DOCUMENTOS SOBRE FRAUDE CIENTÍFICA

Traduções completas ou das partes relevantes dos seguintes documentos:

1. **Good scientific practice in research and scholarship, European Science Foundation Policy Briefing 10, December 2000**

2. **Directiva do BIRBECK College da Universidade de Londres sobre Fraude Científica e Comportamento Censurável em Ciência (Julho 1999)**

3. **On Being a Scientist: Responsible Conduct in Research, da National Academy of Sciences, National Academy of Engineering e Institute of Medicine dos Estados Unidos da América do Norte (EUA)**

4. **Federal Register/ Vol 65 nº235, p.76260 …, Notification of Final Policy, do OFFICE OF SCIENCE AND TECHNOLY POLICY sobre Conduta Censurável em Investigação (EUA 2000)**

Os documentos originais são apresentados em anexo pela mesma ordem

Traduzido de :

December 2000
European Science Foundation Policy Briefing

A Boa Prática na Investigação Científica e no Trabalho Académico

Índice [1]

Prólogo

A necessidade de criar confiança entre a ciência e a sociedade é cada vez mais importante e para isso é vital que a condução da ciência, ela própria, seja baseada nas mais elevadas exigências éticas e que o comportamento censurável dentro da própria ciência seja identificado e tratado de uma maneira aberta e transparente. Diversos casos de comportamento censurável foram noticiados nos últimos anos provenientes de todo o mundo.
(…)
A declaração da ESF que se segue e o relatório em se baseia reflecte o enorme trabalho já realizado pelas organizações membro da ESF.
(…)

Declaração da ESF (Fundação Europeia da Ciência)

A boa prática científica na investigação e no trabalho académico é essencial para a integridade da ciência. Ela fixa referências válidas internacionalmente para a garantia de qualidade, a qual permite a reprodução dos resultados por outros cientistas e o seu posterior aprofundamento . Fornece ainda protecção contra a desonestidade e a fraude científicas. A boa prática alimenta a confiança dentro da comunidade científica e entre a ciência e a sociedade, as quais são ambas necessárias para o progresso científico.

Diversas organizações europeias membro da Fundação Europeia da Ciência (ESF) , algumas instituições individuais de investigação e as universidades publicaram já guias, ou códigos de boa prática científica abrangendo todas as áreas, desde as ciências naturais e sociais, à engenharia e às humanidades.

[1] Nota do tradutos:
Os títulos e nº de página referem-se ao original. Na tradução, a correspondência é feita pelo nº dos parágrafos numerados do original

(…)
Procedimentos para investigar alegações de conduta científica censurável complementam os códigos de boa prática científica.
(…)

Com os seus membros abrangendo 23 países[2] a ESF está excepcionalmente bem colocada para desempenhar um papel pan-Europeu na promoção de abordagens comuns entre as suas organizações membro para gerir e regular as boas práticas científicas.

(…)

Introdução

A natureza da investigação e do trabalho académico (página 4)

1. A investigação científica e o trabalho académico são actividades diversas e multifacetadas abrangendo uma vasta gama de esforços intelectuais e práticos.
(...)
O objectivo é sempre alargar o conhecimento humano dos mundos físico,biológico e social.

2. O progresso na ciência depende da confiança. Os cientistas devem ter confiança nos resultados obtidos por outros cientistas. A sociedade tem também que confiar na honestidade e na motivação dos cientistas e na integridade dos seus resultados. Muita da actual desilusão com a ciência na Europa é devida a perda de confiança pública.

3. Para ganhar e conservar a confiança pública, é vital que a ética e a integridade da ciência estejam acima de qualquer dúvida. As boas práticas no projecto, na conduta, na interpretação e no relato da investigação científica e do trabalho académico são os guardiães da integridade. São os pré-requisitos da confiança mútua dentro da comunidade científica global e de uma confiança maior entre cientistas e o público. Onde existir um clima da confiança, os resultados da ciência são melhor aceites, explorados ou aplicados, em benefício da humanidade,
(…)

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[2] Nota do tradutor:
Em Portugal são membros da ESF
1. **Fundação para a Ciência e a Tecnologia(FCT - Ministério da CES)**
2. **Academia das Ciências**
3. **GRICES (Gabinete de Relações Internacionais da Ciência e do Ensino Superior-Ministério da CES)**

Princípios da integridade científica

8. A integridade científica está no coração da confiança de que depende a comunicação e a colaboração científica
A integridade científica exige que todos os envolvidos na investigação e no trabalho académico adiram, sempre e sem qualquer excepção aos seguintes princípios básicos:

* os mais elevados padrões profissionais no planeamento e na condução da investigação

* uma atitude crítica e uma mentalidade aberta na condução da investigação, no trabalho académico e na análise dos dados.

* franqueza e equidade quanto às contribuições dos parceiros, dos concorrentes, e dos predecessores

* absoluta honestidade em todas as fases do inquérito científico, evitando, em particular:
    - qualquer forma de fraude, como sejam a fabricação ou falsificação de dados ou registos;
    - pirataria ou plágio;
    - a sabotagem do trabalho, dos registos ou dos protocolos de outros cientistas;
    - a quebra de confiança como revisor ou supervisor, e
    - cumplicidade em tais acções de colegas cientistas

Para manter a confiança profissional e pública, **é vital que todos os cientistas aceitem a responsabilidade pessoal de fazer cumprir estes valores fundamentais**.

Boa Prática Científica

9. A boa prática científica abrange todos os procedimentos e práticas que são necessárias para o planeamento, a condução e o relato da investigação e do trabalho académico no âmbito de uma estrutura de integridade científica. Fornecendo padrões comuns, a boa prática facilita os processos vitais de avaliação externa pelos pares, de verificação e de repetibilidade . Isto permite a outros cientistas julgar a validade de novas contribuições para o conhecimento e a compreensão.
(…)

BIRKBECK

(Universidade de Londres)

CONDUTA CIENTÍFICA CENSURÁVEL E FRAUDE

A Faculdade está totalmente empenhada na completa honestidade e integridade na realização de qualquer trabalho empreendido por membros de, ou em nome da, Faculdade, tal como está empenhada na protecção dos seus funcionários de acusações maldosas.
A Faculdade não tem nenhum procedimento separado para investigar alegações de conduta científica censurável. Aplicar-se-ão as seguintes provisões e procedimentos:

1. Procedimentos

a) Conduta censurável e Queixa, Procedimentos (funcionários académicos, Secretário e Bibliotecário)
Charter & Statutes number 51 Parts I and III (misconduct) and VI (grievance). Estes aplicam-se à investigação de assuntos disciplinares graves a serem ouvidos em Tribunal. Tais queixas devem ser feitas ao Secretário dos Governadores.

b) Procedimentos de queixa, disciplinares e de despedimento (relacionados com professores e outros , de escritório, técnico e especializado)
Staff handbook 1998 - section 7 (disciplinares e demissão); section 11 (queixa). Estes tratam das processos disciplinares que abrangem delitos menores e graves(incluindo falsificação de registos). As acções de acordo com os procedimentos são feitas pelo Secretário do Faculdade e Secretário dos Governadores em consulta com o director de pessoal , podendo incluir um painel disciplinar
.

c) Divulgação de interesse publico (denúncia): Política da faculdade (todos os membros da faculdade)
Isto aplica-se a todos os membros da faculdade (funcionários, estudantes e governadores) e cobre o delito e a indecência, incluindo o delito académico e o comportamento imoral. Normalmente a alegação deve ser primeiramente levantado com a Secretaria da Faculdade o Secretário para os Governadores. Dependendo da natureza do alegação, uma investigação interna ou solicitação à polícia pudem ser apropriados. Actualmente disponível no web site da Faculdade (Personnel) ou em cópia de papel no Serviço de Pessoal, e para ser incorporado nas edições futuras do manual dos funcionários.

Em todos os casos, os funcionários interessados devem procurar o conselho do Director do Pessoal, numa base confidencial
.

2. Definição

A conduta censurável na investigação académica inclui, mas não está limitada a:

pirataria - exploração deliberada das ideias de outros sem o devido reconhecimento

plágio - cópia de ideias, de dados ou de texto sem autorização ou reconhecimento

deturpação - tentativa deliberada de representar falsa ou desonestamente as ideias ou o trabalho de outros, seja ou não para benefício e engrandecimento pessoal

fraude - engano deliberado, incluindo a invenção de dados, e a omissão da análise ou da publicação de dados inconvenientes.

3. Boa Prática

A fim evitar, tanto quanto possível, tais incidentes, a boa prática científica deve sempre ser seguida chamando-se a atenção para as boas práticas e para os guias de ética produzidos por muitos Conselhos da Investigação e Associações Académicas e Profissionais.
(...)
.
[aprovado pelos Governadores
Julho 1999]

Tradução de partes de:

ON BEING A SCIENTIST RESPONSIBLE CONDUCT IN RESEARCH

SECOND EDITION
COMMITTEE ON SCIENCE, ENGINEERING, AND PUBLIC POLICY
NATIONAL ACADEMY OF SCIENCES
NATIONAL ACADEMY OF ENGINEERING
INSTITUTE OF MEDICINE
NATIONAL ACADEMY PRESS
Washington, D.C. 1995

Nota do tradutor:

As páginas a que se referem os trechos traduzidos correspondem ao original disponível em http://www.nap.edu/openbook/0309051967/html/... De que se junta cópia

PREFÁCIO

A empresa científica da investigação, como outras actividades humanas, é construída na base da confiança. Os cientistas confiam em que os resultados relatados por outros são válidos. A sociedade confia em que os resultados da investigação reflectem uma tentativa honesta dos cientistas para descrever exactamente o mundo, sem preconceitos. O nível de confiança que caracterizou a ciência e o seu relacionamento com a sociedade contribuiu para um período de produtividade científica sem paralelo. Mas esta confiança apenas irá durar se a comunidade científica se devotar a exemplificar e a transmitir os valores associados com a conduta científica ética.

(…)

TÉCNICAS EXPERIMENTAIS E TRATAMENTO DOS DADOS (página 4)

Um objectivo dos métodos é facilitar a verificação independente de observações científicas. Assim, muitas técnicas experimentais (…) foram projectadas para minimizar a influência do preconceito individual na investigação. Aderindo a estas técnicas, os investigadores produzem os resultados que outros podem mais facilmente reproduzir, o que promove a aceitação daqueles resultados no consenso científico.

(....)

ERRO E NEGLIGENCIA NA CIÊNCIA (página 15)

Os resultados científicos são inerentemente provisórios. Os cientistas nunca podem provar conclusivamente que descreveram algum aspecto do mundo natural ou físico com exactidão completa. Neste sentido todos os resultados científicos devem ser tratados como susceptíveis de erro.

Os erros resultantes da falibilidade humana também ocorrem na ciência. Os cientistas não têm tempo nem recursos ilimitados. Mesmo o cientista mais responsável pode cometer um erro honesto. Quando tais erros são descobertos, devem ser reconhecidos, de preferência no mesmo jornal em que a informação errada foi publicada. Os cientistas que o fazem, pronta e abertamente, raramente são condenados pelos colegas.

