Social Responsibility: A Preliminary Inquiry into the Perspectives of Scientists, Engineers and Health Professionals

J.M. Wyndham, R. Albro, J. Ettinger, K. Smith, M. Sabatello, M.S. Frankel

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Executive Summary

The notion that scientists have a responsibility to society that goes beyond their responsibilities to the profession is long-standing. Yet, there is no consensus on what the content and scope of social responsibilities are or ought to be. While there is a growing literature concerning the issues encapsulated by the phrase "social responsibility of scientists," a review of that literature reveals many and sometimes competing views, and the lack of data to inform the discussion.

It is within this context that the Science and Human Rights Coalition of the American Association for the Advancement of Science (AAAS) and the AAAS Scientific Responsibility, Human Rights and Law Program decided to develop and distribute an online questionnaire to scientists, engineers and health professionals internationally. The primary aim was to learn their perspectives on the nature and scope of their responsibilities and to identify any apparent similarities and differences in perspectives according to multiple demographic variables. This initial data gathering exercise was seen by the Coalition and SRHRL staff as a means to inform a follow-up survey of the international scientific community that would be more representative and scientifically rigorous.

Questionnaire

The questionnaire began with a set of background/demographic questions relating to: field or discipline of work; sector of work; primary source of funding; gender; age; the country in which respondents received their highest degree; and the country in which they spent most of their professional career. Following these questions, respondents were asked to rate how important they considered specific behaviors using a five-point Likert-type scale ranging from 'Critically important' to 'Not at all important', plus an option for 'Unsure'. Each behavior could be considered a responsibility of scientists and is commonly addressed as such in the current literature. Following the scaled questions, respondents were asked to "note below any other important responsibilities of scientists and engineers."

Results

All given responsibilities were considered important, but to varying degrees.

Responsibility	**Percentage response**
Take steps to minimize anticipated risks associated with their work	95.8%
Consider the risks of adverse consequences associated with their work	95.6%
Report suspected misconduct they observe by scientists or engineers	94.1%
Explain their work to the public	93.7%
Serve in advisory roles in the public arena in their area of expertise	92%
Publicly disclose risks associated with their work	90.4%
Consider the potential of each research or development project to contribute to societal well-being	88.8%
Participate in public policy deliberations in their area of expertise	88.8%
Engage in public service activities	82.6%
Take steps so that their research, findings or products are not used inappropriately by others	82.4%

Findings that emerged based on demographic variables include the following:

- Gender did not produce any significant differences across each of the ten responsibilities;
- The younger the respondent, the greater their concern to 'explain their work to the public'; the older the respondent, the greater their concern to 'report suspected misconduct they observe by scientists or engineers';
- Government employees did not consider any responsibility to be more 'critically important' than 'important' and were most likely to mention 'best research/work practices';
- The pattern of responses to the scaled questions was generally similar among those in the health sciences and social/behavioral sciences relative to responses for any of the other disciplines;
- While respondents in the health sciences were most likely to consider a responsibility 'important' (when response options were combined during analysis to be 'important', 'not important' and 'unsure'), engineers were the least likely. A notably high percentage of respondents in the healthcare sector, however, were 'unsure' about the responsibility to 'take steps so that their research, findings, or products are not used inappropriately by others';
- Responses to the scaled questions were similar among respondents from Europe, North America, and the Pacific. Respondents from Africa, Arab States, Asia and Latin America and the Caribbean answered questions similarly to each other but differently from respondents in the previously mentioned regions; and
- All respondents from Latin America and the Caribbean considered 'important' the responsibility to 'take steps to minimize anticipated risks associated with their work'; and respondents from Europe were least likely to consider 'important' the responsibility to 'engage in public service activities'.

Among the questions arising from this preliminary questionnaire are:

- To what extent is a discussion of social responsibilities considered by scientists to be primarily a concern about maximizing benefits rather than minimizing risks?
- What factors (e.g., institutional structures, domestic legal and ethical frameworks, disciplinary codes of conduct) influence individuals' perceptions of their social responsibilities?
- If scientists draw a connection between their professional and social responsibilities, what kinds of public commitments do they recognize, and how do they establish priorities (if at all), among these responsibilities?
- How do concerns for the cultivation of the next generation of scientists and public advocacy for the evidence-based decision making relate to the responsibilities identified in the scaled questions, and to what extent might those also be considered responsibilities?

Next steps

The next stage in this study is to develop a research design and survey that will include a random stratified sample from among the global population of scientists and engineers, thereby enabling us to generalize beyond the sample used in the pilot. A follow-up survey will enable us to explore the potential significance of some of the observations arising from the questionnaire, to document the understanding scientists have about their social responsibilities, and to acquire a deeper appreciation for the different sources of scientists' beliefs about their responsibilities.

I. Introduction

International human rights law recognizes the right of everyone to "enjoy the benefits of scientific progress and its applications," and specifically requires governments to respect "the freedom indispensable for scientific research."[1] Scientific responsibility is the other side of the same coin as scientific freedom. Yet, nowhere in the core international human rights instruments are the responsibilities of scientists explicitly addressed.[2] It is within this context that the Ethics and Human Rights working group of the Science and Human Rights Coalition of the American Association for the Advancement of Science (AAAS) decided in early 2012, "to pursue a project aimed at developing a human rights-based understanding of the ethical responsibilities of scientists, engineers and health professionals as a vital component of the right to enjoy the benefits of scientific progress and a necessary corollary to the obligation of governments to respect scientific freedom."[3]

Around the same time, staff in the AAAS Scientific Responsibility, Human Rights and Law Program (SRHRL), which, since the 1970s, has supported activities aimed at promoting high ethical standards for scientists and engineers,[4] was beginning to examine how the social responsibilities of scientists are related to their professional responsibilities, i.e., upholding standards agreed upon by the scientific community. As a result, the Coalition and SRHRL staff launched a collaborative project to develop an empirical basis for understanding the views of scientists and engineers on the subject.

The notion that scientists have a responsibility to society that goes beyond their responsibilities to the profession is long-standing. Furthermore, the two types of responsibilities are connected.[5] Yet, there is no consensus on what the content and scope of social responsibilities are or ought to be. Section II below draws from existing literature to map the issues encapsulated by the phrase "social responsibility of scientists," revealing the many and sometimes competing views, and the lack of data to inform the discussion.

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[1] Article 15, *International Covenant on Economic, Social and Cultural Rights* (1966).

[2] The core international human rights instruments include the *Universal Declaration of Human Rights* (1948), the *International Covenant on Civil and Political* Rights (1966), the *International Covenant on Economic, Social and Cultural Rights* (1966) and the seven subsequent United Nations human rights conventions. Article 7 of the *International Covenant on Civil and Political Rights* (1966) addresses the right to freedom from torture and states that, "no one shall be subjected without his free consent to medical or scientific experimentation." However, this provision is not specifically or exclusively addressed to the scientific community.

[3] Unless specified otherwise, references to "science" or "scientist" also refer to "engineering" and "engineers," "health" and "health professionals."

[4] Information about these and other activities of the AAAS Scientific Responsibility, Human Rights and Law Program is available here: http://www.aaas.org/page/srhrl-ethics-law-activities

[5] The preamble of the 2010 Singapore Statement on Research Integrity (http://www.singaporestatement.org/statement.html; Accessed January 31, 2015) notes that "The values and benefits of research are vitally dependent on the integrity of research." In other words, to generate benefits for others, scientists must adhere to accepted ethical standards of research. The former cannot be achieved without the latter. Moreover, that this statement, dedicated to research integrity, explicitly recognizes that "Researchers and research institutions should recognize that they have an ethical obligation to weigh societal benefits against risks inherent in their work" is further evidence of a connection between scientists' professional and social responsibilities.

Section III describes an online questionnaire SRHRL distributed to scientists, engineers and health professionals internationally. The primary aim of the questionnaire was to learn how they view the nature and scope of their responsibilities and to identify any apparent similarities and differences in perspectives according to multiple demographic variables. This initial data gathering exercise was seen by the Coalition and SRHRL staff as a means to inform a follow-up survey of the international scientific community and would be more representative and scientifically rigorous.

The findings of the questionnaire are outlined in Section IV. Because this research relied on convenience sampling, the results cannot be generalized beyond the study sample. Nevertheless, the results do suggest potential areas in which specific demographic characteristics may influence a scientists' perspective on their social responsibilities and, as such, offer guidance for development of a more rigorous study that may give rise to generalizable findings.

II. Overview of Social Responsibility

The responsibilities of scientists can be characterized as internal and external: those that require fidelity to the standards of professional practice agreed upon by the scientific community; and those aimed at the larger community. The first set of responsibilities traditionally fall under the umbrella of professional ethics and concern issues such as data management, authorship and crediting the work of others, and the protection of human and animal subjects. These internal responsibilities, understood in terms of professional ethics, vary in their elaboration, in large part as a function of significant differences (e.g., in subject matter, theory, methods, data or analysis) among scientific disciplines.

Beyond the internal responsibilities related to the practice of science are the external responsibilities of scientists towards society. This notion of scientists and science serving society is not new. Francis Bacon, considered the father of scientific epistemology, viewed science as "a system whose ultimate goal would be the production of practical knowledge for 'the use and benefit of men' and the 'relief of the human condition'."[6] In more contemporary times, it is the post-World War II anguish over what science and scientists revealed about atomic power that is considered a primary impetus for the concern about scientists' responsibilities to the world in which they work.[7] Today, the debates over research involving dangerous pathogens[8] have renewed global discussions about the social responsibilities of scientists, as have ongoing arguments over the public funding of scientific research related to the public interest.[9]

Despite this long-standing reflection on the social responsibilities of scientists, as well as a growing literature on the topic, there is no obvious consensus within the scientific community, among policy makers, or between scientists and the larger public about what those responsibilities should entail. [10]

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[6] Simpson, David, Internet Encyclopedia of Philosophy (http://www.iep.utm.edu/bacon/); Accessed January 7, 2015.
[7] *The Day After Trinity: J. Robert Oppenheimer and the Atomic Bomb*, 1981; https://www.youtube.com/watch?v=P1DhWglFeLU; Accessed January 8, 2015.
[8] Frankel, Mark S., 2012. "Regulating the Boundaries of Dual-Use Research," *Science*, 336:1523-1525.
[9] Kintisch, Eli, 2014. "Should the Government Fund Only Science in the 'National Interest'," *National Geographic* (http://news.nationalgeographic.com/news/2014/10/141029-congress-science-investigation-research-funding/); Accessed January 22, 2015.
[10] Glerup, Cecilie and Horst, Maja, 2014. "Mapping 'Social Responsibility' in Science," *Journal of Responsible Innovation*, 1: 31-50.

