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Anticipatory Ethics as a Method for Teaching Engineering Ethics

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1. Introduction

The exponential growth and development of engineering technologies and technological artifacts developed by engineers such as the electron microscope or Cryo-Electron Microscope, create a number of opportunities for introducing ethics to engineering students. All of fields within engineering are also influenced by information Computer Technologies (ICT's). One problem for teaching ethics can be simply stated, the rapid rate of the development of technologies and technological artifacts means that ethical issues with these technologies and technological artifacts are often only recognized after technologies have been developed and after artifacts have already been introduced and after they are being employed. Addressing the ethical issues with the technology often only takes place after the problem has occurred. Anticipating future technological development is difficult because technological development always seems to run ahead of current technology. Our speculations about the technological future outstrips our powers of reflection while identifying what is new with an anticipated technology can't be easily separated from what is merely the continuation of recent tendencies and developments. Anticipatory ethics is a recent development in ethics concerned with examining ethical issues with technologies and technological artifacts from the research and development stage, through the introduction stage, to the stage of marketplace permeation and saturation. [3][4][26][30]. Anticipatory ethical analysis and anticipatory engineering ethics, attempt to identify ethical issues with engineering and ICT technologies before and as technology develops and as a result, identification of ethical issues at an early stage of the technologies development so these problems can be addressed and potentially resolved before the technology is introduced.

This method of analysis can help fill the need in engineering ethics education and all forms of ICT's for the analysis of a wide variety of cases including, historical cases in engineering and ICT Ethics, the study of current technologies and cases as well as a need for an anticipatory ethical analysis of potential cases, related to developing technologies and artifacts. In addition, there is a need for a method that can focus on events that have just occurred (such as e. g. the latest development in wind energy research) and for the analysis of specific artifacts that are already in our world (such as e. g. robotic surgery platforms). The study of the historical cases and present cases provides a foundation for studying possible future developments. A method that is focused on events and technological artifacts helps bridge the gap between historical engineering and ICT Ethics cases, and cases related to anticipated technological developments that are the subject of study of anticipatory ethics. In the current technological environment where developments occur everyday it is important to provide a foundation for students to be able to identify ethical issues within emerging trends and technologies and to identify potential ethical issues as part of current educational practice.

In the contemporary world we are confronted with an overwhelming amount of information that threatens what can be called "event memory." Events seem to occur so rapidly that we potentially forget what just happened several days ago, much less 3 or 6 months ago. The loss of

event memory can lead to a loss of a sense of history. At the same time the "shock of the immediate" also seems to wear off in a matter of moments. The sequence of events that occur in the world has not accelerated, what has altered are the technological means at our disposal to identify and to be informed about what is occurring in the world around us and to analyze and discuss these events. Technological artifacts have altered the way in which we experience events. Smart phones which are also powerful computers allow instantaneous access to information about an event as that event is occurring. New technologies and technological artifacts play a mediational role between our lived experience and what occurs within the surrounding world. The study of historical cases that are archived can provide a basis for keeping a record of what has occurred in the course of the rapid development of events and cases in engineering practice and ICT through the study and archiving of cases. This foundation of cases and archived cases can help students learn to identify similarities between historical cases, similarities that may also be found within present cases, and then with issues related to emerging technologies and cases. Keeping an archive of historical, current, and emerging cases adds to the collective memory of engineering ethics cases. This archive of cases can provide in turn a foundation for an anticipatory ethical analysis.

The case based method developed below focuses on the study of artifacts, events and cases as the basis for anticipatory engineering ethics. What will be presented in this analysis will involve the use of a wide range of examples illustrating the intersection of historical engineering and ICT ethics, artifact and event based Ethics, and anticipatory ethics. This will be interwoven with 3 levels of case analysis.

