Ethics in Science and Engineering
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7

Integrity in Research

7.1 Introduction

Research programs have been used to transform concepts into theories and, simultaneous with this development, has been some degree of diffusion as researchers explore new lines of enquiry as they attempt to make their contributions to the literature (Smith, 2008, page 57).

Ethical issues permeate every stage of the research process from the provision of a title to the study of the analysis of the data as mentioned before (Reagan, 1971; NAS, 1992). There is a range of ethical issues emerging in the fields of qualitative and quantitative research. This has been and remains so for several reasons: quantitative research is rooted in rationality, objectivity and reflection can be used to correct/evaluate and logic of analyses done; and qualitative approaches to data collection are more personalized and allows for expressions of values, beliefs, motivations, emotions in sharing of information. In addition to the ethical responsibilities of researchers, respondents also have ethical responsibilities. And yet, researchers, for several reasons, may or may not adhere to their personal and/or professional ethics.

Science and engineering are built on a foundation of trust insofar as all scientific and engineering research results are an honest and accurate reflection of a researcher's work. Researchers equally trust that their colleagues have gathered data carefully, have used appropriate analytic and statistical techniques, have reported their results accurately, and have treated the work of other researchers with respect. When this trust is misplaced, integrity is called into question (Branscomb, 1985).

Furthermore, any scientist or engineer who is requested to be a coauthor should ignore the data in next-to-final draft before publication (after the data have been *massaged* to look presentable) and check the original data. If this is called into question and the professional standards of science are violated, researchers are not just personally affronted and they feel that the base of their profession has been undermined. This would impact the relationship between science and society (Bertozzi, 2009).

Research is based on the same ethical values that apply in everyday life, including honesty, fairness, objectivity, openness, trustworthiness, and respect for others. A *scientific standard* or an *engineering standard* refers to the application of these values in the context of research. Examples are openness in sharing research materials, fairness in reviewing grant proposals, respect for one's colleagues and students, and honesty in reporting research results.

The most serious violations of standards have come to be known as *scientific misconduct*. The government of the United States defines misconduct as, "fabrication, falsification, or plagiarism in proposing, performing, or reviewing research, or in reporting research results" (Bertozzi, 2009), and this should also include, "peddling hype or myths to the media" (Roy, 1999), which can lead to fame and/or notoriety as well as additional funding for future programs. All research institutions that receive federal funds must have policies and procedures in place to investigate and report research misconduct, and anyone who is aware of a potential act of misconduct must follow these policies and procedures.

Some scientists and engineers believe that the few highly publicized cases of research misconduct, generally manifested as falsification, fabrication, or plagiarism, are just the tip of the iceberg. Others suggest that the relatively few known cases indicate that the overall incidence of misconduct is low. However, these cases generally don't cover publication disputes, unless they involve plagiarism (Ritter, 2001).

Nevertheless, scientists and engineers who violate standards other than fabrication, falsification, or plagiarism are said to engage in questionable research practices. Scientists and their institutions should act to discourage questionable research practices through a broad range of formal and informal methods in the research environment. They should also accept responsibility for determining which questionable research practices are serious enough to warrant institutional penalties. Standards apply throughout the research enterprise, but scientific practices and engineering practices can vary among disciplines or laboratories. Understanding both the underlying standards and the differing practices in research is important to working successfully with others.

Therefore, integrity in research is the application of truth to all activities involved in research. Research consists in working to make new discoveries and expressing that work in the form of publication on the technical and/or the patent literature.

Furthermore, research integrity or research ethics has many facets, of which examples are:

1. defining research misconduct,
2. conducting and reporting experiments,
3. protecting research subjects,
4. giving and claiming credit, and finally
5. reporting misconduct (Whitbeck, 1998).

In fact, "integrity in research is about promoting excellence (high quality) in these activities, and this positive emphasis on excellence should be kept paramount in thinking about honesty in research" (Martin and Schinzinger, 2005).

There have been attempts to define misconduct in research using both wider and narrower definitions, developed in specific contexts, and for different purposes. For example, if the purpose is to punish wrongdoers, a narrow and legalistic definition is likely to be favored. On the other hand, if the purpose of the definition is to assure high-quality research, in all its dimensions, a wider definition might be adopted which will typically emphasize honesty in conducting and reporting experiments; while also including theft, other misuses of research funds, and sexual harassment among researchers (Martin and Schinzinger, 2005). Misconduct is misconduct and it is preferable that any form of misconduct be recognized, whatever forms the definition may take.

Research is systematic enquiry whose goal is communicable knowledge:

a. It's systematic because it is pursued according to a defined plan;
b. It's an enquiry because it seeks to find answers to questions;
c. It's goal-directed because the objects of the enquiry are posed by the task description;
d. It's knowledge-directed because the findings of the enquiry must go beyond providing mere information;

e. Nevertheless, it's communicable because the findings must be intelligible to, and located within some framework of understanding for, an appropriate audience.

Scientific and engineering research takes place in many settings, including universities, government labs, and corporations. The requirements vary somewhat, according to the applicable guidelines and regulations, but truthfulness and responsibility applies in all settings. Furthermore, the activity of reporting research is an important part of conducting research. Research results are useful when they are reported clearly, completely, in a timely manner, and honestly (Martin and Schinzinger, 2005).

The application of ethics to research activities seeks to ensure that research is conducted with acceptable standards of morality in order to preserve integrity, validity and reliability of the study (Ryan, 1995; Fleddermann, 2008). While standards for conducting research zero in on the study itself, ethical issues emphasize people. Such issues include: concerns about fraud, misconduct, harm to subjects, infringement of rights, conflicts of interest, and misrepresentation of self and others (Altman, 1997; Hernon and Calvert, 1997). This also includes the manipulation of the statistics (Huff, 1954; Gibilisco, 2004). Many government departments have adopted new codes of conduct for research performed by staff, consultants, and contactors (Heilprin, 2003; Hileman, 2005). Professional bodies have stipulated codes of conduct to guide scientific and engineering practices but this may not have been enough because of the general lack of (at least reported) disciplinary actions against any perpetrators of misconduct.

Furthermore, the ethical aspects of scientific and engineering research revolve around the responses to: (1) the ethically proper way to collect, analyze and report all aspects of a study, and (2) researcher-respondents interactions (Kitchener and Kitchener, 2009).