(…)

CONDUTA CENSURÁVEL NA CIÊNCIA (página 16)

Além dos erros honestos e dos erros causados por negligencia existe uma terceira categoria de erros: aqueles que envolvem fraude. Criação de dados ou resultados (fabricação), mudança ou adulteração de dados ou resultados (falsificação), e utilização das ideias ou palavras de outras pessoas sem lhes dar o reconhecimento devido (plágio) - todos atacam o coração dos valores em que a ciência se baseia .Estes actos de conduta científica censurável não só destroem insidiosamente o progresso mas também todo o

conjunto de valores em que a empresa científica se apoia.
(…)

RESPOSTA ÀS VIOLAÇÕES DOS PADRÕES ÉTICOS (página 18)

Uma das situações mais difíceis em que um investigador se pode encontrar deve ser a de constatar ou suspeitar que um colega violou os padrões éticos da comunidade científica. É fácil encontrar desculpas para não fazer nada, mas quem testemunhou um comportamento censurável tem a obrigação inequívoca de agir
(…)
Temos a certeza de que levantar a questão de uma conduta imoral é raramente fácil de fazer. Nalguns casos, o anonimato será possível - mas não sempre. Represálias da pessoa acusada e de colegas mais cépticos ocorreram no passado e tiveram consequências sérias. Toda a alegação de conduta censurável é uma acusação importante que deve ser tomada muito a sério. Se mal conduzida, uma alegação pode prejudicar gravemente a pessoa acusada, o autor da acusação , as instituições envolvidas, e a ciência em geral.
(…)

A *National Science Foundation* e o *Public Health Service* exigem que todas as instituições de investigação que recebem fundos públicos tenham procedimentos para lidar com alegações de práticas imorais. Estes procedimentos têm em conta a razoabilidade para o acusado, a protecção do acusador, a coordenação com as agências de financiamento e exigências de confidencialidade e divulgação.
(…)

Traduzido de :
76260 Federal Register/Vol. 65, No. 235 /Wednesday, December 6, 2000 /Notices

OFFICE OF SCIENCE AND TECHNOLOGY POLICY
Executive Office of the President; Federal Policy on Research Misconduct; Preamble for Research Misconduct Policy

AGENCY: Office of Science and Technology Policy.
ACTION: Notificação da política final

SUMÁRIO: O Office of Science and Technology Policy (OSTP) publicou em 14 de Outubro de 1999 um pedido de comentário público à proposta de **política federal sobre conduta censurável em investigação** Federal Register (pp. 55722-55725). O OSTP recebeu 237 conjuntos de comentários antes de terminar do período de consulta pública., em 13 de Dezembro de 1999. Após consideração dos comentários públicos a política foi revista e foi agora. Esta notícia dá a informação de base sobre o desenvolvimento da política, explica como a política foi modificada, e discute planos para sua implementação.

DATA EFICAZ: 6 de Dezembro de 2000. **PARA INFORMAÇÃO ADICIONAL CONTACTAR:** Holly Gwin, Office of Science and Technology Policy, Executive Office of the President, Washington, DC 20502. Tel: 202-456-6140; Fax: 202-456-6021; e-mail: hgwin@ostp.eop.gov.

INFORMAÇÃO SUPLEMENTAR: Os avanços na ciência, na engenharia, e em todos os campos da investigação dependem da fiabilidade do seu registo da investigação seu passado , tal como os benefícios associados com ele em áreas tais como a saúde e a segurança nacional. A confiança pública sustentada no trabalho de investigação requer também a confiança no seu registo de investigação e nos processos envolvidos no seu desenvolvimento em curso. Por estas razões, e de modo a conseguir maior uniformidade nas políticas federais nesta área, o National Science and Technology Council (NSTC) iniciou discussões sobre este tema em Abril de 1996 ...

(....)

Etapas Seguintes [1]

As agências federais têm até um ano a partir da data de publicação desta notícia para implementar a política definida .Um grupo da execução do inter-agências foi estabelecido sob os auspícios do National Science and Technology Council para ajudar as Agências no seu processo de implementação e para se empenharem na

[1] NT: Pagina 76262 , 3ª coluna

obtenção de um nível de uniformidade o mais elevado possível compatível com os seus planos de implementação.

Política Federal sobre Conduta Censurável em Investigação [1]

I. Definição de conduta censurável em Investigação [2]

Conduta censurável em investigação é definida como a fabricação, a falsificação, ou o plágio na proposta, na execução, na revisão ou no relato de resultados da investigação.

- **Fabricação** é inventar dados ou resultados e registá-los ou relatá-los.

- **Falsificação** é manipular materiais, equipamentos, ou processos de investigação, ou mudar ou omitir dados ou resultados de tal modo que a investigação não seja representada com rigor nos registos da investigação. [3]

- **Plágio** é a apropriação de ideias, de processos, de resultados, ou de palavras de uma outra pessoa sem lhe dar o crédito apropriado.

- A conduta censurável em investigação não inclui o erro ou as diferenças de opinião honestas.

II Descobertas de conduta censurável em investigação

Uma descoberta de conduta censurável em investigação requer que:

- Haja um significativo afastamento das práticas aceites pela comunidade de investigação relevante; e
- A conduta censurável seja cometida intencionalmente, com conhecimento , ou imprudentemente; e
- A alegação seja provada por uma preponderância de evidências.

' Pela simples publicação desta directiva nenhuns direitos, privilégios, benefícios ou obrigações são criados ou reduzidos. A criação ou redução de direitos, privilégios, benefícios ou obrigações, se existirem, ocorrerão apenas após implementação desta directiva pelas Agências Federais.

[2] Investigação, como utilizada aqui, inclui toda a investigação básica, aplicada, e de demonstração em todos os campos da ciência, da engenharia, e da matemática. Isto inclui, mas não é limitado a investigação na economia, educação, linguística, medicina, psicologia, ciências sociais, estatística, e investigação que envolva pessoas ou animais.

[3] O registo de investigação (research record) é o registo dos dados ou dos resultados que contêm os factos resultantes do inquérito científico, e incluem, mas não são limitados a, propostas de investigação, registos de laboratório, tanto físicos como electrónicos, relatórios de progresso, sumários, teses, apresentações orais, relatórios internos, e artigos de jornal.

European Science Foundation Policy Briefing

Good scientific practice in research and scholarship

December 2000

10

Contents

Foreword

At a time when the need to build trust between science and society is becoming ever more important, it is vital that the conduct of science itself is based on the highest ethical considerations and that misconduct within science itself can be identified and dealt with in an open and transparent manner. Several cases of misconduct have been reported over recent years from across the World. This does not mean that there is an epidemic of such cases but each one destroys trust both in the science system itself and between scientists. Most agencies concerned with science have taken action to deal with these problems and develop best practice. The ESF statement which follows and the report on which it is based reflects the very large amount of work which has already been undertaken by our Member Organisations. Although we may have overlooked some activities, nevertheless, I trust that this report will help in the ongoing actions necessary to develop and further improve good research practice across Europe. This report is not the end of such efforts. Further developments in the way in which science is conducted are inevitable in a rapidly changing world and there will always be a need to update and refine our approaches and this calls for ongoing action. ESF hopes that this may be carried out in close partnership with other European organisations representing institutions such as academies of sciences and the universities. Finally, I should re-iterate that the public must have confidence in the conduct of science. We in ESF and our Member Organisations are determined that only the highest standards should prevail.

Enric Banda
ESF Secretary General

ESF statement

Good scientific practice in research and scholarship is essential for the integrity of science. It sets internationally valid benchmarks for quality assurance, which enable replication and further studies by other scientists. And it provides safeguards against scientific dishonesty and fraud. Good practice, thus, nurtures trust within the scientific community and between science and society, both of which are necessary for scientific advance.

Several European Science Foundation (ESF) Member Organisations and some individual research institutions and universities have already published guidelines, or codes, for good scientific practice across the full range of the natural and social sciences, engineering and the humanities. However, to be fully effective, such codes have to be more widely adopted by European universities and research institutions, observed by all researchers and scholars and monitored for compliance. Both institutional and individual commitment are prerequisites.

Procedures for investigating allegations of scientific misconduct complement codes of good scientific practice. Such investigations are commonly carried out at local (institutional) level, with guidance and oversight by national bodies. Some countries, however, prefer to carry out investigations at national level.

To achieve full compliance, and thus demonstrate effective self-regulation, the various players – national academies and research funding agencies, universities and research institutions employing scientists and the scientists themselves, each has distinctive advisory, managerial or regulatory responsibilities.

ESF, with its two sets of stakeholders firstly, (its membership drawn from funding agencies, national research organisations and academies of sciences and letters and, secondly, the research community at large) is uniquely placed to play a significant role in promoting the highest levels of scientific integrity and better self-regulation across Europe. At a strategic level, there is a need for more commonality in codes of good scientific practice, in the effective managing and monitoring of those standards and in developing transparent procedures for investigating allegations of scientific misconduct. Pan-European progress in these areas would improve quality assurance, strengthen the self-regulation of science and help reinforce public trust in science. Therefore, ESF believes that the following conclusions and recommendations set out a basis for further action at European level on this important topic:

1. **Both the globalisation of science, with its extensive inter-organisational and international collaborations, and current public concerns about self-regulation underline the need to extend and harmonise codes of good scientific practice and procedures for investigating allegations of scientific fraud.**

2. **European scientific institutions are responding, though somewhat unevenly, to these pressures and are addressing the moral issues of scientific ethics and integrity and the more practical matters associated with self-regulation.**

3. **With its extensive membership in 23 countries, the ESF is uniquely placed to play a pan-European role in promoting common approaches amongst its Member Organisations for managing and regulating good scientific practice.**

4. **The current debate about a *European Research Area* introduces a favourable political dimension and creates a window of opportunity for action.**

5. **At a strategic level, there are several possible initiatives which need to be taken, at a European level, to strengthen approaches to scientific integrity and good scientific practice across Europe. Some of those listed below are purely advisory; others require a more active intervention.**

ESF commits itself:

- **to support and promote vigorously the concepts and principles of good scientific practice in research and scholarship; and**

- **to promote the principle that the selection of scientists by academic institutions should be transparent, based primarily on criteria of scientific quality, creativity and promise, without discrimination on grounds of sex, race, political opinions or cultural backgrounds.**

ESF considers that a number of other actions are necessary. In taking action, it is vital that the approach is inclusive and sensitive to what has already been achieved by many of the ESF Member Organisations and other European organisations and by relevant international developments carried out by International Council of Scientific Unions (ICSU) and other similar bodies. Real progress will require linkages with these initiatives. And it is important that the goal of harmonising policies and procedures on the basis of best practice should be achieved without compromising the principle of subsidiarity in matters of executive action.

Therefore it is recommended that:

- ESF Member Organisations that are national academies should draw up national codes of good scientific practice in research and scholarship, where these do not yet exist; and

- ESF Member Organisations that are national academies should initiate discussions on the most appropriate national approach to procedures for investigating allegations of scientific misconduct (where this has not yet been done), whether by means of an independent national body (as in Denmark), formal procedures in each university and research institution, or by other means.

- ESF Member Organisations that are research-funding agencies should consider ways of making an institution's eligibility to apply for research grants conditional on that institution having adequate policies for good scientific practice and procedures for investigating scientific misconduct.

- ESF Member Organisations that employ scientists should act as responsible employers with clear, fair and robust guidelines for good scientific practice, coupled with effective and transparent management procedures for implementing these guidelines and for investigating allegations of scientific misconduct.

Finally, it is important to consider whether there is a need for any pan-European structures to reinforce national arrangements, for example, by maintaining a college of eminent scientists who might serve on local or national committees investigating scientific misconduct, or by setting up an Ombudsman system to provide a third party for counselling "whistleblowers" in the scientific community. Consideration of such issues will need to involve not only ESF and its Member Organisations but also other relevant European organisations, including those representing the universities.