Unlike scientists' internal responsibilities, subject in recent decades to new ethical guidelines and regulations governing the conduct of research, the nature and scope of scientists' social responsibilities have received far less attention, including less empirical inquiry. As a result, the "negotiation of responsibility between practicing scientists, innovators and the outside world remains an important and contested area of debate to this day."[11]

Statements on social responsibility in science flow in many different directions. For some, scientists' social responsibilities are viewed as a corollary to their advocacy for scientific freedom. In a 1975 report for AAAS, an ad hoc committee "concluded, early in its deliberations, that the issues of scientific freedom and responsibility are basically inseparable. Scientific freedom, like academic freedom, is an acquired right, generally approved by society as necessary for the advancement of knowledge from which society may benefit."[12] Thirty-six years later, the International Council for Science (ICSU) issued a report on the responsibilities of scientists that "explicitly recognized the key social responsibilities of the scientific community that need to accompany the free practice of science." Acknowledging that it had previously emphasized the "preservation of scientific freedoms, ICSU is mindful of the need for scientists to pay equal attention to their responsibilities."[13]

Historically, scientists have, as "communities of common purpose," adopted codes of ethics/conduct to remind them and others of what constitutes their responsibilities. It is such codes that presumably represent the accumulated views of a profession about its self-regulating obligations, which are an essential part of its compact with society to serve the common good. While most of these codes tend to focus on professionals' internal responsibilities, such as maintaining the integrity of the practice of science, many also include provisions related to scientists' broader responsibilities to society.[14] Some examples include the code of the Institute of Electrical and Electronic Engineers, which states that members "accept responsibility in making decisions consistent with the safety, health, and welfare of the public, and to disclose promptly factors that might endanger the public or the environment"; the Ecological Society of America's code, which stresses that "Ecologists will … disseminate results broadly to benefit the local community"; and the 2012 Principles of Professional Responsibility of the American Anthropological Association, which begin with this language: "Anthropology … is an irreducibly social enterprise. Among our goals are the dissemination of anthropological knowledge and its use to solve human problems."

Some statements on the social responsibility of scientists appear motivated by a desire to link science to matters of social justice, peace or human rights. For example, the Code of Ethics of the American Psychological Association "recognize[s] that fairness and justice entitle all persons to access and benefit

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[11] Stilgoe, Jack, Owen, Richard, and Macnaghten, Phil, 2013. "Developing a Framework for Responsible Innovation," *Research Policy*, 42:1568-1580.

[12] Edsall, John T. 1975. *Scientific Freedom and Responsibility* (AAAS: Washington, DC 1975), p. 5; http://archives.aaas.org/docs/1975-ScientificFreedomResponsibility.pdf; Accessed January 8, 2015.

[13] ICSU, 2011. *Principle of the Universality: responsibilities of scientists*; http://wattsupwiththat.com/2011/09/30/principle-of-the-universality-responsibilities-of-scientists/; Accessed January 8, 2015.

[14] What may be the largest searchable collection of scientific and engineering codes of ethics is based at the Center for the Study of Ethics in the Professions at the Illinois Institute of Technology, Chicago, IL USA; http://ethics.iit.edu/node/102; Accessed January 8, 2015.

from the contributions of psychology and to equal quality in the processes, procedures and services being conducted by psychologists." In 2013, the World Federation of Engineering Organizations (WFEO) issued a declaration on "Engineering for a Sustainable Future," which includes the following: "Engineers of the 21st century are called upon to play a critical role in contributing to peace and security in an increasingly challenged world. Engineers have an obligation to protect cultural and natural diversity, and they are central to the … systems and infrastructure networks that underpin civil society, economic activity, protect human health and welfare." It is rare that such statements are in any way linked to or coordinated with one another. In most cases, they emerge independent of any statement that may have preceded them.

For others, social responsibility is grounded in the power of science and its impacts. In his Nobel Lecture upon receiving the 1995 Nobel Peace Prize, physicist Joseph Rotblat made the following appeal to his fellow scientists: "At a time when science plays such a powerful role in the life of society, when the destiny of the whole of mankind may hinge on the results of scientific research, it is incumbent on all scientists to be fully conscious of that role, and conduct themselves accordingly. I appeal to my fellow scientists to remember their responsibility to humanity."[15] A Polish philosopher writes that "There is no doubt that science holds a special position among human practices: it creates knowledge and technologies which allow us to execute ever more power over the world and to foresee consequences of actions more accurately; and at the same time it distributes power among other social institutions … we should say that science bears some special responsibility for those beings over which that power is executed."[16]

In light of such impacts, there are those who view social responsibility as an issue of governance, whereby society must make decisions about how it will oversee the conduct and use of scientific knowledge. Glerup and Horst, scholars from outside the sciences, review a range of governance options, one of which posits that "The purpose of science is to be at society's service and scientists need to be focused on this. Since scientists cannot, however, be expected to do so on their own accord, their conduct needs to be overseen by non-scientific actors, who are perceived to be more able to sustain responsibility."[17]

Finally, one cannot ignore the influence of national and international grant-making bodies on the research enterprise. In the U.S., for example, the National Science Foundation states that "Proposals may not be accepted or may be returned without review if the Project Summary does not clearly address in separate statements 1) the intellectual merit and 2) the broader impacts of the proposed activity."[18] Those "broader impacts" are defined as "the potential to benefit society and contribute to the achievement of specific, desired societal outcomes."[19] In Europe, Horizon 2020, the largest European Union funding program ever,

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[15] Rotblat, Joseph, Nobel Lecture, 1995. "Remember Your Humanity"; http://www.nobelprize.org/nobel_prizes/peace/laureates/1995/rotblat-lecture.html; Accessed January 8, 2014

[16] Lekka-Kowalik, Agnieszka, 2010. "Why Science Cannot be Value-Free: Understanding the Rationality and Responsibility of Science," *Science and Engineering Ethics*, 16: 33-41.

[17] Glerup,Cecilie and Horst, Maja, 2014, *op cit*.

[18] National Science Foundation, Merit Review Facts; http://www.nsf.gov/bfa/dias/policy/merit_review/facts.jsp#1; Accessed January 9, 2015.

[19] NSF Grant Proposal Guide, NSF 15-1, 26 December 2014, "NSF Proposal Processing and Review": http://www.nsf.gov/pubs/policydocs/pappguide/nsf15001/gpg_3.jsp#IIIA2b; Accessed January 9, 2014. For a discussion of NSF's Broader Impacts Criterion in the context of social responsibility, see Holbrook, J. Britt**,** 2012. "Re-assessing the science – society relation: The case of the US National Science Foundation's broader impacts merit review criterion (1997 – 2011)," in *Peer Review, Research Integrity, and the Governance of Science – Practice, Theory,*

intends to fund proposals that "reflect the policy priorities of the Europe 2020 strategy and addresses major concerns shared by citizens in Europe and elsewhere."[20] Private international funders are important players as well, with the United Kingdom's Wellcome Trust emphasizing that it will support "opportunities to engage diverse audiences with medical science and the questions that science raises for society."[21] The funding incentives produced by these policy positions are yet another factor that undoubtedly drives researchers to consider seriously their social responsibilities.

As the above, albeit selective and far from exhaustive, account indicates, interest in these matters, inside and outside science, is real, diverse, and, in some cases, highly passionate. There is a wide range of views on how scientists' social responsibilities might be defined and enhanced, yet there are seldom guidelines or recommendations about how scientists could operationalize the advice in practice. This may not be a bad thing, given the diversity of views and their sources and the absence of data to inform any assessment of the relative value of one perspective over the other.

Current interest in scientists' social responsibilities arises from multiple perspectives on the place of science in society and the expectations that society has of science and scientists, for which a brief overview is in order. Given the public's financial support of science, there is a natural expectation of a return on investment that benefits humanity as well as calls for a greater public voice in deciding priorities for how those funds will be spent.[22] As science has become increasingly intertwined with major social, economic and political issues, scientists have become subject to competing claims from an expanded number of stakeholders who have come to view science as critical to their core concerns. Put another way, the social relevance of science has become crucial to securing public support. There have also been increasing demands that policy decisions affecting society be grounded in scientific findings, thereby creating the expectation that the public will have access to an objective and disinterested voice of reason in the policy arena. Yet, such expectations are undermined when scientists themselves resort to hyping their work or fail to disclose conflicting interests that could affect their professional judgment.

Public attention to scientists' social responsibility has also been triggered by global reports of misconduct by scientists in the course of doing and reporting their research. The 1999 World Conference on Science declared that "The social responsibility of scientists requires that they maintain high standards of scientific integrity and quality control…"[23] Misconduct undercuts that responsibility and increases public skepticism about the scientific community's commitment to the integrity of work intended to benefit society. The search for and uses of scientific knowledge are not without consequences—good and not so good - for

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and Current Discussions. Robert Frodeman, J. Britt Holbrook, Carl Mitcham, and Hong Xiaonan. (Beijing: People's Publishing House), pp. 328 – 362.

[20] Horizon 2020: The EU Framework Programme for Research and Innovation, "Societal Challenges"; http://ec.europa.eu/programmes/horizon2020/en/h2020-section/societal-challenges; Accessed January 9, 2015.

[21] Wellcome Trust, Strategic Plan, 2010-2010; http://www.wellcome.ac.uk/stellent/groups/corporatesite/@policy_communications/documents/web_document/WTDV027438.pdf; Accessed January 9, 2915.

[22] Olden, Kenneth and Ramos, Rosemarie, 2008, "Priority Setting in Health Research: Tradeoffs and Consequences," *Autism Advocate*, First Edition; http://www.autism-society.org/wp-content/uploads/2014/04/Priority-Setting-in-Health-Research.pdf; Accessed January 14, 2015.

[23] UNESCO, *Declaration on Science and the Use of Scientific Knowledge*, adopted by the World Conference on Science, Budapest, 1 July 1999, para 41.

people everywhere. People recognize the enormous power and influence of expert knowledge on their lives, and while they often look to scientists for authoritative answers to complex problems, they are also leery of its sometimes unwelcome effects, leading to a growing recognition of the need to consider the societal benefits and risks/harms generated by knowledge and its applications.

