends on Freedom”, by Stefan Forcey (January 2014)

Communication: “The NSA Back Door to NIST”, by Thomas C. Hales (February 2014)

The NSA: A Betrayal of Trust

Keith Devlin

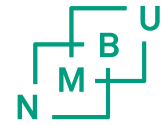
Nanotechnology/ Nanomaterials



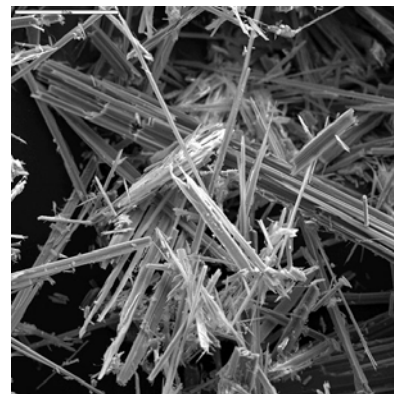
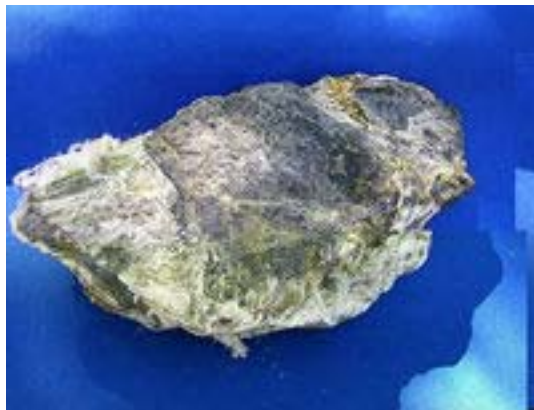
- Development and exploitation of materials and products at the nanometer scale (1-100 nm)
- Nanoparticles – organic (carbon rods, polymers, fullerenes), inorganic (metals, metal oxides, ceramics) or composite
- Three types: natural (colloids), anthropogenic (smoke, soot), or manufactured/engineered
- Many already on the market (sun-creams, self-cleaning surfaces, refrigerators, washing machines)



Environmental and Health Risks



- Environmental and Health risks
 - High reactivity due to high surface area
 - Toxicological responses found in organisms and cell cultures
 - Asbestos analogy: asbestos made from chrysotile, an naturally occurring non-toxic substance.
 - "Grey Goo" and «killer nano-robots»

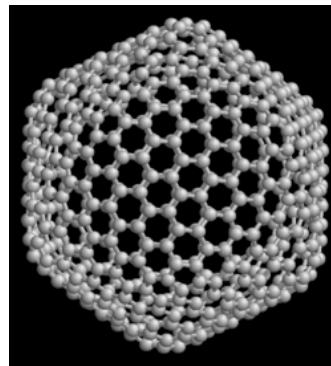
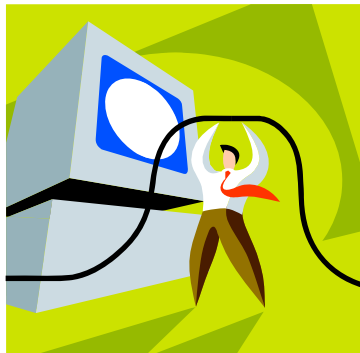


Balancing risks
and benefits

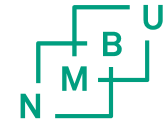
All knowledge has the potential to be
abused or misused; all knowledge has
the potential to be beneficial to society;
all technologies carry risks



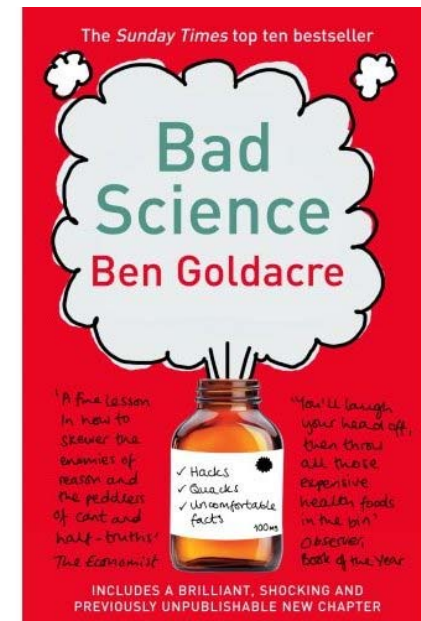
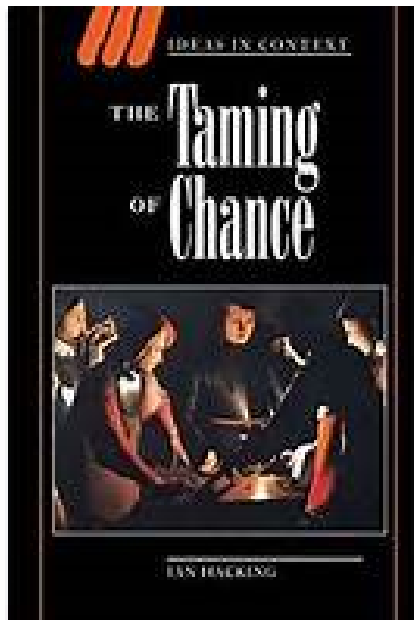
How to deal with uncertainty??



