



# ***ETHICAL DIMENSIONS OF SCIENCE : UNDERSTANDING THE SHADES OF GREY***

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# ***ETHICS IN SCIENCE AND ENGINEERING***

- The complex nature of scientific research today makes the determination of the “**right thing to do**” very difficult
- Society expects the scientific community to not only deliver a better quality of life but also “**do the right thing**”
- In our philosophy, the “**right thing to do**” is called Dharma. Dharma roughly translates into "righteousness", "merit" or "religious and moral duties" governing individual conduct. Ethics in science can be considered as the “Dharma” of scientists
- If ethical issues were only black and white, the decision would have been easier; however, in reality ethical issues that confront us borders on the intersection of ethics and morality, an area which is substantially grey

Who decides and how do you decide what is the “right thing to do”?

# ***ETHICS : A DEFINITION***

Ethics, *n, pl*

A system of moral principles

The rules of conduct recognized in respect to a particular class of human action

The branch of philosophy dealing with values relating human conduct, with respect to the rightness/ wrongness of certain actions and to the goodness and badness of the motives and ends of such actions

# ***ETHICS AND MORALITY***

- Three dimensions : Ethics , morality , humanity
- Humanity : Doing good to others, altruism empathy, sympathy

<b>Ethics</b>	<b>Morality</b>
Defined by law and society	Defined by one's inner conscious and compass
Dos and don't's (black and white)	Shades of grey
Consequence for violation: Punishment	Consequence for violation: Loss of reputation
Objective criteria	Subjective criteria
Universal	Social, cultural, religious mores

## ***DIMENSIONS OF ETHICS***

- Scientific ethics is intimately connected with worldviews, values and belief systems that are deeply rooted in society's historical, cultural, religious and political framework within which it is connected
- Science is our attempt to understand the natural world around us. The scientific method consists of organization of our knowledge in the form of explanations that can be tested, repeated and culminate in predictions about the universe
- The ethical standards in science are then clearly dictated by goals of science. Making up or falsification of data violates the minimum ethical standards that one may wish to set
- The philosophy of ethics and its practice is deeply rooted in social ethos
- While it is possible to universalize them to some extent, the normative practices of what is right or wrong, or good or bad is deeply rooted in our civilization and cultural values

# ***DIMENSIONS OF ETHICS***

- **Personal**

Fritz Haber (1915), Enrico Fermi and Robert Oppenheimer (1945), James Watson and Francis Crick (1954), Charles Leiber (2020)

- **Professional**

The Baltimore Affair (1991) The Schon Papers (2002), The Gallo Case (1984), The Darsee case (1983) etc. In India, K. Rajput and coworkers, Plagiarism in Physics (2002), B. K. Parida vs R. Sundar, NAL (Current Science, 10 December 2011), P. Chiranjeevi, Sri Venkateswara University, (2003-07), Pub Peer image manipulation allegations (2018-19), Anshu Pandey, IISc room temperature superconductivity claims (2019), Nanomaterials, Dr. Rashmi Madhuri and Dr. Prashant Sharma, ISM, Dhanbad (2018), Aarti Ramesh, NCBS (2020)

- **Business**

Enron, Union Carbide, Exxon Mobil, Lucent Technologies, Kingfisher and Jet Airways, Ranbaxy (The Bottle of Lies, K. Eban, 2019)

- **Bioethics**

GM Crops, Stem Cell research, CRISPR CAS 9 and associated gene editing technologies, ethics in clinical trials

- **IT Ethics**

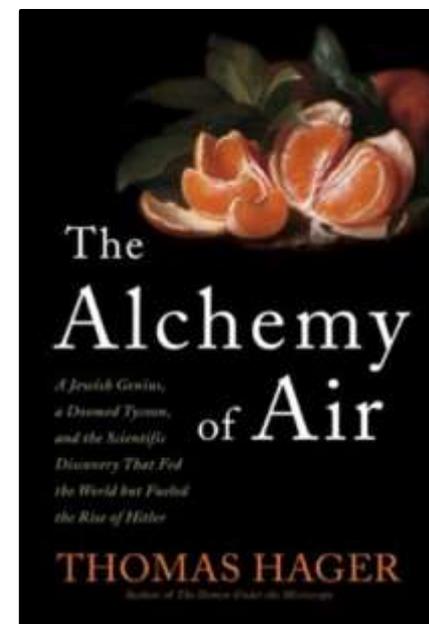
Data privacy (who controls my private information), corporate control of social media, fake news and unverified opinions masquerading as facts, trolling