2. Postphenomenology

A recent development in philosophy of technology is Postphenomenology. Postphenomenology plays an important role in the case-based method developed here. The term was 1st introduced by Don Ihde [20] [21] [22] [23] [24]. As described by Robert Rosenberger, "Postphenomenologists attempt to combine the philosophical traditions of phenonmenology and pragmatism; they investigate issues of human relations to technology; and they place an emphasis upon the analysis of concrete case studies". [25] Postphenomenology and the study of cases using this methodology focuses on how humans interact with technology and technological artifacts, and how this in turn influences how people interact with one another. Rosenberger further states, "Postphenomenologists study technology in terms of the relations between human beings and technological artifacts, focusing on the various ways in which technologies help to shape and mediate between relations between human beings, technologies, and the world. They do not approach technologies as merely functional and instrumental objects, but as mediators of human experiences and practices."[25] If we extend this analysis to engineering technology this means that this technology influences engineering practices, while it also mediates between engineering practices and those who employ the technology. "Second, postphenomenologists combine philosophical analysis and empirical investigation. Rather than "applying" philosophical theories to technologies, the post-phenomenological approach takes actual technologies and technological developments as a starting point for philosophical analysis. Its philosophy of technology is in a sense a philosophy "from" technology."[25] Leaving aside the study of the overarching theme of technology in general, the postphenomenological orientation focuses on technological artifacts and the role they play in influencing how a user of the artifact employs the artifact. What is also studied is how the artifact when it is employed, influences the agent who uses it as well as the agent upon

whom it is employed, and how artifacts mediate the relationship between the user and the recipient of the use of artifacts. These relationships can be seen and explored when they are applied e.g. to robotic surgery platforms.

What is critical in postphenomenology is the study of the relationships that develop between technologies, the users of these technologies, and those upon whom technological artifacts have influence. Technologies and technological artifacts have an influence upon the lived experience of those who employ them and upon the lived experience of those upon whom the artifacts are used. According to Rosenberger all postphenomenological studies share three main components: understanding the roles of technologies in the human technology-world experience, using experimental cases to reflect this experience, and the construction of an analysis of the co-shaping or co-constitution of human and technology to create the human-technology connection."[25] The case based method developed here employs the postphenomenological framework and style of analysis to bring to light the ethical issues of sngineering and ICT, through the study of cases. Postphenomenology will be employed to show the human technology connection. Postphenomenology provides a philosophical approach for exploring human-technology relationships and the connections to technology and technological artifacts that occur in the engineering lifeworld. Postphenomenology in conjunction with case based analysis can be employed to uncover how technological artifacts developed and came to be employed in engineering in conjunction with ICT. These artifacts shape the intentions of designers and users, and those upon whom they are employed. Technological artifacts influence deliberations, choices, the performance of actions and experiences in the world and postphenomenology can be employed to study artifacts and to see how these artifacts change day-to-day lifeworld experiences in the engineering arena. An important insight of postphenomenology is the recognition that "Technological transformations through ['Engineering and ICTs'] are non-neutral because these technologies are not neutral ... overtime we become conditioned by our technologies in non-neutral ways." [25] Technologies and technological artifacts may be used as tools, but they are tools that shape each of us and our experience of the world.

According to Rosenberger,"in the postphenomenological perspective, a technology is conceived as an artifact which comes between a user and the world, transforming the relationship between them. A technology plays a mediating role; it transforms a user's abilities to perceive or act upon the world".[25] This is particularly true of engineering technologies and technological artifacts such as e. g. robotic surgical platforms. Due to the rapid rate of development of technology, and due to the non-neutrality of engineering and ICT technologies and artifacts, the lack of event memory, and due to the insights offered by postphenomenology, a case based methodology can be introduced that focuses on events and cases at 3 levels. 1st, events and artifacts can be focused on individual case studies. (e.g. a case study related to the 1st robotic surgery platform, the Da Vinci system, the system that was introduced in 1999). 2nd, cases can be compared (e. g. after the introduction of the early robotic surgical platforms, other companies introduced their versions of robotic surgery platforms). 3rd, projections can be made based on the 2nd stage of case analysis. This involves the comparison of current cases to potential future cases. (e. g. based upon these earlier platforms, how will they affect the design of future platforms and how will they affect future surgery and how will they influence patients and future patients?