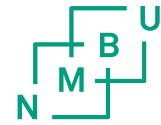
Risk and Uncertainty



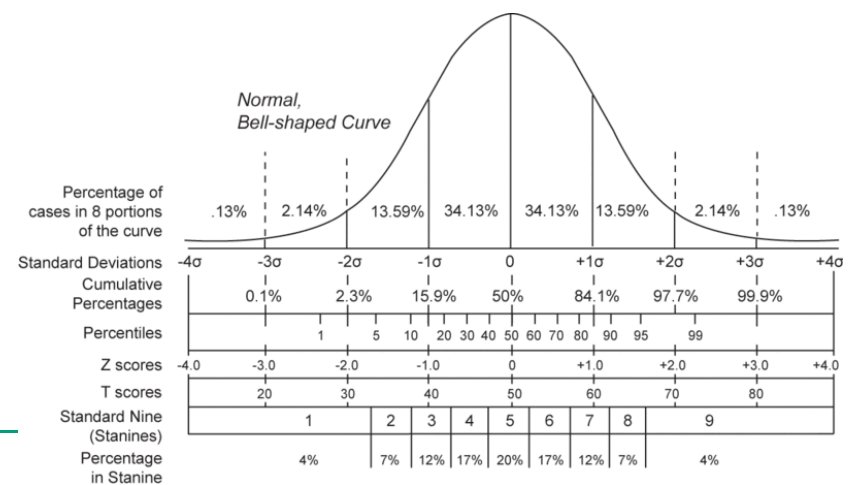
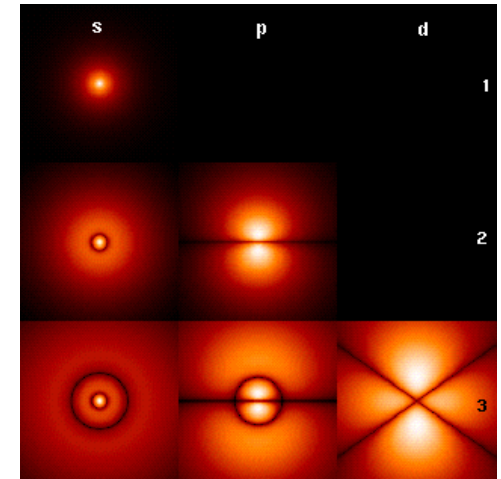
- Probability, Risk and Uncertainty (Ian Hacking: Probability)
- Public perception of risk – Fukushima case
- How the media promote the public misunderstanding of science (Goldacre, Bad Science, 2008)



Chance and Probability (Ian Hacking)

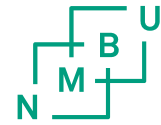


- **Metaphysical/ontological** : From deterministic (cause-effect) to stochastic (by chance). Example quantum physics
- **Epistemological/methodological**: Gathering of knowledge; hypothesis testing; statistics
- **Ethical**: Decision-making and risk assessment



Hacking, I. *The Taming of Chance; The Emergence of Probability*

Chance, Probability and Risk



American Roulette Wheel

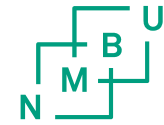


European Roulette Wheel



Blaise Pascal
1623-1662

Risk, Uncertainty and Probability



- Probabilities – probability of outcome given an action
- Risk = probability * consequence (for a risk assessor)
- Uncertainty – any state of affairs with incomplete knowledge



VAKSINE AKSJON

Download This Video

HOVEDSIDE

OM FOLKEAKSJONEN

UNDERSKRIFTSKAMPANJE

RAPPORTER BIVIRKNINGER!

SPRE ORDET!

ROLL NED FOR INNHOLD

Silver Light

Silver Light - Ionisert Kolloidalt Sølv - 1 liter
[401345]

Pris: ~~298kr~~ **289kr** Ant: 1

1 x Silver Light - Ionisert Kolloidalt Sølv - 1 liter ligger nå i din handekurv (øverst til venstre)

Se min Handekurv

Ant	1+	5+	10+
Pris per stk		269kr	239kr
Du sparer	3%	10%	20%

Størrelse: 1 literflaske

Se større bilde

Produktinformasjon:
Silver Light - Ionisert Kolloidalt Sølv - Naturens eget Antibiotikum!?

På grunn av stor pågang akkurat nå rundt dette produktet vil det kunne ta fra 5 - 10 dager før produktet er hos kunden. Det kan også ta 1-3 dager, men vi må ta forbehold om at det kan bli noe forsinkelser i utsendelse, både på grunn av produksjonskapasitet og på grunn av leveranse.