However, a deep commitment to scientific integrity is best achieved by providing sound training in scientific practices, the ethical conduct of science and engineering, and by creating institutional and professional environments that reinforce the high standards addressed in that training. Ideally, this educational process should begin early in the training of future scientists and engineers and continue through the most senior career stages.

Individual scientists and engineers, research institutions, and professional societies bear primary responsibility for the integrity of science and engineering; the legitimacy of scientific practices, and the investigation and response to cases of alleged research misconduct. Institutions and units within them that train and hire investigators are responsible for selecting, socializing, educating, supervising, and disciplining research scientists and engineers (Ryan, 1995).

In all cases, the philosophy behind the modern approach to scientific and engineering research is to:

1. be liberal about the sources of conjecture and hypothesis at the commencement of research,
2. be skeptical in the handling of data and argument, and
3. be astringent in testing findings and explanations on the completion of research.

Individual scientists and engineers, research institutions, and professional societies bear primary responsibility for the integrity of science and engineering, the legitimacy of scientific practices, and the investigation and response to cases of alleged research misconduct. Institutions (and units within them) that train and hire investigators are responsible for selecting, socializing, educating, supervising, and disciplining research scientists and engineers (Ryan, 1995).

This responsibility must be shared, however, by professional societies and the journals that review and publish results of research. Any activity of the Federal Government in this domain should support and complement the institutional role, and federal intervention should occur only when institutions fail to fulfill their responsibilities.

For the individual researcher, integrity embodies a range of good research practice and conduct and includes several facets (NRCNA, 2002):

1. This includes Intellectual honesty in proposing, performing, and reporting research;
2. While Maintaining accuracy in representing contributions to research proposals and reports;
3. It is fairness in peer review;
4. It is collegiality in scientific interactions (including communications and sharing of resources);
5. It's also transparency in conflicts of interest or potential conflicts of interest;
6. It embodies protection of human subjects in the conduct of research;
7. While encompassing humane care of animals in the conduct of research;
8. Furthermore, it's adherence to the mutual responsibilities between investigators and their research participants.

For an institution, integrity is a commitment to creating an environment that promotes responsible conduct by embracing standards of excellence, trustworthiness, and lawfulness.

The reliability of scientific knowledge also derives partly from the interactions among scientists and engineers on an open and trustworthy basis. 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 (Cassell, 1982).

It is at this stage that many technical researchers decide that the experimental design was not incorrect, the failed hypothesis was not incorrect, and they push forward to explain the experimental results. If the conduct of research is 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. And when this occurs, technical integrity has been forfeited.

For example, the experiment that failed becomes the experiment that succeeds 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. On the other hand, 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 the crucial proof of a concept.

Yet, 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 (outlying data points). 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.

Flyers can be influential or not influential. In other words, they can be far removed and inconsistent with the rest of the data or be far removed but consistent with the rest of the data. In the former case, one can do summarization and analysis of the data both with and without the outliers because the inferences and conclusions are different with and without the outliers. In the latter case, separate analyses are similar and not a problem, andthe outliers have little effect on inferences and conclusions. Nevertheless and in either case, all outliers must be reported, to do otherwise is scientific fraud. Obviously, when data deletion changes the results of the study or misrepresents the study, the act of deletion is unethical (Resnik, 2000).

Deception in data reporting dishonors scientists and engineers (from whom the truth is expected). Consequently, investigators who nonchalantly delete data points have probably not thought through their moral obligations as scientists and engineers nor have they thought of the possible consequences their deception might someday wreak on research participants.

High ethical standards in research are keys to protecting clinical research data, ensuring the quality of our research, maximizing the benefits, and minimizing the risks of further development. High ethical standards are also essential for any researcher to obtain approval for his methods, data, medicines and for his peers to put their trust in his research program (and/or products).

The researcher should apply the same high standards wherever he operates, including contract organizations and researchers where collaboration is essential. Collaborators should use principles that are aligned with those of the researcher. In fact, for research that is conducted as part of a collaboration, the researchers raise awareness of his policies at the beginning of the collaboration and include clauses in any collaboration agreement (verbal or preferably written) requiring adherence to the same high standards of ethics.

All collaborators, including the original researcher, should continuously evaluate the risks and benefits of the program at every stage: from initial research, through it, beyond the development stages, and then after a new product is approved for manufacture or a new process is approved for development.

Most researchers are ethical and approach studies with the best interests of the sponsor. Few would argue for further restrictions, and most appreciate the extent of regulatory latitude that exists. However, with these freedoms come crucial decisions that researchers must address both pragmatically and ethically. Obviously, the need to hire skilled people and provide them with sufficient training and oversight to ensure a patient's welfare is of extreme importance. Doing this, however, requires significant investments of time, money, and patience. The benefits pay dividends in terms of quality of data collected from the project. If scientists and engineers make appropriate, ethical choices and responsibly delegate their research-related duties, everyone wins: the scientists and engineers, the sponsor, and most importantly, science and engineering. Unfortunately, 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 (Fleddermann, 2008).

There is also the need to determine if ethics is alive. It is! Yet, it is the minority of researchers who are the miscreants and give ethics a bad name because of their flaunting (bending of the truth) or, for the want of a better word cheating.

7.2 The Nature and Conduct of Research

Research is an activity enabling scientists and engineers to test some hypotheses or conclusions and contribute to knowledge (Shrader-Frechette, 1994). Research is also been defined as the process of making and proving claims (Altman, 1997). Research ethics informs researchers about how to conduct them when carrying out their studies and thereafter.

Research ethics regulations have traditionally focused on informed consent, breaches of confidentiality, stress, injury, coercion, invasion of privacy and deception. The ethical conduct of research protects participants from harm, but individual and/or private interests may intervene and thwart the attainment of public goals.

While research norms have been stipulated by various research councils and professional associations, government-mandated research regulations are absent, and, apply only to drugs investigations where they exist (Shrader-Frechette, 1994).

Thus, there is more than one way of defining research, and there are several traditions as to how research should be carried out.

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Whether or not researchers conduct scientific research, they have an implicit obligation to the society as a result of training and education that they had received (Shrader-Frechette, 1994, page 24). Most of the ethical issues arise with respect to methodological value judgments and such value judgments should be specified even if they are defensible (Shrader-Frechette, 1994, page 54–55).

