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Ethics and Academic Integrity Elements of Ethics in Electrical Engineering

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Abstract: Ethics is the science that studies the theoretical part of the human condition and its values. The individual has the responsibility to conduct ethic decisions and to have an ethical behavior. This article presents the ethics from the research and engineering perspective, its main characteristics; lack of honesty, confidentiality, conflict of interests and intellectual property. The engineering teaching is the act which includes multiple ethic subjects in order to educate the student about the importance of ethics and its repercussions. The students have the right to benefit of ethical behavior from their teachers from the staff of the school. The ethic is essential in all the educational and working fields, but we insisted specially on the electrical engineering field.

Keywords: *ethics, morals, professionalism, electrical engineering.*

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1. Introduction

Society`s health is dependent on the level of ethics that its human component has. The science of ethic is present in the life of every human being and it has a very important role in the day to day life. When we speak about ethic, we include the choices that the individual makes and their correctitude. Ethics are implying choices that are having the base on the morality of the person and in the way they are interacting with others. The majority of the corporations developed for their employees their own ethics code. Usually it can be found on their web page.

In all the institutions that work inside a society is absolutely necessaire to follow an ethical code and to promote right values. Every individual has the obligation to follow the specific rules that are imposed in the working or studding entity.

Ethics is very important in any profession and must be integrated into the employment process and work environment. Due to the impact on the educational environment, in universities, on young students who want to become engineers, ethics is paramount in the development of society. Therefore, it is essential to consider the ethical elements in the relationship with students.

The objective of this paper is to present the ethic from multiple perspectives and especially from the electrical engineering view. We integrated the requests that the students make and the ethical environment that is provided in the educational field.

This paper has six sections, the first one is the introduction, followed by multiple definitions of the ethics over time and the third part presents of the ethics in the engineering. The next section is highlighting the teaching of ethics in engineering, ethics for students and the last section are conclusions.

2. Ethics. Definitions

Ethics, is the science which is studding the theoretical part of values and of the human condition, from the perspective of morality, and with a purpose in the social life, is studding the theoretical part of principles and the basic conceptions in any field of thinking and practicing. In order to archive its main goal, the morality, the individual is controlling and modifying its behavior to a more acceptable and legitimate one.

Ethics in research, reported to people, has repercussions owned to the lack of trust had in the past in the experiments, especially because of their wrong negative results. The only solution at that time being the court

action, which may or may not compensate, but over time this has changed, with England being the first country to introduce compulsory insurance so that court actions will no longer be needed in the case that the results of the experiments are negative.

The first code of ethics in international research is the one in Nuremberg, Germany, since 1947. It was built by lawyers and then transformed to a more detailed level by the Medical Association, known as the Helsinki Declaration. Over time it has been renewed and completed.

We always discuss the importance of ethics in medicine, law or administration, but it is necessary to ask the question of ethics in engineering and in environments that work deeply with humans. The educational environment is the foundation of development and evolution, so it is the first place where ethics is essential.

In the last decades, engineers have focused on what we call "preventive ethics" due to the codes of ethics and problems that have emerged over time. Based on these two elements, engineering ethics has tended to focus its attention on preventing harm to professional misconduct and to the public. These are one of the worrying elements in engineering ethics that were present in the past and they will still be here in the future.

The written codes have as their guide to the idealistic and aspirational aspects of engineering work. There is already concern about human well-being, but this element is not easy to interpret. This approach aims to encourage young people to pursue a career in engineering and maintaining it.

3. Ethics in engineering

General information on ethics aims to make a mix between common and engineering ethics is presented. The ethics from engineering is evolutionary, adaptable and involves the practical part, in addition to the theoretical one. Usually we put ethics labels from a religious or judicial perspective. They suggest common morality by summing up a set of moral ideals that their members follow in culture and society. Ethics transcends the law by its complexity and breadth.

The definition and functioning of the engineering ethics require a knowledge of the professional ethics followed by the critical determination in the profession of engineer which involves contact with people, resources and the environment.

Engineers must always update their database on the standards and rules that govern their professional work. Throughout the university cycle

there are also objects that train the individual about his ethics in life and work. It is important for future engineers to study ethics in order to make the right career decisions. The moral basis of a career leads to the creation of correct and efficient solutions.