Introduction

The nature of research and scholarship

1. Scientific research and scholarship are diverse and multifaceted activities embracing a wide range of intellectual and practical endeavours. These include theoretical studies, experimental work and surveys, as well as the verification, further analysis and extension of earlier work. The objective is always to extend human knowledge and our understanding of the physical, biological and social worlds.

2. Progress in science depends on trust. Scientists must have confidence in the results of other scientists. Also, society has to trust the honesty and motives of scientists and the integrity of their results. Much of the current disillusionment with science in Europe is due to a loss of public trust.

3. To regain and retain public trust, it is vital that the ethics and integrity of science are beyond question. Good practices in the design, conduct, interpretation and reporting of scientific research and scholarship are the gatekeepers of integrity. They are the prerequisites of mutual trust within the global scientific community and of greater trust between scientists and the public. Where there is a climate of trust, the results of science are more likely to be accepted, exploited or applied, for the benefit of humankind.

Self-regulation

4. Science has had a tradition of informal self-regulation to ensure that the highest professional standards of integrity are maintained. Over the past 20 years several trends in the increasingly complex world of science, however, have strained the traditional, low-key approach to self-regulation.

5. Greater competition between scientists for scarce research and scholarship funds and the emphasis on publications as measures of performance have put pressures on scientists to produce results quickly, in turn creating temptations to short-cut proper procedures. Senior researchers and scholars sometimes have insufficient time to involve themselves personally in the day-to-day conduct of the various investigations they may be directing. The greater weight that some public funding agencies attach to the utilitarian value of science, too, has sharpened the focus on outputs, as well as challenging traditional academic values of freedom of thought and action.

6. The ethical issues always inherent in social science and clinical research, where people are the subjects, and increasingly posed by advances in biomedical and biotechnological research, have added to the problem. In today's more inclusive society, these issues are now widely held to be too important, at best, to be left to informal and private debate within the scientific community, or, at worst, neglected by scientists. Last, but not least, self-regulation has been damaged by several well-publicised allegations and some proven cases of scientific misconduct and fraud.

7. All this has turned a spotlight on issues of scientific integrity and professional standards, and put pressure on the scientific community to strengthen the process of self-regulation and make it more visible.

Principles of scientific integrity

8. Scientific integrity is at the heart of the trust on which scientific communication and collaboration depend. Scientific integrity demands that those engaging in research and scholarship should at all times, and without exception, adhere to the following basic principles:

- highest professional standards in designing and conducting investigations
- a critical, open-minded approach in conducting research and scholarship and in analysing data
- frankness and fairness with regard to the contributions of partners, competitors, and predecessors
- absolute honesty at all stages in scientific enquiry, in particular, avoiding:
  - any form of fraud, such as fabricating or falsifying data or records;
  - piracy or plagiarism;
  - sabotaging the work, records or protocols of other scientists;
  - breach of confidence as a reviewer or supervisor, and
  - complicity in such actions by fellow scientists.

To retain professional and public trust, it is vital that all scientists accept personal responsibility to uphold these fundamental values.

Good scientific practice

9. Good scientific practice embraces all the procedures and practices that are necessary for planning, conducting and reporting research and scholarship within a framework of scientific integrity. By providing a common currency, good practice facilitates the vital, external processes of peer review, verification and repeatability. This enables other scientists to judge the validity of new contributions to knowledge and understanding. Standard methodologies for collecting and interpreting information also reduce the individual bias that might be introduced, perhaps unwittingly, by a scientist's personal background and values. And the audit trail created by good scientific practice provides quality assurance and a valuable buttress against scientific misconduct and fraud.

10. To be effective, good scientific practices have to be made explicit in written guidance or codes. There also have to be managerial procedures for implementing them and monitoring processes to ensure compliance. European universities and research institutions are increasingly introducing these measures.

11. The main components of good scientific practice are described in paras. 18-50, along with brief accounts of the present position in selected countries.

Scientific misconduct

12. Allegations of scientific misconduct and fraud first attracted major public and political attention in the USA, where there were several well-publicised cases in the 1980s. Some of these cases led to litigation. Although a few prominent cases may have attracted disproportionate publicity, it was difficult to deny the conclusion that self-regulation of science, based on traditional approaches to instilling values of scientific integrity, was not sufficiently meeting heightened public and political expectations.

13. In response, the US National Academies of Science established a Panel on Scientific Responsibility and the Conduct of Research to review scientific misconduct. In 1992-3 the Panel published a defining two-volume report *Responsible Science: Ensuring the Integrity of the Research Process*.[i] Volume II contains guidelines for good research practice and for handling allegations of scientific misconduct.

Ethical and responsible science

14. The moral dimensions of the sciences and the ethical and social responsibilities of scientists are themselves the subject of academic study and debate. These topics are developed, for example, in two collections of essays published under the patronage of the Confederation of Swiss Scientific Academies [ii] [iii] and books and articles by authorities such as Professor John Ziman FRS.[iv] There is now an international peer-reviewed journal, founded in 1995, devoted to ethical issues of direct concern to scientists and engineers.[1] These studies, however, go beyond the scope of current review.

15. The growing concern about the ethics of science is also reflected in the creation of high-level fora by the International Council of Scientific Unions (ICSU) [2] and by UNESCO,[3] by the agenda of the joint ICSU/UNESCO World Conference on Science in Budapest in 1999, and more recently by a working group report on the Misuse of Science, presented to the 50th Pugwash Conference in Cambridge, UK in August 2000.

The present position

16. Generally speaking, the global scientific community is responding positively, though too slowly in the opinion of some scientists, to the concerns and expectations of society. Questions of scientific integrity, high professional standards and public trust are high on scientists' agendas. Several national, European and international bodies [4] have taken initiatives designed to raise awareness of the ethical dimension of science, to encourage good scientific practice, and to set procedures for investigating allegations of scientific misconduct. All this is helping to strengthen the processes of self-regulation.

17. However, one senses a lack of unanimity in the European scientific community, at both institutional and individual levels, on the extent to which new measures are needed and on the pace of their introduction. There is a clear opportunity for the ESF to exercise leadership by co-ordinating further developments in the European arena.

Good scientific practice

Introduction

18. In the late 1980s, biomedical research witnessed some of the first initiatives in codifying good scientific practice and establishing procedures for dealing with misconduct. By mid-2000 a good deal of progress has been achieved by individual European research organisations. Several of the more significant developments are summarised below.

19. In the mid-1990s the UK Medical Research Council (MRC) produced a series of reports on the ethics of biomedical and clinical research, on good scientific practice and on procedures for inquiring into allegations of scientific misconduct. The MRC has recently published updated guidelines on good scientific practice that could serve as a general model for biomedical research.[v] Other UK research councils have now produced their own guidelines of good scientific practice.[vi]

20. Stimulated by a well-publicised case of scientific misconduct in Germany – the Herrmann/Brach affair, the Deutsche Forschungsgemeinschaft (DFG) in Germany appointed an international Commission, *Selbstkontrolle in der Wissenschaft*, to:

- explore causes of dishonesty in the science system
- discuss preventative measures
- examine the existing mechanisms of professional self-regulation in science.

21. The Commission presented a comprehensive report in late-1997 with an analysis of the issues along with 16 recommendations covering principles and operation of good scientific practice as well as procedures for investigating allegations of scientific misconduct.[vii] These recommendations would provide an excellent basis for developing a set of common European standards.

[1] *Science and Engineering Ethics.*

[2] The Standing Committee on Responsibility and Ethics in Science (SCRES; created in 1996).

[3] World Commission on the Ethics of Scientific Knowledge and Technology (created in 1998).

[4] For example the Comité d'éthique pour les sciences (Comets) of the Centre National de Recherche Scientifique (CNRS) in France; the All European Academies (ALLEA) and the European Union in Europe; the ICSU and UNESCO internationally.

22. By mid-2000, 13 German universities had finalised their rules on good scientific practice, in line with the Commission's recommendations, and work was in progress in another 17 universities.

23. In France, a Working Group on scientific integrity recommended in 1998 that the Institut National de la Santé et de la Recherche Médicale (INSERM) should actively promote good laboratory practice in its units, building on existing legal requirements for clinical research. The Working Group also recommended that the organisation should have formal principles and procedures for dealing with allegations of scientific fraud.

24. The INSERM Working Group noted that, to be most effective, good laboratory practices and procedures for investigating allegations of fraud require some harmonisation between the various universities and research organisations in France, especially when research was being undertaken collaboratively. Looking wider, the Working Group envisaged that the ESF might seek to harmonise ethical codes and good practices at a pan-European level.

25. On handling allegations of serious misconduct, the Working Group argued that there should be a degree of independence (from INSERM) amongst the investigating experts and suggested that, longer term, the ESF should create a college of scientists who could serve as independent experts, on a case-by-case basis, in investigations of scientific fraud allegations anywhere in Europe.

26. In accord with the Working Group recommendation, INSERM has now produced a comprehensive code of good practice in conducting biomedical research. It is in an attractive format suitable for distribution to all its researchers.[viii]

Scope of codes of good scientific practice

27. Though the details will vary to meet the requirements of particular disciplines and national circumstances, guidelines for good scientific practice should cover the following key areas, which are elaborated in the following paragraphs:

- designing and conducting research and scholarship, including documenting and analysing the data or findings
- accumulating, storing or archiving data
- publishing the results of research and scholarship
- protecting intellectual property (IP)
- training, development and mentoring of young scientists
- appointing academics and other researchers.

28. Several codes of good practice have been built around a core of legislative requirements for health and safety in the workplace, the use of human beings and animals in research, environmental protection, data protection and individual privacy.

Design and methodologies

29. All research should be designed so that it has a clear objective, either answering a valid scientific question or, in scholarship, adding to the understanding of an event, individual, concept or phenomenon. The design of the study must be robust, the procedures proposed technically feasible and the intended methods of analysis appropriate.

30. Protocols and plans should, therefore, be written in clear and unambiguous terms. They should include specific details of the aim, materials, methods, time schedules and analytical approaches to be used. Unambiguous and fully documented protocols are not only necessary for those conducting the research, but also for those who may wish to assess or replicate the work at a later date. It is essential that all participants in the research accept responsibility for these crucial initial steps.

31. Throughout the conduct of research all participants must keep clear and accurate records on a daily basis of the procedures followed and the results obtained. Particular attention should be paid to the completeness, integrity and security of these records. Those conducting the research should authenticate their findings by signing the records at the end of each day's work. These records must be kept securely in paper or electronic format. The aim is to provide a continuous and verifiable record of good scientific practice.

32. Research in the humanities and social sciences often involves interactions with people. In these circumstances, private citizens have a right to be protected against unethical interference in their personal lives. The Swedish Council for Research in the Humanities and Social Sciences has published a code of ethical principles[ix], which sets our four key requirements for such research, as follow:

- to inform individuals about all aspects of the proposed research
- to secure their voluntary agreement to participate – the principle of 'informed consent'
- to handle and store personal information under conditions of the highest possible confidentiality
- to use such information exclusively for the purposes of the research.

33. The balance between protecting the individual and allowing genuine researchers to access data is, however, a delicate one. Guidelines should be sufficiently flexible to allow legitimate replication and even secondary analyses of valuable (and costly) data sets to address new, and quite possibly unforeseen, research questions. Such an approach actually reduces the need for new data collection and social surveys – a point that has been acknowledged by data protection commissioners.