Furthermore, as noted by others, "science and society…have each invaded each other's domain, and the lines demarcating the one from the other have virtually disappeared… Experts must respond to issues and questions that are never merely scientific and technical, and must address audiences that never consist only of other experts … science must now be sensitive to a much wider range of social implications."[24] Today "Science … has to meet a series of public expectations, not only about its products but also about its processes and purposes."[25] Scientists are being held accountable not only for how they apply their knowledge and skills to social problems, but also for their decisions about what problems to address. One of the challenges in navigating this complex terrain is how scientists understand and discharge their responsibilities in the face of resistance to scientific authority from some sectors of society who view science as merely another perspective that competes with their preferred view of the world.[26]

Although no consensus has emerged over the past several decades about the boundaries of social responsibility, there does appear to be agreement that it must start with the education of future scientists. A 2009 report completed under the auspices of the U.S. National Academy of Engineering recommended that "Educational institutions and [government] agencies that support ethics education should encourage and reward programs that…teach the social responsibilities of science and engineering,…and that integrate the issues of social responsibility and [the responsible conduct of research]."[27] Others have stressed that education should empower scientists to "reflect upon, discuss, and evaluate" issues related to the "organizational, legal and political context in which they work," giving scientists "important competencies…for deciding and acting in a socially responsible way."[28]

It should be noted that there is no clear agreement among science educators or the community of scientists generally on how best to achieve such educational purpose. Indeed, while a recent volume of essays by those committed to accomplishing that goal presented a number of potentially worthwhile approaches, the volume's editors concluded that "education aimed at preparing future scientists and engineers for social responsibility is presently very limited and seemingly insufficient in view of the enormous ethical and social problems that are associated with current science and technology."[29] While the case for greater emphasis on social responsibility in the education of scientists is compelling, it should be informed by more empirical

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[24] Gibbons, Michael, 1999. "Science's New Social Contract with Society," *Nature* 402: C81-84.
[25] Jasanoff, Sheila, 2010. "Testing Time for Climate Science," *Science* 328: 695-696.
[26] Hoffman, Andrew J., 2011. "Talking Past Each Other? Cultural Framing of Skeptical and Convinced Logics in the Climate Change Debate," *Organization and Environment*, 24: 3-33.
[27] Hollander, Rachelle and Arenberg, co-editors, 2009. *Ethics Education and Scientific and Engineering Research: What's Been Learned? What Should Be Done? Summary of a Workshop* (The National Academies Press: Washington, DC); http://www.nap.edu/catalog/12695/ethics-education-and-scientific-and-engineering-research-whats-been-learned; Accessed January 8, 2009.
[28] Zandvoort, Henk, Børsen, Tom, Deneke, Michael, and Bird, Stephanie J., 2013. "Editors' Overview: Perspectives on Teaching Social Responsibility to Students in Science and Engineering," *Science and Engineering Ethics* 19: 1413-1438.
[29] *Ibid.*

study of what "social responsibility" means in the context of the science and society relationship and, in particular, how scientists consider their responsibilities and translate them into action.

International human rights instruments have little to say explicitly about the social responsibilities of scientists. To the extent that these instruments mention science at all, it is generally as an 'advancement' and a 'benefit', with almost no acknowledgement of potential negative impacts or implications stemming from the conduct or application of science, or the specific role of scientists in society. The Universal Declaration of Human Rights (1948) states that "Everyone has the right freely … to share in scientific advancements and its benefits."[30] Based on this provision, the International Covenant on Economic, Social and Cultural Rights (1966) (ICESCR) in Article 15(1) recognizes the right of everyone "to enjoy the benefits of scientific progress and its applications."[31] In the same provision, the ICESCR calls on states to "respect the freedom indispensable for scientific research" (Article 15(3)).[32] The closest that a human rights instrument comes to addressing the responsibilities of scientists directly is in Article 7 of the International Covenant on Civil and Political Rights (1966), which states that "No one is to be subjected to torture or to cruel, inhuman or degrading treatment or punishment. In particular no one shall be subjected without his free consent to medical or scientific experimentation."[33]

The only human rights instrument to directly address the scientific community is the Convention on the Rights of Persons with Disabilities.[34] Although, as in other human rights treaties, governments have the primary responsibility to ensure that the human rights of persons with disabilities are upheld, the Convention is unique in its explicit expectation that this responsibility is extended to every individual, the private sector, and professionals and staff who are working with, developing technologies for, or providing services, equipment and facilities to persons with disabilities, specifically including new technologies, devices, and accessible information and communication technology.[35] Further, the Convention requires that health professionals, those involved in habilitation and rehabilitation services, private entities that offer facilities and services that are opened or provided to the public, and "stakeholders" more generally are educated and trained in accessibility issues and the human rights of persons with disabilities.[36] Still, the Convention does not explain how exactly to implement this expectation, nor whether the scientific community has a responsibility to take collective action in this spirit (e.g., update its professional codes, provide training, etc.).

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[30] *Universal Declaration of Human Rights*, adopted and proclaimed by the United Nations General Assembly Resolution 217A (III), 1948, Article 27(2).
[31] *International Covenant on Economic, Social and Cultural Rights*, (1966) 993 U.N.T.S. 3, G.A. Res. 2200 (XXI), 21 U.N. GAOR Supp. (No. 16) at 49, U.N. Doc. A/6316, entered into force January 3, 1976 (hereinafter ICESCR).
[32] For further discussion, see Wyndham, Jessica M., 2015. "Article 15 of the International Covenant on Economic, Social and Cultural Rights," *Ethics, Science, Technology, and Engineering*: *A Global Resource*, 2nd Edition, J. Britt Holbrook, Editor (Farmington Hills, MI: Macmillan Reference USA), Vol. 1, pp. 118-119.
[33] *International Covenant on Civil and Political Rights*, (1966) 999 U.N.T.S. G.A. Res. 2200A (XXI), 21 U.N. GAOR. Supp. (No. 16) at 52, UN Doc. A/6316, entered into force March 23, 1976.
[34] *Convention on the Rights Persons with Disabilities*, G.A. Res. 61/106, Annex I, U.N. GAOR, 61st Sess., Supp. No. 49, at 65, U.N. Doc. A/61/49 (2006*), entered into force* May 3, 2008.
[35] *Ibid.*, Preamble (w), Articles 4, 9, 20, 21, 32.
[36] *Ibid.*, Articles 4, 15, 25, 26.

While human rights instruments say very little of the social responsibilities of scientists, deliberations over the past five years about the meaning of Article 15 of the ICESCR have precipitated increased consideration of the issue. As a starting point, it has been recognized by several commentators and in different fora that a human rights-based approach to science requires that measures be taken to prevent abuse and the adverse effects of science and its applications[37] and, thus, that "scientific freedom is not absolute."[38] A qualitative study conducted by the AAAS Science and Human Rights Coalition on the meaning of Article 15 offers additional ideas for how scientists can or should be guided in the conduct of their work. Drawing from 17 focus groups involving U.S.-based scientists, engineers and health professionals, the study elicited the perspectives of participants on the meaning of the right, including with regard to the responsibilities of scientists. Among the responsibilities discussed was the inclusion and consideration of marginalized and vulnerable populations at each stage of the scientific process, including the framing of research questions, the placement of research sites, and the dissemination of findings.[39]

In addition, participants in the AAAS study suggested that 'access to scientific knowledge/information' is a direct benefit of science and considered it a responsibility of the scientific community to provide access to scientific knowledge and information to the general public. They discussed the need for scientists to write in accessible language, recognizing that scientific publications are typically not intended for lay audiences.[40] This emphasis on science communication and engagement is echoed in the UNESCO Declaration on Science and the Use of Scientific Knowledge (1999), which refers to the social responsibility of scientists to maintain high standards of scientific integrity and quality control, to share their knowledge and to communicate with the public.[41]

Two other UNESCO declarations are of relevance here: the Universal Declaration on the Human Genome and Human Rights (1997)[42] and the Universal Declaration on Bioethics and Human Rights (2005).[43] While these instruments do consider "responsibilities" in the context of scientific research, the guidance they offer on the substance of such responsibilities is minimal. Both instruments, addressed primarily to states, acknowledge the social implications of research in their fields of concern, and the human rights framework that may be applied to such research. Neither instrument, however, draws a clear distinction between the ethical, legal, social and economic implications of such research, nor between the ethical and social responsibilities that apply. While both instruments use the language of 'responsibilities', the only

[37] UNESCO, *Venice Statement on the Right to Enjoy the Benefits of Scientific Progress and Its Applications* (2009), Experts' Meeting on the Right to Enjoy the Benefits of Scientific Progress and its Applications, 3rd Meeting, Venice, Italy, 16-17 July 2009, 12.f.

[38] Chapman, A., 2009. "Towards an Understanding of the Right to Enjoy the Benefits of Scientific Progress and Its Applications," *Journal of Human Rights* 8, p. 17.

[39] AAAS Science and Human Rights Coalition, "Defining the Rights to Enjoy the Benefits of Scientific Progress and Its Applications: American Scientists' Perspectives," Report prepared by Margaret Weigers Vitullo and Jessica Wyndham, October 2013. DOI: 10.1126/srhrl.aaa0028. p. 11.

[40] *Ibid.*, p. 7.

[41] UNESCO, *Declaration on Science and the Use of Scientific Knowledge*, op cit.

[42] *Universal Declaration on the Human Genome and Human Rights*, UNESCO Gen. Conf. Res. 29 C/Res.16, reprinted in Records of the General Conference, UNESCO, 29th Sess., 29 C/Resolution 19, at 41 (1997) (adopted by the UN General Assembly, G.A. res. 152, U.N. GAOR, 53rd Sess., U.N. Doc. A/RES/53/152 (1999)).

[43] *Universal Declaration on Bioethics and Human Rights*, UNESCO Gen. Conf. Res. 33 C/Res.36, reprinted in Records of the General Conference, UNESCO, 33rd Sess., 33 C/Resolution 36, at 74 (2005).

specifically defined responsibilities are those that have become traditionally associated with research practices, such as ensuring informed consent, confidentiality, and privacy.

The Universal Declaration on Bioethics and Human Rights, while addressed to states, is also intended to provide guidance "to decisions or practices of individuals, groups, communities, institutions and corporations, public and private" (Article 1), which arguably include individual researchers, research institutions and scientific organizations. The Declaration also explicitly refers to "social responsibility." In the Preamble, reference is made to "considering the desirability of developing new approaches to social responsibility to ensure that progress in science and technology contributes to justice, equity and to the interest of humanity." However, the Declaration does not clearly articulate, let alone define, the scope of such social responsibilities. The Declaration does emphasize that research should be conducted within a framework of respect for "human dignity, human rights and fundamental freedoms," and emphasizes the imperative to maximize individual benefit and minimize harm (Article 4). Similarly overarching goals are reflected in Article 14, which is titled "Social Responsibility and Health." Though absent any direct reference to the responsibilities of scientists, the provision emphasizes social and economic development, including access to health care and medicines, nutrition and water; improvement of living conditions and the environment; elimination of marginalization and exclusion; and reduction of poverty.

The specific suggestions outlined in human rights instruments and related commentary for approaching the social responsibilities of scientists are consistent with the general tenets of a human rights-based approach. That approach requires that the scientific process and scientists themselves be accountable and transparent, that they involve and engage individuals and/or communities affected by their work, and that a rigorous monitoring and evaluation process be undertaken that aims to ensure the human rights of all individuals and communities are protected throughout a given project or process. Articulating how these general principles translate into concrete responsibilities is a task that has only just begun and to which this questionnaire and subsequent survey can make a substantive contribution.