Professional engineering companies have established codes of ethics that represent the rights, duties and obligations of engineers. The written ethical codes cannot cover all the problems that can arise throughout the career. (Fleddermann, 2004)

It should be mentioned that the codes of ethics are not mere documents, so there are no penalties given by the law for its violation, but within the organization in which the activity is carried out, consequences can occur. The codes of ethics have emerged over time through the interaction between man and society.

The influence of the faculty members on the students, but also on the people around them, requires them to have an ethical perspective and moral virtues, being familiar with the principles of morality.

The one that weighs the most is the professional ethics that depends on the attitude of the faculty members and their knowledge about it. When we speak about professional ethics is natural to mention a set of rules and codes identified in the professional practice. The concept of professional ethics is broader than the one of business ethics. Professional ethics also involves the ethics of everyday life.

Engineering codes often refer to honesty. The third canon of the Institute of Electrical and Electronic Engineers encourages his members to "be honest and realistic in declaring claims or estimates based on available data". Canon 7 is requesting from the engineers to "seek, accept and offer sincere criticisms of technical work". The American Society of Mechanical Engineers says that "Engineers must issue public statements only in an objective and truthful manner." A subsection obliges engineers to don`t "participate in the dissemination of false, unfair or exaggerated statements regarding engineering". (Farahani & Farahani, 2014)

The lack of honesty in engineering and science can be manifested in several forms: data forgery, data fabrication or plagiarism. The falsification of data refers to the distortion of the data by eliminating the irregularities or by presenting only the data that correspond to the favorable theory and making the exception of the rest. The fabrication involves the invention of data and the reporting of the results of the experiments although they have not been reported. The use of intellectual property used without the credit or permission of the original owner is called plagiarism. Establishing the barrier between legal and illegal use of intellectual property is difficult.

Confidentiality of data and information is a problem because in private practices engineers may be tempted to disclose confidential information without client approval. Confidential information may be obtained by the engineer directly from the client or discovered by him in the action performed for the client. Due the fact that most engineers are employed, there is the problem of misuse of employer information.

Conflict of interests can harm professionalism. The main cause is that the professionals have a bias in performing the professional duties because they are remunerated for it. These conflicts have the tendency to undermine the trust of public, employers and clients in that judgment or expertise. Engineer ethics codes are those involved in conflicts of interest, claiming that "engineers must act as loyal agents in fulfilling their professional duties".

Intellectual property is the property that results from mental work. There are multiple ways to protect it, such as trademarks or secrets, copyrights or patents. For example, the letter does not possess trade secret, trade secrets are compilations, formulas or devices that are used to gain advantages, especially in business, in front of the competition. This type of secret is not protected by the patent and must be kept inside the company. Patents are government-implemented documents that gives the owner the right to exclude others from producing of the same patent for a period of protection of 20 years from the date of its national or international registration. Trademarks are sounds, words, symbols, phrases or designs associated with services or goods. Copyright is the rights to creative assets such as paintings, graphics, books, music, computer programs, sculptures or movies. These rights protect the expression of the idea, but not the idea itself. Most companies request from the employees to sign a document through which all inventions and patents become property of the company. In this situation the company offers in exchange a share for each product.

The professional model is offering a novel perspective over professions as engineering, medicine or law. One of the main ideas is relating to the models in these areas is the trust that exists with the public. The name of "social contact" with the public is given to the "registered" relationship, in order to promote the public good, the professionals agree to handle their work to archive it. They agree to obey ethics of the practice and standards of technical skills in their development, but not to the benefit of the public. (Harris et al., 2009)

Every researcher, regardless of the field, has to make a commitment. It can be expressed by an oath that is the basis of many professions. The Norwegian National Ethics Committee proposes a text of the form: "I accept that I am part of an international community of researchers. I will

practice in accordance with the recognized standards for good research practice in any situation. I will conduct my research on a fair and honest path, showing respect for people, animals and nature. I will use my knowledge and skills at the highest level of my judgment for the good of humanity and for development. I will not allow interests based on ideologies, religion, ethnicity, prejudice or material advantages that could overshadow my ethical responsibility as a researcher".