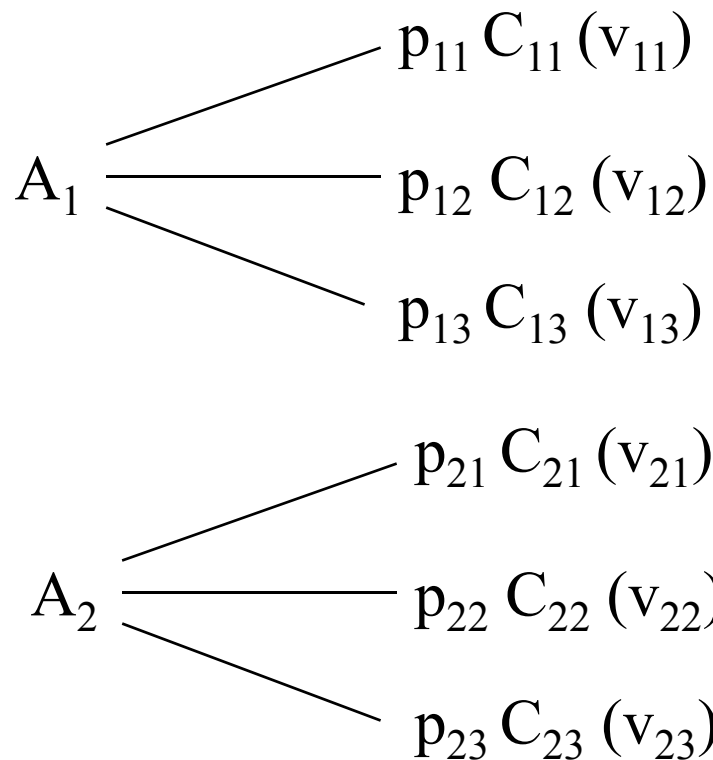
Tips en venn om dette produktet

Gi et gavekort

En Norsk Folkeaksjon

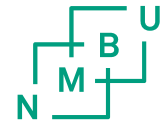
Decision making under uncertainty

- Expected value of an action = "sum of the product of probabilities and consequences"

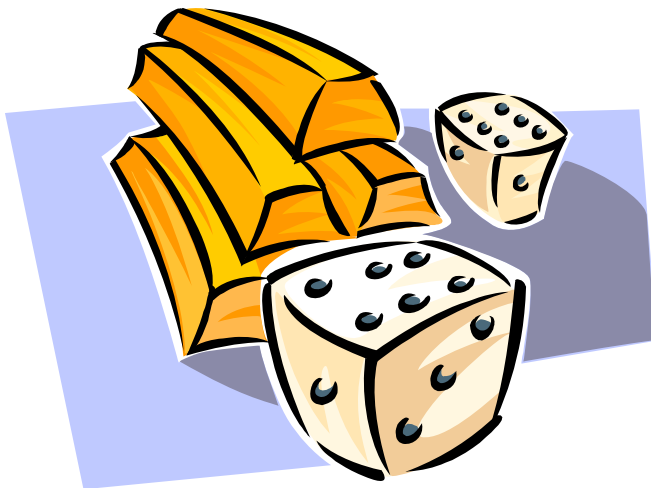


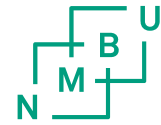
A – alternative
p – probability
C – consequence
v - value

Analogy - Betting



- Which is the best bet?
 - 10 kr on 1 in million chance of winning 1 million kr
 - 40 kr on 1 in 100 chance of winning 5000 kr





Calculate Expected Value

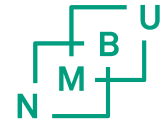
- Bet 1

$$\begin{aligned} 0.99999999 * -10 \text{ kr} &= -10 \text{ kr} \\ 10^{-6} * 10^6 \text{ kr} &= +1 \text{ kr} \\ &= \underline{\underline{-9 \text{ kr}}} \end{aligned}$$

- Bet 2

$$\begin{aligned} 0.99 * -40 \text{ kr} &= -39.6 \text{ kr} \\ 0.01 * 5000 \text{ kr} &= +50 \text{ kr} \\ &= \underline{\underline{+10.4 \text{ kr}}} \end{aligned}$$

Same approach used in -



- Utilitarianism (values as utility/happiness)
- Cost benefit analysis (values as monetary profits or loss)
- Decision Theory (Bayesian theory)
- Environmental Impact Assessment

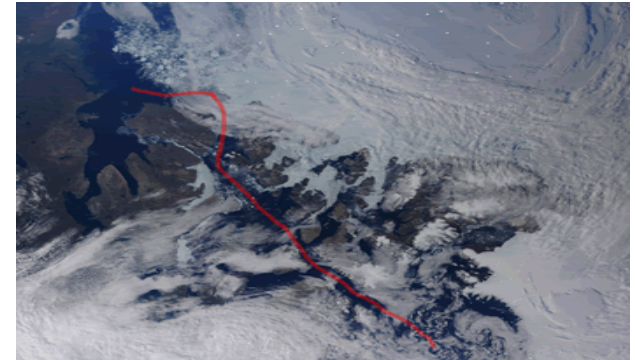
"...economists know the price of everything and the value of nothing..." A. Sen