34. The UK Economic and Social Research Council (ESRC) has produced a draft policy statement and guidelines for the social science community designed to maximise the benefit of social data to the community while protecting the interests of the data subjects.[x]

35. The French Institut de Recherche pour le Développement (IRD) has recently initiated a debate [5] on a professional code specifically for development research. It is seeking to determine whether there are special factors concerning scientific conduct in co-operation-based research for development, bearing in mind the vulnerability of partner countries in terms of their political, social and cultural characteristics, as well as their human and material resources.

Data accumulation, handling and storage

36. Data are produced at all stages in experimental research and in scholarship. Data sets are an important resource, which enable later verification of scientific interpretation and conclusions. They may also be the starting point for further studies. It is vital, therefore, that all primary and secondary data are stored in a secure and accessible form.

37. Institutions must pay particular attention to documenting and archiving original research and scholarship data. Several codes of good practice recommend a minimum period of 10 years, longer in the case of especially significant or sensitive data. National or regional discipline-based archives should be considered where there are practical or other problems in storing data at the institution where the research was conducted.

[5] At http: / / www.ird.fr / fr / inst / ird / debat / en_remarq.shtml

Publishing the results of research and scholarship

38. Publication in a peer-reviewed journal or as a scholarly book is an important stage in the scientific process, marking the point when data, theories, interpretations and paradigms formally enter the public domain. The right to authorship of publications derives solely from a creative contribution to the work in question. In the case of joint authors, each should have made a significant contribution to the creative or analytical process and each has to accept shared responsibility for the content of the resulting article or book. The practice of honorary, or "ghost", authorships is inconsistent with these principles and with good scientific practice.

39. Authorship brings further responsibilities. In particular, authors need to provide accounts of the materials and methods and of any analytical and statistical techniques they used in sufficient detail to enable the reader to judge the validity of the approaches adopted and, if so desired, to replicate the analysis. Authors must also be honest and frank in referring to earlier work, acknowledging the intellectual contributions of other scientists and declaring any potential conflicts of interest.

40. Scientific journals, too, have responsibilities. They should make it clear in their guidelines that they are committed to best international publishing practice. Generally accepted rules have been drawn up and the majority of high quality publications adhere to them. In particular, reviewers and members of editorial boards should be required to declare actual or potential conflicts of interest. Moreover, the membership of such boards and the names of those who serve as expert referees should be published on a regular basis. Many publishers have also issued clear guidelines for authors.

41. Many in the scientific community share their ideas and data freely with colleagues as their thinking proceeds - through discussion, correspondence or at scientific meetings. Any subsequent exploitation of information gained through these informal contacts, without the direct involvement or the explicit approval of the originator of the ideas, amounts to infringement of the proprietary rights of the scientist concerned.

Protection of IP

42. Research workers have a duty to ensure that intellectual property arising from their work is properly safeguarded. This requires them to keep thorough, accurate and contemporaneous records of the steps leading to their discovery. It is important they understand that their records may have to stand up to legal challenge. It is also vital that they avoid public disclosure before patent protection is achieved. Laws on disclosure vary significantly between Europe and the USA.

43. Scientists have a further duty to ensure, insofar as is possible, that their research and scholarship should be developed for the benefit of the community. This may involve assigning or licensing the IP to industry or commerce if a product needs to be developed and marketed.

Training, development and mentoring of young scientists

44. The training and development of young researchers is an important responsibility of all those in science. These activities should not be limited to providing the technical skills necessary to enable them to conduct their research and become independent investigators. Training must also inculcate the core ethical standards and norms of science, as well as principles of best scientific practice.

45. In the past, young scientists have learned these values and norms informally, by working alongside senior scientists and by mentoring. Such approaches were supplemented by occasional publications that offered general advice; for instance Sir Peter Medawar's book *Advice to a Young Scientist.* [xi]

46. With the pressures of today's world, greater formality is needed to help young scientists understand the importance of scientific integrity and to adopt good scientific practices as early as possible in their careers. Some universities now routinely provide short courses on these issues for their graduate students. In 1989 the US National Academy of Science published a booklet *On Being a Scientist: Responsible Conduct in Research*, which described the ethical foundations of scientific practice and some of the professional issues and dilemmas that scientists might encounter. It was addressed to junior research workers, and some 200,000 copies were distributed to graduate and undergraduate students.

47. An expanded second edition was published in 1995, jointly by the National Academy of Sciences, the Institute of Medicine and the National Academy of Engineering.[xii] Although it is written for American readers, the principles and values it describes are universally valid. The booklet could be of value throughout Europe.

48. On the question of mentorship, the DFG Commission advised that it is good practice for graduate students to be associated with two experienced scientists in addition to their formal supervisor, one of whom should be chosen by the student. This arrangement would create a safety valve for mediating in any conflict situations, on scientific practice or other matters, which might arise.

Academic and other scientific appointments

49. Advances in science are the result of free, creative thinking by individual scientists. When recruiting to scientific posts, academic and related institutions should put a high premium on scientific excellence, creativity and potential as selection criteria.

50. Appointment procedures for scientific positions should be transparent, with the selection criteria clearly publicised in advance and adhered to during the selection process. The procedures should also be socially inclusive, aiming to address deficits of under-represented social groups. Under no circumstances should political or any other external influence be applied to press the appointment of particular candidates.

Managing good scientific practice

Introduction

51. Scientists have a moral duty to maintain the highest standards of integrity without the imposition of external controls and the threat of sanctions. Nevertheless, in today's world the sensitivity of the issues involved in scientific integrity underline the need for the scientific community to be seen to be regulating itself. Hence the importance of scientific institutions having formal and transparent procedures for managing and monitoring their policies of good scientific practice.

Responsibilities of institutions

52. It is primarily the responsibility of individual universities and research institutions to develop practical rules for good scientific practice for the scientists they employ. The need to establish clear and robust institutional policies is a central recommendation of most recent reviews of scientific integrity – for example, the DFG Commission.

53. Institutional policies for good research practice must incorporate and reinforce any existing civil legislation or codes of practice concerning, for example, the use of animals in scientific experimentation, human patients in biomedical research and the use of surveys in the social sciences.

54. The rules will affect individual scientists and it is important that universities and research institutions formulate their rules of good scientific practice in a democratic manner that involves their professional members of staff. Once agreed, these rules should be widely publicised [6] and made binding on all members of an institution, if necessary through terms and conditions of employment.

55. Universities and research institutions need to have appropriate management structures and procedures to implement their codes of good scientific practice, including mechanisms for:

- delegating responsibilities for direction, supervision, conflict resolution and quality assurance within their management structures, taking into account the size of each scientific unit
- maintaining an effective management audit trail to verify these procedures
- appointing mediators to whom scientists can turn in conflict situations, including cases of suspected scientific misconduct
- investigating allegations of scientific misconduct
- incorporating the principles and rules of good scientific practice into teaching curricula and the education of young scientists and scholars.

Responsibilities of research groups

56. Institutions should delegate to individual departments, research laboratories and groups the responsibility to adopt good scientific practice and to operate within institutional policy frameworks at all times. These operational groups must develop mechanisms, appropriate to their particular discipline and situation, for ensuring compliance with good practice. In particular, there need to be mechanisms for monitoring methodologies, data records and notebooks and checking the integrity of audit trails. Responsibility for compliance monitoring is best assigned to an experienced member of each research group.

57. At a more philosophical level, there is a responsibility on the heads of schools, departments and research groups and their senior colleagues to create a climate in their groups or units that encourages all to aspire to the highest professional standards in the conduct of their research and scholarship.

[6] A good, recent example of an institutional code is the *Code of Good Scientific Practice* (in the field of Health and Life Sciences) published jointly in July 2000 by the Universitat Pompeu Fabra and the Institut Municipal d'Investigació Mècida, Barcelona.

Responsibilities of individual scientists

58. Recently, there have been suggestions that the intrinsic moral responsibility of scientists to work with absolute integrity might be reinforced if students were to make pledges at their graduation, along the lines of the Hippocratic Oath in the case of medical graduates. Some professional bodies and institutions already do this for their members. The idea would be to extend the approach to the generality of scientists, irrespective of their discipline, at the time of graduation. The support and co-operation of universities would clearly be essential.

59. Such a proposal was discussed at the Budapest World Conference on Science in 1999 and is now being followed up in Europe and in the USA. Some members of the scientific community, however, strongly oppose the idea as impractical.

Leadership by national academies

60. National academies are well placed to provide leadership in the pursuit of scientific integrity and good practice. They are often the most appropriate independent body to establish and support a national committee for scientific ethics and to nominate independent experts to panels investigating cases of alleged scientific misconduct. Those academies that employ scientists have the added responsibility of formulating and managing their own guidelines and codes of practice.

The role of research funding agencies

61. Research funding agencies have a particular opportunity to demonstrate leadership in promoting high standards of scientific integrity. As a condition of their research grants they can oblige institutions and principal investigators to adhere to good scientific practice in the conduct of research and scholarship and to make the results and data collections available, for example by archiving. Some research funding agencies have already gone further. In the USA, as a precondition for accepting research grant applications, the National Science Foundation (NSF) and the National Institutes of Health (NIH) require all submitting universities and other research institutions not only to have in place rules for good scientific practice, but also procedures for handling allegations of scientific misconduct. The DFG Commission recommended a similar approach for Germany.

62. By the same token, funding agencies, research councils and foundations have a duty to set an example by the probity of their research appraisal processes. It is essential that their operating policies and practices be characterised by equity, integrity, confidentiality and transparency. Some have published guidelines.[7]

63. Confidentiality requires that all those who assess or administer applications for research funds should not pass privileged information to others and should take all necessary steps to ensure that it is stored securely. They must be required to treat the research proposals they review confidentially and to disclose any conflicts of interest. This extends to those who contribute to the review process by acting as external referees.

64. Considerations of openness or transparency require that the procedures used by research funding agencies should be published, including the criteria that peer reviewers will apply. The names of their advisory committees, as well as those who carry managerial and administrative responsibilities, should also be publicly available.

[7] For example, the Czech Academy of Sciences, the UK Medical Research Council, and the Swedish Research Council for Engineering Sciences.

The contributions of learned and professional societies

65. Learned and professional societies in science have traditionally prepared guidelines of professional standards for their members, particularly in areas with obvious ethical considerations. The DFG Commission encouraged scientific learned societies to be more active in this area.

Contract research

66. The guidance provided by codes of good scientific practice is equally applicable to contract research funded by commercial sponsors, governments or official agencies. Certain tensions do, however, arise from time to time when research projects are carried out under contract. These frequently relate to the ownership and exploitation of intellectual property and to publication arrangements, which should be clearly addressed and agreed before a contract is finalised.

67. Some government and commercial research customers now expect research organisations to have acquired formal accreditation, such as ISO 9000, as a measure of quality assurance, and may restrict their competitive tendering processes to accredited organisations.

A pan-European approach

68. In early 2000 the European Commission adopted a policy paper by the Commissioner for Research, Training and Development entitled *Towards a European research area*.[xiii] The paper was designed to stimulate a debate about the need for, and ways of achieving, a better overall framework for research in Europe.

69. On scientific ethics, *Towards a European research area* [8] argues that there should be stronger links between ethics committees established at national and European levels. The ethical criteria and rules adopted in national and in European research programmes should be compared with a view to alignment around common principles, while respecting differences in sensitivities and opinions between member states. The paper concludes that the process of spreading best practice would be enhanced if the various national committees included experts from other European countries.

70. Though primarily concerned with scientific ethics, these observations are equally relevant to the policies and management practices needed to achieve more uniform standards of good scientific practice across Europe.

