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Educational Forum

Editor's Note:
The following report exemplifies a graduate student project of the sort discussed in "Teaching Ethics to Scientists and Engineers" in the previous issue of this journal (Volume 1, Issue 3, pp. 299-308). It begins with a problem that the student experiences as ethically significant and reports on interviews conducted to clarify the problem and responsible ways of handling it. Tyson Browning's report shows how a concerned student can use the opportunity to raise, with the faculty and other knowledgeable informants, questions of a technical and ethical nature that are of concern to him. Assignments which give students the tools to address problems they experience complement education on "required topics", and build a student's understanding of, and confidence in, criteria for responsible practice in his field. *C. Whitbeck*

Reaching for the "Low Hanging Fruit": The Pressure for Results in Scientific Research– A Graduate Student's Perspective

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Abstract: *The pressure for results applied by some research funders concerns some academicians. Sometimes, for example, a sponsor requests preliminary data that the researcher is not ready to release. This paper presents three interviews — two with researchers and one with a representative from industry — dealing with these issues and makes recommendations on the basis of those interviews. It also looks briefly at the different norms that exist in industry and academia for research and communication and the tensions these can cause for a scientist working simultaneously in both realms.*

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INTRODUCTION

Ethical challenges sometimes arise in a research environment. As a graduate student working in a research atmosphere, one learns from such situations mainly through one's observation of others and how they respond (or fail to respond) to such challenges. Some may dig more deeply for more objective answers or ways to handle these situations, but many just wait and hope an issue will pass, not knowing how to deal with it. Many cannot identify what and when situations fall into the realm of ethics.

With some first-hand observations and in the context of a report for an ethics course at Massachusetts Institute of Technology (MIT), I set out to examine some of the pressures to obtain timely and useful results present in academically-coordinated research projects. I sought to determine whether there are ethical concerns in this area that deserve consideration. If so, what are they? What kind of pressure for results is justifiable in science? Can pressure for results threaten research integrity? As an approach to answering these questions, I wanted to find out what concerns, if any, experienced researchers have in dealing with pressure for results. I interviewed three individuals who have directly or indirectly worked in industrially sponsored research situations. For the sake of comparison and to get a different perspective, one of the three is a program manager working in industry. As a catalyst for discussion, I constructed a scenario to present a context for these considerations and prepared some questions to delve into the interviewees' perspectives on such matters.

Scenario

The following scenario was designed to prompt the interviewees to think about the situations of interest and was left purposely ambiguous in some senses in order to allow maximum leeway for interpreting possible issues (or lack thereof).

> Professor Jones works at a university, both teaching and conducting research. His field happens to be of interest to a certain group (governmental or industrial) outside the university. Wishing to find better information on which to base important decisions, this group offers to fund the professor for a year of research into particular aspects of his field. Professor Jones agrees to this proposal.
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> After a month, the group sends a representative to check on the progress of Professor Jones's work. This representative requests to see some of the preliminary data from the research. Although hesitant, Professor Jones shows some of his early data to this representative. The representative then asks the professor to attend a meeting that will be held in a few weeks at the group's office and to present these preliminary "findings". Professor Jones, aware of the nature of his work, is very hesitant to do this, fearing that these preliminary data will be misused. Furthermore, he is not at all sure of the accuracy or validity of all of these early data. What if they are incorrect? Will he be deemed responsible for any misuse of the information he presents?

Questions

The questions were developed to encourage the interviewees to think about the issues in different ways. In some cases, their responses led to further queries that would help them express their concerns more explicitly. Some of the initial questions were:

1. What are some of the problems, existing or potential, that you see in this situation?
2. Have you or has someone you know been involved in a situation similar to this? Explain.
3. How should the professor respond in such a situation?
4. How does one learn these techniques? How likely would a new professor, for example, be to know them?
5. What particular differences, if any, do you see between the way industry and academia exchange and use information?
6. In this case, is Professor Jones doing "science" (scientific research) or something else?

The first four questions deal directly with the scenario. Although question six refers to it as well, the last two questions attempt to identify the more philosophical underpinnings of the responses to the first questions.

The Interviewees

Due to the sensitive nature of these issues — at least in the opinion of one — I have maintained the anonymity of the three interviewees. I included representatives from both academia (two) and industry (one) with the expectation that their perspective on these issues might differ.

Professor A is a senior professor of environmental engineering at MIT. Professor B is a professor of organizational behavior in the Sloan School of Management at MIT. The representative from industry works as a program manager and new business developer in a high-tech industry.