To answer fully the question of what are the social responsibilities of scientists, it would be necessary to understand the larger science-society relationship and how scientists interact with other social sectors, including the space science occupies as part of differently organized national science systems. Neither science, nor any other sector of society, is responsible in a vacuum. It is the relationship between science and the rest of society that offers a framework, guidance, or boundaries for "being responsible" or "acting responsibly." A comprehensive assessment of the social responsibilities of scientists would require collecting data not only on scientists' views of their responsibilities, but also on how non-scientists view such responsibilities, noting where there are similarities and differences between those two perspectives. (Even within each "perspective," there would not likely be clear consensus.)

This study has a more limited objective, however. It highlights the scientific community's views of its responsibilities to the larger society. This focus makes sense for several reasons: (1) it is consistent with the mission of AAAS and its scientific membership organization partners in the AAAS Science and Human Rights Coalition; (2) it constitutes a manageable research project that is both practical and doable with existing resources; (3) it is timely, if not overdue, given the increasing attention to the topic, to examine empirically what the most directly affected community thinks about calls for its members to assume greater responsibility for their work; and (4) it is important for any professional community to articulate the values

and norms that will guide the actions of its members, in order that both members of the profession and those with whom it interacts are aware of what responsibilities members have toward others. So while this is only a first step in defining and understanding what constitutes a culture of a socially responsible science, it is nevertheless a critical step that warrants further empirical study as a basis for recommending realistic actions that scientists and their institutions should take.

III. Questionnaire

A. Questionnaire design

The study partners established an ad hoc advisory group to advise on questionnaire content, design, sampling and analysis. The group was drawn from among members of the AAAS Committee on Scientific Freedom and Responsibility and the National Conference of Lawyers and Scientists, a joint AAAS and American Bar Association committee. Members of the advisory committee included substantive experts on issues of scientific responsibility and experts knowledgeable about research design.

The questionnaire began with a set of background/demographic questions. These questions were intended to explore links between demographic variables and how respondents defined their responsibilities and also to help determine how effectively our dissemination effort captured the views of a diverse group of scientists. The seven background questions related to: field or discipline of work; sector of work; primary source of funding; gender; age; the country in which respondents received their highest degree; and the country in which they spent most of their professional career. We separated the final two background questions to try to capture any distinction between the influences of education as compared to one's professional culture on the responses received. No individually identifiable information was collected. Multiple responses were permissible for each of the background questions, with the exception of the questions concerning gender and age.

Following the demographic questions, respondents were asked to rate how important they considered specific behaviors using a five-point Likert-type scale ranging from 'Critically important' to 'Not at all important', plus an option for 'Unsure'. Each behavior could be considered a responsibility of scientists and is commonly addressed as such in the literature. The ten behaviors were:

i. consider the potential of each research or development project to contribute to societal well-being;
ii. consider the risk of adverse consequences associated with their work;
iii. publicly disclose risks associated with their work;
iv. take steps to minimize anticipated risks associated with their work;
v. take steps so that their research, findings, or products are not used inappropriately by others;
vi. explain their work to the public;
vii. report suspected misconduct they observe by scientists or engineers;
viii. serve in advisory roles in the public arena in their area of expertise;
ix. participate in public policy deliberations in their area of expertise; and
x. engage in public service activities.

Following these questions, respondents were asked to "Please note below any other important responsibilities of scientists and engineers." In the absence of an empirical body of research on how scientists understand their responsibilities, and given the exploratory goal of this pilot, the final question provided an open-ended response format allowing respondents to offer feedback perhaps unanticipated by the questionnaire design (see Appendix A for the questionnaire).

B. Questionnaire dissemination

The strategy for disseminating the questionnaire reflected the overall aim of collecting information and views from a reasonably wide group of professionals who identify themselves as scientists, engineers or health professionals globally, as opposed to attempting to yield responses from a random sample. Given AAAS's location in the United States and customary audience, special efforts were made to disseminate the questionnaire beyond the United States and to reach out specifically to engineers. Beginning in early April 2013, the questionnaire was disseminated through several different means: (1) social media, principally generated by AAAS; (2) AAAS institutional listservs aimed at specific target audiences, including individuals involved with issues of science policy, science funding, professional ethics, and science and human rights; (3) AAAS members; (4) scientific, engineering and health societies and academies in the United States and internationally; (5) foreign Embassies in Washington, DC; and (6) international non-profit and multilateral scientific organizations. With the exception of dissemination at the 3rd World Conference on Research Integrity in Montreal, Canada, in May 2013, dissemination was almost exclusively online using SurveyMonkey, a free online survey design and analysis program.[44]

In total, we received 2,670 completed questionnaires. We discarded 322 responses from individuals who did not provide a field or discipline of work or those whose response was ambiguous or indicated they were not a scientist, engineer or health professional. A further 195 responses were discarded because the respondent did not answer any of the scaled questions or the open-ended question. In total, the results described in this report reflect 2153 responses.

Discipline

Only questionnaires from professionals who indicated they were scientists, engineers, or health professionals were analyzed. However, beyond seeking to learn the perspectives of scientists generally about their responsibilities to society, another aim was to determine whether there was any difference in those perspectives based on discipline. Thus, the first question asked respondents to identify the field or discipline in which they work. Respondents were not provided a list from which to select; rather by filling in a box, they could provide whatever level of detail they chose.

The respondents represented a wide range of disciplines. To facilitate the analysis and the potential identification of commonalities in responses according to discipline, disciplines were grouped as set out in Table 1.

[44] https://www.surveymonkey.com/MySurveys.aspx

Table 1: Categorization of disciplines

Discipline	Sub-Discipline	% of total
Life Sciences	Agricultural sciences/Natural resources, Biological/Biomedical Sciences	36.9%
Physical Sciences	Astronomy, Atmospheric Science & Meteorology, Chemistry, Geological and Earth Sciences, Physics, Ocean/Marine Sciences, Other Fields (physical sciences)	31%
Engineering and Mathematics	Engineering, Computer & Information Sciences, Mathematics	14.2%
Social/Behavioral Sciences	Communication, Psychology, Social Sciences	9.6%
Health Sciences	Health Sciences	8.3%

Sector and Funding Source

By far the greatest percentage of responses to the questionnaire came from respondents in the education sector (42.2%). Students/Post-docs constituted 17.7% of respondents, and government employees constituted 16%. Respondents from the remaining sectors each constituted less than 7% of the total number of respondents: non-profit (6.9%), commercial/industry (6.2%), independent-practice/self-employed (4%), healthcare (2.9%), not currently employed/retired (3.2%), research institution (0.4%), and other (0.4%).

There were some regional differences with regard to the sectors from which respondents came (see pages 22-23 for a description and account of the responses by region). From Arab States and the Pacific, more respondents came from the government sector than any other sector, and in Asia and Europe almost as many respondents came from the education sector (27% and 24% respectively) as were students/post-docs (24% and 25% respectively). It may also be worth noting that only among students/post-docs were there more female than male respondents (53.9% as compared to 45.8%). Among respondents from the commercial/industry sector, 77.4% were male.

Age and Gender

Among respondents, 58.3% were male and 41.1% were female. By far the greatest gender disparity within a field existed among engineers, 75.4% of whom were male. Of the total respondents who indicated their age group, 26.5% were under 35, 32.9% were 35 – 50 years old, and 39.6% were over 50. Nineteen respondents (0.9%) provided no response to this question (Asia is the only region in which there were more respondents in the lowest age bracket than in the higher age brackets). The percentage of female respondents in each age group decreased as the age group increased.

Region

Respondents were asked two questions concerning the region from which they come: (1) in what country did you receive your highest degree?; and (2) in what country have you spent most of your professional career? In response to the first question concerning highest degree, respondents identified 67 distinct countries, while 74 countries were identified in response to the question concerning the country in which

the respondents had spent most of their professional career. In both instances, over 60% were from the United States and over 90% from countries with very high human development, according to the United Nation's Human Development Index.[45]

Complete demographic information is available in Appendix B.

IV. Results

This section describes key observations arising from the responses to the scaled questions and the open-ended responses.

A. Analysis of responses to scaled question

The questionnaire contained a five-point Likert-type scale that asked respondents to rate the extent to which they considered a given responsibility to be of importance, if at all. The scale ranged from 'Critically important' to 'Not at all important', with 'Unsure' as an additional option. Respondents could choose not to respond to one or more of the questions.

The results of the scaled questions were analyzed in two ways: according to each of the six response options provided and as combined categories under three headings--'important', 'not important' and 'unsure'. By combining the data, general patterns of response were sometimes easier to discern than when the responses were not combined. Table 2 indicates how the categories of response were combined.

Table 2. Categories of response – uncombined and combined

Original/Uncombined categories of response	Combined categories of response
Critically important	Important
Very important	
Important	
Not very important	Not important
Not at all important	
Unsure	Unsure

General

Table 3 shows the overall responses to the scaled questions, organized according to which responsibilities were considered most 'critically important'.

[45] United Nations Development Program, *Human Development Report 2014 - Sustaining Human Progress: Reducing Vulnerabilities and Building Resilience*, 2014.

Table 3: Overall responses to the questionnaire

Responsibility	Critically Important	Very Important	Important	Not Very Important	Not At All Important	Unsure	No Response
Take steps to minimize anticipated risks associated with their work	48.0%	35.5%	12.3%	2.0%	0.7%	0.7%	0.8%
Report suspected misconduct they observe by scientists or engineers	45.4%	32.1%	16.6%	2.5%	0.6%	1.7%	1.2%
Consider the risks of adverse consequences associated with their work	39.8%	38.7%	17.2%	2.6%	0.8%	0.6%	0.4%
Publicly disclose risks associated with their work	31.8%	36.6%	22.0%	6.0%	0.9%	2.1%	0.5%
Explain their work to the public	31.3%	36.8%	25.7%	4.6%	0.8%	0.4%	0.5%
Take steps so that their research, findings, or products are not used inappropriately by others	24.3%	30.6%	27.6%	11.0%	2.7%	3.0%	0.9%
Serve in advisory roles in the public arena in their area of expertise	25.2%	38.8%	28.0%	6.0%	0.6%	0.8%	0.7%
Participate in public policy deliberations in their area of expertise	23.8%	33.7%	31.3%	8.5%	1.1%	0.9%	0.7%
Consider the potential of each research or development project to contribute to societal well-being	19.7%	36.7%	32.4%	8.9%	1.6%	0.6%	0.2%
Engage in public service activities	16.2%	32.2%	34.2%	13.1%	2.0%	1.4%	0.9%

The percentage of respondents answering 'critically important' to each question ranged from 16.2% to 48%. The three instances in which approximately 40% or more of respondents answered 'critically important' were:

- Take steps to minimize anticipated risks associated with their work (48%)
- Report suspected misconduct they observe by scientists or engineers (45.4%)
- Consider the risks of adverse consequences associated with their work (39.8%)