# THE UNCOMFORTABLE LEGACY OF FRITZ HABER

- Fritz Haber is a controversial, complex and tragic figure in the history of science
- He was awarded the Nobel Prize in chemistry in 1919 for developing the direct synthesis of ammonia from its elements. The reaction made possible industrial-scale production of fertilizers. Today, half the nitrogen found in the body of every living person has come out of the famous Haber-Bosch Process. Haber is often called the “Alchemist of Air” since his chemistry enabled production of “bread from air”
- Fritz Haber also pioneered the use of deadly poison gases on the battlefields of World War I. He personally oversaw the unleashing of 168 tons of chlorine gas on the French and English soldiers at Ypres on 22 April 1915. His passion and commitment in leading this research was the beginning of the age of “chemical warfare” a scourge that threatens humanity even today
- He was awarded the Noble Prize in 1919 in spite of his being responsible for the killing of thousands of people



1868-1934



Was Fritz Haber a saviour of humanity or its murderer ?

# ***DIMENSIONS OF ETHICS***

## Honesty

- *Science progresses only to the extent that scientists are honest*
- *Science is often defined as the search for truth*
- *However this does not automatically imply that individuals who pursue science (scientists) are honest*
- *Honesty between people*
  - *Give credit where it is due*
  - *Admission of falliability*
  - *Courage to admit wrongness*

## Objectivity

## Integrity

## Carefulness

## Open-ness

# ***DIMENSIONS OF ETHICS***

Competency

Transparency

Accountability

Confidentiality

Research publication ethics

Research mentorship

Respect for colleagues

Harassment and bullying

Gender sensitivity

Social responsibility

Non discrimination ( gender, cast, creed or religion)

Animal and human protection

*What is Ethics in Research & Why is it Important?, David B. Resnik,  
December 23, 2020*

# UNDERSTAND IMPACT IN THREE DIMENSIONS

Individual

*Good scientific practices, personal integrity, publication and dissemination of science, authorship issues, conflicts of interests and peer reviewing*

Community

*Education of science, PI's responsibilities to co-workers and peers, safety in workplace, environmental safety, admission of fault and failures*

Society

*Risk and benefits of new chemical or biological entities, impact of science on SDG goals, unintended consequence of science on society, applying the "cautionary principles" in decision making*

Responsibility

Individual

Community

Society

Impact on

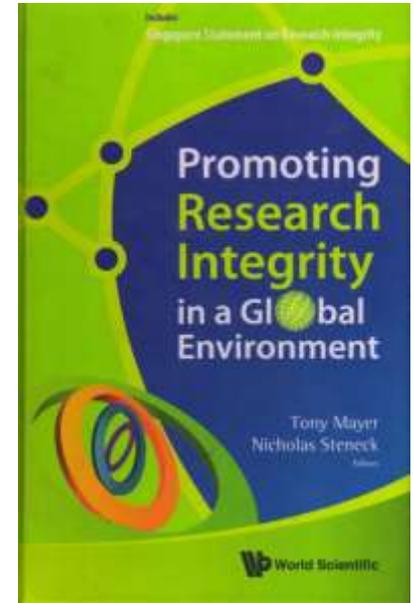
*Jan Mehlich, et al., Chemistry, A European J., 2017, 23, 1210*

# ***STATEMENT ON RESEARCH INTEGRITY***

(Second World Congress on Research Integrity, 2010)

## **Four principles**

1. Honesty in all aspects of research
2. Accountability in the conduct of research
3. Professional courtesy and fairness in working with others
4. Good stewardship of research on behalf of others



# ***ETHICS OF SCIENCE***

*Ethics becomes important to science because of the impact of science on society, economy and the environment*

## **Two domains of ethics in science**

### **Internal :**

Good Scientific Practices ( GSP) defined by intellectual honesty, truthfulness, integrity, objectivity, healthy skepticism, fairness to fellow scientists, self-critical, disinterestedness

### **External:**

Conflict of interests, ideological orientation, dual-use science, dealing with uncertainties in science, when do you know “you know enough”, ability to weigh the risks with benefits, chemical and bio-safety, adherence to internal protocols (e.g., The Hague Convention on Chemical Warfare. Montreal Protocol, Minamata Convention, UN Sustainable Development Goals

# ***RELEVANCE OF ETHICS***

- Unless truth is preserved, the scientific system and its product cannot survive
- Science is a collective and community enterprise dependent on shared values
- Faith and trust is one of the most important values in the conduct of scientific research