Medical students have the "Oath of Hippocrates". Today, researchers in science, technology or engineering must face extraordinary ethical challenges that can harm the work of a doctor. The oath made at the beginning of a profession implies the need to recognize the influences in the society and the responsibility towards the field in which they work. It provides a good basis for developing the research profession and it will inspire the research teams to achieve their goals. (Milici & Poienar, 2019)

Ethics in electrical engineering

Engineering is recognized as a profession that is learned and integrated in the same category as medicine, justice or other professions, being based on higher education and supplemented by years of experience and exercise in the field. The public's perception of the engineer status is unclear, for example, it is confused with that of a mechanic or others alike. Each branch of engineering, may it be electrical, mechanical, civil or others, has specific codes of ethics.

The code of engineering ethics was built by the Electrical Engineering Council. Ethics has been defined as a specific set of moral values or principles of care that conduct the care of a person who is responsible for the group - a group or profession on the basis of rights, honesty and fairness. An electrical engineer must follow a system of moral principles and values, allowing a standard dynamic care package to lead and modulate life in the individual. The basic element of professional leadership is *integrity*. (Brey & Jansen, 2015)

4. Teaching ethics in engineering

At the moment in universities and colleges the ethics are taught in two ways; through a real ethic course and in the second direction through the ethical approach by introducing ethical problems in other courses. The university professors introduced ethics at the beginning of the fundamental courses, in the specialized courses and in the design courses. (Steneck, 1999)

Multiple types of courses introduce ethical issues in their structure due to the need to comply with the EC 2000 directives. There are simply not enough teachers, or the needed resources, to teach ethics courses dedicated to engineering in each accredited institution.

The majority of textbooks use cases, large and small, as an object of study in the analysis and thinking of moral difficulties in the field of engineering. The ethics textbooks contain a multitude of opinions about their non – applicability and applicability of moral theory and philosophy in the ethic codes of professional societies in specific situations. (Harris et al., 1995; Lynch, 1997; Whitbeck, 1987)

If engineering is a scientific experiment, the ideas that we have about conducting scientific experiments there are three implications to lead to. The engineers have to analyze the consequences that their work in quality of scientists may produce. They must be able to provide a secure exit from the experiment and must ensure that they have the written consent of the subjects undergoing the experiments. This can result in the fact that engineers must inform consumers and users about the opportunities and risks that their product has.

The conception of engineering as a social experiment conducts us to the following idea: how it can contribute to teaching ethics in engineering. An educational program in the United States that is concerned with studying the link between scientific knowledge, technological systems and society is STS - Science and Technology Studies. There are some voices that are against the application of history and sociology in the reasoning of ethics because these two courses describe, what was the state of practical engineering and not what it should be. Technicians can extract several analytical tools for engineering ethics from more than 35 years of research in sociology, politics and history of technology and science. Understanding how to integrate into the design of buildings and public housing, relationships of different genres can prevent engineers of the possible results of their design. By understanding the reasons why scientists and engineers rely the majority of their work on numbers can help by offering more strongly qualitative support assessments in or outside the field of engineering. (Downey & Lucena, 1995; Hughes, 1998; Jasanoff et al., 2001; Porter, 1995; Vincenti, 1993; Wynne, 1991)

Understanding that the rules correspond to practical engineering rather than opposite, may help the engineer explaining his activity to the public and to the government bodies. (Lynch & Kline, 2000)

The teaching of ethical engineering is presented in an analytical framework in Diana Vaughan`s book, from 1986, about Challenger space

rocket accident. She presented the famous accident as a model of immoral calculation. (Vincenti, 1993)

Pressured by NASA-Aeronautics and Space Administration the project managers had to fit the launch in a short timeframe and they had to reject all the warning from the engineers. The engineers at Morthon-Thiokol Company, in a teleconference, suggested the delay of the launch due to the opinion of the manufacturer of solid-fuel booster rockets until the temperature rose above 53F. The deputy technical director of the Marshall Space Flight Center, George Hardy, was "appalled" by this proposal. During an unofficial discussion in Morthon-Thiokol, Vice President Jerry Masson told Vice President Robert Lund "It's time to take off your engineering hat and put on your management hat to make a decision". (Lynch & Kline, 2000; Martin & Schinzinger, 1996)

Ignoring the warnings from the engineers, the managers kept the same data that constituted the argument against launching. The next morning, the catastrophe occurred, Challenger was destroyed and shortly after launch the crew died. The cause was the ignite of the liquid fuel tank due to the hot gases passed through an o-ring unproperly sealed. (Boisjoly, 1987)

A large number of engineering students described this case as an immoral calculation by the managers of Morthon-Thiokol, a calculation represented by the infamous order to change the engineer hat to the manager's hat. However, Vaughn presented the complexity of the situation in a more precise way. Using a method called "historical ethnography", she reconstructed the actions of engineers and managers at NASA and Morthon-Thiokol for a period of 10 years. They were aware from the very start of the fact that there were issues with the o-rings. Many times, they have repaired a sequence of the issue.