In contrast, the percentage of respondents answering 'not very important' to each question ranged from 2% to 13%. The four responsibilities for which between approximately 9% and 13% of respondents answered 'not very important' were:

- Engage in public service activities (13.1%)
- Take steps so that their research, findings, or products are not used inappropriately by others (11%)
- Consider the potential of each research or development project to contribute to societal well-being (8.9%)
- Participate in public policy deliberations in their area of expertise (8.5%)

While the percentage of respondents answering 'critically important' almost, though never, reached more than 50%, once the responses were combined, the percentage of respondents answering 'important' as compared to 'not important' ranged from 82.5% to 95.9%. Table 4 lists the ten responsibilities in the questionnaire in descending order of importance as reflected by the percentage of respondents answering 'important' according to the combined data:

Table 4: Percent of respondents indicating 'important' for each given responsibility according to combined data

Responsibility	**Percentage response**
Take steps to minimize anticipated risks associated with their work	95.8%
Consider the risks of adverse consequences associated with their work	95.6%
Report suspected misconduct they observe by scientists or engineers	94.1%
Explain their work to the public	93.7%
Serve in advisory roles in the public arena in their area of expertise	92%
Publicly disclose risks associated with their work	90.4%
Consider the potential of each research or development project to contribute to societal well-being	88.8%
Participate in public policy deliberations in their area of expertise	88.8%
Engage in public service activities	82.6%
Take steps so that their research, findings or products are not used inappropriately by others	82.4%

Table 4 indicates that all potential responsibilities were considered important by more than 80% of respondents. This finding, and the results of the questionnaire in general, should be considered in light of the following: (1) whether a person considers a responsibility to be important, in principle, may not

necessarily reflect how they would act if faced with a related choice in practice; and (2) this result may reflect sample bias as it may be that primarily individuals concerned with issues of social responsibility chose to respond to the questionnaire.[46]

Discipline

Analysis of the data by discipline reveals several patterns. First, the pattern of responses among those in the health sciences and social/behavioral sciences is similar, as compared to responses by respondents from other fields. In both scientific fields, between 40-57% of respondents answered 'critically important' with regard to four responsibilities:

- Consider the risks of adverse consequences associated with their work;
- Publicly disclose risks associated with their work;
- Take steps to minimize anticipated risks associated with their work; and
- Report suspected misconduct they observe by scientists or engineers.

In no other discipline did more than 40% of respondents answer 'critically important' with regard to the responsibility to 'publicly disclose risks associated with their work'. Furthermore, among other disciplines, the 'critically important' responses across all questions were generally lower.

Second, there was a degree of consensus among respondents across the disciplines on the level of importance of the responsibilities to 'consider the risks of adverse consequences associated with their work' and to 'take steps to minimize anticipated risks associated with their work'. In both cases, the 'important' response rates across disciplines were within two to three percentage points. Respondents from the health sciences were uniformly the most likely, or second most likely, to rate a responsibility as 'important'. With just two exceptions, they were the least likely to rate a responsibility as 'not important'.

Finally, the largest divergence in response rates reflected in the combined data was in response to the responsibility to 'consider the potential of each research or development project to contribute to societal well-being'. While, the average across the disciplines was 90.4%, 95.5% of health scientists considered this responsibility to be 'important', and only 86.8% of physical scientists agreed. This difference in responses was the largest across the questions among all disciplines. Eight point differences arose with regard to the responsibilities to 'take steps so that their research, findings, or products are not used inappropriately by others', to 'explain their work to the public' and to 'engage in public service activities'. The respondents from the health sciences most commonly responded 'important' while the engineers least often responded as such. There are no other discernible patterns concerning the disciplines most or least likely to consider a responsibility to be 'important'.

Sector and Funding Source

While the overall findings concerning the importance of each given responsibility is similarly reflected across all sectors, the sector data do reveal some patterns suggestive of the possible strength with which the respondents believe a responsibility to be important. This is indicated by a comparison of the

[46] AAAS Science and Human Rights Coalition, Coalition Meeting Report, July 14-15, 2014, p.14 (comments made by Hugh Gusterson during a concurrent session titled, "Scientific Responsibility, Ethics and Human Rights").

percentage of respondents answering 'critically important' as compared to 'very important' with regard to a given responsibility. For example, in no instance did the percentage of respondents from the government sector consider a responsibility to be more 'critically important' than 'very important'. This is the only sector in which this pattern of responses occurred. From the commercial, healthcare and non-profit sectors, only the responsibility to 'consider the risks of adverse consequences associated with their work' was considered more 'critically important' than 'very important'. In all remaining sectors, anywhere from three to nine of the responsibilities were considered more 'critically important' than 'very important'.

At the other end of the scale, the 'not very important' response rate revealed a similar pattern as described in the general findings above. However, there are two observations worth noting with regard to the analysis of this data by sector. First, fewer than 10% of respondents in the government and healthcare sectors ranked any question as being 'not very important'. In contrast, among the not currently employed/retired and independent/self-employed, more than 10% of respondents indicated 'not very important' to at least half of the questions. One potential explanation worth exploring in a follow-up survey is whether the institutional structures in the government and healthcare sectors influence individuals' perceptions of their responsibilities.

The second observation concerning the data disaggregated by sector relates to the percentage of respondents who answered 'unsure' to any given question. While between zero and 5% of respondents indicated 'unsure' to most questions (8 out of 10 questions), in the healthcare sector, 14.3% of respondents indicated they were 'unsure' about the importance of the responsibility to 'take steps so that their research, findings, or products are not used inappropriately by others'. Respondents in this sector constituted just 3% of total questionnaire respondents. As a result, it is not possible to draw clear conclusions from this observation. However, the almost 10% difference in response from this sector as compared to all others may warrant investigation in a subsequent survey.

In addition to identifying the sector in which they work, respondents were asked to identify their primary source of funding. The majority of respondents to the questionnaire were funded by government (61.8%), with a further 14.2% funded by non-profits, and 9.7% from commercial/industry sources. There were no discernible patterns arising from the analysis of the data according to source of funds.

Age and Gender

Overall, the data indicate no notable differences in response rates according to the age and gender of the respondent. The one exception is with regard to the responsibility to 'explain their work to the public'. In total, 31.3% of respondents considered this responsibility to be 'critically important'. There is, however, a potentially notable difference in response rate according to age. Of respondents over the age of 50, 28% considered this responsibility to be 'critically important', as did 31% of 35-50 year olds and 36.3% of respondents under 35. Thus, the responsibility to 'explain their work to the public' decreases in each increased age group. The opposite is evident in response rates to the question concerning the responsibility to 'report suspected misconduct they observe by scientists or engineers': 42.2% of respondents under 35 considered this responsibility to be 'critically important', as did 44.7% of respondents

35-50 years old and 48.1% of respondents over 50. In both instances, however, when the data are combined, the differences in response rate are either minimized or no longer exist.[47]

Region

Given the heavily weighted distribution in favor of North America and Europe, it is difficult to draw many conclusions from the regional data. That said, some observations are possible and these could be further explored.

An analysis of the combined data collected according to region reveals one important similarity: the responsibility to 'take steps to minimize anticipated risks associated with their work' is considered 'important' by the highest or second highest percentage of respondents across all regions. In contrast, the responsibility to 'engage in public service activities' was considered 'not important' by the highest or second highest percentage of respondents across all regions.

In addition to those similarities mentioned above, other similarities in response rates are discernible in two distinct sub-sets of regions: (1) Europe, North America, and the Pacific; and (2) Africa, Arab States, Asia and Latin America and the Caribbean. The first regional sub-set is dominated by respondents from Australia and New Zealand in the Pacific, Canada and the United States in North America, and Germany and the United Kingdom in Europe. These countries share similar levels of human development and, in most cases, have adopted similar socio-economic and political structures. The second regional sub-set includes all respondents from countries of low and medium human development.

In the first group, the responsibility to 'consider the risks of adverse consequences associated with their work' was considered 'important' by the highest or second highest percentage of respondents. In contrast, in the second group, this responsibility was only considered 'important' in one region (Africa), while the responsibility to 'consider the potential of each research or development project to contribute to societal well-being' was considered 'important' by the highest or second highest percentage of respondents (in the first group, this responsibility was considered 'not important' by 9-12% of respondents).

In the first group, the same two responsibilities were considered 'not important' by the highest and second highest percentage of respondents: 'take steps so that their research, findings, or products are not used inappropriately by others' and, as mentioned above, 'engage in public service activities.' In the second group, the responsibility to 'publicly disclose risks associated with their work' was considered 'not important' by the highest or second highest percentage of respondents. Finally, the percentage of respondents answering 'not important' or 'unsure' was consistently higher in the first group than the second group.

Two additional observations can be made based on these data. First, in two instances, 100% of respondents from a region answered 'important'. In Latin American countries, 100% of respondents considered the responsibility to 'take steps to minimize anticipated risks associated with their work' to be 'important'. In Arab States, the same response was recorded with regard to the responsibility to 'report suspected

[47] Based on a chi-square test the p-value is very low (p=0.000), indicating strong evidence that the observed differences are statistically significant.

misconduct they observe by scientists or engineers'. Second, while the percentage of respondents answering 'important' generally ranged from 84% to above 96%, in Europe just 72.9% considered the responsibility to 'engage in public service activities' to be 'important'. This is a response rate more than 10% lower than in any other region.

Demographic information was collected on both the country in which respondents received their highest degree and where they have spent most of their professional career in anticipation of there being a discernible difference in responses to the scaled questions relative to the range of variables. The data reveal no such difference. It is possible, however, that this finding is due to the nature of the sample, where the overwhelming number or responses were from North America. A more representative response rate among scientists elsewhere would be needed to assess whether a difference exists in views on the social responsibilities of scientists based on the two demographic variables identified.

Summary

In summary, we received 2153 useable responses to the questionnaire, the large majority of which came from scientists in North America in the education sector. More than 80% of respondents answered 'important' to all of the scaled questions and there were no notable differences in response based on gender or funding source. Any differences in response analyzed by age were either minimized or did not exist once data were combined. Some potentially interesting differences exist among responses analyzed by sector, discipline and region.

As compared to responses from all other sectors, respondents in the government sector did not consider any responsibility to be more 'critically important' than 'important.' In contrast, respondents from the government and health sectors were least likely to consider a responsibility to be 'not very important.' Furthermore, the patterns of response were most similar among respondents who identified their discipline as being health-related or in the social/behavioral sciences. Respondents from a health-related discipline were most likely, or second most likely, to consider a responsibility to be 'important'.

Finally, patterns of response based on region were identified, with respondents from Europe, North America and the Pacific most likely to respond similarly to each other, and respondents from Africa, Arab States, Asia and Latin America and the Caribbean most likely to record similar responses.

B. Analysis of responses to open-ended question

As mentioned earlier, following completion of the scaled questions, respondents were given the opportunity to identify "any other important responsibilities of scientists and engineers."