Science is built on the dictum “trust, but verify”. Unfortunately these days there is too much trusting but not enough verifying

## ***CONFLICTS IN SCIENTIFIC RESEARCH***

- Openness versus secrecy
- Openness versus competitiveness
- Needs of the employer versus that of the society
- Truth versus desired outcome
- Peer reviewer and author

Learning to understand and manage the conflicts of interest is a must learning for those practicing science and technology

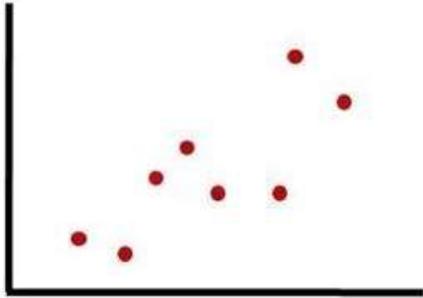
## ***ETHICAL ISSUES IN RESEARCH***

- Falsification and fabrication of data
- Plagiarism
- Selective use of data without making it explicit
- Manipulation of graphs and figures
- Destruction of primary data
- Sabotage of others work

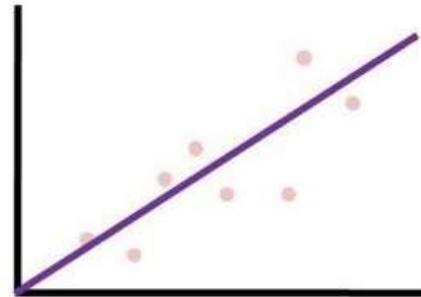
One or more of the above acts constitutes serious scientific misconduct

# DATA: THE TRUE DEVIL OF SCIENCE

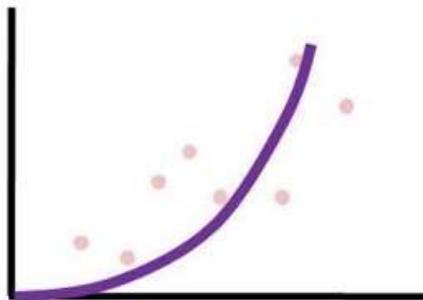
Actual data



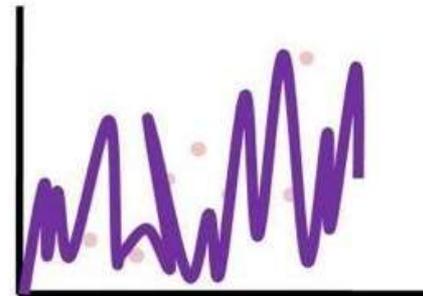
How you saw it:  
Perfectly linear, as expected



How your supervisor saw it:  
Perfectly exponential, amazing new stuff



How the referee saw it:  
Pure noise



## ***SHADES OF GREY***

- Self-plagiarism
- Overstating the impact of your research
- Citation abuse-Gaming the citation system
- Ignoring science cited in patents
- Publishing work without co-authors consent or consent of the lab where the work was done
- Attribution of credit in team science, where large teams pursue a project
- Splitting data into multiple papers merely to increase the number of publications, when a single paper would have been more desirable
- Citing web based information, information from institutional repositories, pre-publication archives, Blogs, Tweets etc
- Accepting to peer-review a manuscript where you have no expertise or competence
- Compromising the safety of your co-workers while experimenting; ignoring environmental and health issues in the conduct of research
- Misusing grant funds
- Not owning responsibility when an ethical violation is detected
- Pursuing pseudoscience

# **SHADES OF GREY: AUTHORSHIP ISSUES IN SCIENCE**

- An author of a paper must have contributed significantly to the research. By the same token, no one should be invited to be an author unless he or she has made a significant contribution. Of course, the question here is who must finally decide
- Authorship is warranted when (a) one makes substantial contributions to the conception or execution of work (b) drafting of work or revising it critically for the information contained therein (c) final approval of the version to be published and (d) agreement to be accountable for all aspects of the work regarding accuracy and integrity
- On the rare occasion that either during the review process or in the published work, a result is found to be erroneous or misleading, **all** the authors must be held accountable
- Gratuitous authorships constitutes serious violation of ethics
- The order in which authors are listed has no importance