Their conclusion was that some erosion was present on the o-rings and that some redirections of the hot gas passing through them were acceptable and expected because of the redundancy of having 2 o-rings and because compressed air was used to fix the o-rings, Prior to launching, holes appeared in the kit separating the o-rings from the solid fuel.

Vaughn calls "deviant normalization" the incremental process that the technicians, managers and engineers considered an acceptable risk the design of o-rings. She mentions that this behavior is a normal practice in the experimental projects with multiple unknowns, that develop at a large scale. (Vincenti, 1993)

In the launch day, the specialists come to the conclusion that beside the acceptable risk construction, the low temperature is another factor to

take in consideration. On the experimental cases, there wasn`t a temperature of 53F of the o -rings and realized that its needed a longer sealing time for the o-rings as the temperature decreases time (they did not needed the physicist Richard Feynman, Nobel laureate to highlight this fact). From the point of view of NASA, everything seemed as if the engineers were inventing instant principles.

Vaughn's investigation presents that for the temperature of the o-rings there was no criteria, even if NASA provided for the entire space shuttle at ambient temperature from 31F to 99F in a LCC - Launch Commit Criteria. The managers made decisions when the engineers had no irrefutable evidence to support their point. Vaughn results show that the disaster was the result of a "normalization of the deviance" and not caused by an amoral calculation of risk and benefit by unethical managers. The fact that the information was transmitted incomplete is a structural secrecy, in the organization, is normal in large bureaucracies. The product of culture that was supported by the NASA engineering as a "production culture" and from anywhere.

Vaughn's approach was used by Ronald R. Kline to the classroom and concluded that it has its difficulties and advantages. The benefit consists in the fact that students can study an individual characteristic identified in the engineering practice that presents how a normalization of the deviation from the initial expectations of the original design can be maintained by experienced people with good intentions (so people with ethics). Also, it demonstrates the confusing boundaries between managers and engineers, the adversity of distributing purely technological information in a bureaucracy and the issue of controlling a team by those from the outside who depend on the same group in terms of correct information. (Hughes, 1998; Kline, 1980; Kline & Pinch, 1996)

The negative result of this perspective is that some of the students are wrong interpreting that the executing engineer is not responsible for the accident caused by his design and that the only necessity in the ethical engineering is to have a cover insurance for the malpractice. In order to eliminate this interpretation, Kline requests from the students to study the normative implications of Vaughn in the practical engineering. (Lynch & Kline, 2000)

Universities and professional engineering societies are recognizing the more and more acute need of taking steps toward ethically educating engineers about the social implication of their work. Kline sustains that the STS experts are well positioned in order to provide a deeper opinion over the engineering practice in engineering and on its broad connections with

economy, politics etc. They extend the traditional approach of the practitioner engineers and moral philosophers.

In time, the big accidents from the history proved to be a role model in the improvements of devices and they have an important mark in the pedagogy of engineering ethics. The STS perspective helps to push us to approach more than "ethical disaster". (Petroski, 1985)

Adopting STS analytical conceptions, like Vaughn's accident research can bring daily engineering practice into the classroom to empower the cultivation of engineering ethics.

Thomas Hughes' research of "the Boston Bridge, a transportation infrastructure project", presents the elaborate complexity of engineering involving a lot of competing social groups in a real-time public project. (Petroski, 1985)

Analyzing this type of strategies, rather than spectacular accidents, can be more conclusive in the work of convincing academic colleagues engineering students that in addressing everyday issues of colossal importance, on ethical and social implications of engineering, they need better methods.

