Ethics in Science and Engineering
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Codes of Ethics and Ethical Standards

6.1 Introduction

As best as is know at this time, every society and professional group has in place a range of norms to guide the behavior of its members. Similarly, colleges and universities are built on moral obligations, ethical responsibilities and principles and codes of behavior (Baca and Stein, 1983, page 7). Furthermore, there is a direct correlation between levels of moral outrage expressed and the importance of what is expected (the *norm*, an indicator of professionalism) from ethical standards (Braxton and Bayer, 1999, page 3).

In the realm of higher education, norms specify the desired practices with respect to teaching, research and service. Without norms, faculty members would be free to follow their own unconstrained preferences in teaching and research. Norms also represent what is considered important by a group articulating how professional choices mesh with services (Braxton and Brayer, 2002, 4).

It might be argued (unsuccessfully one hopes) that it is difficult to establish unambiguous ethical standards in academia, and this leads to a range of judgment calls (Whicker and Kronenfeld, 1994, page 9). The nature of this challenge is shaped by factors such as information overload and competency, both of which impact on departmental cultures, individual academic roles and identities. Furthermore, there is a relationship between academic communities and the ideas they express (Becher and Trowler, 2001, page 23). Academic culture comprises disciplinary knowledge, growth, enquiry methods, and research outcomes.

Whether or not they are in academic world or the commercial world or the governmental world, most scientist and engineers believe that they are honest; capable of acting not from instinct, but rather from a reasoned set of rules that are defined under varios (relevant *codes of ethics*). Briefly, a code of ethics provides a framework for ethical judgment (the incentive to do the *right thing*) by a scientist or engineer (Martin and Schinzinger, 2005; Fleddermann, 2008); although there are thoughts (not necessarily agreeable) that many plausible-sounding rules for defining ethical conduct might be destructive to the aims of scientific enquiry (Woodward and Goodstein, 1996).

For most of history, the discussion of ethics was dominated first by superstition and later by religious doctrine, and thus largely resistant to reasoned examination. It is only in the last few centuries have ethics been rigorously pursued outside of religious doctrine. Currently, even those who hold strong religious convictions are now dependent upon arguments from secular ethics to resolve disagreements with people of different religious beliefs and cultures. Likewise, most religious doctrines now accept that their texts should be viewed critically as products, at least in part, of human cultures.

Alternatively, if a scientist or engineer does not consider a religious text as the first, last, and only word on ethics, then he is left to find another basis for ethics (Schwartz, 2001, 2003, 2005). To reduce the problem of interpretation and the prevalence of inherent prejudices, one needs to seek a universal basis that can transcend the boundaries of faith and culture.

Despite the capacity for rationality, scientist and engineers have several significant obstacles to overcome when considering ethics. Foremost, there is evolutional memory and behavior patterns which can lead scientists and engineers to value themselves first, the scientific or engineering community second, and colleague third, if they are given any value them at all. Such patterns of thought are often referred to as, "moral intuition or moral instinct," i.e. that which feels right is right (or ethical) (Sommer, 2001).

However, not every scientist or engineer has the same instincts about ethics and not all instincts appear to be equally valid. Indeed, it is easy for any scientist or engineer to criticize or condemn the value or prejudices of others and so free themselves from ethical issues. Indeed, it is very difficult for scientists and engineers to distance themselves from their own views, so that they can dispassionately search for prejudices among the beliefs and values others hold.

Likewise, it is important that ethics, whenever possible, avoid deferring to potentially prejudiced instincts. As rational beings, scientist and engineers are not supposed or required to be slaves to these instincts.

Scientific research offers many other satisfactions in addition to the exhilaration of discovery. Researchers have the opportunity to associate with colleagues who have made important contributions to human knowledge; with peers who think deeply and care passionately about subjects of common interest, and with students who can be counted on to challenge assumptions. With many important developments occurring in areas where disciplines overlap, scientists and engineers have many opportunities to work with different people, explore new fields, and broaden their expertise.

Researchers often have considerable freedom both in choosing what to investigate and in deciding how to organize their professional and personal lives. They are part of a community based on ideals of trust and freedom, where hard work and achievement are recognized as deserving the highest rewards. And their work can have a direct and immediate impact on society, which ensures that the public will have an interest in the findings and implications of research.

Research can entail frustrations and disappointments as well as satisfactions. An experiment may fail because of poor design, technical complications, or the sheer intractability of nature. A favored hypothesis may turn out to be incorrect after consuming months of effort. Colleagues may disagree over the validity of experimental data, the interpretation of results, or credit for work done. Difficulties such as these are virtually impossible to avoid in science and engineering. They can strain the composure of the beginning and senior scientist alike. Yet struggling with them can also be a spur to important progress. Scientific progress and changes in the relationship between science and engineering and society.

Individuals operate according to their own beliefs of what is considered moral and what is not. There must be some over-riding code of ethics for scientists and engineers. However there will always be those scientists and engineers whose code is very simple: self first, self last, and, if there is anything left, self again.

The role of a *code of ethics* is characterized by both descriptive and prescriptive aspects. One can choose to affirm or deny role responsibility. Particularly when the occupant of a position is a scientist or engineer, it might be expected that the requisite knowledge and skills demanded by in these esteemed positions would be sufficient to guarantee research integrity except in a few extraordinary cases.

There is a direct relationship between the health of a profession and the maintenance of ethical standards, in academia and industry (Craine, 2004). Central to this relationship is the society culture which varies within and across societies.

The ethical culture of a society is a combination of intended and unintended outcomes that emerge from each of the facets of society (Figure 1). The nature of the ethical environment depends on how these facets impact at the membership level. Society leaders are basically mandated to enforce policies, rules and regulations. The manner in which that is done depends on the administrative style of leaders of each particular society.

The various scientific and engineering disciplines are world-wide professional disciplines (Harris, 2004). The members of these disciplines collect factual data and the ensuing treatment of the data to discover new arenas of knowledge is universal. No one can foresee the tortuous path of scientific and engineering investigation and know where experimentation and observation and may lead. Then there is always the mode of data interpretation.