Scientific Uncertainty

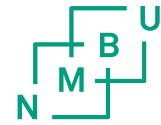
“any departure from the unachievable ideal of complete determinism” Walker (2003)

- **Properties of the world** (i.e., how the world is, was or will be)
 - Uncertain consequences, probabilities of those outcomes,...
- **Properties of knowledge** (i.e., what we can determine about the status of the world).
 - Uncertain estimates of determinate entities, such as current fish stocks.
- **Application of scientific knowledge and technology:**
 - (i) as knowledge-base and advice for public and private decision-makers.
 - (ii) as introduction of new technologies or technical solutions into society, the natural environment or industry



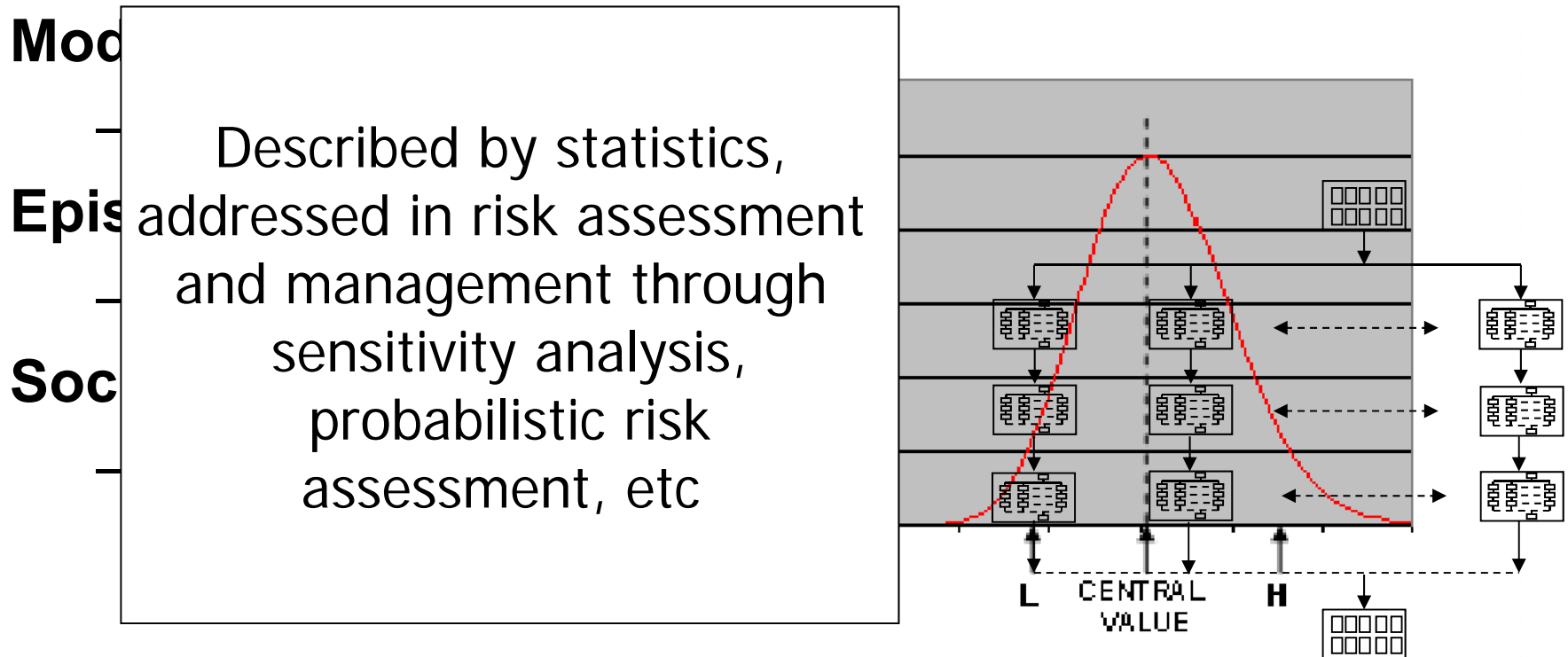
Strand and Oughton, 2010

Sources and Dimensions of Uncertainty



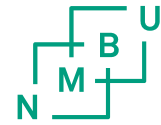
Technical or Numerical Uncertainty

–Inexactness

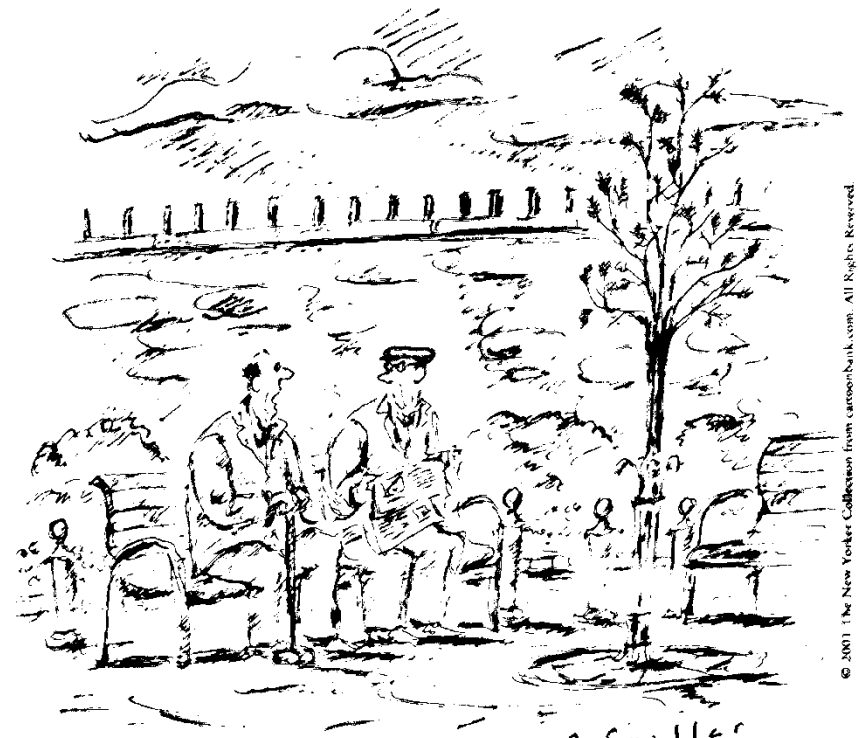


Walker et al, 2004; Strand and Oughton, 2010

Public perception of risk



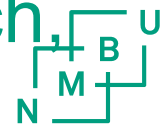
”Expert” – the public is ignorant, misunderstands risks, is irrational in their attitude towards risks. They smoke and drive but reject the much smaller risks associated with GM foods, pesticides, food additives, chemical industry, etc.



© 2001 The New Yorker Collection from cartoonbank.com. All Rights Reserved.

“My goal is to die before there’s a technology breakthrough that forces me to live to a hundred and thirty.”

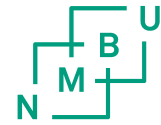
Ranking Risks: Risk of death (Wilson and Crouch 2001)



Action	Average annual risk per 100 000 "active persons"	Average annual deaths
Scuba diving	42	126
Hunting	3	600
Skiing	12	41
Tilting soda machines	2.5	5
Being hit by meteorite	0.04	2
Chloroform in drinking water*	0.07	?

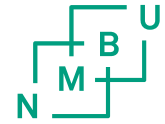
*legal limit

Lifestyle Risks (Wilson and Crough, 2001)



Action/state of affairs	Annual per Capita Risk per 100,000
Mountaineering	60-600
Cigarette smoking	300
Motor vehicle accident	15
Home accidents	11
Potassium-40 in body	1
Drinking 140 pints of beer a year	0.2
Living near a nuclear power plant	0.1

Case 4: Fukushima Radiation Risk Perception

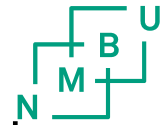


- Tens of thousands died in the Fukushima earthquake, nearly half a million were made homeless, yet since the accident most of the focus has been on the consequences of the nuclear incident.