The decisions about what and how to teach engineering and ICT students in engineering or ICT Ethics classes and how to teach it presents teachers with a variety of difficulties. There is a limited amount of time for the introduction of material related to ethics into the engineering and ICT curriculums. How can a method be developed to optimize this limited amount of time? An important issue involves preparing students to think about what is occurring and preparing to them think about what is occurring and what is about to occur next, in the world around them. Students are thrust into a complex and continuously changing technological world that is not of their making and yet it is a world to which they must become calibrated in as rapid a fashion as possible in order to become effective professionals. Required courses within a curriculum prepare students for what accrediting institutions think is necessary for students to navigate and be successful in professional existence, once they have graduated. The already overcrowded technical curriculum allows for little attention to be inserting a sustained discussion of ethical, social and political issues into this overcrowded curriculum. The injection of a discussion of ethical issues into a curriculum is made even more difficult when professors often defend ideologies and the use of essential categories that are discipline specific and they remain committed to the pursuit of research agendas that are at times beyond the understanding of the students who are being taught and that have questionable relevance to the careers students are pursuing. A method for teaching engineering and ICT ethics must connect to the life world of engineering professionals in the field and to problems occurring in that world and to the lived experiences of the students who are being taught. Three factors are in need of consideration, the role of events and related cases that occur in the life world, how artifacts play a role in these events, and how these events and artifacts need to be integrated into case-based analysis. The 3 levels of cases discussed above can help integrate historical, current, and potential cases and issues into engineering and ICT Ethics classes through the use of levels of cases.

3. Genuine Substances, Objects and Artifacts

How objects and artifacts are defined plays an important role in the case-based method developed in this analysis. There are two fundamental approaches to objects and artifacts that can influence case-based analysis. The first approach is concerned with the identity of objects and with the foundations of the classification of these entities. According to Franssen et al, “most of the philosophical work done so far on identity and classification does address the identity and classification of naturally occurring entity - atoms, substances, animals, human beings. etc.” [9]. The difficulty with this approach to entities which has dominated the study of metaphysics and philosophy of science is that ‘artifacts’ cannot be neatly classified according to categories used to classify naturally occurring entities. In the philosophy of technology, technological artifacts have not been the primary object of study. This is made clear in the following quote from Lynne Rudder Baker, “For a long time throughout the history of philosophy artifacts have been in a neglected domain artifacts came into focus as objects of philosophical study only at the beginning of the modern era.” [9]. Artifacts have been ignored and devalued and relegated to a lesser status than natural objects by many philosophers and they are not considered to be an important subject of study. According to Lynne Rudder Baker there are five criteria that are related to what have been identified as ”genuine substances’ or entities that are irreducibly real and she suggests that artifacts have been discredited on the basis of all of them” [1].

1. Fs are genuine substances only if Fs have an internal principle of activity.

2. Fs are genuine substances only if there are laws that apply to Fs as such or there could be a science of Fs.
3. Fs are genuine substances only if whether something is in F is not determined merely by the entity's satisfying some description.
4. Fs are genuine substances only if Fs have an underline intrinsic essence.
5. Fs are genuine substances only if the identity and Persistence of Fs are independent of any intentional activity.

According to Baker "these five criteria can serve as a summary for the reasons why artifacts are not taken seriously as full members of the furniture of the world and, as a consequence, are not seen as being of Interest to metaphysicians as artifacts." [9]. The point of Baker's analysis is to highlight the focus of philosophical work that reflects upon objects that are taken to be genuine substances in philosophy while neglecting and ignoring the role of artifacts as central to lived experience within the surrounding life world. In contrast with this view of objects, there is a 2nd approach that focuses on how technology and the technological artifacts developed as a result of the development of technology and as a result engineering and ICT technology have come to play a crucial role in designing artifacts that will potentially improve human wellbeing.