The pursuit of science and engineering requires freedom of thought and, in the academic sense, unrestricted communication. It is through the professionalism of the members of the scientific and engineering disciplines that world knowledge and technology advances. Yet there are continuous reports of unethical behavior in the form of data manipulation, cheating, and plagiarism at the highest levels of the disciplines. The causes are manifold whether it is the need to advance in one of the chosen disciplines or to compete successful for and obtain research funding.

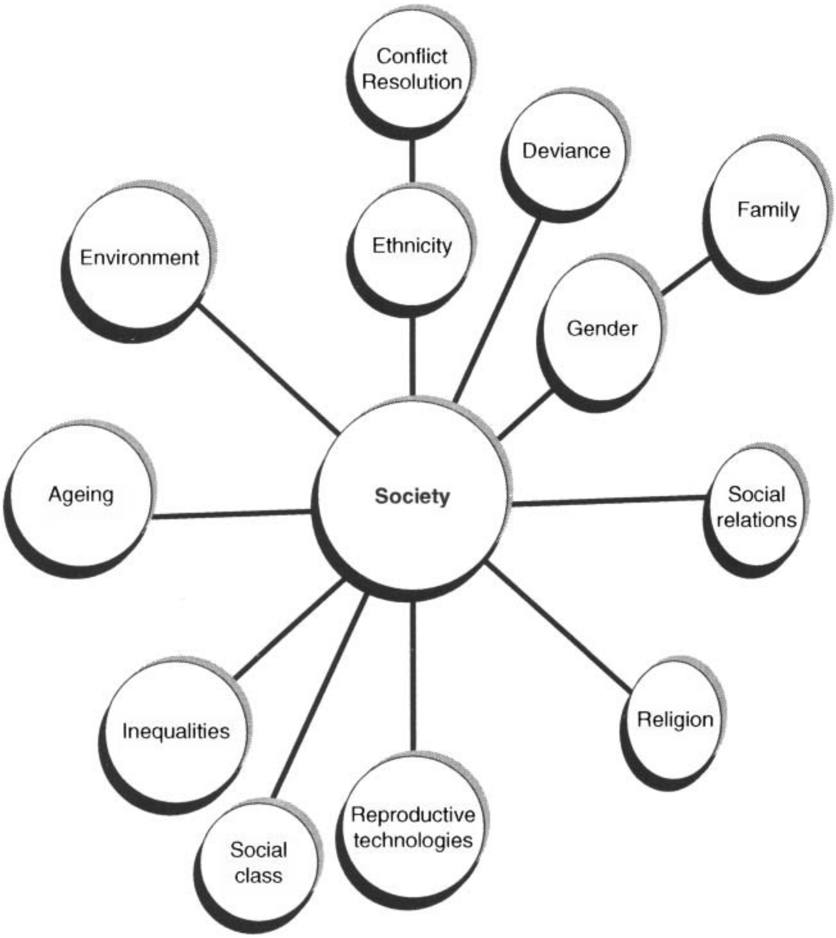

Figure 1. Ethically loaded social issues.

Research in the scientific and engineering disciplines offers the exhilaration of discovery. In addition, researchers have the opportunity to associate with:

1. colleagues who have made important contributions to human knowledge,
2. peers who think deeply and care passionately about subjects of common interest, and
3. students who can be counted on to challenge assumptions.

Also, scientists and engineers have many opportunities to work with different people to explore new fields and broaden their expertise, especially where disciplines overlap (Harris, 2004).

The reliability of scientific knowledge also derives partly from the interactions among scientists and engineers on an open and trustworthy basis (Davis, 1991; Alcorn, 2001; Altman, 1997). By engaging in such social interactions at society meetings and other forums where knowledge is presented and discussed, researchers must call on their technical understanding of the world and convince a collection (or community if the work is published in a technical journal) of peers of the correctness of their concepts, which requires a fine understanding of the methods, techniques, and conventions of technical research science and engineering.

However, research in any technical discipline can entail frustration and disappointment as well as satisfaction. Whether or not an experiment fails or a hypothesis turns out to be incorrect are all learning experiences. Instead of attempting to rationalize why an experiment failed, the investigator should determine if the experimental design was correct (or incorrect) or whether the collapse of a favored hypothesis is more likely the commencement of a modified hypothesis that is more logical than the previous hypothesis.

It is at this stage that many technical researchers decide that the experimental design was not incorrect or the failed hypothesis was not incorrect and they push forward to explain the experimental results. If the conduct of research in not monitored closely by peers and supervisors a situation exits where bending of the truth (it may not be called cheating but that is what it is) and the empirical objectivity of the researchers is lost. Often when this occurs, technical integrity has been forfeit.

For example, the experiment that failed becomes the experiment that succeeded because of a data point that has just been discovered. The defeated hypothesis becomes the successful hypothesis because the experimental design produced a datum point that the researcher was seeking. The means by which the datum point came about is another issue and is looked upon as good fortune by the supposedly unbiased and totally honorable involved researcher. Or the datum point was discovered in a blinding flash of untruthful inspiration by the researcher's co-worker who knew how important such a data point would be. The experiment that failed becomes the experiment that provided crucial proof of a concept.

On the other hand, too many points can be a hindrance to a researcher and lead to hours (or minutes or seconds) of heart rending consideration. The result might be that out of twenty four shotgun-patterned points on an x-y chart, eighteen points are omitted as flyers. The result is an x-y relationship on the chart that gives credence, even proof, to the hypothesis and results in wide acceptance of the hypothesis and copious honors for the researcher. After the success of such a brilliant hypothesis, there are few if any (perhaps because of funding constraints) who will repeat the work to determine if the data are correct. The hypothesis lives on and it is only after serious issues have been raised at some future time that the hypothesis is reworked. By then the original researcher may have retired after a distinguished career whose reputation in now beyond reproach. Younger researchers who could not make any sense of the hypothesis and report their data are at first criticized and ostracized.