- Reports of iodine tablets selling out in Europe
- More than 25 embassies closed or relocated from Tokyo



Oughton and Howard, EP&E 2012

Fukushima Challenges:



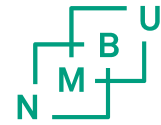
- To date nobody has died due to the radiation exposure, although over 1000 people have been reported to have died due to evacuation and stress.
- More than 90,000 people are still under evacuation due to the radioactive contamination, even though half are from areas cleared for rehabilitation (additional dose less than 2-5 mSv per year – equivalent to background radiation or increased cancer risk of less than 1 in 10,000)
- Produce from Fukushima is still suffering from low market prices even though contamination levels are well below acceptable levels

Is it irrational to show such aversion to the radiation risks from Fukushima?

What factors impact on risk perception?



The Nuclear Rabbit



[Earless bunny video stokes Japan nuke fears](#) - [Jun 10 2011 - 10connects.com]

[Experts say it is unlikely a rabbit born without...](#) - [Jun 10 2011 - ONE News]

[Japanese earless rabbit no nuclear mutant, say ...](#) - [Jun 10 2011 - ONE News]

[Earless bunny raises fear of effects of nuclear...](#) - [Jun 09 2011 - New York Daily News]

[Japan's earless rabbit: A radiation mutant?](#) - [Jun 09 2011 - The Week Magazine]

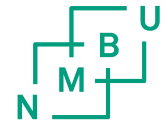
[Fukushima's "mutant" earless bunny](#) - [Jun 09 2011 - Salon]

[Earless rabbit born near Fukushima nuclear powe...](#) - [Jun 09 2011 - Batangas Today]



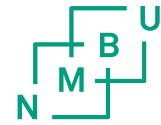
Blog: "When it's grown wings and spits acid then I'll worry"

Risk Assessment: Factual and Ethically Relevant Criteria

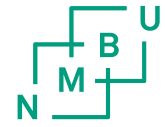


- Factual knowledge - consequences
 - Who or what is affected?
 - What is the size of the harms and benefits?
 - Autonomy and liberty
 - Have affected persons given consent to/have control over any imposed risk?
 - Is there a risk of privacy infringements?
 - Equality and justice
 - How are harms and benefits distributed?
 - What are the alternatives?
-

Pascal's Wager



	God exists (G)	God does not exist (~G)
Living as if God exists (B)	$+\infty$ (heaven)	-N (none)
Living as if God does not exist (~B)	$-\infty$ (hell)	+N (none)



Precautionary Principle

'In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.'