A second approach to artifacts and the approach adopted here is that of phenomenology and postphenomenology, where the way that we exist in the world of lived experience, is characterized primarily by practical action. The actions we perform are is often accomplished through the use of 'artifacts.' According to Gallagher and Zahavi, "in our everyday lives we are pragmatists. To put it differently, our primary way of encountering worldly entities is by using them rather than theorizing about them or perceiving them in a detached manner." [12] The 1st view, which is the view outlned above by Baker, involves theorizing about the nature of objects while abstracting the objects from the contexts within which they are used. The 2nd approach is the phenomenological and postphenomenological approach. The phenomenological approach of Heidegger, "*emphasizes that the world, rather than being simply a complex of entities characterized by substantiality, materiality, and extension, is in fact a network of meaning. More precisely the world we live in, and the world as we perceive it, is a world saturated by practical reference of use."* [12]. In the world of technology and technological artifacts and by extension the world of engineering and ICT technologies, artifacts play a critical role in engineering practices. This can be seen in the arena of e.g. robotic surgery platforms where the artifact (the surgical platform) has a use. What this approach to artifacts reveals is that ethical and social issues arise for technologies and technological artifacts because of the contexts within which they are used. However, this can be taken a step further, ethical and social issues emerge for technologies due to how the technologies and technological artifacts are designed, how they are used and according to the outcomes produced by the technologies and technological artifacts.

The descriptive account of practical activities in the surrounding world is characterized by the way in which artifacts are employed to accomplish tasks and this use of an artifact establishes a relation between an agent's lived experience and the surrounding world. An engineer designs a robotic surgical platform, while a surgeon uses a robotic surgical platform to perform surgery on a patient in an operating room equipped with a robotic surgery platform. With the phenomenological approach "in daily life we do not interact with ideal theoretical objects, but with tools and objects of practical or emotional or aesthetic or personal value. [Our interest is guided

by practical and social concerns just as our actions are guided and shaped by patterns of normality by how others act when we use equipment or instruments my goals are in her subjectively structured when I use anything as a natural object for manufacturing a piece of equipment, my uses are guided by the mere fact that there are right and wrong ways to use such things: my uses are guided by norms."[19]. What this means in the context of the use of a robotic surgery platform is that there are 2 levels of norms, norms related to how technology and technological artifacts are employed, and norms related to how engineering practitioners should comport themselves towards those on whom the artifacts are employed.

The method developed for engineering and ICT ethics developed here is based upon the idea that ethical issues with technological artifacts need to be understood from the perspective of contexts of use of the artifact. Case studies at the 3 levels of cases referred to above allow students to see, first, the context of use of historical technologies and technological artifacts. Second, see the context within which technologies and technological artifacts are currently being used, and from these 2 types of analysis, third, the projection of new technologies and technological artifacts and how they may be developed and used in the future. This method for the study of cases engages students in describing the way, within the context of the use technologies and technological artifacts, how they a wide variety of stakeholders, from the design of the artifact through development of the artifact to the use of the artifact. Ethical issues emerge for technologies and technological artifacts based upon how these technological artifacts are designed, developed and used, and how these stages of development affect all of the stakeholders when the artifacts are employed.

4. Agency, Artifacts, and Ethics

In order to understand the ethical issues involved with technological artifacts that are at the center of the events that are studied in case studies, we first need a preliminary understanding of ethics. An artifact based ethical analysis creates difficulties for ethical analysis because of how artifacts lack agency. Issues of agency related to artifacts must therefore be traced back to the humans that use the artifacts. What needs to be brought into focus is how agents employ artifacts to perform actions. A basic definition of ethics can be related to agents who perform actions. Dwight Furrow identifies the focus of ethical analysis as involving a series of factors related to how agents perform actions. As Furrow states, ethics is related to evaluating actions and actions are performed by those capable of being moral agents. Moral agents are defined in the following way, "A moral agent is a person who has the ability to discern right from wrong and to be held accountable for his or her own actions. Moral agents have a moral responsibility not to cause unjustified harm. [11] Traditionally, moral agency is assigned only to those who can be held responsible for their actions." [8] Since artifacts are incapable of being held responsible for their actions, artifacts are incapable of being moral agents, so the agent employing an artifact has to be the focus of moral agency. Furrow also states, "When we evaluate an action, we can focus on various dimensions of the action. We can evaluate the person who is acting, the intention or motive of the person acting, the nature of the act itself, or the consequences." [11]