Deleting data points is hardly uncommon, initially, all of the data points are printed on a scatter plot, and so-called flyers that do not match the plot are omitted. This is such a familiar situation in research that there are many reasons for deleting the non-conforming data.

This would imply that there are certain situations in which the practice is considered to be acceptable but such deletion actually amount to misrepresentation. Flyers can be influential or not influential insofar as they are far removed and inconsistent with the rest of the data, or are far removed but consistent with the rest of the data. In the former case, summarization and analysis of the data both with and without the outliers can be performed and the different inferences and conclusions are assessed, with and without the flyers. Nevertheless and in either case, all outliers must be reported. To do otherwise, is tantamount to technical fraud though dishonesty (intentional deception) (Resnik, 1998, 2000).

Another form of deception occurs when the reader is led to believe that the research design and execution were, according to the data points, flawless. Needless to say, both of these false impressions are intended not to further the ends of research but to further the self- interest of the investigator; such as making the publication more publishable, to garner honor or admiration or to discover a finding for the investigator and his research school.

Deception in data reporting is a remarkably reprehensible act. It dishonors scientists and engineers (from whom we expect the truth; anyone, scientist or not, can lie and deceive). It also dishonors the institution (which technically owns the data) so that the act of misrepresentation blemishes, by extension, the reputation of the institution; and to the extent that the data might someday be implemented in a commercials scenario.

Consequently, investigators who are blasé about deleting data points have probably neither thought through their moral obligations as scientists and engineers nor reasoned about the possible consequences their deception might influence future research participants. It is, as pointed out above, an expression of self-interest, and egomania.

In short, unethical behavior in the science and engineering disciplines is alive and continues to plague the minds of those who see such behavior as well as the general public who may experience such behavior when it is reported in the popular press. There is also the need to determine if ethics is alive. It is! But it is the minority (at least we hope a minority) of researchers who are the miscreants and give ethics a bad name because of their flaunting or bending of the truth or, for the want of a better word (if there is such a word) cheating.

6.2 Ethics

Ethics is not the same as feelings. Feelings provide important information for our ethical choices. Some people have highly developed habits that make them feel bad when they do something wrong, but many people feel good even though they are doing something wrong. And often our feelings will tell us it is uncomfortable to do the right thing if it is difficult.

On the other hand, ethics is not religion. Many people are not religious, but ethics applies to everyone. Most religions do advocate high ethical standards but sometimes do not address all the types of problems we face. Similarly, ethics does not mean following the law. A good system of law does incorporate many ethical standards, but law can be a function of power alone and designed to serve the interests of narrow groups.

Ethics does not involve following culturally accepted norms. Some cultures are quite ethical, but others become corrupt; the old adage when in Rome, do as the Romans do is not a satisfactory ethical standard.

Finally, ethics is not science or engineering. Science and engineering do not give direction on what is right and what is wrong. Scientific and engineering sub-disciplines may provide an explanation for human events but ethics provides reasons for how humans ought to act. Just because something is possible from a scientific or engineering aspect does not mean it is ethical.

The realm of ethics is concerned with standards and requirements for socially acceptable behavior in addition to following proper procedures for getting things done at any level of interaction: individual, group, organizational, community, governmental or regional.

Ethics has several strands:

1. descriptive ethics, that is, the actual behavior of scientist and engineers and the ethical requirements of their behavior;
2. normative ethics or identification of the values that sufficient to guide interaction;
3. meta-ethics which questions the meanings of all that ethics has been concerned about;
4. applied ethics or the application of normative rights to specific issues, disciplines and settings (Kitchener and Kitchener, 2009).

The requirements in this regard are stipulated in various Code of Ethics documents of scientific and engineering societies, such as the American Chemical Society (ACS) and the American Institute for Chemical Engineers (AIChE) as well as the many and other technical societies across the world. However, such codes do not resolve the issues which, in the final analysis, depend on personal decision-making and because knowledge claims must be free from bias, prejudice and personal values (Kitchener and Kitchener, 2009).

These codes cannot and must not be ignored by using claims of academic freedom. There are many instances where laws have been flaunted because an attorney has argued successfully that to obey the law is an infringement of his client's constitutional rights. It is not his client's constitutional right to bring harm to another person by violating a Code of Ethics.

There are several descriptions or definition of ethics including:

1. a system of moral principles, which are the ethics of human culture,
2. the rules of conduct recognized in respect to a particular class of human actions or a particular group; culture, which includes medical and Christian ethics;
3. moral principles, such as the ethics as of an individual which forbid betraying a confidence, and
4. the branch of philosophy that deals with values relating to human conduct; especially in respect of the correct or incorrect nature of certain actions and the motives behind such actions (Becker and Becker, 2002). Ethics is also "the normative science (and engineering) of conduct and conduct is a collective name for voluntary actions (Lillie, 2001)."

In this regard voluntary actions are those actions that could have been done differently (Lillie, 2001; Harris, 2004). Such actions may be good or bad, right or wrong, moral or immoral. Ethics focuses not on what men think but what they ought to think and do. An ethical science and engineering is an in-depth systematic study of the standards for judging right and wrong, good and bad, principles guiding means and how far we will or should go (Lillie, 2001; Howard and Çorver, 2008).

Whether the conduct of a scientist or engineer is correct or faulted may be (Lillie, 2001):

1. instinctive and discernible through individual actions,
2. intentional, which may be direct and motivating or indirect,

3. rooted in desire, which is a consciousness to act in a particular manner, or
4. a matter of calculated choice.

Indeed the actions of one person can impact on the actions of others and, as such, the general nature and direction of actions in a society may affect the choices of others and their level of consideration for moral standards (Lillie, 2001). This has an impact on concerns for the common good, levels of egoism and altruism and the eventual emergence of rights, duties and entitlements.