5. Ethics for students. Ethics for the engineering student

Most engineering colleges include ethics in their courses as a required element in the accreditation process. Some institutions have specific courses in ethics, while others require a humanities classes, philosophy for example, about morals and ethics. Most students consider that they are ethical persons and do not see the usefulness of the ethics course in the program. The implementation of the ethics courses does not aim to identify the condition of morality and ethics of the students, but the implementation of the professional ethics in their system. (Wynne, 1988)

The engineering students have to follow engineering ethics in order to be able to make the right decisions throughout their career. Ethical problems are characterized by the fact that they can have several solutions.

Ethics courses include the following elements:

1. Increasing appreciation for the ethical behavior;
2. Presentation of permitted ethic codes in the domain of engineering;
3. Engineering experiments which present specific non-ethical or ethical decisions and their consequences.

The purpose of ethics courses is to bring awareness of individuals in the engineering environment, and not only, the importance of correct decisions and thinking in all circumstances.

Overall, in education, between students and faculty members, the professional ethics has a definite dignity. Around the world have been developed multiple codes of professional ethics, which differ from one university to another. The majority of the values are respected.

Students have certain preferences regarding the components of ethics, such as:

- Correctness of behavior and politeness;
- Teacher-student confidentiality;
- Material payment of notes;
- The degree of tolerance and resistance of the teacher;
- Confidence and respect for the student;
- Suitable clothing and accessories;
- Avoiding inappropriate humor;
- Teachers do not use the utilities offered by the school for private benefits;
- To evaluate and grade students correctly;
- Normal behavior in the classroom;
- Motivation for learning;
- Spirit of cooperation and partnership with students;
- The teachers must respect the educational rules of the institution;
- Balanced performance of duties;
- Avoiding the teacher's humility or pride;
- Not using students in pursuing personal benefits;
- Avoid humiliation of students;
- Lack of discrimination of students;
- To take account of responsible students.

These elements were identified by Richard Pring and David Carr in their research that involved 24 components analyzed from the perspective of 350 students of the Islamic Azad University in Iran. 60% of the students selected were female and the rest male. They answered, from a personal point of view, a questionnaire of 24 questions about the faculty members from the perspective of the professional ethics. The study conclusion was that, from the perspective of behavior and politeness, the individuals behave politely in their relations with the students. So, overall, the results present a high professional ethics of the faculty. (Haghighattalab et al., 2019)

The study carried out by the two aimed at identifying the ethical components in education. Unfortunately, most universities in Iran do not

have a code of ethics for faculty members, students, or administrative staff. The Code of Ethics helps students and teachers improve their learning and teaching due to ethical behavior and will help create a beneficial classroom environment. Continuous studies are being starting to detect the branches in which the implementation of regulations and ethical codes is necessary to reach a high level of ethics in education. (Philip & Philip, 2015; Pring, 2001; Steneck, 1999]

6. Conclusions

An engineer in any field must follow the codes of ethics, be based on respect for people, integrity, honesty, be impartial in his professional judgment, respect professional confidentiality, properly use intellectual property, trademarks, patents and copyrights.

At the level of each company the Ethical Code is elaborated by the Commission for the elaboration of the ethical code. It applies to all hierarchical levels in the organizational structure. The principles contained in it are moral: integrity, loyalty, responsibility and respect for the law; and professional: competence, professionalism, transparency, objectivity, team spirit and tradition.

In the electric field, the presence of ethics is needed, so companies on this profile want to centralize their priorities on quality and competence to reach high performance; care and commitment to clients, by maintaining a relationship in which communication and understanding are paramount; the responsibility towards the community is manifested by the importance given to the environment through its protection and sustainable development; respect for tradition and past, always connecting with experience in the electric field; transparency in business and respect for employees for the perpetuation of a healthy and sustainable business environment.

The ethical code defines the principles, rules of conduct and values that employees and the company must adhere to and aims to promote ethical conduct in order to increase the efficiency in the electric field in order to achieve the proposed objectives. Failure to comply with the ethical code is an act of indiscipline and is sanctioned according to the internal regulations and the laws in force.

Ethics is made up of multiple elements and can be seen as an unwritten law that must be respected for the smooth running of things and for integration into today's society. Its complexity helps in finding solutions to problems that arise not only in the electric field, but in all areas of the

research. Ethics imposes respect for man and society and implements standards of harmonious integration and collaboration.