Of the total 2153 responses that serve as the basis of this study, there were 509 responses to the open-ended question (23.7% of the total). From among all respondents to the questionnaire, engineers, social/behavioral scientists and health scientists were most likely to respond to the open-ended question. In contrast, a lower percentage of life and physical scientists responded to the open-ended question. Among the sectors, the respondents from education were most likely to respond to the open-ended question, whereas students/post-docs were least likely. Respondents answering this question were most likely to be over 50 years of age (53.2%), with the response rate decreasing as the age of the respondents

decreased. There was little difference in response rates by gender. Respondents from North America were more likely to respond to the open-ended question than respondents from other regions. While the native language of respondents was not recorded, this may account for the differing response rates by region.

The responses were analyzed using a systematic qualitative coding process. First, an inductive open coding approach was used to identify themes reflected across the responses resulting in the coding list below. Using Dedoose (www.dedoose.com), a web-based application designed for analyzing data across quantitative, qualitative and mixed methods research, the qualitative responses were analyzed to identify themes and patterns.

Coding list

Research/Work Practices

- Behave ethically
- Be fiscally responsible
- Maintain scientific/academic integrity and honesty
- Work effectively with colleagues

Communication

- Disseminate findings within the scientific community
- Effectively communicate with the general public

Education

- Mentor students and young scientists/engineers
- Provide and/or promote quality STEM education in schools
- Provide ethics training to future scientists
- Support under-represented populations
- Stay up-to-date on contemporary scientific research in discipline

International Cooperation

- Promote human rights and peace

Policy

- Provide expertise to policy makers

Societal Impacts

- Knowledge and understanding
- Prevent negative societal impacts (general)
- Promote sustainability and consider environmental impacts of work
- Respect local communities or individuals impacted by research
- Serve society, solve problems

The final coding frame was applied across the responses, resulting in 1087 tagged excerpts. Table 5 below sets out the number of responses tagged according to each category and the percentage of total tags that number represents. (It should be noted that one response may have resulted in multiple tags and any comments that did not fit into a sub-category but fit into a macro-category were tagged for the macro-category only. Thus, the sum of responses to the sub-categories does not always equal the total for the associated macro-category).

Table 5: Number of responses organized by coding frequency *(n=509)*

Macro-category	Sub-category	Number of Responses	Percentage of Total Tags (n=1087)
Best Research/Work Practices		181	17%
	Maintain scientific/academic integrity	109	10%
	Behave Ethically	42	4%
	Work effectively with colleagues	23	2%
	Be fiscally responsible	10	1%
Education		144	13%
	Mentor students and young scientists/engineers	57	5%
	Provide and/or promote quality STEM education in schools	39	4%
	Provide ethics training to future scientists	23	2%
	Support under-represented populations	6	1%
	Stay up-to-date on contemporary scientific research in discipline	6	1%
Societal Impacts		114	10%
	Serve society, solve problems	37	3%
	Promote sustainability and consider environmental impacts of work	25	2%
	Respect local communities or individuals impacted by research	19	2%
	Prevent negative societal impacts (general)	13	1%
	Knowledge and Understanding	25	2%
Communication		72	7%
	Effectively communicate with the general public	55	5%
	Disseminate findings within the scientific community	14	1%
Policy		31	3%
	Provide expertise to policymakers	24	2%
International cooperation		12	1%
	Promote human rights and peace	6	1%

In the analysis of these data by demographic descriptor, the responses were normalized to take into account the differences in overall questionnaire participant rates. For example, if there were five men who participated in the questionnaire and ten women, each male response was given double weight.

Discipline

Across disciplines, engineers had a consistently high comparative response frequency in every macro-category except 'education' and 'communication', for which all disciplines recorded similar response rates. Physical scientists most often mentioned 'communication' as a responsibility while social scientists most

often mentioned 'societal impacts' and 'policy', and health scientists recorded the highest or second highest response rates for 'best research/work practices', 'international cooperation' and 'policy'. As compared to respondents in other fields, life scientists are notable for the very few mentions of 'international cooperation'.

Sector

The most notable difference in response rates across sectors occurred with regard to responses addressing 'best research/work practices'. Overall, 48% (37/77) of respondents from government addressed this responsibility, while just 28% (64/229) from education did so. Respondents from the education sector, unsurprisingly perhaps, most commonly addressed 'education' (38%), with 22% addressing 'societal impacts'.

Funding Source

Overall, 'best research/work practices' was the most commonly tagged code and was mentioned as frequently by respondents across all funding sources, indicating a shared concern about research and work practices regardless of funding source. The other observation worth noting is that 90% of comments regarding fiscal responsibility came from respondents with funding from government.

Age

Respondents over the age of 50 had the highest response rate in all macro-categories, with the exception of 'communication', for which respondents in the 35-50 year age group more frequently mentioned this responsibility. The difference across age groups is particularly stark with regard to 'international cooperation', a responsibility not mentioned by any respondent in the youngest age group, and mentioned four times as frequently by respondents over 50 years of age as compared to the 35-50 year old respondents. Respondents over 50 years of age were the only age group to mention human rights in their responses. Are older scientists more conscious of human rights as they relate to their work because they lived through times of robust debate about the impacts of science on human rights, for example, with the dawn of the nuclear age and following revelations about the use and impacts of Agent Orange? Have concerns about scientific freedom that came to the fore in the 1970s and 1980s with regard, in particular, to scientists in the Soviet Union since dissipated? In order to help answer these questions and determine the reason for the difference in responses by age may be worth exploring further in a follow-up survey.

Gender

In contrast to the overall lack of difference in responses from men and women to the scaled questions, one difference was noted in the qualitative responses. Significance testing reveals that the proportion of female respondents over the age of 50 who mentioned 'best research/work practices' and 'societal impacts' is significantly lower than among male respondents (P-value<0.019 and <0.006, respectively).

Region

Of respondents trained and/or working in North America, 25% responded to the qualitative question (358 responses in total), as compared to 17% from Europe (69 responses in total). While the percentage

response rates from other regions were higher, the 'n' for each region was so low as to render their assessment of little value. Consequently, this assessment focuses on a comparative analysis of responses from Europe and North America, using in the first instance the demographic data based on region of professional career.

As compared to respondents who had spent most of their professional career in Europe, those in North America were less concerned with issues of 'best research/work practices' (46% vs 34%) and 'societal impacts' (29% vs 19%). In contrast, those in North America were more concerned with issues of 'education' (20% vs 32%), 'communication' (7% vs 14%), 'international cooperation' (0% vs 11%), and 'policy' (1% vs 8%). Interestingly, the differences in percentage were either narrowed slightly or, in the case of 'communication', disappeared altogether when the data were analyzed according to region of highest degree. Yet, differences of six percent or more still existed with regard to 'best research/work practices', 'societal impacts', and 'education'. These findings may be worth exploring further in a follow-up survey.

Issues for further Investigation

In the spirit of a pilot study, the final open-ended question provided an opportunity for respondents to raise any additional topics and concerns, and to articulate beliefs, priorities, and other understandings they perceived as relevant to discussions of scientists' social responsibilities, but unaccounted for or unanticipated by the survey. Here we offer a preliminary analysis of this qualitative set of responses to complement the preceding presentation and analysis of the quantitative scaled questions. In doing so, we will point to several emergent and suggestive patterns in the answers to this open-ended question that, taken together with the results from the scaled questions, could lead to potential avenues for future research.

One such example is the question of scientific practice, responsibilities, and the language of risk. Among the 509 respondents answering the open-ended question, only 15 mentioned the term "risk" to describe various kinds of perceived hazards related to the potential failure to adequately carry out one's responsibilities. In other words, only 2.95% of respondents who also answered the final open-ended question mentioned risk. If we consider the total number of 2153 respondents, the percentage referring to risk becomes much smaller, at 0.7%. Among this already tiny percentage were multiple respondents referencing questions two through four of the survey, which ask respondents to rate the importance of various questions relating to risk as it is associated with their work. Overall, then, respondents did not regularly couch their answers in terms of risk, when given the opportunity. This could be because they felt the issue of risk has been already adequately addressed in the questionnaire or because they perceived a discussion of social responsibilities to be primarily concerned with maximizing benefits rather than minimizing risks.

Indeed, when risk was noted, this was in terms of the need to weigh "risks" versus "benefits" or the need to "mitigate risk," all concerns that track closely with the use of the term in the questionnaire itself. Only two respondents appeared to depart from the concept of risk assumed in the questionnaire, referring to the "risks of newly discovered phenomena" and the "willingness to innovate and take risks." In assessing the ways scientists think about their responsibilities, one relevant consideration is to identify sources for the lexicon scientists use to talk about their responsibilities. Given that 70.33% of respondents answering the

final question were from North America, one might assume that prevailing frameworks in the United States for the responsibilities of scientists, as derived from the Belmont Report[48] and/or represented by the U.S. Government's Common Rule,[49] for example, might be especially influential. Particularly with respect to scientific work with human subjects, these frameworks encourage a risk/benefit assessment. In the U.S. context, the discourse of risk is prominent. Yet, responses to the open-ended question largely ignored it. This raises the question of where scientists in North America, in particular the U.S., derive their working understanding of their responsibilities, if not from such federal frameworks. The question of whether and how nationally derived frameworks, both ethical and legal, might influence what responsibilities scientists recognize, and how these responsibilities are framed and interpreted, remains a question deserving of further attention.

Meanwhile, respondents used the word "integrity" 26 times, representing 5.1% of respondents who answered the final question. By "integrity," however, they often appeared to mean different things. A minority of respondents used this word to refer to personal integrity. This meaning of the word often coincided with "honesty," a term used almost as frequently as integrity. In these cases, integrity is not necessarily a particular characteristic of scientists or scientific practice so much as a way to refer to the ethics of individuals. More often the term integrity was used to describe "responsible conduct" or to refer to "professional integrity." Such a concern emphasizes primary attention to the practices of science and appears to assume that internal ethical responsibilities are distinct from other responsibilities.

Other respondents offered further elaboration of integrity, specifying the "integrity of the discipline," the "integrity of [the] data," "integrity of methodology and results," or "strict adherence to scientific method." In each case, reference is made to a different perceived feature of scientific practice, e.g., data collection. These notions of integrity are closely related for respondents concerned with a commitment to the "quality of science" or to the "competence" of a given scientist. Related to this is another concern raised in conjunction with integrity, the fact of "peer review." This can be understood as a way to talk about accountability to other scientists, which one respondent describes as an example of "self-policing." That integrity is a regular concern of respondents is also suggested by the organization of qualitative results in Table 5, which includes responses not explicitly using the word "integrity," for which 109 responses are understood to raise a set of concerns considered to be synonymous with "scientific/academic integrity."