RESULTS OF THE INTERVIEWS

This is not a verbatim transcription of each interview but rather a summary of the response made to each question by each interviewee. The summaries do not state my interpretations (unless noted). My views as an engineering graduate student as well as some recommendations follow in the section entitled "Analysis and Conclusions."

1. What are some of the problems, existing or potential, that you see in this situation?

Professor A saw two: (1) a concern for a lack of quality control in the data at this point, implying that the data may not mean what they say; and (2) if this working relationship was established through a contract, perhaps adherence to that contract could become an issue. Aside from this, however, Professor A could

not pinpoint any explicitly ethical issues in the scenario, at least as constructed.

Professor B also said that concerns depended on the kind of process upon which they had previously agreed. Did the group arrange for "research" or "consulting", "action research" or "hypothesis testing"?* Both parties in this scenario should agree on exact definitions and what they entail. Furthermore, is this research based on a grant or on a contract? What was contracted? In this interviewee's estimation, the group has a right to research findings and a final report (and possibly progress reports, if contracted). Certainly there is no problem with presenting a research status report along the way. Extra requirements should not be added as an afterthought however. "Unfortunately," Professor B added, "they have a right to hound the professor." After all, they do pay the bills. Finally, Professor Jones must take precautions so that the group does not bias the research process. For example, if the group is the subject of the research, will presenting the research to them bias the collection of further data? Such a bias, according to Professor B, could present a problem. But is it an ethical one?

The industrial representative pointed out that industry has schedules with milestones, and some definition of "progress" as "earned value" is assumed: if hours were spent on a project, what was accomplished? Hence, the problem here is the apparent lack of an up front understanding of the delivery of a "product"—how much? what? and when? These questions need to be addressed and understood by both parties in such a situation.

2. ***Have you or has someone you know been involved in a situation similar to this? Explain.***

Professor A has been involved in these types of industry-university arrangements, but noted that only political, not necessarily ethical, issues arose. Usually, of course, such proceedings occur without undue pressure. In most cases, the fund providers do not "hound" the researchers; undue pressure is not a concern. On the other hand, Professor B is currently involved in a situation where these issues arise on a weekly basis. Professor B certainly thinks that the contractor has made some inappropriate requests. The industrial representative has also been involved in these types of arrangements from the "other side", and said that usually issues of differing expectations arise, but not ethical concerns. The industrial representative indicated that the scenario seemed to him more the exception than the rule.

3. ***How should the professor respond in such a situation?***

Professor A was quick to point out that a professor cannot always be held responsible for all that is done with all of the *information* he or she presents. However, Professor A also noted that one should know for whom one is working. One can best avoid controversy by establishing clear ground rules from the outset. Included among these, perhaps, for the sake of understanding, should be a statement about ensured access to all information, such that "all parties are equally free to misuse the information."

* Action research" or "hypothesis testing" is a differentiation made in the management sciences and perhaps in other fields as well.

Professor B responded more specifically, saying that Professor Jones should, if possible, try to get out of presenting unvalidated data. Instead, perhaps, he could offer to talk about previous research or the theory and process of the current work. He should make it clear to the group that it is too early to suggest findings from the data. If nevertheless forced to present preliminary data, he should plaster the report with disclaimers on every page, and mention at every possible juncture the nature of the data and that no conclusions can be drawn at this point.

The representative from industry reiterated that these issues need not arise: they should be agreed upon up front.

4. How does one learn these techniques? How likely would a new professor, for example, be to know them?

Professor A lamented that, unfortunately, what to do in such circumstances is mainly learned in the 'breach'. Professor A was not aware of any explicit process for imparting the techniques of sorting out these issues and questions. Professor B noted that required courses in research methodology in Ph.D. programs were places where, at least in the field of management science, the possibility of such issues arising is at least mentioned—although techniques for dealing with them may not always be explicit. Professor B also remarked that mentoring with senior faculty could impart some of the skills needed in scenarios such as this one. The industrial representative suggested that professors work with or even in industry for a time to gain that perspective. As for industry learning how to better approach these issues, the industrial representative discerned even greater difficulty. Perhaps efforts should be made to enable professors to become a part of teams in industry rather than just contractors to them.