Ethics consists of those morally permissible standards of conduct each member of a group wants every other (member) to follow even if their following them would mean he or she had to follow them too. Thus, it is reasonable to assert that writing a properly functioning code of ethics is a collective task (Davis, 2007). Without a reasonable amount of group consensus concerning morally permissible standards of conduct relevant to the group, the code finds its home scribbled on a sheet of paper rather than in the actions and decisions of members of the group.

Ethical disagreements on rights, duties and entitlements are also possible and may take the form of disagreement in belief, when an individual believes in 'p' and another in 'not p' and as such one persistently challenges the other, and disagreement in attitude, when one has a favorable attitude and the other an unfavorable attitude towards an issue (Stevenson, 2006).

Furthermore, a code of ethics should fulfill many purposes within a scientific and engineering organization by:

1. increasing ethical sensitivity and judgment,
2. strengthening support for the moral courage, and
3. fine-tuning and the sense of identity of the organization.

Furthermore, there is a wide variety of codes of ethics, which are written by specific technical groups and which have their own purpose for existence and allow each group to face a set of ethical challenges that are unique to the group (Lichtenberg, 1996).

A code of ethics should be the benchmark of the acceptable standards of conduct, which members of a scientific or engineering organization make binding upon themselves. Often, codes of ethics prioritize commonly conflicting principles, which underlie the standards of conduct within an organization by prioritizing the principles in order to give guidance on how a member is to act as a responsible agent of the organization when situations require an element of compromise between principles (Davis and Stark, 2001). For example, as a profession, engineers have agreed that a commitment to public safety is essential when acting as a professional engineer. This agreement is reflected in professional codes such as any code of ethics for engineers. Likewise, codes of the scientific professionals should emphasize a similar priority to a commitment to upholding the safety and health of individuals. Yet the differences in the focus of their respective codes of ethics reflect the differences in the challenges that scientists and engineers face while attempting to address their respective concerns.

Because different groups are composed of different people with different purposes having differing means of accomplishing differing ends, priorities specific to one group may to be contradictory to those of another group. The reason for the differences in, say, priorities is because the tasks of one group, say engineers, may directly involve the improvement of conditions of society (or groups within society), whereas the priorities of another group may involve the improvement of the condition of individuals. In addition, the type of activities engaged in by members of an organization determines the situations in which the practice of ethical conduct may be jeopardized, and therein lies the reason for writing codes of ethics specific to an organization and the members.

This idea of moral responsibilities specific to a group is also central to the process of designing a code of ethics.

Generally, it seems that codes of ethics with a clearly defined purpose are more clearly stated and better organized. Many codes make effective use of defining a purpose by beginning the document with a preamble or a statement of intent. The preamble sets the tone of the document and outlines both the purpose of the organization and the purpose of the code. The statement of intent fulfills a similar purpose, but it focuses more on the purpose of the code and less on the purpose of the organization than does a preamble. Both are good ways to establish cohesion within the group that is essential to the proper functioning of a code of ethics.

To many, the code of ethics is merely a set of well meaning statements on a rarely seen and even less frequently and effectively implemented document but, in fact, the code of ethics must truly reflect the virtues of the group. Through a process of achieving consensus, writing a code of ethics becomes an excellent group-defining task. Consequently, a well-defined membership in the group, an outcome of devising and publicizing a code, aids in the functioning of the code. Through identification as a member of the group, a member's sense of duty to other members of the group and to the group's collective agreements expressed in the code is strengthened. As a result, the effectiveness of the code of ethics is also strengthened.

In addition, there are several items that must be considered when deciding what should be included in the code of ethics:

1. the persons, or groups of persons, affected by the organization or the members of the organization,

2. the main area of activity of the organization,
3. the unethical decisions and actions that the organization would like to prevent,
4. the means by which these the unethical decisions and actions can be prevented,
5. the types of ethical problems that members of the organization are most likely to encounter, and
6. the means by which conflicting principles be resolved (Davis and Stark, 2001).

The answers to these questions leads to the formulated what needs to be included in the organization's code of ethics, the next step is to decide what the code of ethics are for the organization. Just as principles within a code differ from group to group, so to, methods of organization differ from scientist to engineer, and wit in the respective sub-disciplines.

For example, the factors that may affect how an organization develops a code of ethics could include such aspects as:

1. the length of the code;
2. the means by which statements for inclusion in the code were formulated, and
3. the form of organization that is most familiar to the members (Schwartz, 2001, 2003, 2005). If relationships were a major consideration in the formulation of statements, it seems most appropriate to organize the code according to relationships. However, if relationships were not a major consideration but principles were a major consideration, it is most appropriate to organize the code according to principles and guidelines for the principles.

Thus, a code of ethics is a means of uniquely expressing the collective commitment of an organization to a specific set of standards of conduct while offering guidance in how to best follow those codes. As such, authors of a code of ethics should explore methods of organizing a code and use of language in the code that will be well received (and readable and understandable and not in *legalese*) by the membership. For example, William Shakespeare once stated, "kill all the lawyers," but this was taken out of context and was not the intent of that particular speech, as written in the play *Henry V*. Yet, many people are willing to take that statement out of context with their own individual preferences for the interpretation of the meaning. Codes of ethics should not allow the reader to do this! Giving guidance encourages the membership of an organization to develop and practice moral reasoning based on the collectively agreed-upon principles of the group enumerated in the code.

A workable code of ethics is written with the awareness that the code will be used in a variety of different situations, and each situation will prompt those involved to refer to the code for specific guidance (Harris, 2004). Thus, the code must be written with enough information to be of use in the specifics of a situation while remaining general enough to be used for a wide variety of situations. It is most likely this challenge that lies behind the inclusion of sections entitled such as, "Suggested Guidelines for use with the Code of Ethics, Standards of Practice or Rules and Procedures." In such sections, there are attempts by the organization to foresee situations one might encounter that call for ethical considerations. In many instances these guidelines attempt to provide guidance on how to resolve conflicting principles (Davis and Stark, 2001).