In this regard, responses indicate that the concept of integrity could be interpreted in a two-fold manner. It can first be treated as a personal responsibility to ensure that one's work and conduct are "in accordance with the discipline's practices and guidelines" (though not necessarily critically examining whether these guidelines are sufficient). A second level of integrity appears to be aimed at the discipline and the scientific community as a whole. Here, respondents made both specific suggestions to improve scientific integrity on a broad scale (e.g., by critically examining the organizations' standards, directly confronting and reporting co-workers when they are suspected of committing misconduct) and in relationship to the need to foster strong team work, to provide feedback and to listen to cross-cultural and other views as part of the backbone of promoting scientific knowledge. This distinction may have significant implications for the

[48] National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, The Belmont Report: Ethical Principles and Guidelines for the Protection of Human Subjects Research (Washington, D.C.: Department of Health, Education, and Welfare, 1979).

[49] U.S. Department of Health and Human Services. Code of Federal Regulations - Title 45 Public Welfare CFR 46.

social responsibility of scientists: while the latter interpretation more easily espouses the values of human rights, the first is less likely to do so given that most codes of ethics in scientific, engineering and health fields do not include any reference to human rights (see Part II). It will be useful to explore in a representative sample these two interpretations of integrity and whether one of them is endorsed by the scientific community more than the other.

Although these results are preliminary, they point to interesting possibilities for further research on how scientists understand their responsibilities. For example, respondents appear more concerned with scientific "integrity" than with the possible "risks" associated with the practice of science. At least 42 respondents refer to "ethics" or to the "ethical" conduct of scientists. But the extent to which scientists understand their responsibilities in ethical or other terms remains an important question. The emphasis that respondents place on scientific integrity suggests a narrow account of ethics as specifically professional, and as bounded by an understanding of one's responsibilities that is coextensive with professional codes of ethics.

The references to integrity offered by a majority of respondents appear to restrict its meaning to activities specific to the practice of science and do not, in general, appear to extend these responsibilities to society at large. The implication is that numbers of scientists draw a sharp distinction between the integrity of science per se, as a sphere of activity, and society, from which science is an activity held apart. Understanding better how scientists understand their relationship to society would notably sharpen appreciation of where scientists understand their responsibilities to begin and end.

A related finding is what respondents have to say about one particular set of responsibilities, those around teaching and mentorship. This is an area of concern not previously covered by the questionnaire, but it is an area of concern for respondents. A total of 119 respondents indicated a responsibility to mentor in some fashion, comprising 23.38% of those answering the final question, which is consistent with the relatively higher proportion of overall respondents to the questionnaire from the field of education. What we are calling "mentorship" includes references to: training, teaching, serving as role models, K-12 education, the "development of young scientists," and an explicit attention to the "next generation" of scientists. Sometimes, as with training, emphasis is upon skills transfer in the sciences. Others express a need to promote science education at all levels of formal education.

Another expressed goal is to "educate the public" about the role of science in society, how it works and what it contributes to addressing publicly recognized problems and challenges (e.g., "climate change," a topic mentioned by several respondents). These matters, as raised by the responses, suggest a tension between two orientations to perceived responsibilities: the obligation to reproduce the scientific enterprise through the cultivation of students and the next generation of scientists, on the one hand, and outreach taking the form of a public advocacy for the scientific point of view and the value of science to solve societal problems, on the other. The first commitment is consistent with the concern for "scientific integrity" discussed earlier, and reinforces a conception of the practice of science as specific and as set apart in important ways from society at large. A focus on educating the public, however, expands on the notion of mentorship and recognizes a role for scientists bridging their activities as scientists with potentially more encompassing social roles and responsibilities.

Perhaps the least clear set of responses offered in the open-ended section has to do with the varieties of expressed concerns about the relationship of scientists to publics. Here, there was notable ambiguity regarding the identification of "publics" to which scientists should be responsible. Given the relative lack of sharp identification of the responsibilities of scientists to society more broadly, as discussed in Section II above, this is not surprising. As already highlighted, many respondents emphasized primary obligations to science itself, while not prioritizing broader commitments by scientists beyond the often methodological or technical practice of science. A second set of respondents made explicit reference to the relationship of science to "policy," if often different questions of policy. These responses make the greatest sense when a national frame of reference is taken for granted. That the primary public is assumed to be a nation-state is most evident in concerns for policy that stress applications of science, for example, to "national security." While the open-ended responses of scientists did not enable assessment of whether respondents took for granted the discourse of one or another national framework for interpreting their responsibilities (see the earlier discussion of "risk"), they did draw regular if generic connections between the relevance of science and national science policy.

Nevertheless, these responses do not exhaust the ways people discussed the importance of "publics" in their answers. Respondents equivocated about this, at times referring to "publics," "public services," or simply to "society." This could be a national frame, but need not be. If 55 answers refer explicitly to "policy-relevant research" or to the need to support policymakers, a further 106 responses can be classified as identifying different "societal impacts," ranging from "public service activities" or human rights, to public health, sustainability and the need to "save our planet," among others. In other words, 31.63% of respondents articulated a responsibility to publics. However, a commitment to "public service" is also paired in some responses with the "common good," or more expansively with "people" of all sorts. This wider-ranging sentiment often has an international scope best captured by reference in at least one answer to scientists acting as "world citizens." If a segment of scientists draws a connection between their professional and public responsibilities, a next step is to determine with greater precision what kinds of public commitments scientists recognize, whether and how they establish priorities among them, and why they hold those views.

V. **Conclusion**

This study was intended as a preliminary step toward development of a robust international survey aimed at identifying and understanding the perspectives of scientists, engineers and health professionals related to their social responsibilities, including an assessment of the demographic factors that may shape those perspectives. Among questionnaire respondents, all given responsibilities were considered important, but to varying degrees, with the highest ranked responsibility being to "take steps to minimize anticipated risks associated with their work" and the lowest being to "take steps so that their research, findings or products are not used in appropriately by others." Similarities in response were evident across some demographic groups and within sub-groups. For example, in the scaled question there was no notable difference in responses by gender, and the pattern of responses among those in the health sciences and social/behavioral sciences were similar.

At the same time, some specific differences in response by demographic characteristic were found. While healthcare workers were most likely to consider a responsibility 'important', engineers were the least likely.

In their open-ended responses, engineers demonstrated generally high concern for all issues of responsibility, while respondents in other disciplines emphasized specific concerns: physical scientists – 'communication'; social scientists – 'societal impacts' and 'policy', and health scientists – 'best research/work practices' 'international cooperation' and 'policy'. A connection to government, whether as a direct employee of government or recipient of government funding, also gave rise to specific responses. Government employees, unlike respondents in all other sectors, did not consider any responsibility to be more 'critically important' than 'important.' However, in the open-ended question, government employees were considerably more likely to mention 'best research/work practices' than respondents from any other sector, just as respondents funded by government were more concerned with 'fiscal responsibility' than others.

Among respondents of different age groups there were consistent responses, except with regard to two responsibilities: 'explain their work to the public' was a responsibility considered less important, the older the respondent; while 'report suspected misconduct they observe by scientists or engineers' was considered more important the older the respondent. In response to the open-ended question, only respondents over 50 mentioned 'human rights' and 'international cooperation'.

The analysis of responses by region revealed similar responses in two distinct groupings: Europe, North America, and the Pacific; and Africa, Arab States, Asia and Latin America and the Caribbean. As discussed earlier, the countries from which respondents in these regions share similar levels of human development and, in the case of the first group, come from similar religious traditions and shared historical roots, and have adopted similar socio-economic and political structures. The similarities in responses among the first group were not evident in the open-ended responses. Respondents from Europe raised issues of 'best research/work practices' and 'societal impacts' more frequently than their North American colleagues. In contrast, those in North America demonstrated more concern with issues of 'education', 'communication', 'international cooperation' and 'policy'.

In preparing for the next stage of this research, we plan to develop a research design that will include a random stratified sample from among the global population of scientists and engineers, thereby enabling us to generalize beyond the sample used in the pilot. To achieve such a sample from across multiple fields, we will work with a broad spectrum of disciplinary societies and other national and international scientific organizations, and, similarly, to expand across sectors of employment, we will extend our reach into the private sector by including key industry groups. This effort will require that we consider issues of computer accessibility and internet connectivity in the survey design and methodology, as well as the translation of the survey and responses. We will consider expanding the demographic variables gathered through the original questionnaire; for example, with the potential addition of religion, research ethics education/training (whether as student or teacher), and exposure to codes of ethical conduct or similar documents.

In addition to widening the scope of our inquiry to reach a broader international audience, the follow-up survey will enable us to explore the potential significance of some of the observations arising from the questionnaire. We have, for example, pointed out several interesting correlations suggested by the pilot data, but will they hold up under greater methodological rigor? A more robust survey design capable of demonstrating statistical significance would permit more confident observations on the strength and

weaknesses of those correlations. Are there really minimal differences in perspectives among respondents of different gender and age? If so, does that finding depend on the country or region from which the respondent comes? A stratified global survey may help answer those questions, just as it may help determine the extent to which there are, indeed, similarities or differences across regions in perspectives on social responsibilities.

We also want to explore what factors influence whether scientists believe they have responsibilities to society, whether and how they establish priorities among responsibilities, and what they see as the opportunities or challenges that affect their ability to discharge those responsibilities effectively. In doing so, we also want to explore the boundaries of what scientists consider to be their social responsibilities. To what extent is a discussion of the social responsibilities of scientists seen as primarily a concern about maximizing benefits as opposed to also minimizing risks? How should the cultivation of the next generation of scientists and public advocacy for the scientific point of view be addressed within a social responsibility framework?

A basic concern inspiring the development of the survey is to acquire a sharper appreciation for the different sources of scientists' views about their responsibilities. Where do scientists acquire their ideas about these responsibilities? Understanding if and how these sources vary across disciplines or kinds of scientific activity, nationality, institutional locations, gender, type of employment, or other factors, promises to help us answer several basic questions, such as whether the responsibilities that scientists regularly identify are specific to the practice of science or extend to include recognition of a more encompassing set of moral and social obligations. The extent to which scientists either do or do not recognize a set of responsibilities superseding the practice of science fundamentally informs how scientists might conceive of their public role.

To answer the question of how scientists, engineers and health professionals view their social responsibilities and to identify key factors that help shape those views can contribute to ongoing national and international conversations about the relationship between science and society and, more specifically, about the roles and responsibilities of scientists in society. Such an analysis can help inform public expectations about science and the evaluation of options for exercising oversight of science. It should also enhance discussions among scientists about the normative forces that underlie their social responsibilities, provide a major "data point" for considering specific recommendations on the nature and scope of those responsibilities (leading, perhaps to their codification in codes of ethics/conduct and other relevant statements of principle and/or practice), and suggest ways that such responsibilities might be integrated into the education and training of scientists. To get to there from here, however, means that we need to go beyond the pilot study and generate a strong empirical record on which to base recommendations to scientists and the public.