References

Boisjoly, R. M. (1987). Ethical decisions — Morton Thiokol and the space shuttle Challenger disaster. American Society of Mechanical Engineers Annual Meeting, Pap. No. 87- WA/TS-4. http://ethics.iit.edu/eelibrary/biblio/ethical-decisions-morton-thiokol-and-space-shuttle-challenger-disaster

Brey, P., & Jansen, P. (2015). *Ethics assessment in different fields. Engineering Sciences.* https://satoriproject.eu/media/2.b-Engineering.pdf

Downey, G. L., & Lucena, J. C. (1995). Engineering studies. In S. Jasanoff, G. Markle, J. Petersen & T. Pinch*, Handbook of science and technology studies* (pp.167-188). Sage.

Farahani, M., & Farahani, F. (2014). The study on professional ethics components among faculty members in the engineering. *Procedia - Social and Behavioral Sciences*, *116*, 2085-2089. https://doi.org/10.1016/j.sbspro.2014.01.524

Fleddermann, C. B. (2004). *Engineering ethics*. Pearson Education.

Haghighattalab, S., Chen, A., Fan, Y., & Mohammadi, R. (2019). Engineering ethics within accident analysis models. *Accident Analysis and Prevention, 129,* 119-125. https://doi.org/10.1016/j.aap.2019.05.013

Harris, C. E., Pritchard, M. S., & Rabins, M. (1995). *Engineering ethics: Concepts and cases*. Wadsworth.

Harris, C. E., Pritchard, M. S., & Rabins, M. J. (2009). *Engineering ethics. Concepts and cases*. Wadsworth Cengage Learning.

Hughes, T. P. (1998). *Rescuing Prometheus*. Pantheon Vintage Books.

Jasanoff, S., Markle, G., Petersen, J., & Pinch, T. (2001). *Handbook of science and technology studies*. Sage.

Kline*,* R. R. (1980). Professionalism and the corporate engineer: Charles P. Steinmetz and the American Institute of Electrical Engineers. *IEEE Transactions on Education*, *23*(3), 144-150. https://doi.org/10.1109/te.1980.4321399

Kline, R. R., & Pinch T. (1996). Users as agents of technological change: The social construction of the automobile in the rural United States. *Technology and Culture*, 37(4), 763-795. https://doi.org/10.2307/3107097

Lynch, W. T. (1997). Teaching engineering ethics in the United States. *IEEE Technology and Society Magazine*, *16*(4), 27-36. https://doi.org/10.1109/44.642561

Lynch, W. T., & Kline, R. (2000). Engineering practice and engineering ethics. *Science, Technology and Human Values*, *25*(2), 195-225. https://doi.org/10.1177/016224390002500203

Martin, M. W., & Schinzinger, R. (1996). *Ethics in engineering* (3rd ed.). McGraw-Hill.

Milici, L. D., & Poienar, M. (2019). Ethics - from research to the product. *Catalogul oficial al "CAdet INOVA" - Cercetări și inovații în viziunea tinerilor cercetători.* Editura Academiei Forțelor Terestre "Nicolae Bălcescu".

Petroski, H. (1985). *To engineer is human*: *The role of failure in successful design*. St. Martin's Press.

Porter, T. M. (1995). *Trust in numbers: The pursuit of objectivity in science and public life*. Princeton University Press.

Pring, R. (2001*)*. Education as a moral practice. *Journal of Moral Education*, 30(2), 101-112. https://doi.org/10.1080/03057240120061360

Steneck, N. H. (1999). Designing teaching and assessment tools for an integrated engineering ethics curriculum. *FIE'99 Frontiers in Education. 29th Annual Frontiers in Education Conference. Designing the Future of Science and Engineering Education. Conference Proceedings (IEEE Cat. No.99CH37011).* https://doi.org/10.1109/fie.1999.841685

Vincenti, W. (1993). *What engineers know and how they know it*. Johns Hopkins University Press.

Whitbeck, C. (1987). Integrating ethics teaching into courses in engineering design, *Science*, *Technology and Society, 62*(63), 12-17. http://ethics.iit.edu/eelibrary/node/1817

Whitbeck, C. (1998). *Ethics in engineering practice and research*. Cambridge University Press.

Wynne, B. (1988). Unruly technology: Practical rules, impractical discourses and public understanding. *Social Studies of Science*, *18*(1), 147-167. https://doi.org/10.1177/030631288018001006