[8] Section 7.2

Investigating allegations of scientific misconduct

Introduction

71. Major incidents of scientific dishonesty are uncommon, but they do cause considerable concern when they do occur. They not only call into question the data reported, but also undermine public confidence in science and the mutual trust between scientists. The Herrmann/Brach affair is still reverberating in Germany. And as recently as August 2000, a principal author had to retract a molecular biology paper already published in *Science*, after peer review, because a co-author had admitted altering gel records and other data.[xiv]

Formal procedures

72. The primary responsibility for establishing a procedure for investigating allegations of malpractice rests with each university and research institute where research is carried out. Preliminary enquiries should normally be carried out in that institution. It is also the responsibility of each institution to ensure that its entire staff are aware of what constitutes misconduct and that its investigating procedures are properly publicised.

73. Whatever the source of an allegation of scientific misconduct, it is essential to ensure that justice is done, and is seen to be done, to the complainant and to the accused. *Bona fide* complaints must be pursued with integrity, in confidence and without detriment to the complainant. Equally, staff who are the subject of such allegations are entitled to expect that their work will be regarded as honest unless proved to be otherwise, and that they will be protected against ill-founded, frivolous, mischievous or malicious allegations.

74. With these considerations in mind, the following general requirements, largely based on the recommendations of the DFG Commission, should be included in all procedures for investigating allegations of misconduct:

- a definition of categories of action that seriously deviate from good scientific practice and which are held to constitute scientific misconduct
- jurisdiction, rules of procedure (including rules for the burden of proof), and time limits for preliminary and substantive investigations designed to ascertain the facts
- the rights of the involved parties to be heard, and rules for the exclusion of conflicts of interest
- the confidentiality of investigations, though if there is conflict between the need for confidentiality and the need to seek the truth, the latter must prevail
- the range of available sanctions, which should be related to the seriousness of any proven misconduct
- the jurisdiction for determining sanctions.

Local and national investigations

75. In the USA, the two main public research-funding agencies, the NSF and the NIH, have established permanent offices to maintain the integrity of their science programmes - the NSF Office of Inspector General (OIG) and the NIH Office of Research Integrity (ORI). However, the primary responsibility for dealing with allegations of scientific misconduct rests with institutions. The federal bodies, OIG and ORI, are there to provide policy guidance and technical assistance to those institutions and to perform a review and oversight function. Since it was formed in 1992, ORI has logged more than 1,500 allegations of misconduct in public health and biomedical research. About 20% required a formal inquiry. Misconduct has been proved in about 100 cases – about 6% of the original allegations.

76. Apart from in Scandinavia, the European approach is also to investigate allegations locally – by the university or research institute where the alleged misconduct took place. In most countries this is done without the oversight of national bodies like the ORI in the USA. Several research bodies [9] have issued regulations for dealing with allegations of scientific misconduct in their research institutions.

77. The approach in Scandinavia is the main departure from the prevalent European practice of investigations being undertaken at institutional level. The Danish Medical Research Council founded the Danish Committee on Scientific Dishonesty in 1992, initially to investigate allegations of fraud in biomedical research. The Committee now works under the Danish Research Ministry and covers the full range of scientific disciplines. The Danes believe that centralising the investigation introduces an important independent element at the outset and overcomes any inhibitions that universities might have in investigating one of their own scientists.

78. Other Nordic countries have largely followed the Danish model of an independent committee of investigation, but they generally allow local institutions to conduct preliminary investigations. For example, the Research Council of Norway established a National Committee for the Evaluation of Dishonesty in Health Research in 1994. As well as investigating cases of alleged scientific dishonesty, the Committee promotes measures to prevent dishonesty in health research. To date the Committee has investigated nine cases.[xv]

79. In early 1999, a Parliamentary Commission in Sweden made wide ranging recommendations in a report *Good Practice in Research* designed to increase public oversight of the research system, including setting up a national commission to deal with cases of alleged scientific fraud.

Appeals

80. Natural justice requires that arbitration and appeal arrangements are available. Responsibility for establishing such a facility might be undertaken by national funding agencies and/or professional bodies. Arrangements for access to arbitration and appeal mechanisms must be available equally to employing authorities, complainants and those who have been the subject of allegations of misconduct.

Ombudsman

81. To address the dilemma facing scientists who have doubts about the conduct of other, possibly senior, scientists, the DFG Commission recommended the creation of a national Ombudsman (or a small committee). Its mandate should be to advise and assist scientists and scholars in questions of good scientific practice and its impairment through scientific dishonesty, and to give an annual public report on its work.

82. A mediating person or committee of this sort could become a trusted third party to whom scientists would turn with their problems. It would alleviate the isolation that potential "whistle blowers" experience and could provide wise counsel not available locally. The Ombudsman could take up matters judged to be of serious concern with the university or research institute in question. But he or she would not have a mandate to investigate alleged misconduct. In addition to its intrinsic benefits, setting up a mediating authority along these lines would send a clear message to the public and politicians that science is taking self-regulation seriously.

83. The DFG Ombudsman, in fact a three-person committee, has been active for a year or so and has made its first report to the DFG Senate.

[9] Including the Medical Research Council (UK) and, in Germany, the Max Planck Gesellschaft and the Herman von Helmholtz Gemeinschaft.

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European Science Foundation,
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67080 Strasbourg Cedex, France
Tel: +33 (0)3 88 76 71 25
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BIRKBECK
(University of London)

SCIENTIFIC MISCONDUCT AND FRAUD

The College is totally committed to complete integrity and honesty in the conduct of all work undertaken by members of, or on behalf of, the College, whilst also being committed to protecting its staff from malicious accusations.

The College has no separate procedure for investigating allegations of scientific misconduct. The following provisions and procedures will apply:

1. Procedures

a) Misconduct and Grievance Procedures (for academic staff, Clerk and Librarian)

Charter & Statutes number 51 Parts I and III (misconduct) and VI (grievance). These provide for the investigation of serious disciplinary matters to be heard by a Tribunal. Such complaints should be made to the Clerk of Governors.

b) Disciplinary and Dismissal, and Grievance Procedures (for academic-related, other-related, clerical, manual, technical and craft staff)
Staff handbook 1998 - section 7 (disciplinary and dismissal); section 11 (grievance). These deal with disciplinary actions covering both minor and gross misconduct (including falsification of records). Actions in accordance with the procedures is taken by the College Secretary and Clerk to the Governors in consultation with the Personnel Director and may include a disciplinary panel.

c) Public Interest Disclosure (Whistleblowing): College Policy (all members of the College)

This applies to all members of the College (staff, students and governors) and covers malpractice and impropriety, including academic malpractice and unethical behaviour. The allegation should normally first be raised with the College Secretary and Clerk to the Governors. Depending on the nature of the allegation an internal investigation or reference to the police might be appropriate. Currently available on the College web site (Personnel) or in hard copy from Personnel, and to be incorporated in future editions of the staff handbooks.

In all cases, staff are invited to take the advice of the Director of Personnel, on a confidential basis, if they have concerns.

2. Definition

Misconduct in academic research is taken to include, but is not limited to:

> **piracy** - the deliberate exploitation of ideas from others without acknowledgment
> **plagiarism**- the copying of ideas, data or text without permission or acknowledgment
> **misrepresentation** - the deliberate attempt to represent falsely or unfairly the ideas or work of others, whether or not for personal gain or enhancement
> **fraud** - deliberate deception, including invention of data, and the omission from analysis and publication of inconvenient data.

3. Good Practice

In order to avoid such incidents as far as possible, good scientific practice should always be followed and attention is drawn to the good practice and ethical guidelines produced by many Research Councils and professional and academic associations. Information about these can be sought from your Head of School, Dean of Faculty, or the Research Grants & Contracts Office.

[Approved by Governors July 1999]

ON BEING A SCIENTIST

RESPONSIBLE CONDUCT IN RESEARCH

Committee on Science, Engineering, and Public Policy

National Academy of Sciences
National Academy of Engineering
Institute of Medicine

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PREFACE

The scientific research enterprise, like other human activities, is built on a foundation of trust. Scientists trust that the results reported by others are valid. Society trusts that the results of research reflect an honest attempt by scientists to describe the world accurately and without bias. The level of trust that has characterized science and its relationship with society has contributed to a period of unparalleled scientific productivity. But this trust will endure only if the scientific community devotes itself to exemplifying and transmitting the values associated with ethical scientific conduct.

In the past, young scientists learned the ethics of research largely through informal means—by working with senior scientists and watching how they dealt with ethical questions. That tradition is still vitally important. But science has become so complex and so closely intertwined with society's needs that a more formal introduction to research ethics and the responsibilities that these commitments imply is also needed—an introduction that can supplement the informal lessons provided by research supervisors and mentors.

The original "On Being a Scientist," published by the National Academy of Sciences in 1989, was designed to meet that need. Written for beginning researchers, it sought to describe the ethical foundations of scientific practices and some of the personal and professional issues that researchers encounter in their work. It was meant to apply to all forms of research—whether in academic, industrial, or governmental settings—and to all scientific disciplines. Over 200,000 copies of the booklet were distributed to graduate and undergraduate science students. It continues to be used today in courses, seminars, and informal discussions.

Much has happened in the six years since "On Being a Scientist" first appeared. Research institutions and federal agencies have developed important new policies for dealing with behaviors that violate the ethical standards of science. A distinguished panel convened by the National Academies of Sciences and Engineering and the Institute of Medicine issued a major report on research conduct entitled *Responsible Science: Ensuring the Integrity of the Research Process*. Continued questions have reemphasized the importance of the ethical decisions that researchers must make.

To reflect the developments of the last six years, the National Academy complex is issuing this new version of "On Being a Scientist." This version incorporates new material from *Responsible Science* and other recent reports. It reflects suggestions from readers of the original booklet, from instructors who used the original booklet in their classes and seminars, and from graduate students and professors who critiqued drafts of the revision. This version of "On Being a Scientist" also includes a number of hypothetical scenarios, which have proved in recent years to provide an effective means of presenting research ethics. An appendix at the end of the booklet offers guidance in thinking about and discussing these scenarios, but the scenarios remain essentially open-ended. As is the case for the entire document, input from readers is welcomed.

Though "On Being a Scientist" is aimed primarily at graduate students and beginning researchers, its lessons apply to all scientists at all stages of their scientific careers. In particular, senior scientists have a special responsibility in upholding the highest standards for conduct, serving as role models for students and young scientists, designing educational programs, and responding to alleged violations of ethical norms. Senior scientists can themselves gain a new appreciation for the importance of ethical issues by discussing with their students what had previously been largely tacit knowledge. In the process, they help provide the leadership that is essential for high standards of conduct to be maintained.

The original "On Being a Scientist" was produced under the auspices of the National Academy of Sciences by the Committee on the Conduct of Science, which consisted of Robert McCormick Adams, Francisco Ayala (chairman), Mary-Dell Chilton, Gerald Holton, David Hull, Kumar Patel, Frank Press, Michael Ruse, and Phillip Sharp. Several members of that committee were involved directly in the revision of the booklet, and the others were consulted during the revision and reviewed the resulting document.

This new version of the booklet was prepared under the auspices of the Committee on Science, Engineering, and Public Policy, which is a joint committee of the National Academies of Sciences and Engineering and the Institute of Medicine. The revision was overseen by a guidance group consisting of Robert McCormick Adams, David Challoner, Bernard Fields, Kumar Patel, Frank Press, and Phillip Sharp (group chairman).

The future of science depends on attracting outstanding young people to research—not only people of enormous energy and talent but people of strong character who will be tomorrow's leaders. It is incumbent on all scientists and all administrators of science to help provide a research environment that, through its adherence to high ethical standards and creative productivity, will attract and retain individuals of outstanding intellect and character to one of society's most important professions.