The brevity of many codes of ethics seems insufficient for fulfilling the many purposes of the codes. While codes that are short in length and content do illustrate an organization's commitment to fundamental principles, these codes may fail to give substantial guidance to the organization's members in situations which often require some sort of give and take between fundamental principles.

It is important for a code of ethics to include such guidance through the development of a code, because an organization makes collective agreements about what conduct is ethical and what conduct is unethical. In addition, the practice of ethics may be (some would insist always) situation-specific. A code of ethics lacking in guidance fails to address this very important aspect of the practice of ethics; thus, the code will likely fail at accomplishing its intended purposes.

Codes of ethics change with time due to changes in the organization, changes in society, and a desire by the organization management or by the membership to improve the effectiveness of a code. In this sense, a code of ethics should be thought of as a living document which must be adapted to the changing atmosphere of an organization, and the environment in which the organization operates. Through a process of revision, the codes of ethics keeps place with the times and changes in the law of the land.

From this perspective, the future of codes of ethics (and their ultimate usefulness) are left to the organization, to the membership, and the responsible fulfillment of the sections of the codes.

Since the actions of one person can impact on the actions of others and, as such, the general nature and direction of actions in a society may affect the choices of others and their level of consideration for moral standards (Lillie, 2001). This has a definite impact on concerns for the common good, levels of egoism and altruism and the eventual emergence of rights, duties and entitlements (Frankel, 1989).

Among scientists and engineers, ethical disagreements on rights, duties and entitlements are also possible and may take the form of disagreement in belief, when an individual believes in one aspect of the work and not the other; one persistently challenges his colleague, and disagreement in attitude, when one has a favorable attitude and the other an unfavorable attitude towards the data (Stevenson, 2006).

The extent and frequency of agreements and disagreements would vary with the extent to which there exists an ethical environment (Haydon, 2006). Schools and universities, like all other organizations, share an ethical environment. All societies have norms of conduct. Norms are synonymous with morals which signify how people should treat each other. Norm conformity is recognized as an obligation or duty and, in the absence of norms being identified, people can be guided by the consequences of their actions.

Values, laws and religious teachings are part of the ethical environment which must be evaluated and changed, if necessary (Haydon, 2006). This can happen through individual action, legal changes, education. Implicit in the creation and maintenance of an ethical environment is the emergence of regimes of reason or unreason; which are constitutive of conscious and unconscious, opposing and accepted values that often clash with each other in a society (Leitch, 1992).

An assessment of rights, duties and entitlements is also a moral issue and human moral capacities and judgments are shaped by personality, socialization, situational demographic (such as age, gender, and ethnicity) and broader societal factors.

For example, a PhD student following an experimental program decides that his original project title and synopsis require rigorous and taxing laboratory work, which may be beyond his capabilities. Although giving the supervisor/mentor glowing reports of the work as it (supposedly) progressed (but refusing to turn over the laboratory notebook for examination, and each time using some convenient excuse) has changed the program. He has been encouraged to do this by working with others who were not formally involved in the program and without the knowledge of the supervisor/mentor. No formal (or informal) requests were ever submitted by the student to formalize the change of plan and the supervisor/mentor discovers the deception at the time of drafting the thesis. When confronted with this issue, the student is unrepentant and the university powers-that-be are perceived to agree with the student's actions (insofar as the student received no form of reprimand). By allowing this, the university is encouraging the student to move into area of cheating and unethical behavior; and the word gets around that students can graduate by doing whatsoever they wish, without any form of guidance; essentially by flaunting the rules, or bending the rules to accomplish graduation.

Generally, such actions are due to the need to achieve a purpose, or to satisfy an interest or desire (Furrow, 2005). These factors do not impact institutions independently of each other but in combination. Indeed, morally inappropriate behavior is driven by thoughts and feelings that were cultivated and reinforced across time and space. Furthermore, moral autonomy is not achievable when personal desires, emotions, and inclinations persistently influence the judgment of a scientist or engineer. Moral autonomy must be exercised within certain ethical boundaries – even if it conflicts with individual's needs and desires and such needs and desires must be evaluated (Furrow, 2005). Reasoning is instrumental in helping to pursue and attain certain goals.

If the act performed by the individual scientist or engineer is not in his power not to perform, then he is responsible for that act and must face the consequences (Chisholm, 2008). This would establish the morality of the action given that to act morally is to act autonomously, not as a result of technical or social processes (Williams, 2006). However the selective orientation to autonomous or independent individual-level action is not to be shaped and reshaped on a whim. It must be reinforced by accountability and evaluation standards. In addition to these, the promotion of ethical behavior would serve to reduce ethical lapses in the academic environment (where responsibility is often taken lightly but authority reigns supreme) as well as in other environments (Kezar et al., 2008).

However, once a promise or commitment is made, scientist and engineers are obligated to keep it and such obligations are very difficult to escape (Furrow, 2005). Some scientists and engineers may not keep their obligations because they are not quite comfortable with themselves and/or because of others giving them different advice. The result is diminished willpower or intention to fulfill an obligation. Intentions are the outcomes of deliberating with oneself to decide what to do (Williams, 2006).

The assessment of rights, duties and entitlements is also a moral issue, which can be shaped by personality, socialization, situational demographic (age, gender, and ethnicity) and broader societal factors. Generally, scientist and engineers want to achieve a purpose or satisfy an interest or desire (Furrow, 2005). These factors do not impact independently of each other but in combination. Indeed, morally appropriate behavior is driven by thoughts and feelings that are cultivated and reinforced throughout generations. The argument is that moral autonomy is not achievable when personal desires, emotions, and inclinations persistently influence the judgment of scientists and engineers. However, moral autonomy has to be exercised within certain societal boundaries even if it conflicts with an individual's needs. In this regard, it is necessary for the scientist and engineer to evaluate their thoughts and desires (Davis and Stark, 2001; Furrow, 2005).