5. What particular differences, if any, do you see between the way industry and academia exchange and use information?

Professor A mentioned the standard of "context-free information" in academia (see discussion later in this paper). Ideally, the government would be similar. Actually, however, since the government is divided into specialized agencies, it ends up acting more like industry, being selective and contextual in the information it uses.

Professor B saw industry as relatively closed, trying to apply specific research for profit. On the other hand, the university treats information as relatively public (although specific projects can be classified for defense purposes); academicians try to build and test theories and publish for other academics. According to Professor B, not only does this standard obviously not apply to the same degree in industry, but industry often has to dig harder to extract even academic findings; i.e., there is less diffusion of new knowledge from academia to industry than there is within academic circles.

The industrial representative views the university as highly driven by the school's calendar year and student support issues. Hence, in setting up arrangements to transfer information from university to industry, scheduling is a constant problem. The industrial representative made no specific reference to different perspectives on what information is considered useful however.

6. In this case, is Professor Jones doing "science" (scientific research) or something else?

Professor A thought not: this is a contract for "technology," not a grant to do research. The areas of investigation and expectations are defined and constrained. Here, there is a specific goal in mind (probably of benefit to the industry or agency), whereas "science" has no end—and furthermore is not "ethical"; rather, it is amoral. If there is a latent ethical issue in this scenario, it would be: is the professor in this work representing a non-objective process as objective? (i.e., is he representing applied, contextual science as basic, unbiased science?) This is ethical misconduct in the form of deception that damages the credibility of science. Professor B concurred, saying, "No, this is not science," especially if the result is only a report to a single company. Perhaps, if data processing and analysis are rigorous and results are publishable, then some "science" can nevertheless come from this work.

The industrial representative, on the other hand, thought that most professors must believe it is science (or else why would they agree to do it?). But, he asked, cannot science be accomplished even when profit is the motive? Why does the motive matter? Everyone has a motive, in fact, and having one does not preclude a useful purpose. The motive in industry is, admittedly, focused on payoffs, not on "knowledge for knowledge's sake."

ANALYSIS AND CONCLUSIONS

The interviewees' comments contain some common themes that point to some methods of dealing with these issues when and if they arise. Some general guidelines can provide assistance for the majority of occasions where these questions become issues in research, however infrequently they may arise.

Dealing with the Issue

One motif in the responses is the idea of a contract—i.e., a specific delineation of the expectations of both sides about any deliverables and their schedule. But many contracts poorly describe the deliverables because some issues do not always arise. (Indeed, some individuals seem to think that, if they are not anticipated, they will not arise.) Final products and some major reports—the tangibles—are usually detailed, but the intangibles often are not. These include the situations where someone requests preliminary data. (This has more potential to become a problem in large scale projects with many levels of participation and management—notably when the sponsor sends representatives to monitor research who must then report their findings back up their chain of command at home. Understandably, they require something [specific] to report!) Time and money also constrain contract preparation and specification.

Parties cannot make perfectly anticipatory contracts, of course. However, based on the considerations here, parties should *make arrangements as explicit as possible in areas of preliminary data handling, agreeing up front on what data will be shared and when*. Those not answering this question at the beginning of a project

may find themselves having to deal with it later and may find the quality of their research product compromised. In making research collaborations between industry and universities work smoothly, incorporating these considerations into the initial contract should simply be viewed as part of the "design for manufacturability" of the research product.

Recognizing the Source of the Tension

The academic interviewees, especially Professor B, drew a distinction between "academic research" and "consulting". Consulting is seen more as professional advice to a client. When the professional is a scientist, advice is usually generated through some use of scientific methodology. When asked if the work Professor Jones is doing in this scenario is "science" (i.e., truly scientific research) the professors said "no". It is interesting that, in the professors' opinions, some elements of what constitutes science are missing from Professor Jones's task. Certainly the members of corporate research and development teams consider themselves scientists, and many certainly do research. Why the disparity?