Several important distinctions are made within this passage. 1st, ethical issues related to the development of technologies and technological artifacts are based upon the idea that what a technological artifact does, is exert an influence upon how an agent perform an action. In

addition, this action is an extension of the agent's action. An engineer designs a robotic surgical platform. A robotic surgical platform in turn is an extension of the operator of the platform's intentions and actions. In other words, the actions performed through the use of technological artifacts, such as robotic surgical platforms, are only capable of being evaluated based upon the actions of the person or persons designing and controlling the technological artifact. 2nd, if this is true and if we endorse the distinctions identified in the preceding passage and apply them to the use of artifacts, there are three possible levels of ethical evaluation for person's designing and using artifacts. We can evaluate the actions of a person designing or controlling the actions of technological artifacts. We can evaluate the intentions of the person designing or controlling and directing the actions of a technological artifact, we can evaluate the actions of the person using the artifact, or, we can evaluate the consequences of the actions intended by the person designing or controlling the actions of a technology or a technological artifact. This applies to robotic surgical platforms in the following way, the intentions, actions, and outcomes of the designer of the robotic surgical platform can be evaluated. The intentions of the person operating and employing the surgical platform can be evaluated, the actions of the operator of the platform can be evaluated, and the outcomes of the actions of the operation of the surgical platform can be evaluated. The use of the surgical platform on a patient can also be evaluated from the perspective of the agent upon whom the surgical platform is used. From this perspective we need to ask, what is the intention of the surgical platform for the patient, what act is performed, and what outcome aimed at for the patient? This analysis can also be carried out from the perspectives of each of the stakeholders affected by the design and use of the surgical platform.

Unless technological artifacts are fully autonomous, we assume that the actions of artifacts are subject to ethical evaluation based upon the actions of the person controlling the artifact, the intentions of that person and the consequences produced by that person's use of the artifact. Ultimately it is the person or persons, who are controlling the technological artifacts, who are subject to moral evaluation. If we want to identify the ethical issues with the design and use of technological artifacts, we need to ask, what actions are performed when the artifact is used, what are the intentions of those using the technological artifacts, and what are the consequences of the use of technological artifacts? A 4th dimension can be added to these 3 dimensions related to virtue ethics and the character traits of those using technological artifacts, here we can ask, what are the character traits of the person designing or controlling the technological artifact? [38]

Ethical issues with artifacts emerge as the result of the interaction of how an artifact is employed by a user in a specific context, in contrast with how those who experience how the artifact is employed by the user in that context. With robotic surgical platforms there is the designer of the platform, there is the user of the technological artifacts (the surgical platform), the technological artifacts, and there is who and what is influenced by the activities of the designers and users of the artifact. The intention of the users of designers and users of artifacts involves instrumental reasoning and establishing a purpose for the technological artifacts (such as e.g. a robotic platform performing surgery) as well as those affected by the purpose of the technological artifacts, which involves the technical issue of being a patient affected by the robotic surgical platform. At one level it is from this interaction between the technical use of the artifact by those employing the artifact (the surgeon using the robotic surgical platform) and how the technical use of the technological artifact affects another person, the patient, that ethical

issues with technological artifacts arise. A preliminary ethical analysis using standard ethical principles (and codes of ethics).and policy recommendations from government agencies such as CDC and international agencies such as WHO, can be developed from how the intentions behind actions, actions and outcomes of actions affect the stakeholders affected by the technology. Those affected by the technology and the technological artifacts include the designers of the technology, those who employ the technology and those upon whom the technology is used. There are a variety of stakeholders who are affected by the manufacturing of the technology and the use of the technological artifacts.