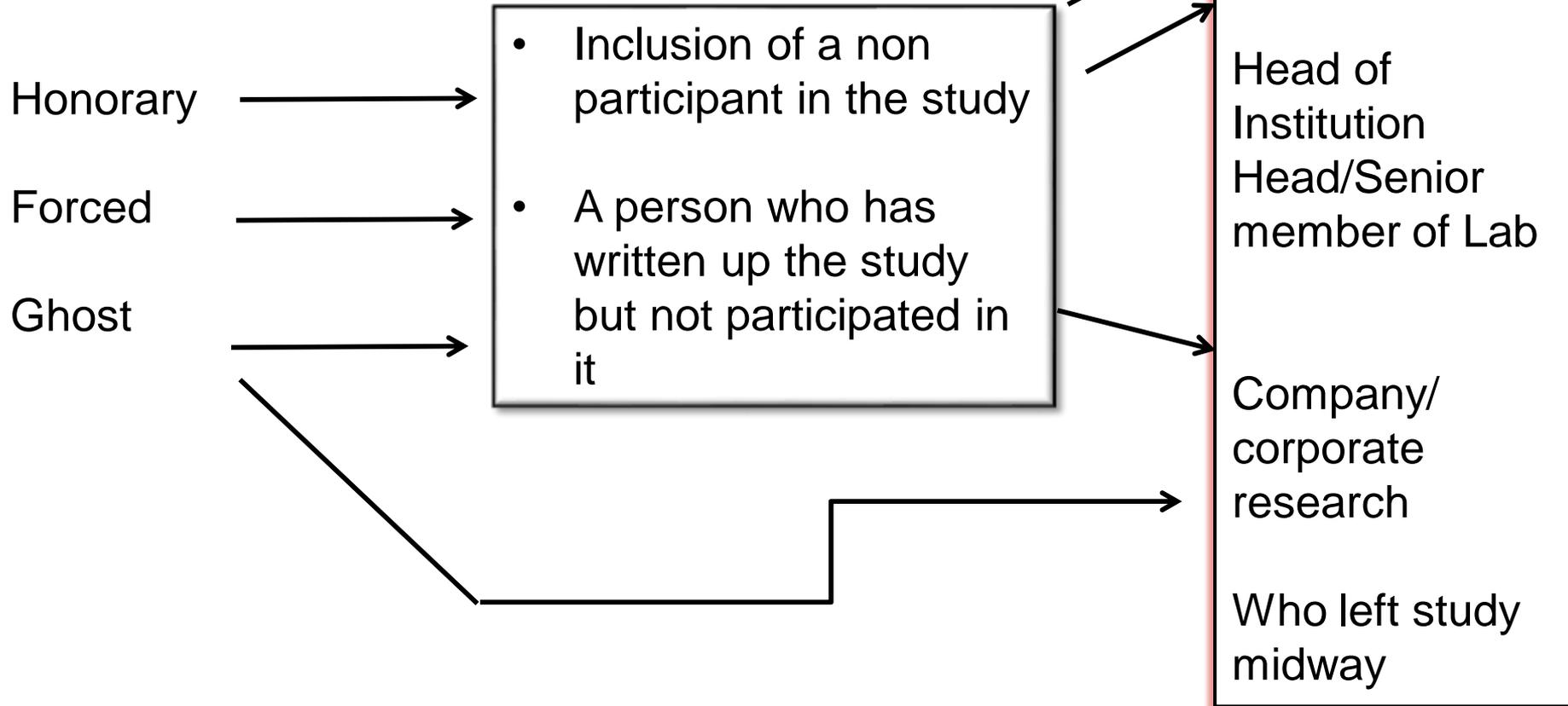
*Vancouver Protocol on Authorship, updated May 2022, [www.icmje.org/icmje-recommendations.pdf](http://www.icmje.org/icmje-recommendations.pdf)*

*R. N. Zare, Current Science, 2014, 106, 1171*

*G. L. Kiser, Nature, 2018, 561, 135*

# SOURCES OF THREATS TO RESEARCH INTEGRITY

## Inappropriate Authorship Issues



## ***SHADES OF GREY : CITATIONS AND ATTRIBUTIONS***

- Acknowledging and citing **all** relevant prior research and authors
- Cite only papers that you have read; Do not copy bibliography from a previous publication, blindly
- Necessary copyright permissions to reproduce figures and tables from previously published information including websites and Creative Commons
- Acknowledge those who helped you in the course of work

# ***WHAT MOTIVATES MISCONDUCT IN SCIENCE***

- Publish or perish
- Emphasis on quantity , not quality
- Competitive environment; the race to get ahead and be there first
- Peer recognition, awards and rewards, career growth
- The tyranny of metrics
- Increasing emphasis on “news value” of science
- Eagerness to please your ‘Boss’
- Win peer recognition / awards / prizes / career growth
- Individual bias, prejudice and preconceived ideas