[Rio, 1992]

The Large Hadron Collider, CERN

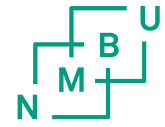
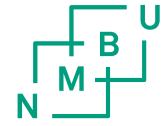


Photo: Fabrice Coiffirini, AFP

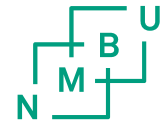
- Lawsuit bought against CERN, claiming the scientists were risking creating a black hole www.lhcdefense
-



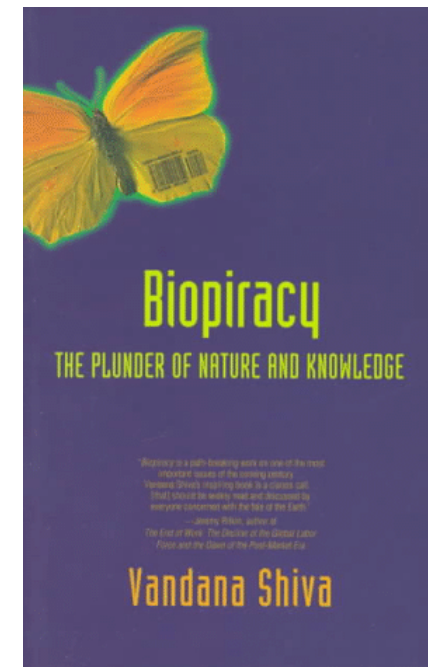
Difficulties

- There is no one definition of the precautionary principle
 - What is meant by "serious and irreversible"?
 - How to distinguish between possible, probable and scientifically plausible consequences and probable consequences?
 - How do the possible benefits weigh into the equation?
-

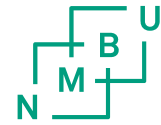
Distribution of Risks and Benefits



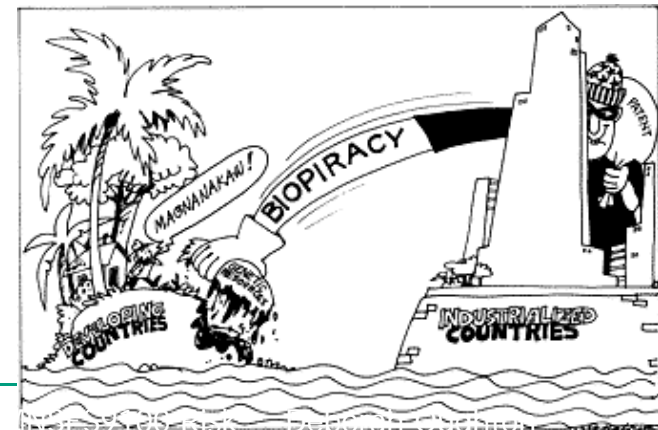
- Negative consequences of research (eg., biofuels and price of food)
- Bioprospecting and Biopiracy
- Testing of risky technology in developing countries
- Inequitable distribution of the benefits of science and technology (Global Justice)
 - Within a country (public, industry, inequity, ...)
 - between industrialised and developing countries (energy, IT, “brain drain”, etc...)



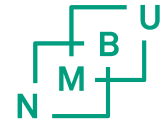
Trade Related Intellectual Property Rights



- Corporations and OECD countries are investing millions of dollars in "bioprospecting" and assay analysis of biomaterials
- People in developing countries/the South could be missing financial benefits from the exploitation of their resources and the commercialisation of their indigenous knowledge.



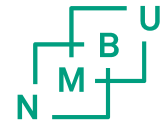
Patent Examples



- US and Japanese patents on Neem products (a tree in India used for centuries as a biopesticide and medicine)
- US patent on Basmati rice, Mexican yellow Enola beans
- Australian patent on Zimbabwe and Zambian cows (embryo sales: \$800 million/year)
- Univ. of Wisconsin patent on a "super sweet" protein from Gabon berries (\$ 1.4 billion)



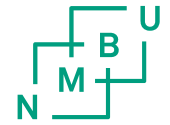
Pfizer and Trovan tests in Nigeria



- Clinical trials carried out in 1996 during a meningitis epidemic in Nigeria
- Pfizer trials on an “untested” antibiotic Trovan on 200 children selected from crowds at a makeshift meningitis camp in Kano. Gave half the children Trovan; half the children a comparison drug made by a rival company
- Court case started October 2007 (Pfizer eventually settled out of court, 2011)
- Charges were that no consent was obtained from parents, that actions resulted in the death of children or left them deaf, blind or paralysed
- Suspicion stirred by news of the trial- in 2006 parents refused to have children immunised against polio



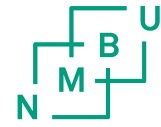
Italian Earthquake Trial



Media reports: 7 scientists charged with manslaughter for «failing to predict an earthquake»

Issue: How to communicate risk and uncertainty?