The reality of individual, group, organizational and cultural differences universally has generated a diversity of moral codes; most people do not subscribe to a single moral code. This has resulted in moral relativism which does not mean that there is no true objective moral code. Relativism has been justified on the basis of physical and cultural differences and the consequent promotion of tolerance for different views (Rachels, 2000). In the context of social changes, communication and interactions with other countries, there has been significant cross-fertilization of ideas and influence; orienting people to make judgments on levels of morality (Furrow, 2005).

It is generally known that once a promise or commitment is made, it very difficult to withdraw from the obligation (Furrow, 2005). Some scientists and engineers may not keep their obligations because they are not quite comfortable with themselves and/or because of others giving them different advice. The result is diminished willpower or intention to fulfill the obligation. Intentions are defined as, the outcomes of deliberating with self to decide what to do (Williams, 2006).

While it is true that beliefs are not under voluntary control, it is also true that scientists and engineers choose what to believe, and, as a result, choice is under our control. In this regard, it is essential for the scientist and enginery to remain open-minded and always be ready to evaluate arguments, findings, and the different perspectives of each person involved.

Consequently, it is necessary, in fact essential, to realize that:

1. the end does not justify the means;
2. a rational basis must be established for dealing with uncertainty in any type of research;
3. while researchers prefer to minimize errors, the outcome of such preferences must be thoroughly evaluated (Shrader-Frechette, 1994).

If the act that the individual performs is in his power not to perform, then he is responsible for that act and must face the consequences (Chisholm, 2008). This would establish the morality of the action given; that to act morally is, 'to act autonomously, not as a result of social processes'

(Williams, 2006). It must be noted, however, that the orientation to autonomous or independent individual-level action is shaped and reshaped by a changing society. As a result, the central influencing factor is the quality of individual-level socialization despite the changing nature of the context. It is further reinforced by law enforcement, cultural influences, accountability arrangements and monitoring and evaluation standards. In addition to these, the promotion of equity initiatives would serve to reduce ethical lapses in universities and other settings (Kipnis, 1983; Kezar et al., 2008).

6.3 Codes of Ethics

Codes of Ethics are intended to legally reinforce the need for respect for scientific and engineering data as well as for all other human beings independent of what anybody thinks about location, upbringing, gender, ethnicity, religious affiliation, age, culture, level of education, and other characteristics. Ethical issues have come and will remain at the fore because of a scientist or engineer's prioritization of differences as he seeks to arraign a more privileged position in his respective group, organization, and/or the world of academia. This requirement can be further compounded by procedural inconsistencies in any research project and the absence of a philosophical basis for discussions of ethics dictates the need for a more comprehensive theory to guide future research (Kitchener and Kitchener, 2009). This should focus on:

1. behavior and basic moral requirements;
2. ethical rules for decision making,
3. ethical principles that are used to justify ethical rules;
4. ethical theory providing explanations of how a scientist or engineer should act, and
5. meta-ethics which discusses and evaluates the meaning of ethics.

In addition, there seems to be much truth in the post-modern view of scientific and engineering research ethics that every research activity, question and decision has ethical underpinnings. Ethical issues must (they usually do) focus on:

1. research procedures of developing a title, research design, data collection, data interpretation and analysis, report writing, and communication of findings;
2. power relations of the researcher and researched;
3. views of respondents about future use of research findings, and
4. the researcher's assessment of his beliefs and values (Thomas, 2009).

Professionalism entails a multiplicity of tasks and a variety of new roles; not all individuals occupying these roles of trust have been adequately prepared for and socialized to them. Society is characterized by autonomous spheres of endeavor within which only some roles are realized, and therefore accountability may be weak or lacking. Conversely, actions are often collective, i.e., via team approaches to problem posing and problem solving, which can undermine individual responsibility. Indeed, the importance of recognizing the role of the society in contributing to incidences of research misconduct was noted during conference discussions. All of these potentially conflicting factors may make it difficult for a researcher to know with confidence what is ethically expected of him or her.

Briefly, research misconduct is, "fabrication, i.e., making up results and recording or reporting them, falsification, i.e., manipulation of research materials, equipment, or processes, or changing or omitting data or results such that the research is not accurately represented in the research record, and plagiarism, i.e., the appropriation of another person's ideas, processes results, or words without giving appropriate credit" (OSTP, 1999).

Codes of ethics are often considered to be controversial documents and some scientists and engineers even consider them to be unnecessary. On the other hand, others believe that codes are useful and important, but disagree (or are uncertain) about why codes are necessary.

Many scientific societies have developed codes of ethics that encompass a broad range of behavior and practice as a means of fostering research integrity. These codes presumably represent the ideals and core values of a profession, and can be used to transmit those values and more detailed ethical prescriptions as part of the education of scientists and engineers. They also provide standards for reviewing claims of misconduct and for sanctioning improper behavior.

When misconduct allegations are reviewed by societies, the results may not be made public, thereby diminishing the potential deterrent effect. Societies should, therefore, consider making public the outcomes of their misconduct review.

One of the pivotal questions faced by a scientific society is whether to institute measures to enforce its code of ethics with disciplinary proceedings and sanctions. Many societies choose not to engage in enforcement, using their ethics codes primarily for educational purposes. For other societies, ethics codes enforcement allows them to demonstrate their willingness to hold their members accountable for their conduct. Yet another option adopted by some societies is referral of a grievance to the institution that owns the data to conduct an investigation, with the society reserving the right to publicize the findings of that investigation.

The potential for and the limitations of codes of ethics to ensure research integrity provoke varying points of view. While codes are intended to codify standards of behavior in professional roles, their limitations are such that conduct cannot be guaranteed and, in some instances, cannot be predicted. The contexts of scientific research can present unique circumstances that create difficulty in describing behavior that is uniformly right or wrong. Any decision or dilemma requires an examination of competing values as well as good judgment and common sense, and the individual value systems of each member must also be factored into decision-making.