We can next turn to the ways in which the actions of technological artifacts through their use may be evaluated, we will continue to use a robotic surgical platform as an example. If a robotic surgical platform is used by a surgeon to perform surgery on a patient, the platform mediates between the surgeon and the patient. If an error is made the error will be traced to the actions of the surgeon controlling the surgical platform that performs the action. There could also be a technical flaw with the performance of the platform. These could be taken back to a fault in the design of the platform. The patient upon whom the surgery is performed will need to be well informed about how the surgical platform works in order to assess whether or not they will opt in for robotic surgery. This can be viewed as a matter of informed consent. However, if a patient is not fully informed about how the robotic platform works, they may claim that their right to informed consent has been violated. What might be at issue is the intention of a hospital to use surgical platforms and the training of surgeons to employ a robotic platform, in contrast with the negative right of patient to have the surgical platform used upon them in a safe way. For surgeons the use of the robotic platform may lead to greater precision in surgery while from the perspective of the patient, there may be a focus on the need for safety. This can also be viewed as a matter of positive and negative rights. Patients have a negative right to be free from being misinformed about the issues related to robotic surgical platforms. Real world case studies using a wider variety of stakeholders, can be employed to help train students to develop much greater detail in an ethical analysis than what is presented in this oversimplified example.

5. Cases/Historical Cases/History of Cases

The method of analysis developed here involves analysis of cases from 3 time frames, historical, historical, present, and anticipated future cases at 3 levels. [48] These 3 levels of analysis include 1st, analyzing individual cases, 2nd, comparing historical and current individual cases, and 3rd, developing an anticipatory ethical analysis of future possibilities based upon the comparing of historical and current cases, and projecting technological developments into the future.

5.1 Cases/Historical Cases

An important element of the method developed here for case analysis involves providing a framework for conducting the case analysis. This requires creating a rubric that can be used by students to construct their case analyses. The following rubric which can be applied to engineering ethics cases was developed for required Engineering Ethics and Computer Sciences Ethics classes during 3 accreditation cycles.

Steps in Ethical Case Analysis

1. Get the facts straight. Review the case. Briefly recap the details of the case at the

beginning of your paper.
2. Identify the central stakeholders in the case.
3. Identify the technical/professional issue/problem in the case.
4. Identify the Ethical issue/ problem or issues/problems in the case.
5. Analyze the case from 3 perspectives, use 1 ethical principle for each perspective. Attempt to resolve the technical and ethical issues/problems using both technical and ethical standards.
6. Will your solution to the issue/problem withstand criticism from the perspectives of both a variety of Ethical principles and Professionals in your field?
7. What recommendations can you make about the issues/problems in the case based upon your ethical analysis?

The 1st level of case analysis is focused on a technology, an individual artifact, or an individual case. In terms of cases studies related to robotic surgery, this analysis could occur on 3 different levels. On the 1st level there are classic historical cases. As technological artifacts surgical robots could be studied in the sequence of their historical development. The technology in general could be studied or specific examples could be studied.

Surgical Robots
Types of Surgical Robots
Anthroorobot Puma Artemis Probot 8 RoboDoc Aesop Rams Da Vinci

This 1st level of analysis could also be applied to another subject such as autonomous vehicles. The subject in general could be studied or individual cases can be studied. Historical cases related to autonomous vehicles such as, Cars, Trucks, Trains, Ships and Airplanes. Once these topics are analyzed individually, specific examples of these subjects could be analyzed. They could then also be used in a project where the 3 cases are compared to one another. Each of these cases can be analyzed individually and they can also be used within a group project where they can be combined into a team project where the cases are analyzed in the historical sequence in which they occurred. Each case has technical problems, social problems and ethical problems associated with it. A simple diagram can situate these cases in the context of autonomous vehicles.