How the media promote public misunderstanding of Science - #1



Misleading stats

Relative Risk

- The risk of having a heart attack is 50% higher if you have high cholesterol
- The extra risk of having a heart attack if you have high cholesterol is 2%

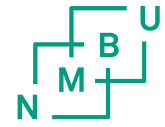
Absolute Risk

- These are the same (hypothetical) figures – how?

→ Media often focuses on relative rather than absolute risk

- 4 in 100 men in their 50s with normal cholesterol will have a heart attack
 - 6 in 100 men in their 50s with high cholesterol will have a heart attack
-

“Jessica Alba has the perfect wiggle, study says” Daily Telegraph 25th Aug 2007

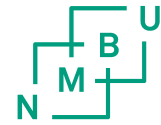


- Jessica Alba, the film actress, has the ultimate sexy strut, according to a team of Cambridge mathematicians. The academics found that it is the ratio between hips and waist that puts the sway into a woman's walk - and the nearer that ratio is to 0.7, the better.

- Goldacre, 2006
-



How the media promote public misunderstanding of Science - #2



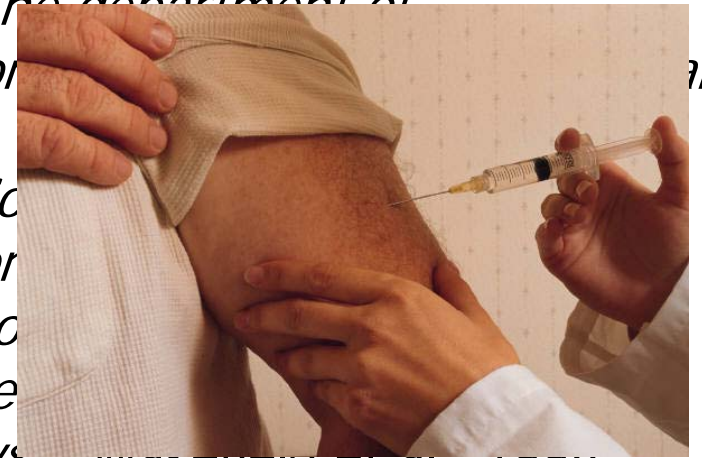
”Research has shown... ”

Hypothesis

- ”MMR vaccines increase the risk of autism”

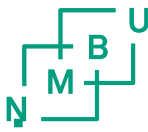
Paper published in the Lancet by Andrew Wakefield in 1998 suggested a link between MMR vaccine and autism

“ 12 children, consecutively referred to the department of paediatric gastroenterology with a history of autistic disorder ... were investigated ... in eight children, the onset of behavioural symptoms had been linked either by the parents or with measles, mumps, rubella vaccination. In these eight children the average interval between first behavioural symptoms was 6.2 days. WAKEFIELD et al., 1998

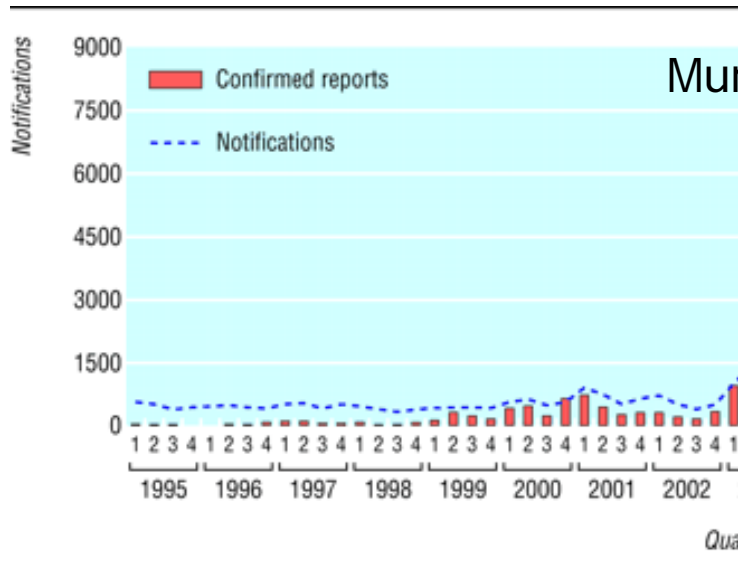


Evidence

How the media promote public misunderstanding of Science - #2 MMR..N



- Massive media attention in UK
- Vaccinations down from over 90% to 38% in some areas
- Measles and mumps increasing (mumps epidemic in 2005 -5000 notifications in January)