Therefore, the adoption of a code of ethics is significant for the professionalization of the members of a society because it is one of the external hallmarks testifying to the claim that the group recognizes an obligation to society that (hopefully) transcends mere economic self-interest.

Codes of Ethics shape the behavior of scientists and engineers and offer the means by which research should proceed.

Conceptual work needs to focus not only on potential determinants of research integrity and misconduct but also on the specific indicators of research integrity and misconduct. It is important that research examines positive ethical practice as well as research misconduct. In considering misconduct, intent is also important because the very same manifestations may happen by design, by inattention or inadvertence, or even out of ignorance. Furthermore, departures from ethical standards may be isolated events or part of a more general pattern or practice of research misconduct.

Under the broad umbrella of research integrity and misconduct, a program of study would want to include attention to all aspects of the research process from data collection through dissemination. For example, research could usefully address such elements of conduct as:

- Authenticity of the work process
- Fabrication of data

- Falsification of data
- Authenticity of work product
- Plagiarism
- Misappropriation of other's data
- Accurate reporting of results
- Having or using appropriate expertise in the conduct of research
- Authorship and appropriate credit
- Data access or sharing
- Protection of human subjects/animals
- Honoring agreements of privacy and confidentiality

Manifestations of research misconduct can often be very low profile, invisible activities. At times, they are modest transgressions that become large in their significance because they are incremental over time. How apparent or observable misconduct is and even when or where it takes place can be highly dependent on the research process itself. As suggested above, factors like the site of research (e.g., laboratory versus field) or even the mode of conducting studies (e.g., solo investigator versus multi-investigator team) can affect both the norms of and opportunities for misconduct.

If the provisions specified in a code of ethics can be supported with good reasons, there is no reason why a profession does not include an affirmation of those provisions as part of what it professes. This does not preclude individual members from autonomously accepting those provisions and jointly committing themselves to their support. In fact, there is always a strong positive case for professional codes of ethics. For those who disagree, perhaps an examination of the individual's ethics might be in order?

The code is to protect each professional from certain pressures (for example, the pressure to cut corners in laboratory work to get the next publication out. In fact, having a code of ethics allows a scientist or engineer to object to pressure to produce substandard work not merely as an ordinary moral agent, but *as a professional*. Scientists and engineers should be able to state, without recrimination, that as a professional, "I cannot ethically put personal or business concerns ahead of my professional ethics."

Supporting a professional code will help assure each scientist and engineer a working environment in which it will be easier than it would otherwise be to resist pressure to do much that the engineers would rather not do. Scientists and engineers should support the codes of their respective professions code; supporting the code helps make the profession a practice of merit, since the code should generate benefits for all scientists and engineers (David, 1991).

The possible functions of a code of ethics include: (1) a collective recognition by members of a profession of its responsibilities; (2) an environment in which ethical behavior is the norm and, therefore, expected; (3) the code can serve as a guide or reminder in specific situations; (4) the process of developing and modifying a code of ethics can be valuable for a profession; (5) a code can serve as an educational tool, providing a focal point for discussion in classes and professional meetings, and (6) a code can indicate to others that the profession is seriously concerned with responsible, professional conduct (Harris et al., 1995).

6.4 The Premise Behind Codes of Ethics

A code of ethics is adopted by a society or by an organization in an attempt to assist the society membership when called upon to make a decision (usually most, if not all) understand the difference between correct actions *and incorrect actions* and to apply this understanding to their decision (Annas, 2006).

Codes of ethics should be developed by all scientific disciplines; with the process of development offering ample opportunity for contributions from all sectors of a society's membership.

Ethics and publication standards are not always effectively transmitted from one generation of scientists and engineers to the next, or even to current members of a society. Hence, any effort to develop standards should be linked to a plan for their dissemination and for the education of those to whom they (will) apply. For example, ethics consulting services sponsored by societies may help members assess options for responsible conduct.

If a society decides to enforce its standards with review and disciplinary procedures, it should be prepared to devote adequate resources to do so effectively. Enforcement procedures should accord due process and ways to initiate a grievance should be commonly known.

Thus, for the scientist and engineer, a code of ethics often focuses issues related to work, although the code may also focus on social issues, and set out general principles about the beliefs of the society or organization on matters such as:

1. mission statement,
2. quality of work,
3. standards of behavior towards others,
4. privacy, and/or
5. the environment.

More important, the code should delineate proper procedures to determine whether a violation of the code of ethics has occurred and, if so, what remedies should be imposed (Luegenbiehl, 1983; Johnson, 1991; Ladd, 1991).

The effectiveness of such codes of ethics depends on the extent to which management supports them with sanctions and rewards. Violations of the code of ethics of a society or organization usually can subject the perpetrator or violator to the prescribed consequences, such as expulsion from the society or dismissal from the organization.

In some cases, a code of ethics may be adopted by a profession or by a governmental or non-governmental organization as a code of practice: which also regulates the behavior of the members of that profession. A code of practice may also be styled as a code of professional responsibility; which will discuss issues that need to be discussed and the difficult decisions that will often need to be made, and provide a clear account of what behavior is considered ethical or correct in the circumstances. In a membership context, failure to comply with a code of practice generally results in (or, really should result in) expulsion from the professional organization.

Codes of ethics are created in response to actual or anticipated ethical conflicts. Considered in a vacuum, many codes of ethics would be difficult to comprehend or interpret. It is only in the context of real life and real ethical ambiguity that the codes take on any meaning. In fact, the best way to use these codes is to apply them to a variety of situations and see what results. It is from the back and forth evaluation of the codes and the cases that thoughtful moral judgments can best arise.

The underlying premise of any code of ethics is that the scientist or engineer should not sacrifice professionalism by rejecting one or more of the guidelines in relevant code of ethics of the organization.

However, the relevant code of ethics should offer the following:

1. clear and unambiguous advice,
2. no opportunity for someone endorsing the opposite course of action also use the code to support his choice;

3. the different guidelines within the code should not give conflicting guidance but guidelines should point to the same outcome, and
4. the professional code of ethics should not conflict with the individual moral compass of the scientist and/or engineer (Davis and Stark, 2001).