Autonomous Vehicles
Autonomous Cars/Trucks/Trains/Ships/Planes

Current developments with Autonomous Cars
Tesla, Google, and Uber

Project future developments with Autonomous Cars
Tesla, Google, and Uber

5.2 Historical Cases and Present Cases

In addition to historical cases such as cases related to autonomous cars, there are also current developments with technologies and technological artifacts including surgical robots.
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Surgical Robots
Current Developments
Da Vinci Alf X Flex Cyberknife Novalis Gamma Knife System Robodox Rio Robotic Air Arias

Depending on the choice of subjects made by an instructor, any number of cases could be selected for study. In other areas of engineering ethics there are also cases that emerge at any given moment in time, such as e. g. issues related to the development of energy. The design and development of energy platforms are a type of engineering procedure, that fits into a historical sequence of procedures as diagrammed below.

Energy Platforms
Wind Hydro Nuclear

Nuclear Plants
Three Mile Island Chernobyl Fukishima Future (Thorium, Salt Cooled)

Similar taxonomical diagrams can be constructed for other areas of engineering ethics, such as research on engineering related to Oil recovery. A focus could be much more specific, e. g. it could focus on Oil rigs.

Oil Rig Accidents
Ocean Ranger Deep Water Horizon Petrobras' Echova Drilling Platform

Examples can developed for other the areas of chosen by the instructor of and/or students in the course. Below is a preliminary diagram for Space vehicles.

Space Vehicles
Challenger Columbia Apollo 13 Mission to Mars

Technologies that have recently emerged and that will continue to develop, can also be the object of study. A number of companies are developing vehicles for a mission to Mars. As present cases emerge, they become part of the fabric of contemporary events and they can be studied as individual cases. Historical cases were once present cases. However, historical cases can still be related to present cases. Some recent examples of this can be found in the development of robots.

Robots
Home Use Industrial Military

Each of these subjects could be studies at the historical cases, present cases and the imagined or projected future cases.

5.3 Present Cases related to Anticipated cases

There are also examples of anticipated technologies and technological artifacts. For surgical robots there are anticipated developments.

Surgical Robots

Anticipated Developments
Miro Raven Surgenius Turp

In the process of teaching ethics it is important to realize that historical cases provide a good area for the study of the nature of technology, this can include study of specific examples of the technology and engineering, and of both successes and failures.

What can be introduced after the study of this sequence of cases is that developments related to recent cases can be employed as the basis for studying emerging and anticipated cases. In the diagram above we see a framework that combines the 3 levels of analysis that is at the center of the method introduced in this paper. A method that introduces historical, present cases, and then attempts to anticipate emerging and future, can follow the pattern depicted below for robotic surgery platforms.

Surgical Robots
Historical Surgical Robot Platforms
Anthroorobot Puma Artemis Probot 8 RoboDoc Aesop Rams Da Vinci

Current Surgical Robot Developments
Da Vinci Alf X Flex Cyberknife Novalis Gamma Knife System Robodox Rio Robotic Air Arias

Anticipated Surgical Robot Developments
Miro Raven Surgenius Turp

This introduction of cases at the 3 levels identified above can be done for all of the subjects that the instructor chooses to have a class study. If groups are assigned to study a specific subject, the students in each group can then pick a specific subject or artifact to study. When groups are selected in a class of 28 to work together to compare their individual case studies with one another and to develop a group presentation there presentations will introduce members of the class to their subject, ethical issues, and attempt to resolve technical issues through application of ethical issues. In this way the students in class can easily be introduced to 8 subjects and 32 cases through student presentations.

6. Anticipatory Ethics

One of the problems that is often stated about anticipating technological developments and anticipatory ethics is that we cannot foresee or predict the future. With the method presented in this discussion an effort is made to address this issue. The effort begins with assigning students to study individual historical cases. Students are called upon to reflect upon individual cases and then in a more detail analysis to combine these individual cases into a comparison of the individual cases with one another. The work related to comparing historical cases and current cases leads to the projection of trajectories for emerging cases. Through the use of imagination, the projection of cases can be extended to the future. The world of the future can be conceived to be a fictional world that is similar to the current world but different in other ways. The world where a space mission to the Moon is conducted, based on previous missions to the Moon, is a familiar world, but the world of a mission to Mars is an imaginary world, that we approach through imaginatively projecting future possibilities. After conducting individual case analysis,