Scientific results must also be presented in a manner that would avoid future misuse or misinterpretation. Membership in a profession carries with it an implicit commitment to pursue the welfare of the profession. This is partly done by avoiding hasty, unconfirmed statements, incomplete analyses, and by speaking out about these in the studies of peers; thus, the significance of peer reviews. This is why many journals have stipulations to deal with fraud and may require researchers to place their raw data in a special archive (Shrader-Frechette, 1994, page 57). However, different research applications often carry different degrees of risk for the public and, as such; researchers must aspire to high standards of reliability and validity in order to minimize damaging implications.

The philosophy behind the modern approach to scientific and engineering research is to:

1. be liberal about the sources of conjecture and hypothesis at the commencement of research,
2. be skeptical in the handling of data and argument, and

3. be astringent in testing findings and explanations on the completion of research.

Research misconduct is significant misbehavior that improperly appropriates the intellectual property (or contributions) of others, that intentionally impedes the progress of research, that risks corrupting the scientific record, or compromises the integrity of scientific practices. Such behaviors are unethical and unacceptable in proposing, conducting, reporting research, or in reviewing the proposals or research reports of others.

A deep commitment to scientific integrity is best achieved by providing sound training in scientific practices and the ethical conduct of science and engineering. Also by creating institutional and professional environments that reinforce the high standards addressed in that training. Ideally, this educational process should begin early in the training of future scientists and engineers and continue through the most senior career stages.

In scientific research, no formal process exists for reviewing questions about the scientific integrity of individuals and assessing and periodically renewing their professional membership and privileges in the scientific community. Thus, institutions bear particular responsibility for maintaining high professional standards (Ryan, 1995). In fact, there is a direct relationship between the health of the academic profession and the maintenance of ethical standards.

Central to this relationship is a departmental culture which varies within, and across campuses. Departmental cultures are characterized by:

1. the willingness of academics to act responsibly at all time,
2. the maintenance of self-regulation and peer review (within the boundaries of academic freedom and collegial self-governance),

3. exposure to the requirements of academia beyond the sub-discipline of a scientist or engineer, and
4. the willingness of academics to look out for each other.

Indeed, culture in many respects may be deemed to be more important than rules or regulations because it provides a means for dealing with tensions and pressures at all levels including interpersonal relations and professional relations.

In the modern world, many scientists and engineers are not committed to think of the consequences of their actions (Kearney, 1999), the focus is on personal image. Such occurrences render it possible for any mechanical expression of responsibility to be eroded. The scientist and engineer have to be responsible first before one can become or act like a professional and the demonstration of responsibility cannot be talked into being. Where there are interactional bonds, there is a commitment to be responsible.

Often when a professor has stolen an idea or concept and a complaint has been made to the university authorities, many of you have been told, "it is only a young professor seeking funding for his project," and the matter has been dismissed by the university management and the board of trustees (Board of Regents or Board of Trustees).

The academic tradition emphasizes intellectual honesty and critical self-discipline with respect to the scholarship of discovery; the scholarship of integration; the scholarship of application; and the scholarships of teaching. (Hamilton, 2002).

However, academic freedom is "a condition of work, designed to enable academics without suffering adverse consequences in their employment" (Tight 1988, 4). However, the integrity of the academic staff depends on how well they appreciate, understand and behave in an ethical fashion while enjoying their academic freedom.

In some instances and in a different realm of their operations, universities may engage in unethical practices because of the autonomy that they have been allowed. Issues of ethics generally occur on the boundaries of academic freedom; therefore, raising questions about the need for discussion and consensus about the limits of academic freedom (Neave, 1988) and, by extension, whether or not there should be limits to universities' autonomy.

The modern university is an institution for teaching, learning, protection of the culture, contributor to economic growth and a knowledge factory. The university was a community of scholars and students united by a search for a deeper understanding of nature and humankind. However it has now become a series of specialized factions, disciplines, students and research activities, united only by occupancy of a common territory (Pocklington and Topper, 2002). Professors establish academic tribes and territories in such a context that academic freedom is synonymous with academic subjectivity, where individuals utilize disciplinary jargon to justify their actions and guard their territories. The university has also been viewed as radical when, in fact, it is most conservative in its institutional conduct, and it is also seen as a law unto itself (Kerr, 2001).

The expectations for the responsible conduct of research are complex and not always well defined, leaving guidance for the responsible conduct of research disorganized. Some responsible practices are defined through law and institutional policies that must be followed. Others are set out in non-binding codes and guidelines that should be followed. Still other responsible practices are commonly accepted by most researchers but not written down. Instead, they are transmitted informally through mentoring, based on the understandings and values of each mentor. This situation is further complicated by the fact that researchers are not routinely tested on their knowledge of responsible practices or licensed. Moreover, their behavior as researchers is inconsistently monitored and the penalties for irresponsible behavior vary considerably.

Most researchers do care about responsible behavior in research and pay a great deal of attention to best research practices. The fact remains, however, that it can take some effort to find out what these practices are and how to act when the complex rules for responsible practice seem to conflict with one another.

Concern about misconduct in research first surfaced in the early 1980s following reports of cases of egregious misbehavior. One researcher republished under his own name dozens of articles previously published by others. Other researchers (in one way or another) falsified or fabricated research results. To make matters worse, it seemed as if research institutions sometimes ignored, or deliberately covered up problems, rather than investigate them. Eventually Congress stepped in requiring Federal funding agencies and research institutions to develop research misconduct policies.

Furthermore, even though Federal policies technically apply only to federally funded research, many research institutions apply Federal research misconduct policies to all research. Many research institutions have also broadened the basic Federal definitions to include other inappropriate practices. In combination, Federal and institutional research misconduct policies define research practices that researchers must avoid. Failure to do so can result in the termination of employment or ineligibility to receive Federal funding.

Research misconduct policies provide guidance on responsible conduct in three areas:

1. They establish definitions for misconduct in research;
2. They outline procedures for reporting and investigating misconduct;

3. They provide protection for whistleblowers (persons who report misconduct) and persons accused of misconduct.

Thus, the definitions of misconduct in research and the procedures for handling allegations of misconduct in research form the basis for effective self-regulation in research.

At first glance, all aspects of research conduct would appear to be governed. However, this is not actually the case as there are several vagaries that allow scientists and engineers the freedom in which to conduct their research.

The ultimate question for scientific and engineering researchers is reduced to the best way to juggle various aspects of the project; including, How to study protocol requirements, and how to handle financial and professional pressures imposed by the sponsor.