BRUCE ALBERTS
President, National Academy of Sciences

KENNETH SHINE
President, Institute of Medicine

ROBERT WHITE
President, National Academy of Engineering

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Finally, the committee thanks its able staff: Steve Olson, science writer, whose help in drafting this revision was invaluable; Deborah Stine, who managed the project and ran the focus groups on the document; and Jeffrey Peck and Patrick Sevcik, who provided administrative support at various stages.

A NOTE ON USING THIS BOOKLET

This booklet makes the point that scientific knowledge is defined collectively through discussion and debate. Collective deliberation is also the best procedure to apply in using this booklet. Group discussion—whether in seminars, orientations, research settings, or informal settings—can demonstrate how different individuals would react in specific situations, often leading to conclusions that no one would have arrived at individually.

These observations apply with particular force to the hypothetical scenarios in this booklet. Each scenario concludes with a series of questions, but these questions have many answers—some better, some worse—rather than a single right answer. An appendix at the end of this booklet examines specific issues involved in several of the scenarios as a way of suggesting possible topics for consideration and discussion.

This booklet has been prepared for use in many different settings, including:

- Classes on research ethics
- Classes on research methods or statistics
- Classes on the history, sociology, or philosophy of science
- Seminars to discuss research practices or results
- Meetings sponsored by scientific societies on a local, regional, or national level
- Meetings held to develop ethics policies or guidelines for a specific laboratory or institution
- Orientation sessions
- Journal clubs

A useful format in any of these situations is to have a panel discussion involving three or four researchers who are at different stages of their careers—for example, a graduate student, a postdoctoral fellow, a junior faculty member, and a senior faculty member. Such panels can identify the ambiguities in a problem situation, devise ways to get the information needed to resolve the ambiguities, and demonstrate the full range of perspectives that are involved in ethical deliberations. They can also show how institutional policies and resources can influence an individual's response to a given situation, which will emphasize the importance for all researchers to know what those institutional policies and resources are.

Finally, discussion of these issues with a broad range of researchers can demonstrate that research ethics is not a complete and finalized body of knowledge. These issues are still being discussed, explored, and debated, and all researchers have a responsibility to move the discussion forward.

CONTENTS

INTRODUCTION

The geneticist Barbara McClintock once said of her research, "I was just so interested in what I was doing I could hardly wait to get up in the morning and get at it. One of my friends, a geneticist, said I was a child, because only children can't wait to get up in the morning to get at what they want to do."

Anyone who has experienced the childlike wonder evoked by observing or understanding something that no one has ever observed or understood before will recognize McClintock's enthusiasm. The pursuit of that experience is one of the forces that keep researchers rooted to their laboratory benches, climbing through the undergrowth of a sweltering jungle, or following the threads of a difficult theoretical problem. To succeed in research is a personal triumph that earns and deserves individual recognition. But it is also a communal achievement, for in learning something new the discoverer both draws on and contributes to the body of knowledge held in common by all scientists.

Scientific research offers many other satisfactions in addition to the exhilaration of discovery. Researchers have the opportunity to associate with colleagues who have made important contributions to human knowledge, with peers who think deeply and care passionately about subjects of common interest, and with students who can be counted on to challenge assumptions. With many important developments occurring in areas where disciplines overlap, scientists have many opportunities to work with different people, explore new fields, and broaden their expertise. Researchers often have considerable freedom both in choosing what to investigate and in deciding how to organize their professional and personal lives. They are part of a community based on ideals of trust and freedom, where hard work and achievement are recognized as deserving the highest rewards. And their work can have a direct and immediate impact on society, which ensures that the public will have an interest in the findings and implications of research.

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

Scientific progress and changes in the relationship between science and society

are creating new challenges for the scientific community. The numbers of trained researchers and exciting research opportunities have grown faster than have available financial resources, which has increased the pressure on the research system and on individual scientists. Research endeavors are becoming larger, more complex, and more expensive, creating new kinds of situations and relationships among researchers. The conduct of research is more closely monitored and regulated than it was in the past. The part played by science in society has become more prominent and more complex, with consequences that are both invigorating and stressful.

To nonscientists, the rich interplay of competition, elation, frustration, and cooperation at the frontiers of scientific research seems paradoxical. Science results in knowledge that is often presented as being fixed and universal. Yet scientific knowledge obviously emerges from a process that is intensely human, a process indelibly shaped by human virtues, values, and limitations and by societal contexts. How is the limited, sometimes fallible, work of individual scientists converted into the enduring edifice of scientific knowledge?

The answer lies partly in the relationship between human knowledge and the physical world. Science has progressed through a uniquely productive marriage of human creativity and hard-nosed skepticism, of openness to new scientific contributions and persistent questioning of those contributions and the existing scientific consensus. Based on their observations and their ideas about the world, researchers make new observations and develop new ideas that seem to describe the physical, biological, or social world more accurately or completely. Scientists engaged in applied research may have more utilitarian aims, such as improving the reliability of a semiconductor chip. But the ultimate effect of their work is the same: they are able to make claims about the world that are subject to empirical tests.

The empirical objectivity of scientific claims is not the whole story, however. As will be described in a moment, the reliability of scientific knowledge also derives partly from the interactions among scientists themselves. In engaging in these social interactions, researchers must call on much more than just their scientific understanding of the world. They must also be able to convince a community of peers of the correctness of their concepts, which requires a fine understanding of the methods, techniques, and social conventions of science.

By considering many of the hard decisions that researchers make in the course of their work, this booklet examines both the epistemological and social dimensions of scientific research. It looks at such questions as: How should anomalous data be treated? How do values influence research? How should credit for scientific accomplishments be allocated? What are the borderlines between honest error, negligent error, and misconduct in science?

These questions are of interest to more than just the scientific community. As the influence of scientific knowledge has grown throughout society, nonscientists have acquired a greater interest in assessing the validity of the claims of science. With science becoming an increasingly important social institution, scientists have become more accountable to the broader society that expects to benefit from their work.

THE SOCIAL FOUNDATIONS OF SCIENCE

Throughout the history of science, philosophers and scientists have sought to describe a single systematic procedure that can be used to generate scientific knowledge, but they have never been completely successful. The practice of science is too multifaceted and its practitioners are too diverse to be captured in a single overarching description. Researchers collect and analyze data, develop hypotheses, replicate and extend earlier work, communicate their results with others, review and critique the results of their peers, train and supervise associates and students, and otherwise engage in the life of the scientific community.

Science is also far from a self-contained or self-sufficient enterprise. Technological developments critically influence science, as when a new device, such as a telescope, microscope, rocket, or computer, opens up whole new areas of inquiry. Societal forces also affect the directions of research, greatly complicating descriptions of scientific progress.

Another factor that confounds analyses of the scientific process is the tangled relationship between individual knowledge and social knowledge in science. At the heart of the scientific experience is individual insight into the workings of nature. Many of the outstanding achievements in the history of science grew out of the struggles and successes of individual scientists who were seeking to make sense of the world.

At the same time, science is inherently a social enterprise—in sharp contrast to a popular stereotype of science as a lonely, isolated search for the truth. With few exceptions, scientific research cannot be done without drawing on the work of others or collaborating with others. It inevitably takes place within a broad social and historical context, which gives substance, direction, and ultimately meaning to the work of individual scientists.

The object of research is to extend human knowledge of the physical, biological, or social world beyond what is already known. But an individual's knowledge properly enters the domain of science only after it is presented to others in such a fashion that they can independently judge its validity. This process occurs in many different ways. Researchers talk to their colleagues and supervisors in laboratories, in hallways, and over the telephone. They trade data and speculations over computer networks. They give presentations at seminars and conferences. They write up their results and send them to scientific journals, which in turn send the papers to be scrutinized by reviewers. After a paper is published or a finding is presented, it is judged by other scientists in the context of what they already know from other sources. Throughout this continuum of discussion and deliberation the ideas of individuals are collectively judged, sorted, and selectively incorporated into the consensual but ever evolving scientific worldview. In the process, individual knowledge is gradually converted into generally accepted knowledge.

This ongoing process of review and revision is critically important. It minimizes the influence of individual subjectivity by requiring that research results be accepted by other scientists. It also is a powerful inducement for researchers to be critical of

"Scientists are people of very dissimilar temperaments doing different things in very different ways. Among scientists are collectors, classifiers and compulsive tidiers-up; many are detectives by temperament and many are explorers; some are artists and others artisans. There are poet-scientists and philosopher-scientists and even a few mystics."
— Peter Medawar, Pluto's Republic, Oxford University Press, New York, 1982, p. 116.

their own conclusions because they know that their objective must be to try to convince their ablest colleagues.

The social mechanisms of science do more than validate what comes to be known as scientific knowledge. They also help generate and sustain the body of experimental techniques, social conventions, and other "methods" that scientists use in doing and reporting research. Some of these methods are permanent features of science; others evolve over time or vary from discipline to discipline. Because they reflect socially accepted standards in science, their application is a key element of responsible scientific practice.

EXPERIMENTAL TECHNIQUES AND THE TREATMENT OF DATA

One goal of methods is to facilitate the independent verification of scientific observations. Thus, many experimental techniques—such as statistical tests of significance, double-blind trials, or proper phrasing of questions on surveys—have been designed to minimize the influence of individual bias in research. By adhering to these techniques, researchers produce results that others can more easily reproduce, which promotes the acceptance of those results into the scientific consensus.

If research in a given area does not use generally accepted methods, other scientists will be less likely to accept the results. This was one of several reasons why many scientists reacted negatively to the initial reports of cold fusion in the late 1980s. The claims were so physically implausible that they required extraordinary proof. But the experiments were not initially presented in such a way that other investigators could corroborate or disprove them. When the experimental techniques became widely known and were replicated, belief in cold fusion quickly faded.

In some cases the methods used to arrive at scientific knowledge are not very well defined. Consider the problem of distinguishing the "facts" at the forefront of a given area of science. In such circumstances experimental techniques are often pushed to the limit, the signal is difficult to separate from the noise, unknown sources of error abound, and even the question to be answered is not well defined. In such an uncertain and fluid situation, picking out reliable data from a mass of confusing and sometimes contradictory observations can be extremely difficult.

In this stage of an investigation, researchers have to be extremely clear, both to themselves and to others, about the methods being used to gather and analyze data. Other scientists will be judging not only the validity of the data but also the validity and accuracy of the methods used to derive those data. The development of new methods can be a controversial process, as scientists seek to determine whether a given method can serve as a reliable source of new information. If someone is not forthcoming about the procedures used to derive a new result, the validation of that result by others will be hampered.

Methods are important in science, but like scientific knowledge itself, they are not infallible. As they evolve over time, better methods supersede less powerful or less acceptable ones. Methods and scientific knowledge thus progress in parallel, with each area of knowledge contributing to the other.

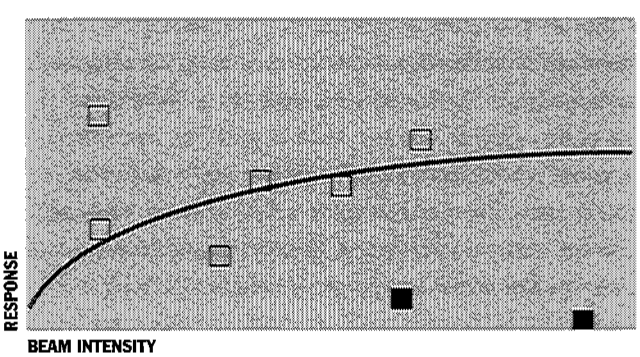
A good example of the fallibility of methods occurred in astronomy in the early part of the twentieth century. One of the most ardent debates in astronomy at that time concerned the nature of what were then known as spiral nebulae—diffuse pinwheels of light that powerful telescopes revealed to be quite common in the night sky. Some astronomers thought that these nebulae were spiral galaxies like the Milky Way at such great distances from the earth that individual stars could not be distinguished. Others believed that they were clouds of gas within our own galaxy.