Our scientific ecosystem is largely responsible for the behavioural aberration of scientists. Our young researchers face problems with long working hours, high pressure, expectation to obtain results and publish papers quickly in top journals, job insecurity and large teaching commitments. These pressures motivate misconduct

## ***HOW ETHICAL AM I?***

- Ethics is supposed to help us answer the question : What should I do and is it the right thing to do?
- It is the law I impose on myself, independent of any expectations of reward or punishment
- Ethics is different from morality in that it is an individual choice
- Is it the hope for the heavens and the fear of the hell or the fear of consequences of a bad Karma that forces us to be good ? If , this were so, we are not ethical
- Although, we know that we must be always truthful, often we are not except when mandated by the law
- Ethics is to simply do a thing because it is right. Ethics is much more than fear disguised as virtue
- Ethics has no relationship to competence in our domain of expertise
- Ethics is about character; Character defines our “being” of “who we are”

When large number of people make ethical choices, we change the world

## ***SCIENTIFIC OATH***

“ I acknowledge that I am a part of an international community of researchers. I will practise my activities in line with the recognised standards for good research practice. I shall conduct my research in an honest and truthful way and show respect for humans, animals, and nature. I shall use my knowledge and skills to the best of my judgement for the good of humanity and for sustainable development. I shall not allow interests based on ideology, religion, ethnicity, prejudice, or personal material advantages to overshadow my ethical responsibility as a researcher”

Like the medical profession, should all those entering the scientific professions be asked to take an oath of good conduct ?

## ***SUMMARY***

- Unethical behavior and misconduct is an aberration of the mind born out of ignorance and avarice
- When ignorance and avarice combine, it becomes a potent force for unethical conduct
- Only awareness / education / training / value based living can solve the problem

Science without conscience is but the ruin of the soul :  
Francois Rabelais

## ***BACKGROUND READING : BOOKS***

- Ethics in Chemistry, J. Schummer and T. Borsen, World Scientific, Singapore, 2021
- The Ethics of Science: an Introduction, D. B. Resnick, Routledge, London, UK, 1998
- Responsible Conduct of Research, A. Shamoo and D. Resnik, 3rd Edition, Oxford University Press, New York, USA, 2015
- Ethics in Science Education, Research and Governance, K. Muralidhar, A. Ghosh and A.K Singhvi, INSA, New Delhi, India, 2019
- On Being a Scientist: A Guide to Responsible Conduct in Research: Third Edition, National Academies Press, Washington, DC, USA, 2009
- Engineering Ethics: An industrial Perspective, Elsevier/Academic Press, New York, 2006
- The Ethical Chemist: Professionalism and Ethics in Science, J. Kovac, Pearson Education Inc., New Jersey, USA, 2004
- Impure Science : Fraud, compromise and political influence, R. Bell, John Wiley & Sons, New York, USA, 1992
- Betrayers of Truth : W. Broad and N. Wade, Simon & Schuster, New York, USA, 1982

## ***BACKGROUND READING : PAPERS***

- Jan Mehlich, et al., The Ethical and Social Dimensions of Chemistry: Reflections, Considerations and Clarifications, Chemistry, A European J., 2017, 23, 1210
- W.F. van Gunsteren, The Seven Sins in Academic Behavior in the Natural Sciences, Angew.Chem.Int.Rd.,2103, 52, 118
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- O. P. Sharma, Ethics in Science, Indian J. Microbiol., 2015, 55, 341
- Ethics in Science, [www.chem.vt.edu](http://www.chem.vt.edu/ethics/hbauer) / ethics / hbauer
- Office of Research Integrity, [http://ori.hhs.gov](http://ori.hhs.gov/html/misconduct) / html / misconduct
- <https://www.opcw.org/hague-ethical-guidelines>
- [https://acswebcontent.acs.org/gcce\\_training/story\\_content/external\\_files/Global%20Chemists'%20Code%20of%20Ethics.pdf](https://acswebcontent.acs.org/gcce_training/story_content/external_files/Global%20Chemists'%20Code%20of%20Ethics.pdf)
- [https://acswebcontent.acs.org/gcce\\_training/index\\_wrapper.html](https://acswebcontent.acs.org/gcce_training/index_wrapper.html) ( A self-learning module for ethics)

**THANK YOU**