A Code of Ethics is much more needed by an academic than an intellectual because the intellectual knows that he/she has to produce, visualize, articulate, and justify new ideas, approaches and relationships without resorting to any unreasonable or questionable practices. An academic has to specify the terms and conditions of freedom while intellectuals naturally have a better understanding of freedom or thought. Because they believe ideas are not constrained by circumstances they can enjoy their freedom more. The Academics do not necessarily enjoy theirs and this may account for the lack of creativity in much of their work.

7.2.1 Single Investigators

As professionals, researchers have not been particularly concerned about rules for self-regulation. Since the goal of research is to advance knowledge through critical inquiry and scientific experimentation, it has commonly been assumed that the normal checking that goes on in testing new ideas is sufficient to keep researchers honest. Based on this assumption, research arguably does not need specific rules for self-regulation because it is, by definition, an activity that routinely monitors itself.

The lack of a perceived need for specific rules poses problems for researchers who want guidance on responsible research practices. Intellectually and professionally researchers organize their lives around fields of study. However, the societies that represent many fields of study for the most part have not developed comprehensive guidelines for responsible research practices. Many do have codes of ethics, but most codes of ethics are simply general statements about ideals and do not contain the specific guidance researchers need to work responsibly in complex research settings.

Fortunately, there are a few important exceptions to this last generalization. Comprehensive descriptions of responsible research practices can be found.

7.2.2 Team Investigators

The problems that can arise from a single investigator may be overcome by appointing a principal investigator to the project.

The principal investigator (PI) is charged with either conducting research activities of his own or supervising those who do. In reality, few scientist and engineers run their own studies. Instead, they hire qualified technicians or laboratory assistants to conduct basic experimental procedures, study the data, perform data assessments, and to keep accurate records of the laboratory activities.

In many cases, the regulations or conventions do not require that the principal investigator has any specific training or expertise, other than a current/former investigator in the laboratory with (hopefully) expertise in the area under study. Therefore, the extent to which study procedures are delegated and the level of experience, training, and education of those to whom the tasks are delegated are left to the discretion of the principal investigator.

In addition, principal investigators frequently designate sub-investigators. Most often, they designate sub-investigators from within the department where the research is being carried out (although there may be no requirement that the sub-investigators have specific training or expertise). These individuals are appointed to act as a surrogate for the principal investigator, and they work with the remainder of the project team just as the principal investigator would.

7.2.3 Misrepresenting Credentials

Misrepresenting credentials (lying on a resumé) is another, but common, type of deception. Researchers have been to forge credentials, which can be either blatant or take more subtle forms (Ogden, 1999; Martin and Schinzinger, 2005).

Some candidates lie on their resumés, some candidates embellish a little, while some embellish a lot, and others just lie. Most of the time, that lie is about their education. The key to stop such practices is to check resumés thoroughly, not just checking the address and telephone number, but by thoroughly checking every line item listed for education and employment. Without assiduously checking the facts and claims, it is impossible to determine who will include untruths on his resume.

The indications (but not conclusive signs) that a candidate may be lying on their resume are that the candidate is: well dressed, well spoken, well experienced in the field, on the defensive when asked to verify his education, and unable to produce evidence for his education.

Fake diplomas are also used to misrepresent an applicant's educational attainment. A search of the Internet will produce several online diploma mills that are willing to provide the custom replicated diplomas from any learning institution. The selling companies are part of a growing number of Internet sites where people can purchases unearned credentials from real universities.

One of the earliest cases discussed by the NSPE Board of Ethical Review (Case 79-5) was about an engineer who received a PhD from a nondescript (diploma mill) organization that required no attendance or study at its facilities. The engineer then listed the degree on all his professional correspondence and brochures and the NSPE board believed (or has ruled in the past) that when listing a PhD, there is no reason to identify the university from which the degree was obtained. Merely by listing the advanced degree alone, it is widely understood that it conveys an earned doctorate.

7.2.4 Misleading Listing of Authorship

Misleading listing of authorship is another area where deception can be perceived to occur and the order of authors' names in many scientific and engineering disciplines is usually understood to convey information about the relative contributions of the authors, with the earlier listing indicating greater contributions.

Authorship conventions may differ greatly among disciplines and among research groups. In some disciplines the group leader's name is always last, while in others it is always first. In some scientific fields, research supervisors' names rarely appear on papers, while in others the head of a research group is an author on almost every paper associated with the group. Some research groups and journals simply list authors alphabetically.

In some disciplines, the listing order is not considered important and alphabetical listing is the order of the day.

Many journals and professional societies have published policies (guidelines) that lay out the conventions for authorship in particular disciplines. These policies state that a person should be listed as the author of a paper only if that person made a direct and substantial intellectual contribution to the design of the research, the interpretation of the data, or the drafting of the paper, although students will find that scientific fields and specific journals vary in their policies. Just providing the laboratory space for a project or furnishing a sample used in the research is not sufficient to be included as an author, though such contributions may be recognized in a footnote or in a separate acknowledgments section. The acknowledgments sections can also be used to thank others who contributed to the work reported by the paper.

On the authors' side, a frank and open discussion of how these guidelines apply within a particular research project (as early in the research process as possible) can reduce later difficulties. Sometimes decisions about authorship cannot be made at the beginning of a project. In such cases, continuing discussion of the allocation of credit generally is preferable to making such decisions at the end of a project.

Decisions about authorship can be especially difficult in interdisciplinary collaborations or multi-group projects. Collaborators from different groups or scientific disciplines should be familiar with the conventions in all the fields involved in the collaboration. The best practice is for authorship criteria to be written down and shared among all collaborators.

Above all, it is unethical to omit the name of a coauthor that makes a significant contribution to the research (Chapter 8). It then becomes a question of the nature of the contribution by the proposed coauthor. Was the person a technician solely operating a spectrometer and doing nothing else? Conversely, was he a high level technician or a professional who operated the spectrometer and presented an interpretation to the other authors?

Answers to these and related question should prepare the way to clearly designate the authorship of the paper.

7.3 Collecting Research Data

Ethical issues permeate every stage of the research process from the provision of a title to the study onto the analysis of the data as mentioned before. There are a range of ethical issues emerging in the fields of qualitative and quantitative research. This has been and remains so for several reasons: First, quantitative research is rooted in rationality and objectivity and reflection can be used to correct/ evaluate the logic of analyses done, and secondly qualitative approaches to data collection are more personalized and allow for expressions of values, beliefs, motivations, emotions in sharing of information.