One astronomer who thought that spiral nebulae were within the Milky Way, Adriaan van Maanen of the Mount Wilson Observatory, sought to resolve the issue by comparing photographs of the nebulae taken several years apart. After making a series of painstaking measurements, van Maanen announced that he had found roughly consistent unwinding motions in the nebulae. The detection of such motions indicated that the spirals had to be within the Milky Way, since motions would be impossible to detect in distant objects.

Van Maanen's reputation caused many astronomers to accept a galactic location for the nebulae. A few years later, however, van Maanen's colleague Edwin Hubble, using the new 100-inch telescope at Mount Wilson, conclusively demonstrated that the nebulae were in fact distant galaxies; van Maanen's observations had to be wrong. Studies of van Maanen's procedures have not revealed any intentional misrepresentation or sources of systematic error. Rather, he was working at the limits of observational accuracy, and his expectations influenced his measurements.

THE SELECTION OF DATA

Deborah, a third-year graduate student, and Kathleen, a postdoc, have made a series of measurements on a new experimental semiconductor material using an expensive neutron source at a national laboratory. When they get back to their own laboratory and examine the data, they get the following data points. A newly proposed theory predicts results indicated by the curve.



During the measurements at the national laboratory, Deborah and Kathleen observed that there were power fluctuations they could not control or predict. Furthermore, they discussed their work with another group doing similar experiments, and they knew that the other group had gotten results confirming the theoretical prediction and was writing a manuscript describing their results.

In writing up their own results for publication, Kathleen suggests dropping the two anomalous data points near the abscissa (the solid squares) from the published graph and from a statistical analysis. She proposes that the existence of the data points be mentioned in the paper as possibly due to power fluctuations and being outside the expected standard deviation calculated from the remaining data points. "These two runs," she argues to Deborah, "were obviously wrong."

1. How should the data from the two suspected runs be handled?
2. Should the data be included in tests of statistical significance and why?
3. What other sources of information, in addition to their faculty advisor, can Deborah and Kathleen use to help decide?

Though van Maanen turned out to be wrong, he was not ethically at fault. He was using methods that were accepted by the astronomical community as the best available at the time, and his results were accepted by most astronomers. But in hindsight he relied on a technique so susceptible to observer effects that even a careful investigator could be misled.

The fallibility of methods is a valuable reminder of the importance of skepticism in science. Scientific knowledge and scientific methods, whether old or new, must be continually scrutinized for possible errors. Such skepticism can conflict with other important features of science, such as the need for creativity and for conviction in arguing a given position. But organized and searching skepticism as well as an openness to new ideas are essential to guard against the intrusion of dogma or collective bias into scientific results.

VALUES IN SCIENCE

Scientists bring more than just a toolbox of techniques to their work. Scientist must also make complex decisions about the interpretation of data, about which problems to pursue, and about when to conclude an experiment. They have to decide the best ways to work with others and exchange information. Taken together, these matters of judgment contribute greatly to the craft of science, and the character of a person's individual decisions helps determine that person's scientific style (as well as, on occasion, the impact of that person's work).

Much of the knowledge and skill needed to make good decisions in science is learned through personal experience and interactions with other scientists. But some of this ability is hard to teach or even describe. Many of the intangible influences on scientific discovery—curiosity, intuition, creativity—largely defy rational analysis, yet they are among the tools that scientists bring to their work.

When judgment is recognized as a scientific tool, it is easier to see how science can be influenced by values. Consider, for example, the way people judge between competing hypotheses. In a given area of science, several different explanations may account for the available facts equally well, with each suggesting an alternate route for further research. How do researchers pick among them?

Scientists and philosophers have proposed several criteria by which promising scientific hypotheses can be distinguished from less fruitful ones. Hypotheses should be internally consistent so that they do not generate contradictory conclusions. Their ability to provide accurate experimental predictions, sometimes in areas far removed from the original domain of the hypothesis, is viewed with great favor. With disciplines in which experimentation is less straightforward, such as geology, astronomy, or many of the social sciences, good hypotheses should be able to unify disparate observations. Also highly prized are simplicity and its more refined cousin, elegance.

Other kinds of values also come into play in science. Historians, sociologists, and other students of science have shown that social and personal beliefs—including philosophical, thematic, religious, cultural, political, and economic beliefs—can shape scientific judgment in fundamental ways. For example, Einstein's rejection of quantum mechanics as an irreducible description of nature—summarized in his insistence that "God does not play dice"—seems to have been based largely on an aesthetic conviction that the physical universe could not contain such an inherent component of randomness. The nineteenth-century geologist Charles Lyell, who championed the idea that geological change occurs incrementally rather than catastrophically, may have been influenced as much by his religious views as by his geological observations. He favored the notion of a God who is an unmoved mover and does not intervene in His creation. Such a God, thought Lyell, would produce a world in which the same causes and effects keep cycling eternally, producing a uniform geological history.

Does holding such values harm a person's science? In some cases the answer has to be "yes." The history of science offers a number of episodes in which social or personal beliefs distorted the work of researchers. The field of eugenics used the techniques of science to try to demonstrate the inferiority of certain races. The ideological rejection of Mendelian genetics in the Soviet Union beginning in the 1930s crippled Soviet biology for decades.

Despite such cautionary episodes, it is clear that values cannot—and should not—be separated from science. The desire to do good work is a human value. So is the conviction that standards of honesty and objectivity need to be maintained. The belief that the universe is simple and coherent has led to great advances in science. If researchers did not believe that the world can be described in terms of a relatively small number of fundamental principles, science would amount to no more than organized observation. Religious convictions about the nature of the universe have

POLYWATER AND THE ROLE OF SKEPTICISM

The case of polywater demonstrates how the desire to believe in a new phenomenon can sometimes overpower the demand for solid, well-controlled evidence. In 1966 the Soviet scientist Boris Valdimirovich Derjaguin lectured in England on a new form of water that he claimed had been discovered by another Soviet scientist, N. N. Fedyakin. Formed by heating water and letting it condense in quartz capillaries, this "anomalous water," as it was originally called, had a density higher than normal water, a viscosity 15 times that of normal water, a boiling point higher than 100 degrees Centigrade, and a freezing point lower than zero degrees.

Over the next several years, hundreds of papers appeared in the scientific literature describing the properties of what soon came to be known as polywater. Theorists developed models, supported by some experimental measurements, in which strong hydrogen bonds were causing water to polymerize. Some even warned that if polywater escaped from the laboratory, it could autocatalytically polymerize all of the world's water.

Then the case for polywater began to crumble. Because polywater could only be formed in minuscule capillaries, very little was available for analysis. When small samples were analyzed, polywater proved to be contaminated with a variety of other substances, from silicon to phospholipids. Electron microscopy revealed that polywater actually consisted of finely divided particulate matter suspended in ordinary water.

Gradually, the scientists who had described the properties of polywater admitted that it did not exist. They had been misled by poorly controlled experiments and problems with experimental procedures. As the problems were resolved and experiments gained better controls, evidence for the existence of polywater disappeared.

also led to important scientific insights, as in the case of Lyell discussed above.

The empirical link between scientific knowledge and the physical, biological, and social world constrains the influence of values in science. Researchers are continually testing their theories about the world against observations. If hypotheses do not accord with observations, they will eventually fall from favor (though scientists may hold on to a hypothesis even in the face of some conflicting evidence since sometimes it is the evidence rather than the hypothesis that is mistaken).

The social mechanisms of science also help eliminate distorting effects that personal values might have. They subject scientific claims to the process of collective validation, applying different perspectives to the same body of observations and hypotheses.

The challenge for individual scientists is to acknowledge and try to understand the suppositions and beliefs that lie behind their own work so that they can use that self-knowledge to advance their work. Such self-examination can be informed by study in many areas outside of science, including history, philosophy, sociology, literature, art, religion, and ethics. If narrow specialization and a single-minded focus on a single activity keep a researcher from developing the perspective and fine sense of discrimination needed to apply values in science, that person's work can suffer.

CONFLICTS OF INTEREST

Sometimes values conflict. For example, a particular circumstance might compromise—or appear to compromise—professional judgments. Maybe a researcher has a financial interest in a particular company, which might create a bias in scientific decisions affecting the future of that company (as might be the case if a researcher with stock in a company were paid to determine the usefulness of a new device produced by the company). Or a scientist might receive a manuscript or proposal to review that discusses work similar to but a step ahead of that being done by the reviewer. These are difficult situations that require trade-offs and hard choices, and the scientific community is still debating what is and is not proper when many of these situations arise.

Virtually all institutions that conduct research now have policies and procedures for managing conflicts of interest. In addition, many editors of scientific journals have established explicit policies regarding conflicts of interest. These policies and procedures are designed to protect the integrity of the scientific process, the missions of the institutions, the investment of stakeholders in institutions (including

A CONFLICT OF INTEREST

John, a third-year graduate student, is participating in a department-wide seminar where students, postdocs, and faculty members discuss work in progress. An assistant professor prefaces her comments by saying that the work she is about to discuss is sponsored by both a federal grant and a biotechnology firm for which she consults. In the course of the talk John realizes that he has been working on a technique that could make a major contribution to the work being discussed. But his faculty advisor consults for a different, and competing, biotechnology firm.

1. How should John participate in this seminar?
2. What, if anything, should he say to his advisor—and when?
3. What implications does this case raise for the traditional openness and sharing of data, materials, and findings that have characterized modern science?

INDUSTRIAL SPONSORSHIP OF ACADEMIC RESEARCH

Sandra was excited about being accepted as a graduate student in the laboratory of Dr. Frederick, a leading scholar in the field, and she embarked on her assigned research project eagerly. But after a few months she began to have misgivings. Though part of Dr. Frederick's work was supported by federal grants, the project on which she was working was totally supported by a grant from a single company. She had known this before coming to the lab and had not thought it would be a problem. But she had not known that Dr. Frederick also had a major consulting agreement with the company. She also heard from other graduate students that when it came time to publish her work, any paper would be subject to review by the company to determine if any of her work was patentable.

1. What are the advantages and disadvantages of Sandra doing research sponsored entirely by a single company?
2. How can she address the specific misgivings she has about her research?
3. If Sandra wishes to discuss her qualms with someone at her university, to whom should she turn?

the investments of parents and students in universities), and public confidence in the integrity of research.

Disclosure of conflicts of interest subjects these concerns to the same social mechanisms that are so effective elsewhere in society. In some cases it may only be necessary for a researcher to inform a journal editor of a potential conflict of interest, leaving it for the editor to decide what action is necessary. In other cases careful monitoring of research activities can allow important research with a potential conflict of interest to go forward while protecting the integrity of the institution and of science. In any of these cases the intent is to involve outside monitors or otherwise create checks to reduce the possibility that bias will enter into science.

PUBLICATION AND OPENNESS

Science is not an individual experience. It is shared knowledge based on a common understanding of some aspect of the physical or social world. For that reason, the social conventions of science play an important role in establishing the reliability of scientific knowledge. If these conventions are disrupted, the quality of science can suffer.