Here it would help to make a distinction between basic and applied research, although such a distinction is often difficult to maintain. The National Science Foundation recognizes that industry and academia interpret these realms slightly differently, and uses the following definitions:

> **Basic Research**: Within the Federal, university, and nonprofit sectors, basic research is defined as research directed toward increases in knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific application toward processes or products in mind. For the industry sector, basic research projects are defined as "original investigations for the advancement of scientific knowledge which do not have specific commercial objectives, although they may be in fields of present or potential interest to the reporting company."
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> **Applied Research**: Within the Federal, university, and nonprofit sectors, applied research is defined as research directed toward gaining "...knowledge or understanding necessary for determining the means by which a recognized and specific need may be met." The applied research definition for the industry sector is modified to include " research projects which represent investigations directed to discovery of new scientific knowledge and which have specific commercial objectives with respect to either products or processes."[1]

The professors spoke of science as relatively unbiased and context-free. (Nothing can be completely context-free, of course, but most would agree that it is within our ability to be "relatively less" context-oriented, such that a distinction could be drawn between obvious examples of both extremes [with many gray areas remaining, naturally].) Therefore, they must mean basic science. In the scenario, Professor Jones is doing applied science. Alvin Weinberg summarized applied science succinctly, stating that "...applied science is merely a means to a nonscientific end...,"[2] whereas in basic science, science is the end as well as the means. Will not different ends cause tension in the means?

Within a university, not all research is basic, fundamental research—much is applied research. Basic research norms entail relatively context-free approaches to

investigation and open exchanges of ideas and information. "Deliverables" usually take the form of a (yearly) report; grants are more prevalent than contracts. In fact, the word "contract" almost always implies applied research,* which is usually what industry, with its shorter-term interests, is interested in funding. Vannevar Bush framed the tension between basic and applied research well in *Science — The Endless Frontier*:

> [I]t is important to emphasize that there is a perverse law governing research: under the pressure for immediate results, and unless deliberate policies are set up to guard against this, *applied research invariably drives out pure.* The moral is clear. It is pure research which deserves and requires special protection ... [emphasis in original.] [3]

Here the concern is not with the issue of contention for funds between basic and applied science, or with who decides *what* research will be done, but with who decides *how* research will be done. Which set of norms pertain to applied research, those of pure science or those of industry? What is *expected* of a scientist — in *any* context? Scientists do both basic or applied research. Yet they can feel the tension between two sets of norms operating simultaneously. In the scenario, even though Professor Jones is doing applied science, his position qua scientist—using scientific methodology and his credibility as a scientist—nevertheless demands that he recognize and adhere to certain ethical norms of the scientific community.** Herein lies the unease, and a basis of potential ethical issues in this area: *a tension can exist between the differing expectations of industry and academicians about the purposes and processes of research and the distribution of results*. One manifestation of

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* However, the specific mechanism is sometimes dependent on the sponsoring agency, not the type of research. Additionally, from a legal perspective, even grants can be interpreted as a form of contract, including expectations of performance — even if the expectations are only that the research will proceed on a scientific basis (without a specific deliverable).

** Although not everyone would consider scientists as a professional class like engineers, lawyers or doctors, chemists and physicists have official codes of professional ethics. (The physicists' code is only a few years old; the chemists' code dates back to the 1930's.) These explicit codes or statements are based largely on ensuring that each profession upholds the public's perception of their proper, respective function. How does society perceive the proper role of the scientist? Unless that question is answered, perhaps there are difficulties in classifying breaches of the norms of science as ethical issues. Above all else, scientists are expected to be objective and as thorough as possible. Thus, breaching that norm would be an ethical violation.

On the other hand, science grew out of a hobby, not a profession — out of curiosity, not a service. Perhaps the democratization of science and the transition to an accountable role requires a new perception. (See discussion below.)

There is also a tendency to blend scientific norms, many of which overlap. To list successful attributes of academia that some hold as norms. Consider David Hamburg's observations:

"What attributes made the research universities great? I suggest eight: (1) high standards of science and scholarship; (2) free and open inquiry; (3) objective methods of assessing information, ideas and people; (4) respect for diversity in people and subject matter; (5) constant attention to opportunities for young people; (6) broad scope of coverage of subject matter on an in-depth basis; (7) a premium on advancement of knowledge; and (8) a sense of social responsibility. These assets are all formidable; and universities should fight to retain them and build on them; these are the essential features that must be preserved."[4]

It is not difficult to perceive how a trend towards applied science funding requirements and pressure for results can affect (1), (2), (3), (5), (6) and (7).

this stress is the pressure scientists find themselves under to present data before they have been subjected to rigorous scientific tests. Industry is sometimes willing to risk being wrong if the potential rewards are great enough.

To use a simple metaphor, let one view of research be represented by a cube and another by a sphere. Perhaps this can portray those who see science as a building block of knowledge versus those who see it as a ball to "get rolling" to take them somewhere. Neither view is incorrect, although most would see the latter as more practical (at least immediately). Both views exist, and tensions can arise when those who see science as a cube perceive "corners getting cut", forcing them to adopt the spherical view.