In addition to the ethical responsibilities of researchers, respondents also have ethical responsibilities. More often than not respondents do not breach their ethical commitments, spoken or unspoken. Researchers, for several reasons, may or may not adhere to their personal and/or professional ethics.

Research ethics regulations have traditionally focused on informed consent, breaches of confidentiality, stress, injury, coercion, invasion of privacy and deception. The ethical conduct of research protects participants from harm and enlightens them on the goals of research. For example individual and/or private interests may intervene and thwart the attainment of public goals.

Whether or not researchers conduct scientific research, they have an implicit obligation to the society as a result of training and education that they had received (Shrader-Frechette, 1994, 24). Value-freedom in research is impossible because human beings cannot be completely objective with respect to the exact margin of error, choice of statistical test, sample selection, research designs, data interpretations, assumptions and theories. Most of the ethical issues arise with respect to methodological value judgments and such value judgments should be specified even if they are defensible (Shrader-Frechette, 1994, 54–55).

Because of the complexity of scientific and engineering research, mistakes and errors are inevitable (Bertozzi, 2009). Nevertheless, researchers have an obligation to the public, to their profession, and to themselves to be as accurate and as careful as possible. Scientific disciplines have developed methods and practices designed to minimize the possibility of mistakes, and failing to observe these methods violates the standards of science and engineering. Every result must be carefully prepared, submitted to the peer review process, and scrutinized even after publication.

Beyond honest errors are mistakes caused by negligence. Haste, carelessness, inattention (any of a number of faults) can lead to work that does not meet scientific standards or engineering standards. Researchers who are negligent are placing their reputation, the work of their colleagues, and the public's confidence in science at risk. Errors can do serious damage both within science and in the broader society that relies on scientific results.

Scientific and engineering data must also be presented in a manner that would avoid future misuse or misinterpretation. Membership in a profession carries with it an implicit commitment to pursue the welfare of the profession. This is partly done by avoiding hasty, unconfirmed statements, incomplete analyses and by speaking out about these in the studies of peers, thus the significance of peer reviews. This is why many journals have stipulations to deal with fraud and may require researchers to place their raw data in a special archive (Shrader-Frechette, 1994). However different research applications often carry different degrees of risk for the public and, as such, researchers must aspire to high standards of reliability and validity in order to minimize damaging implications. This raises concerns for epistemic and ethical objectivity.

Research on scientific misconduct has found that there are several categories of people who may engage in unethical practices, deliberately or not: new faculty members who have not been properly mentored, individuals seeking promotion or tenure, and those who like to see their name in print.

Organizational justice research has focused on processes that shape justice perceptions and evaluations. It has been established that motivations specify the desired conclusion (Blader and Bobocel, 2005). Many organizations support the importance of procedures for outcomes (Blader and Bobocel, 2005). Research has also unearthed several factors in addition to perceptions of fairness that impact on organizational justice (Gilliland and Paddock, 2005).

Some examples of ethical issues in research are:

1. failing to keep important analysis of documents of a period of time,
2. maintaining incomplete records of findings,
3. seeking the status of co-author without making a significant contribution to the article,
4. not allowing one's peers access to data collected and analyzed (especially after the article was published),
5. exploiting research assistants without acknowledging their assistants, and
6. bias in sampling (Barnbaum and Byron, 2001).

It is unethical for researchers to ignore the role of language in the making of meanings in the lives of the researched (Mertens et al., 2009). Researchers have also been identifying the biases in study findings which indicate that minority ethnic groups as being four times as likely as whites to be schizophrenic. They have criticized the unusually large correlations between race and social class and hurricane survival in Southern United States. This brings to the forefront the issue of social justice. Ethical issues also resonate in the choices and representations of dimensions of diversity to be researched (Mertens et al., 2009).

Ethical concerns also surface when looking at the criteria for: fairness, the study's ability to elicit from respondents information that they were unaware of, unawareness of social construction of reality by others.

Ethics, it has been established, is concerned with what should and should not be done and this is one of the requirements of a profession. Professional ethics constitute standards that are widely accepted within the profession (Schwartz, 2009). Generally the stipulations of ethical associations worldwide emphasize: high technical standards, a certain range of abilities, skills, and cultural knowledge, integrity, honesty, and respect, and responsibility. These are supposed to be borne in mind when developing, carrying out and reporting research results (Wolf et al., 2009).

Sometimes ethical concerns of researchers emanate from their awareness of the entities or communities or organizations that they represent, or from attempting to be neutral or from holding on to a specific set of principles In turn, the public's assessment of research or evaluation research in particular would focus on the approach to the study, degree of accuracy and reporting of results (Wolf et al., 2009). In an effort to balance clients' and societal needs evaluation researchers for example have to meander their way through ethical concerns and maintain ethical standards despite differences in stakeholders' interpretations. Juxtaposed in the realities of evaluation research are the 'change agents' role of evaluators, personal values of evaluators and the persistent need for objectivity in research. The outcome has been differences in the ethical orientations of individual researchers (Wolf et al., 2009).

With respect to experimental research on scientific and engineering issues (*randomized experiments*, sometimes called wildcat experiments), it has been established that their partial success in identifying cause-effect relationships is useful, bringing value to same; their role in decision-making and their contribution in reducing the cost of wrong decision-making must continue to be valued. Once this approach is providing the best possible answer in the circumstances, then it is doing what good ethics requires. Ethical concerns persist however with respect to risks and benefits and decision about which causal relation is more important to be investigated (Mark and Gamble, 2009).

7.3.1 Bias in Analytical Methods

Bias is a form of self-deception, which is sometimes motivated irrationality but other times it constitutes a more purposeful evasion. For example, researchers suspect an unpleasant reality, perhaps sensing that the data are going against what they want to believe. Then, instead of confronting the data honestly, they purposefully disregard the evidence or downplay its implications. The purpose and intention involved is typically unconscious or less than fully conscious (Martin and Schinzinger, 2005).

The accuracy of a test is a measure of how close the test result will be to the true value of the property being measured. As such the accuracy can be expressed as the *bias* between the test result and the true value. However, the absolute accuracy can only be established if the true value is known (Speight, 2002).