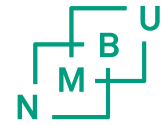


Pic: Jeremy Selwyn



BMJ 2005;330:1132-1135 (14 May),
doi:10.1136/bmj.330.7500.1132

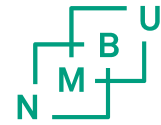
Wakefield and MMR consequence



- Partial retraction by co-authors (2004)

"We wish to make it clear that in this paper no causal link was established between (the) vaccine and autism, as the data were insufficient. However the possibility of such a link was raised, and consequent events have had major implications for public health. In view of this, we consider now is the appropriate time that we should together formally retract the interpretation placed upon these findings in the paper, according to precedent."
 - 2010: British General Medical Council found that Wakefield had been "dishonest and irresponsible" in conducting his autism research in England.
 - Paper retraction by Lancet 2010
-

Research Ethics Guidelines



- General guidelines – NENT and NESH (www.etikkom.no)
 - Research Ethics Guidelines for Natural Science and Technology (NENT)
 - Research Ethics Guidelines for Social Sciences, Humanities, Law and Theology



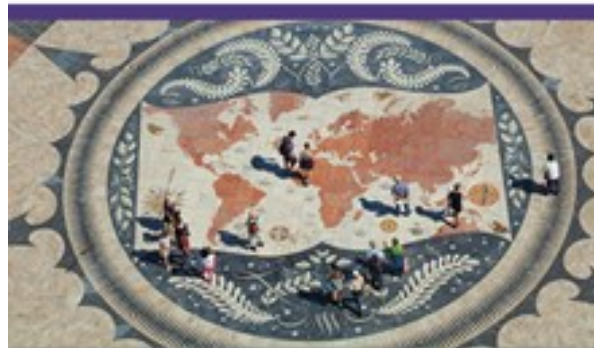
Guidelines for Research Ethics in Science and Technology



NENT • The National Committee for Research Ethics in Science and Technology



Guidelines for Research Ethics in the Social Sciences, Humanities, Law and Theology



NESH • The National Committee for Research Ethics in the Social Sciences and the Humanities

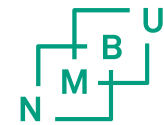


Guidelines for Research Ethics on Human Remains



The National Committee for Research Ethics on Human Remains

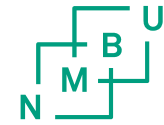
NENT Guidelines 2016



CONTENT

<i>Foreword</i>	4
<i>Summary</i>	5
<i>Guidelines</i>	8
Research ethics	8
The obligations of research to society	8
Scientific integrity, truthfulness and accountability	9
Uncertainty, risk, and the precautionary principle	12
Protection of research subjects	13
Protection of animals used in research	14
The relationship between research and other knowledge-bearers and forms of knowledge	15
Commissioned research, openness and conflicts of interest	16
Whistleblowing and ethical responsibility	17
Dissemination of research to the general public	18
<i>Proposed scientific oath</i>	20





NENT Guidelines 2016

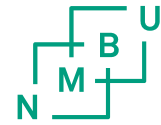
Research ethics

The concept of "research ethics" refers to a broad set of standards, values, and institutional arrangements that contribute to constituting and regulating research activities. These include the duty of honesty in research as well as responsibility to colleagues, other people, animals, the environment, and society in the widest sense.

The obligations of research to society

- 1 Research has an independent responsibility for the role it plays in social developments.
- 2 Research should be compatible with sustainable development.
- 3 Research has a responsibility to contribute to greater global justice.

Personal and Institutional Responsibility

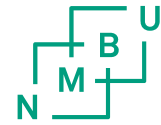


Stig S. Frøland, prof. Rikshospitalet

..does Utgard mean that natural scientists should try to predict how their results could be used or misused? ... Utgard demands that scientists should undertake an ongoing ideological and political assessment in their research. This is incompatible with research... there is only one ethical demand for research: that it has acceptable quality and that the results are presented as objectively as possible"

Letter in Aftenposten 29th April 2010

NENT: Proposal for a Science Pledge (as part of PhD inauguration/graduation)



- *"I will carry out my activities as a scientist truthfully and honestly. I will endeavour to use my scientific knowledge for the benefit of mankind. I will show respect for animals and nature. I will act in accordance with research ethics, and shall not let ideology, religion, ethnicity or material benefits impede my ethical responsibility as a researcher."* Revised text: MNSES students, Spring 2011



Science 19 November 1999:
Vol. 286, no. 5444, p. 1475
DOI: 10.1126/science.286.5444.1475

EDITORIAL

A Hippocratic Oath for Scientists

Sir Joseph Rotblat

The tremendous advances in pure science made during the 20th century have completely changed the relationship between science and society. Through its technological applications, science has become a dominant element in our lives. It has enormous potential for good, but it has also created great perils, threatening the very existence of the human species. Scientists can no longer do their work in isolation. They must now do so with the welfare of the individual or with state policies.