students can work together in groups where they combine cases. With this background, working together students can then work to develop and present a group presentation where the individual cases from history, the contemporary world and future possibilities are compared with one another. This is done through 3 levels of ethical analysis. Anticipatory ethics takes this a step further by requiring the members of a group to attempt to represent an unknown future in a multitude of competing visions related to possible developments for technologies and technological artifacts involving engineering technology. What technology must be developed and employed to attempt to address the challenges that need to be confronted and overcome for a successful mission to Mars? At the center of this analysis is an analysis that includes a variety of stakeholder perspectives that need to be included in our moral considerations.

Reflection upon the future development of engineering technology and technological artifacts, and then upon the ethical problems that may arise as a result of these developments requires that students sketch out and engage with visions of what engineering technology and technological artifacts in the future might look like. One the key points of anticipatory ethics is to use reflecting upon the future and ethical problems that may arise in the future, in order to influence actions in the present. This can be accomplished by projecting current trajectories, imagined future states and scenario's, and attempting to determine whether these states are desirable or undesirable. According to Bhuta et al, "the study of the future is an exercise where" the lines between forecasting, prediction, speculation, envisioning, and even science, are blurred." [2] This reflection upon the future development of technology and technological artifacts, as they may come to exist in the future, is necessary for attempting to make improvements in the present. Reflecting upon the future is aimed at influencing action and thought in the present." [2] To reflect upon competing visions of the future is to contest competing visions of the present. The present is the place from which we make decisions about what future we want to come into existence. Our visions of the future influence how we think about the present and from the present we make projections about which future will exist. Students need to be encouraged to engage in this reflective activity.

This view of the significance of anticipatory ethics is nowhere more important than with reflecting upon the future of the development of technology related to a mission to Mars. The method developed in this analysis is aimed at developing in students the habit of reflecting upon the future. Reflecting upon the development of engineering technologies and technological artifacts and how they may continue to develop in the future must also include reflecting upon social and ethical issues that may arise with this development. Some of the questions that need to be taken into consideration about the introduction of a mission to Mars can be developed from the questions that are asked about autonomous weapons by Bhuta et al.[2] The kinds of questions that need to be asked can include, what kinds of human cognitive judgment and decision making are the archetypes for what is variously understood as 'autonomy' in the context of developing technology for a mission to Mars? Can engineering technologies adequately replicate technology that will be needed for a mission to Mars? Are engineering technologies best understood as an extension of human task autonomy, with increasing autonomization of judgments and decisions being the relative index for judgments about technology for space missions? Can engineering technology supplement human-judgment without also creating human-judgment displacement? Can the risks posed by the behavioral uncertainty attendant upon increasing employment of engineering technologies and technological

artifacts be adequately assessed in the context of developing technology for a mission to Mars? In the contemporary circumstances, where there is exponential technological development and growth, educators are called upon to prepare students for addressing technical and ethical issues in the present, and as they may arise in both the short- and long-term future.

7. Conclusion

This analysis has argued that the study of cases is critical to introducing students to engineering and ICT ethics. The details of cases introduce students to the technical and ethical idiosyncrasies at issue within the cases studied. The study of cases lets educators give examples of the important technical distinctions that are needed for students to be proficient in their fields of study. At the same time cases provide an important avenue for introducing students to ethics and to ethical issues arising within these same cases. With the introduction of the 3 levels of cases as suggested above, educators can provide students with a foundation, through anticipatory ethics, for confronting problems and ethical issues in a world that will soon be upon them. It is incumbent upon educators to prepare students to think about a range of cases including cases that may potentially emerge as the result of and in light of an uncertain future. The study of cases and anticipatory ethics can help educators to prepare students for confronting current issues and emerging issues. This study can perhaps help make the contemporary world a better place and eventually contribute to making the world of the future, a better place.

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