In the simplest sense, a convenient method to determine a relationship between two measured properties is to plot one against the other. Such an exercise will provide either a line fit of the points or a spread that may or may not be within the limits of experimental error. The data can then be used to determine the approximate accuracy of one or more points employed in the plot. For example, a point that lies outside the limits of experimental error (a flyer) will indicate an issue of accuracy with that test and the need for a repeat determination (Speight, 2002).

However, the graphical approach is not appropriate for finding the absolute accuracy between more than two properties. The well-established statistical technique of regression analysis is more pertinent to determining the accuracy of points derived from one property and any number of other properties. There are many instances in which relationships of this sort enable properties to be predicted from other measured properties with as good precision as they can be measured by a single test. It would be possible to examine in this way the relationships between all the specified properties of a product and to establish certain key properties from which the remainder could be predicted, but this would be a tedious task.

The example is the researcher who omits eighteen out of twenty four points on the basis that only six of the points were true and the remainder,the eighteen points that he omitted or discarded, were flyers.

This is bias in favor of the researcher's theory that he must prove to be the correct theory, for whatever reason.

The impact of analytical bias on scientific and engineering medical decisions is mostly unknown. A large margin of error may be acceptable in some circumstances, whereas other scenarios demand more accurate and precise laboratory measurements. Often, scientist and engineers interpret laboratory results within the larger context of the project history and physical examination, but the influence of imprecision in laboratory data on a scientist or engineer's assessment can be dangerous, if not fatal.

7.3.2 Misuse of the Data

Data misuse occurs when data obtained (through experimentation) is used in the wrong context and may even be data from another researcher that is used without the user's consent. The data can be used for support of an incorrect theory. Another example is when a scientist or engineer uses data that has been entrusted to them in a manner not intended by the owner of the data.

The related issue, *data protection,* is safeguarding data against misuse. Ways in which this is done is by keeping data under lock and key whether it is in a locked safe or on a computer hard-drive where it is protected by encryption, firewalls, and user authentication.

Such systems prevent any access without a key, combination, or password and will record the details (time, terminal, logged in ID) of both successful and unsuccessful access attempts. This provides traceability and so deters casual miss-use.

7.3.3 Falsification and Fabrication of the Data

Falsification of data is the selective alteration of data collected in the conduct of scientific investigation or the misrepresentation of uncertainty during analysis of the data. Falsification also includes the selective omission/deletion/suppression of conflicting data without scientific or statistical justification.

Falsification includes such practices as:

1. The alteration of data to render a modification of the variances in the data;
2. The entry of incorrect dates and experimental procedures in a laboratory notebook or in any other record keeping device,
3. The misrepresentation of the results from statistical analysis,
4. The misrepresentation of the methods of an experiment such as the equipment used to conduct the experiment,
5. The addition of false or misleading statements in the manuscript or published paper,
6. The publication of the same research results in multiple papers; this is self-plagiarism. This

includes presenting the same set of slides at a series of meetings in which only new one slide is added for each meeting that, literally, adds nothing to the presentation, but is included to seemingly add another conclusion and for the author to be invited to other meetings.

7. The providing false statements about the extent of a research study in an abstract submitted for publication and oral presentation at a professional society meeting.

Fabrication of data is the intentional act of creating records that do not exist and for which there is no basis in fact with the intent to mislead or deceive. In short, the data is a pipe dream or has been conjured up for various reasons, none of which are legitimate!

Researchers who manipulate (fabricate or falsify) their data in ways that deceive others, even if the manipulation seems insignificant at the time, are violating both the basic values and widely accepted professional standards of science and engineering. Researchers should draw conclusions based on their observations of nature. If data are altered to present a case that is stronger than the data warrant, the researchers mislead their colleagues and potentially impede progress in their field or research. They undermine their own authority and trustworthiness as researchers. And they introduce information into the scientific or engineering record that could cause harm to the broader society.

Because of the critical importance of methods, scientific and engineering papers must include a description of the procedures used to produce the data, sufficient to permit reviewers and readers of a scientific or engineering paper to evaluate not only the validity of the data but also the reliability of the methods used to derive those data. If this information is not available, other researchers may be less likely to accept the data and the conclusions drawn from them. They also may be unable to reproduce accurately the conditions under which the data were derived.

7.3.4 Plagiarism and Theft

Plagiarism is intentionally or negligently submitting the work of others as one's own. It is also claiming credit for someone else's ideas or work without acknowledging it, in contexts where one is morally required to acknowledge it (LaFollette, 1992).

Plagiarism is also the theft of intellectual property and is not unlike stealing from a commercial business. A special case of plagiarism is the, "frowned upon but not always unacceptable," practice of *self plagiarism* in which an author will use segments of his own published material (e.g., methods section of a scientific paper) in a new publication without reference.

Plagiarism and falsification of data or fabrication of data are the primary means of scientific fraud. Whether data are made up, copied from someone else, or manipulated to achieve some desired end result, it's always fraud. But perhaps the more interesting question concerning fraud is why it happens.

Scientists and engineers who believe that they deserve more recognition are more likely to falsify, plagiarize or manipulate the data in order to report successful results. This has been so since the era of Newton, Dalton, Darwin, and Freud as they sought fame and prestige. Small scale deviant practices are likely to persist because, despite the canons of scientific research scientists and engineers can always attribute small inconsistencies to unavoidable errors that accompany or infiltrate all research.

On the other hand, and quite often, the reason is money. There were several environmental labs in the 1980s and 1990s whose employees were caught changing the time clock on their GC/MS data systems or changing the baseline on a chromatographic analytical method (processes known colloquially as time traveling and peak shaving). In another case, data were shown to be completely fictitious. A lab received samples and sent out data with no intervening lab procedures. At the behest of the U.S. Environmental Protection Agency and state regulators, federal marshals swooped down on the lab, impounded its data, and took most of the staff to jail (Ryan, 2002).

One of the major determinants of judgments of the degree of responsibility is whether a controllable act is perceived or intentionally committed or due to negligence (Werner, 1995). Since judgment can only be reliably made after some period if observation or investigation. There is a general feeling that whether practices have increased.

Before deciding whether an ethical crisis exists, we have to determine whether one of three situations exists:

1. whether ethical standards are unknown and unclear,
2. whether they are clear but ignored, or
3. whether they are being followed. (McDowell, 2000).