Multiple factors shape the norms, values, knowledge, and conduct of scientists and engineers and thus should be part of any research agenda on research integrity. Since the research enterprise is itself a social process, there are a number of individual, situational, and structural influences that can affect what scientists and engineers believe and how they work in general as well as under special conditions.

There are a number of considerations for any scientific and engineering society regarding enforcement. Due process considerations are essential in a review of misconduct if expulsion from society membership is a possible outcome. In addition, reviewers of misconduct allegations must have the right to access all sources of relevant information. There should also be a plan for transmitting a finding of misconduct to appropriate persons/institutions should be in place to protect the integrity of the research record. All parties involved in the review of misconduct are vulnerable to being sued and junior scientists and engineers may be reluctant to participate in disciplinary proceedings out of fear of professional vulnerability.

Enforcement of a code of ethics is not an easy task and societies must be willing to expend sufficient resources to do it well. The question of whether enforcement will serve as a real deterrent to misconduct is by no means settled. Therefore, careful drafting or redrafting of society codes may permit enforcement while addressing some of these concerns.

6.5 Codes of Ethics and Peer Reviews

Basic research can provide an understanding of the manifestations of research integrity and misconduct and the factors that affect their occurrence. In addition, basic research can help refine measures of research integrity. This research base can also offer a solid framework for intervention strategies designed to have a positive impact on research behaviors. However, the research process does not end with the implementation of intervention activities. Evaluation of interventions is an important component of any agenda of inquiry.

As scientific societies become more intentionally involved in devising strategies to promote research integrity (or consider new approaches for doing so): they should carefully examine what they are doing and review the effects of any such actions.

Many scientists and engineers have long maintained that evaluation research should accompany planned organizational or institutional change whether in the public, private, or nonprofit sectors. Rigorous evaluation, especially when grounded in a commitment to continuous quality improvement; provides a framework for meaningful assessment and for self correction. As a research strategy, it permits examining the impact of interventions or actions through an assessment of both the implementation process and the outcomes for targeted groups. In many respects, it provides the link between theory and practice.

When scientific societies or, for that matter, academic institutions develop research integrity programs, evaluation research can play an important role in assessing the effectiveness of these initiatives. Furthermore, it offers additional empirical assessments of relationships among factors that are hypothesized to promote research integrity. Results from evaluation studies provide evidence about what works and does not work, which in turn contributes to program improvement efforts over time.

For example, if basic research finds that conforming to the standards of responsible research conduct is highly correlated with the level of knowledge people have about the standards, then this work has implications for the development of an intervention strategy. It would be logical to develop an educational program to help professionals learn what is considered appropriate versus inappropriate research behavior. But, what is an effective educational strategy? Is an on-line educational course going to be effective? Conversely, is an educational approach based on a mentoring model likely to be more effective? As with any intervention, often it is useful to conduct pilot projects where different strategies can be introduced, ideally on a randomized basis, and compared to determine the most effective methods.

Evaluation research provides the methodology for conducting such research, involving both a process and outcome evaluation of the interventions implemented. The key elements to consider in conducting an evaluation include:

1. defining program goals for a specified target audience (e.g., graduate students will be made aware of the ethical standards for research and the strategies for adhering to these standards),
2. designing and implementing activities to achieve these goals (e.g., an educational program consisting of a one-credit course established as a graduation requirement or developing an independent learning CD-Rom training module);
3. delineating in advance a plan for evaluation, which addresses issues of a) measurements and instrumentation (e.g., measures of knowledge that use a paper/pencil test or measures of decision-making that use hypothetical case scenarios); b) timing of data collection (e.g., at the end of each course); c) methods of analysis (e.g., quantitative); d) plan and format for reporting

the results; and e) implications for an organization's activities, and
4. reporting results and ensuring a system for linking knowledge gained through research to further organizational planning and action.

Evaluation research offers considerable benefits to scientific societies or other institutions seeking to introduce change. While the goals may be clear, the strategies likely to achieve those goals may be quite uncertain. Introducing change on an experimental basis with appropriate evaluation has the advantage of encouraging an organization to be open to change without a long-term commitment to any given strategy. Such a model generates evidence, which becomes valuable input into decisions about future changes that may need to be made to improve further the outcomes of programmatic efforts.

While evaluation methodology is useful when concrete activities are pursued, there are limitations to its implementation; when scientific societies are engaged in work that is more symbolic than programmatic At present, scientific societies have been limited in developing intentional interventions. Indeed, as we have discussed above, efforts within organizations are generally quite intermittent or weak (as distinct from unimportant). The strength of the activity or intervention needs to be of sufficient substance to warrant systematic evaluation and to have outcomes that can be specified.

In an effort to go mitigate unethical behavior, the "ethics review process" should be detailed in the code, although if a charge is brought against a member, where appropriate, it is recommended that the academic or other institution that employs the member should make the investigation and resolve the issue. When it is determined that an ethical violation has occurred, a recommendation is made to the society president for action the president must be able to follow specific guidelines. A finding of plagiarism may result in a letter of reprimand and an author can be barred from publishing in any society for up to five years; an author's correction or retraction should also be required. The penalties for fabrication or falsification need to be more severe. Publication of a retraction is mandatory and various publications, leadership roles, privileges and rewards are precluded. The society may decide to publish the charges and findings in the relevant society publications (e.g., a newsletter or weekly/monthly magazine). A report of the actions should also be forwarded to the author's employing institution as well as to the appropriate government offices if federal funds are involved.

In addition, the society must also be prepared to review and, if necessary, revise its code of ethics over a three-year period, even if the revised code is longer and more detailed than The Original Code.

Therefore, while intentional change of any scope should be evaluated, it is also the case that basic research reviewed by peers.

The development of the science and engineering disciplines has paralleled the reconciliation of ethical issues. In the process, concerns and mechanisms for accountability in research must be an imperative.

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