Appendix A: Questionnaire

Scientists' and engineers' perspectives on their responsibilities

The purpose of this short questionnaire is to learn how scientists and engineers view the nature and scope of their responsibilities. The questionnaire is anonymous and should take no more than 5-10 minutes to complete. The data gathered will be used to inform an in-depth survey to be conducted later this year. Your willingness to provide input is greatly appreciated.

This is a joint activity of the Ethics and Human Rights Working Group of the AAAS Science and Human Rights Coalition and the AAAS Program on Scientific Responsibility, Human Rights and Law.

To complete this questionnaire online, go to: https://www.surveymonkey.com/s/SciEngResponsibilities-Questionnaire. Paper copies may be mailed to Jessica Wyndham, AAAS Scientific Responsibility, Human Rights and Law Program, 1200 New York Ave., NW, Washington, DC 20005, USA

Background Information

A. In which field or discipline do you work? (e.g., astrophysics, mechanical engineering, psychiatry)

_____

B. In what sector do you work?

- ☐ Not currently employed
- ☐ Student/Postdoc
- ☐ Education (all levels)
- ☐ Government
- ☐ Industry/Commercial sector
- ☐ Non-profit
- ☐ Independent practice/Self-employed
- ☐ Other _____

C. What is the primary source of funding for your work?

- ☐ Government
- ☐ Non-profit (e.g., Foundation)
- ☐ Industry/Commercial sector
- ☐ Not applicable
- ☐ Other _____

D. Gender: __Female __Male

E. Age: __under 35 __35-50 __ over 50

F. In what country did you receive your highest degree? _____

G. In what country have you spent most of your professional career? _____

Questionnaire

Please indicate with an 'x' in the relevant box how important you believe the following responsibilities are in the work of scientists and engineers:

	Critically important	Very important	Important	Not very important	Not at all important	Unsure
Consider the potential of each research or development project to contribute to societal well-being						
Consider the risks of adverse consequences associated with their work						
Publicly disclose risks associated with their work						
Take steps to minimize anticipated risks associated with their work						
Take steps so that their research, findings, or products are not used inappropriately by others						
Explain their work to the public						
Report suspected misconduct they observe by scientists or engineers						
Serve in advisory roles in the public arena in their area of expertise						
Participate in public policy deliberations in their area of expertise						
Engage in public service activities						

Please note below any other important responsibilities of scientists and engineers.

Thank you for completing this questionnaire. To learn more about the activities of the AAAS Science and Human Rights Coalition, please visit: http://srhrl.aaas.org/coalition/index.shtml. For information on the AAAS Scientific Responsibility, Human Rights and Law Program, see http://srhrl.aaas.org/about/mission/.

Appendix B: Questionnaire responses – demographics

Table 1: Sector

Sector	Code	n-Count	% of total respondents (n=2153)
Education (all levels)	EDU	909	42.2%
Student/Post-doc	STUD	380	17.7%
Government	GOV	344	16.0%
Non-Profit	NONPR	150	7.0%
Commercial/Industry	COM	133	6.2%
Independent Practice/Self-Employed	SELF	87	4.0%
Not Currently Employed/Retired	NOEMP	69	3.2%
Health Care	HEALTH	63	2.9%
Research Institution	RESEAR	8	0.4%
Other	OTHER	8	0.4%
No Response	NR	2	0.1%

Table 2: Funding

Funding Source	Code	n-Count	% of total respondents (n=2153)
Government	G	1331	61.8%
Non-Profit	N	305	14.2%
Commercial/Industry	C	209	9.7%
Not Applicable	NA	194	9.0%
Internal Funds	I	65	3.0%
Other	O	26	1.2%
Personal Income	P	13	0.6%
No Response	NR	10	0.5%

Table 3: Age

Age	Code	n-Count	% of total respondents (n=2153)
Over 50	3	854	39.7%
35-50	2	709	32.9%
Under 35	1	571	26.5%
No Response	NR	19	0.9%

Table 4: Gender

Gender	Code	n-Count	% of total respondents (n=2153)
Male	M	1254	58.3%
Female	F	886	41.2%
No Response	NR	13	0.6%

Table 5A: Country of Highest Degree

Country	n-Count	Region	Human Development Index
Argentina	11	LAC	Very High
Australia	85	Pacific	Very High
Austria	7	Europe	Very High
Bahrain	3	Arab States	High
Bangladesh	2	Asia	Low
Belgium	9	Europe	Very High
Bosnia and Herzegovina	1	Europe	High
Brazil	8	LAC	High
Bulgaria	8	Europe	High
Canada	72	North America	Very High
Chile	2	LAC	Very High
China	7	Asia	Medium
Colombia	3	LAC	High
Costa Rica	1	LAC	High
Croatia	2	Europe	Very High
Cuba	4	LAC	High
Cyprus	1	Europe	Very High
Egypt	7	Arab States	Medium
Finland	8	Europe	Very High
France	26	Europe	Very High
Germany	88	Europe	Very High
Ghana	4	Africa	Medium
Greece	4	Europe	Very High
Hungary	7	Europe	Very High
India	27	Asia	Medium
Iran	8	Asia	High
Iraq	4	Arab States	Medium
Ireland	18	Europe	Very High
Israel	8	Europe	Very High

Italy	44	Europe	Very High
Japan	5	Asia	Very High
Jordan	1	Arab States	Medium
Kenya	2	Africa	Low
Korea	2	Asia	Very High
Lebanon	1	Arab States	High
Malaysia	1	Asia	High
Mexico	7	LAC	High
Morocco	1	Arab States	Medium
Nepal	1	Asia	Low
Netherlands	34	Europe	Very High
New Zealand	13	Pacific	Very High
Nigeria	2	Africa	Low
Norway	1	Europe	Very High
Oman	2	Arab States	High
Philippines	5	Asia	Medium
Portugal	2	Europe	Very High
Qatar	5	Arab States	Very High
Republic of Macedonia	2	Europe	High
Romania	3	Europe	High
Russia	13	Europe	High
Saudi Arabia	1	Arab States	High
Singapore	1	Asia	Very High
Slovenia	4	Europe	Very High
South Africa	14	Africa	Medium
Spain	23	Europe	Very High
Sudan	1	Africa	Low
Sweden	4	Europe	Very High
Switzerland	14	Europe	Very High
Syria	1	Arab States	Medium
Taiwan	1	Asia	
Turkey	5	Europe	High
United Arab Emirates	2	Arab States	Very High
United Kingdom	167	Europe	Very High
Uruguay	1	LAC	High
USA	1321	Asia	Very High
Venezuela	1	LAC	High
Yemen	1	Arab States	Low
Other	9	Other	
TOTAL	2153		

Table 5B: Region of Highest Degree

Region of Country Location	n-Count	%
North America	1393	64.7%
Europe	500	23.2%
Pacific	98	4.6%
Asia	60	2.8%
Latin America-Caribbean	38	1.8%
Arab States	32	1.5%
Africa	23	1.1%
Other	9	0.4%
TOTAL	2153	

Table 6A: Country of Professional Career

Country	n-Count	Region	Human Development Index
Argentina	10	LAC	Very High
Australia	95	Pacific	Very High
Austria	6	Europe	Very High
Bangladesh	2	Asia	Low
Belgium	2	Europe	Very High
Bhutan	1	Asia	Medium
Bosnia and Herzegovina	1	Europe	High
Brazil	8	LAC	High
Bulgaria	8	Europe	High
Cameroon	2	Africa	Low
Canada	68	North America	Very High
Chile	3	LAC	Very High
China	7	Asia	Medium
Colombia	2	LAC	High
Costa Rica	1	LAC	High
Cote d'Ivoire	2	Africa	Low
Croatia	2	Europe	Very High
Cuba	5	LAC	High
Denmark	2	Europe	Very High
Ecuador	2	LAC	High
Egypt	5	Arab States	Medium
Finland	4	Europe	Very High
France	15	Europe	Very High
Germany	76	Europe	Very High

Ghana	5	Africa	Medium
Greece	3	Europe	Very High
Guatemala	1	LAC	Medium
Hungary	5	Europe	Very High
India	20	Asia	Medium
Indonesia	2	Asia	Medium
Iran	11	Asia	High
Iraq	2	Arab States	Medium
Ireland	19	Europe	Very High
Israel	5	Europe	Very High
Italy	42	Europe	Very High
Japan	3	Asia	Very High
Jordan	2	Arab States	Medium
Kenya	1	Africa	Low
Korea	2	Asia	Very High
Lebanon	1	Arab States	High
Lesotho	1	Africa	Low
Mexico	9	LAC	High
Monaco	1	Europe	
Morocco	4	Arab States	Medium
Nepal	1	Asia	Low
Netherlands	32	Europe	Very High
New Zealand	11	Pacific	Very High
Nigeria	3	Africa	Low
Norway	2	Europe	Very High
Oman	3	Arab States	High
Pakistan	3	Asia	Low
Peru	1	LAC	High
Philippines	6	Asia	Medium
Portugal	5	Europe	Very High
Qatar	24	Arab States	Very High
Republic of Macedonia	3	Europe	High
Romania	2	Europe	High
Russia	7	Europe	High
Saudi Arabia	2	Arab States	High
Singapore	2	Asia	Very High
Slovenia	4	Europe	Very High
South Africa	15	Africa	Medium
Spain	28	Europe	Very High
Sudan	1	Africa	Low
Swaziland	1	Africa	Low
Sweden	3	Europe	Very High
Switzerland	20	Europe	Very High
Taiwan	3	Asia	

Turkey	13	Europe	High
United Arab Emirates	5	Arab States	Very High
United Kingdom	116	Europe	Very High
Uruguay	2	LAC	High
USA	1340	North America	Very High
Venezuela	2	LAC	High
Other	25	Other	
Total	2153		

Table 6B: Region of Professional Career

Region of Country Location	n-Count	%
North America	1408	65.4%
Europe	424	19.7%
Pacific	106	4.9%
Asia	63	2.9%
Arab States	50	2.3%
Latin America/Caribbean	46	2.1%
Africa	31	1.4%
Other	25	1.2%
TOTAL	2153	

Table 7: Discipline

Disciplines	Code	Sub-Disciplines Included	n-Count	% of total respondents (n=2153)
Life Sciences	L	Agricultural Sciences/Natural Resources, Biological/Biomedical Sciences	795	36.9%
Physical Sciences	P	Astronomy, Atmospheric Science & Meteorology, Chemistry, Geological & Earth Sciences, Physics, Ocean/Marine Sciences, Other Fields (physical sciences)	668	31.0%
Engineering	E	Engineering, Computer & Information Sciences, Mathematics	305	14.2%
Social/Behavioral Sciences	S	Communication, Psychology, Social Sciences	207	9.6%
Health Sciences	H	Health Sciences	178	8.3%
TOTAL			2153	