Two of the distinctions between these views lie in the scope of data collection and in the dissemination of results. Many (including industry and most government agencies) want payoffs from investing in specific areas: data should pertain to those areas. Industry does not want its information circulated: trade secrets and proprietary information prolong product life cycles and maintain profits. From the "cubic" view, however, data collection is less context-oriented. To what extent must data consideration be context-free to be called "science"? Open communication also comprises an important element of what academicians call science. (This is one reason for including question five about the use and exchange of information.) The old question of "If a tree falls in the woods and no one is around to hear it, does it make a sound?" becomes in this case, "If an individual makes a discovery through the use of scientific methods, but that individual never shares that information with anyone else, has scientific research really been accomplished?" It has been said (by academicians) that "research does not exist until it has been published." Industrial researchers would beg to differ. Is "proper" dissemination of results essential to science? Here the purpose is not to resolve this question, rather simply to acknowledge two opposite but valid answers.

These disjunctions are not "wrong", but their existence must be recognized because of the tensions they can create. Scientists often step from the realm of basic research to the realm of applied research and consulting. However much these realms may overlap in content and methodology, the norms of each can be different. Thus, those like Professor Jones who do applied/contracted research must be especially aware of potential pressures. And they must inform their graduate students, who should not have to learn only through mistakes.

Allowing the dissolution of the norms of pure science—even if merely by funding those who take the practical, "spherical" view of science and not those who hold the more rigorous, basic, "cubic" view (as Bush feared)—presents more of a philosophical quandary. But is it an ethical one? Professor A noted the potential ethical problem in misrepresenting a less rigorous, less objective process as a rigorous, objective one and thereby discrediting science. Perhaps this is an untenable view, since total objectivity escapes everyone, and since scientists are beginning to be recognized publicly as a special interest group. Many see this as a positive thing, claiming that there can be no return to the "good ol' days" (actually, post World War II) of government funding without questions (i.e. based on trust) and without a requirement for results. Yet, "There is no question that in their professional capacities scientists and engineers must live by an ethic of objectivity."[5] To deny what many scientists claim as their defining characteristic

implies reshaping the traditional function and perception of science. As more and more of science is subjected to the pressure for results, however, saving the norms of science (assuming this is desirable) takes on an even greater significance. Of course, we may decide as a society that, as far as government funds are concerned, the norms of science need to become more democratically determined, even at the expense of objectivity, a norm of science.

SUMMARY

How can young researchers handle the pressure for results? The issue should not be made larger than it is; rarely is it a problem in most projects. However, especially to some scientists, it is a worthy concern. As a graduate student who has worked as a scientist and as an engineer in both basic and applied research realms, the author has observed that information, awareness, and willingness to explain these issues and concerns to others, especially industrial contacts, are invaluable. Harmony can be approached, if not always achieved, through the understanding of and respect for the different norms. Hence, explicit measures should be taken to inform graduate students and young professors of these issues. Researchers must learn how to deal with these issues—how to say "no" to requests for preliminary data and when (and how) they are justified in doing so. Care must be taken to notice potential problems up front and provide for them in contracts. With an understanding and an appreciation of the different cultures, collaborations between universities and industries can be made to run much more smoothly, and the price of saying "no" can be reduced. Then diversity can be a strength rather than a source of tension.

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NOTES AND REFERENCES

1 Jankowski, J.E. Jr. (1992) *National Patterns of R&D Resources*, National Science Foundation, NSF 92-330, Washington, D.C., pp. 33-34.

2 Weinberg, Alvin M. (1965) Scientific Choice, Basic Science, and Applied Missions, in *Basic Research and National Goals, A Report to the Committee on Science and Astronautics, U.S. House of Representatives*, by the National Academy of Sciences, p. 280.

3 Bush, Vannevar, ed. (1945) *Science—The Endless Frontier*, Office of Scientific Research and Development, Washington, D.C. (reprinted July, 1960 by NSF), p. xxvi.

4 Hamburg, David (1994) Constructive Responses to the Changing Social Context of University-Government Relations, In: Guston D. and Keniston K., eds. *The Fragile Contract: University Science and the Federal Government*, MIT Press, Cambridge, MA, pp. 228-229.

5 Skolnikoff, Eugene B. and Brooks, Harvey (1975) Science Advice in the White House? Continuation of a Debate, *Science* **187**:38.