Whether or not there is a crisis in professional responsibility depends very much on the extent to which individuals were responsible and disciplined before acquiring professional status. The fact remains that the search for truth, knowledge and understanding of the world pose powerful ethical demands for the individual who wants to be part of a community of individuals who call themselves scientists and engineers (Guba, 1990). Indeed, methodological, analytical and ethical issues are closely interconnected (Ryen, 2009) particularly so because we have to relate with people in doing research, people whose attitudes, values, perceptions of issues vary.

Whenever conflicts of interest interfere with the conduct of research, it should not be undertaken (Bok, 2006).

7.4 The Controls

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 code 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.

Ideally, prevention of scientific misconduct is the best protection of the public as well as of the reputation of the various scientific disciplines. To develop an appropriate focus on ethics standards, one should consider how a scientific community functions. The behavioral messages of established faculty members, for instance, are a significant source of learning.

The influence of the hidden or informal curriculum may run counter to the educational messages of the formal means of communicating normative behavior and expectations. Based on studies, it is observed that trainees and junior colleagues model their professional behavior, to a large extent, on what their leaders do, not what they say. Established scientists and engineers are effective if they openly explain their difficult decisions as based on issues of right and wrong. In other words, modeling is a primary factor in assuring ethical conduct.

The most effective control is the development and publication of 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. However, 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.

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 outcome of any review of the misconduct by a member, no what his level in the scientific or engineering community.

In their role as publishers, societies have the opportunity to influence research conduct. Societies should review their codes of ethics to determine whether they appropriately cover publication ethics, a critical element in promoting research integrity. The society's leadership should work closely with new editors and new generations of researcher-scholars regarding ethical standards and their crucial role in helping to ensure the integrity of research. Society journals should develop educational programs regarding publication policies that promote integrity in publishing scholarly work.

The scientific societies should establish a consortium of journal editors to develop, where appropriate, consistent standards for publishing scientific research. Scientific societies should work together to establish a uniform policy regarding authorship in the context of multi-disciplinary research collaborations.

Criteria for authorship and the responsibilities, including relative contributions, of authors should be clearly stated by society journals. Furthermore, specific standards for online publication should be developed by the societies.

There should be no cover-up or attempted cover-up of misconduct in any of the on scientific or engineering disciplines.

Once misconduct by a member of any society has been proven, there should be no show of wrist-slapping. The member responsible for the misconduct should be expelled from the society and it made known publically why he is no longer welcome as a member of that society.

Furthermore, in order to keep one's nose clean, any scientist or engineer who is requested to be a coauthor should ignore the data in next-to-final draft before publication (after the data have been massaged to look presentable) and check the original data (Chapter 8). If there are inconsistencies in the transposition of the data from the laboratory notebook to the would-be draft for publication, the invited co-author should make noises to have this explained and, if necessary corrected, keep a paper trail as means of exoneration.

Finally, a checklist (which is not necessarily all-inclusive) is presented below that contains a range of questions that scientists and engineers can use in research with the accompanying ethical issue (italicized):

1. How is the laboratory notebook structured and what provisions are there to have the entries signed and dated by a witness?
   Ethical issue: should be signed and dated by a witness.
2. Did the laboratory notebook include changes in the views of the researcher relating to the

subject being researched, data, theory, and the method?
Ethical issue: Omitting to include such changes.

3. Are there notations relating to new ideas from the literature?
Ethical issue: Failure to acknowledge the sources.
4. ·What are the controls over having sufficient information?
Ethical issue: Failure to acknowledge the need for further information.
5. Which methods or combination of methods were used to collect data and apply to date workup?
Ethical issue: Using methods that will gave results that are in keeping with, and support, the theory of the researcher.
6. What are the data requirements for the research?
Ethical issue: Acquiring data from other researchers even if it means an invasion of their work (without permission) and without acknowledgement of the source.
7. What are the limitations of the research?
Ethical issue: Deliberately claiming fewer limitations once the theory has been seemingly proven.
8. How is the research problem defined?
Ethical issue: The issue of using a definition that fits the preliminary data rather than the original project definition.
9. Has the available literature been reviewed extensively and carefully for prior work?
Ethical issue: Selective reviewing for preferential papers and omission of other papers that may point the way for further work or refute the researcher's theory.

10. Is your study original in terms of methods, equipment, data generation, and procedures? Ethical issue: Claiming originality without a clear basis or failure to acknowledge prior work.
11. Which sampling techniques were used? Ethical issue: Deliberately excluding standard methods of sampling because data acquired by these methods may point unfavorable to the researcher's theory.
12. Should a research proposal include all or one of the following: title, abstract, background, all of the relevant literature, data collection methods, and implications? Ethical issue: failure to disclose all of the relevant information in the proposal and knowing the outcome of the research because of undisclosed data.
13. Is there a plan analyzing and interpreting the data? Ethical issue: Deliberately omitting an unbiased plan and/or omitting some of the data that do not support the theory.
14. Is there a plan to repeat experiments or field work if more data are required? Ethical issue: Fabricating additional data when the researchers should go back into the laboratory to repeat experiments, to do additional experiments, or perform more field work.
15. Is the researcher willing to seek evidence that might dispute his theory? Ethical issue: Failure to seek alternate evidence and/or ignore evidence that contradict the researcher's theory.
16. Is the researcher willing seek pursue an alternate theory on the basis of deviant data (e.g., flyers on an x-y plot of the data)?

Ethical issue: Ignoring or deleting any such information that threatens the theory.

17. By what means will the researcher would you analyze his data?
Ethical issue: Deliberately analyzing data in a manner which supports the theory and/or data which cannot be replicated.
18. Does the researcher show originality in techniques and procedures used to conduct the study, in exploring the unknown, in using the data, and in outcomes of the study?
Ethical issue: Claiming originality for the work without a rationale for making such claims.
19. Dues the data in the laboratory notebook help to align thinking and provide ideas for future study?
Ethical issue: Make inferences/judgments without serious consideration of the true nature of the data.
20. Is the researcher sure the he is not simply empathizing (agreeing) with the work of others under whose supervision he works and mirroring the supervisor's experience and data?
Ethical issue: Losing rational and emotional balance during or after the study when the data are being assessed.

References

Altman, E. 1997. "Scientific Research Misconduct." *In Research Misconduct: Issues, Implications and Strategies.* E. Altman and P. Hernon (Editors). Ablex Publishing, New York.

Barnbaum, D.R. and M. Byron, M. 2001. *Research Ethics: Text and Readings*. Prentice Hall, Upper Saddle River, New Jersey.

Bertozzi, C. (Chair). 2009. On *Being a Scientist: A Guide to Responsible Conduct in Research 3rd Edition.* National Academy of Sciences, Washington, DC.

Blader, S.L. and Bobocol, D.R. 2005. "Wanting is Believing: Understanding Psychological Processes in Organizational Justice by Examining Perspectives of Fairness." *In What Motivates Fairness in Organizations?* S.W. Gilliland (Editor). Information Age Publishing, Charlotte, North Carolina.

Bok, D. 2006. *Universities in the Marketplace.* University of Princeton, Princeton, New Jersey.

Branscomb, L.M. 1985. Integrity in Science. American Scientist, 73(Sept/Oct): 421.

Cassell, J. 1982. "Does Risk-Benefit Analysis Apply to Moral Evaluation of Social Research?" *In Ethical Issues in Social Science Research.* Johns Hopkins University Press, Baltimore, Maryland.

Fleddermann, C.B. 2008. *Engineering Ethics 3rd Edition.* Pearson Prentice Hall, Upper Saddle River, New Jersey.

Gibilisco, S. 2004. *Statistics Demystified,* McGraw-Hill, New York.

Gilliland, S.W. and Paddock, W.L. 2005. "Images of Justice: Development of Justice Integration Theory." *In What Motivates Fairness in Organizations*? S.W. Gilliland (Editor). Information Age Publishing, Charlotte, North Carolina.

Hamilton, Neil. (2002). *Academic Ethics.* Praeger Press, Greenwood Publishing Group, Santa Barbara, California.

Heilprin, J. 2003. "Truth in Science – Goal for New Interior Code." *Casper Star-Tribune,* May 31, page A7.

Hernon, P., and Calvert, P.J. 1997. "Research Misconduct as Viewed from Multiple Perspectives." *In Research Misconduct: Issues, Implications and Strategies.* E. Altman and P. Hernon (Editors). Ablex Publishing Corporation, New York.

Hileman, B. 2005. "Research Misconduct." *Chemical & Engineering News.* American Chemical Society, Washington, DC. 83(35): 24–26.

Huff, D. 1954. How to Lie with Statistics. W.W. Norton and Company Inc., London, United Kingdom.

Kearney, R. 1999. "The Crisis of the Image: Levinas' Ethical Response." *In The Ethics of Postmodernity: Current Trends in Continental Thought edited by G.B. Madison and M. Fairbean.* Northwestern University Press, Evanston, Illinois.

Kerr, C. 2001. The *Uses of the University.* Harvard University Press, Cambridge, Massachusetts.

LaFollette, M.C. *Stealing into Print: Fraud, Plagiarism, and Misconduct in Scientific Publishing.* University of California Press, Berkeley, California.

Mark, M.M. and Gamble, C. 2009. "Experiments, Quasi-Experiments and Ethics." *In Handbook of Social Research Ethics.* D.M. Mertens and P.E. Ginsberg (Editors). Sage Publications, Thousand Oaks, California.

Martin, M.W., and Schinzinger, R. 2005. *Ethics in Engineering 4th Edition.* McGraw Hill, New York.

McDowell, B. 2000. *Ethics and Excuses: The Crisis in Professional Responsibility.* Quorum Books, Westport, Connecticut.

Mertens, D.M. and Ginsberg, P.E. 2009. "Ethical Issues in Research Practice." *In Handbook of Social Research Ethics.* D.M. Mertens and P.E. Ginsberg (Editors). Sage Publications, Thousand Oaks, California.

NAS. 1992. *Responsible Science: Ensuring the Integrity of the Research Process*: National Academy of Sciences, National Academy Press, Washington, DC.

Neave, G. 1988. "On Being Economical with University Autonomy: Being an Account of the Prospective Joys of a Written Constitution." *In Academic Freedom and Responsibility.* M. Tight (Editor). Open University Press, Milton Keynes, Buckinghamshire, England.

NRCNA. 2002. *Integrity in Scientific Research: creating an environment that promotes responsible conduct.* National Research Council of the National Academies. The National Academies Press, Washington, DC.

Ogden, T. 1999. *Control Magazine.* Putnam Publishing Co., New York. March, page 41.

Pocklington, T., and Topper, A. 2002. No Place to Learn: Why Universities Aren't Working. UBC Press, Toronto, Ontario, Canada.

Reagan, C.E. 1971. *Ethics for Scientific Researchers, 2nd Edition.* Thomas Publishers, Springfield, Illinois.

Resnik, D.B. 2000. "Statistics, Ethics, and Research: An agenda for education and reform." *Accountability in Research,* 8: 163–188.

Roy, R. 1999. "Comment. Chemistry in Britain." *Royal Society of Chemistry,* London, United Kingdom.

Ryan, K.J. (Chair) 1995. "Integrity and Misconduct in Research." *Commission on Research Integrity.* United States Department of Health and Human Services, Washington, DC.

Ryan, J.F. 2002. "Fraud." *Today's Chemist at Work.* American Chemical Society, Washington, DC. Volume 11(11): 9.

Shrader-Frechette, K. 1994. *Ethics of Scientific Research.* Rowman and Littlefield Publishers Inc., New York.

Smith, R.B. 2008. *Cumulative Social Inquiry: Transforming Novelty into Innovation.* The Guilford Press, New York.

Speight, J.G. 2002. *Handbook of Petroleum Product Analysis.* John Wiley & Sons Inc., Hoboken, New Jersey.

Tight, M. 1988. "Editorial Introduction." *In Academic Freedom and Responsibility.* M. Tight (Editor). Open University Press, Milton Keynes, Buckinghamshire, England.

Werner, B. 1995. *Judgments of Responsibility: A Foundation for A Theory of Social Conduct.* The Guilford Press, New York.

Whitbeck, C. 1998. *Ethics in Engineering Practice and Research*. Cambridge University Press, New York.

Wolf, A., Turner, D., and Toms, K. 2009. "Ethical Perspectives in Program Evaluation." *In The Handbook of Social Research Ethics*. D.M. Mertens and P.E. Ginsberg (Editors). Sage Publications, Thousand Oaks, California.