Many of the social conventions that have proven so effective in science arose during the birth of modern science in the latter half of the seventeenth century. At that time, many scientists sought to keep their work secret so that others could not claim it as their own. Prominent figures of the time, including Isaac Newton, were loathe to convey news of their discoveries for fear that someone else would claim priority—a fear that was frequently realized.

The solution to the problem of making new discoveries public while assuring their author's credit was worked out by Henry Oldenburg, the secretary of the

"We thus begin to see that the institutionalized practice of citations and references in the sphere of learning is not a trivial matter. While many a general reader—that is, the lay reader located outside the domain of science and scholarship—may regard the lowly footnote or the remote endnote or the bibliographic parenthesis as a dispensable nuisance, it can be argued that these are in truth central to the incentive system and an underlying sense of distributive justice that do much to energize the advancement of knowledge."

— Robert K. Merton, "The Matthew Effect in Science, II: Cumulative Advantage and the Symbolism of Intellectual Property," *Isis*, 79: 621, 1988.

Royal Society of London. He won over scientists by guaranteeing rapid publication in the society's *Philosophical Transactions* as well as the official support of the society if the author's priority was brought into question. Oldenburg also pioneered the practice of sending submitted manuscripts to experts who could judge their quality. Out of these innovations rose both the modern scientific journal and the practice of peer review.

The continued importance of publication in learned journals accounts for the convention that the first to publish a view or finding, not the first to discover it, tends to get most of the credit for the discovery. Once results are published, they can be freely used by other researchers to extend knowledge. But until the results become common knowledge, people who use them are obliged to recognize the discoverer through citations. In this way scientists are rewarded through peer recognition for making results public.

Before publication, different considerations apply. If someone else exploits unpublished material that is seen in a privileged grant application or manuscript, that person is essentially stealing intellectual property. In industry the commercial rights to scientific work belong more to the employer than the employee, but similar provisions apply: research results are privileged until they are published or otherwise publicly disseminated.

Many scientists are generous in discussing their preliminary theories or results with colleagues, and some even provide copies of raw data to others prior to public disclosure to facilitate related work. But scientists are not expected to make their data and thinking available to others at all times. During the initial stages of research, a scientist deserves a period of privacy in which data are not subject to disclosure. This privacy allows individuals to advance their work to the point at which they have confidence both in its accuracy and its meaning.

After publication, scientists expect that data and other research materials will be shared with qualified colleagues upon request. Indeed, a number of federal agencies, journals, and professional societies have established policies requiring the sharing of research materials. Sometimes these materials are too voluminous, unwieldy, or costly to share freely and quickly. But in those fields in which sharing is possible, a scientist who is unwilling to share research materials with qualified colleagues runs the risk of not being trusted or respected. In a profession where so much depends on interpersonal interactions, the professional isolation that can follow a loss of trust can damage a scientist's work.

Publication in a peer-reviewed journal remains the standard means of disseminating scientific results, but other methods of communication are subtly altering how scientists divulge and receive information. Posters, abstracts, lectures at professional gatherings, and proceedings volumes are being used more often to present preliminary results before full review. Preprints and computer networks are increasing the ease and speed of scientific communications. These new methods of communication are in many cases just elaborations of the informal exchanges that pervade science. To the extent that they speed and improve communication and revision,

THE SHARING OF RESEARCH MATERIALS

Ed, a fourth-year graduate student, was still several months away from finishing an ongoing research project when a new postdoc arrived from a laboratory doing similar work. After the two were introduced, Ed automatically asked about the work going on in the other lab and was surprised to hear that researchers there had successfully developed a reagent that he was still struggling to perfect. Knowing that both labs had policies requiring the sharing of research materials, Ed wrote a letter to the head of the other lab asking if the laboratory could share some of the reagent with him. He didn't expect there to be a problem, because his project was not in competition with the work of the other lab, but a couple of weeks later he got a letter from the lab director saying that the reagent could not be shared because it was still "poorly developed and characterized."

The new postdoc, upon hearing the story, said, "That's ridiculous. They just don't want to give you a break."

1. Where can Ed go for help in obtaining the materials?
2. Are there risks in involving other people in this situation?
3. What kinds of information is it appropriate for researchers to share with their colleagues when they change laboratories?

they will strengthen science. But if publication practices, either new or traditional, bypass quality control mechanisms, they risk weakening conventions that have served science well.

An example is the scientist who releases important and controversial results directly to the public before submitting them to the scrutiny of peers. If the researcher has made a mistake or the findings are misinterpreted by the media or the public, the scientific community and the public may react adversely. When such news is to be released to the press, it should be done when peer review is complete—normally at the time of publication in a scientific journal.

Sometimes researchers and the institutions sponsoring research have different interests in making results public. For example, a scientist doing research sponsored by industry may want to publish results quickly, while the industrial sponsor may want to keep results private—at least temporarily—to establish intellectual property rights prior to disclosure. Research institutions and government agencies have started to adopt explicit policies to reduce conflicts over such issues of ownership and access.

In research that has the potential of being financially profitable, openness can be maintained by the granting of patents. Patents enable an individual or institution to profit from a scientific discovery in return for making the results public. Scientists who may be doing patentable work have special obligations to the sponsors of that work. For example, they may need to have their laboratory notebooks validated and dated by others. They may also have to disclose potentially valuable discoveries promptly to the patent official of the organization sponsoring the research.

In some situations, such as proprietary research sponsored by industry or mili-

tarily sensitive research, openness in disseminating research results may not be possible. Scientists working under such conditions may need to find other ways of exposing their work to professional scrutiny. Unclassified summaries of classified work can compensate for the lack of open scrutiny that allows the validation of results elsewhere in science. Properly structured visiting committees can examine proprietary or classified research while maintaining confidentiality.

THE ALLOCATION OF CREDIT

The principle of fairness and the role of personal recognition within the reward system of science account for the emphasis given to the proper allocation of credit. In the standard scientific paper, credit is explicitly acknowledged in three places: in the list of authors, in the acknowledgments of contributions from others, and in the list of references or citations. Conflicts over proper attribution can arise in any of these places.

Citations serve many purposes in a scientific paper. They acknowledge the work of other scientists, direct the reader toward additional sources of information, acknowledge conflicts with other results, and provide support for the views expressed in the paper. More broadly, citations place a paper within its scientific context, relating it to the present state of scientific knowledge.

Failure to cite the work of others can give rise to more than just hard feelings. Citations are part of the reward system of science. They are connected to funding decisions and to the future careers of researchers. More generally, the misallocation of credit undermines the incentive system for publication.

CREDIT WHERE CREDIT IS DUE

Ben, a third-year graduate student, had been working on a research project that involved an important new experimental technique. For a national meeting in his discipline, Ben wrote an abstract and gave a brief presentation that mentioned the new technique. After his presentation, he was surprised and pleased when Dr. Freeman, a leading researcher from another university, engaged him in an extended conversation. Dr. Freeman asked Ben extensively about the new technique, and Ben described it fully. Ben's own faculty advisor often encouraged his students not to keep secrets from other researchers, and Ben was flattered that Dr. Freeman would be so interested in his work.

Six months later Ben was leafing through a journal when he noticed an article by Dr. Freeman. The article described an experiment that clearly depended on the technique that Ben had developed. He didn't mind; in fact, he was again somewhat flattered that his technique had so strongly influenced Dr. Freeman's work. But when he turned to the citations, expecting to see a reference to his abstract or presentation, his name was nowhere to be found.

1. Does Ben have any way of receiving credit for his work?
2. Should he contact Dr. Freeman in an effort to have his work recognized?
3. Is Ben's faculty advisor mistaken in encouraging his students to be so open about their work?

In addition, scientists who routinely fail to cite the work of others may find themselves excluded from the fellowship of their peers. This consideration is particularly important in one of the more intangible aspects of a scientific career—that of building a reputation. Published papers document a person's approach to science, which is why it is important that they be clear, verifiable, and honest. In addition, a researcher who is open, helpful, and full of ideas becomes known to colleagues and will benefit much more than someone who is secretive or uncooperative.

Some people succeed in science despite their reputations. Many more succeed at least in part because of their reputations.

AUTHORSHIP PRACTICES

The allocation of credit can also become an issue in the listing of authors' names. Science has become a much more collaborative enterprise than it was in the past. The average number of authors for articles in the *New England Journal of Medicine*, for example, has risen from slightly more than one in 1925 to more than six today. In some areas, such as high-energy physics or genome sequencing, the number of authors can rise into the hundreds. This increased collaboration has produced many new opportunities for researchers to work with colleagues at different stages in their careers, in different disciplines, or even in widely separated locations. It has also increased the possibility for differences to arise over questions of authorship.

In many fields, the earlier a name appears in the list of authors, the greater the implied contribution, but conventions differ greatly among disciplines and among research groups. Sometimes the scientist with the greatest name recognition is listed first, whereas in other fields the research leader's name is always last. In some disciplines supervisors' names rarely appear on papers, while in others the professor's name appears on almost every paper that comes out of the lab. Some research groups and journals avoid these decisions by simply listing authors alphabetically.

Frank and open discussion of the division of credit within research groups—as early in the research process as possible and preferably at the very beginning, especially for research leading to a published paper—can prevent later difficulties. The best practice is for authorship criteria to be explicit among all collaborators. In addition, collaborators should be familiar with the conventions in a particular field to understand their rights and obligations. Group meetings provide an occasion to discuss ethical and policy issues in research.

The allocation of credit can be particularly sensitive when it involves researchers at different stages of their careers—for example, postdocs and graduate students, or senior faculty and student researchers. In such situations, differences in roles and status compound the difficulties of according credit.

Several considerations must be weighed in determining the proper division of credit between a student or research assistant and a senior scientist, and a range of practices are acceptable. If a senior researcher has defined and put a project into motion and a junior researcher is invited to join in, major credit may go to the senior

WHO SHOULD GET CREDIT FOR THE DISCOVERY OF PULSARS?

A much-discussed example of the difficulties associated with allocating credit between junior and senior researchers was the 1967 discovery by Jocelyn Bell, then a 24-year-old graduate student, of pulsars. Over the previous two years, Bell and several other students, under the supervision of Bell's thesis advisor, Anthony Hewish, had built a 4.5-acre radiotelescope to investigate scintillating radio sources in the sky. After the telescope began functioning, Bell was in charge of operating it and analyzing its data under Hewish's direction. One day Bell noticed "a bit of scruff" on the data chart. She remembered seeing the same signal earlier and, by measuring the period of its recurrence, determined that it had to be coming from an extraterrestrial source. Together Bell and Hewish analyzed the signal and found several similar examples elsewhere in the sky. After discarding the idea that the signals were coming from an extraterrestrial intelligence, Hewish, Bell, and three other people involved in the project published a paper announcing the discovery, which was given the name "pulsar" by a British science reporter.

Many argued that Bell should have shared the Nobel Prize awarded to Hewish for the discovery, saying that her recognition of the signal was the crucial act of discovery. Others, including Bell herself, said that she received adequate recognition in other ways and should not have been so lavishly rewarded for doing what a graduate student is expected to do in a project conceived and set up by others.

researcher, even if at the moment of discovery the senior researcher is not present. By the same token, when a student or research assistant is making an intellectual contribution to a research project, that contribution deserves to be recognized. Senior scientists are well aware of the importance of credit in science and are expected to give junior researchers credit where warranted. In such cases, junior researchers may be listed as coauthors or even senior authors, depending on the work, traditions within the field, and arrangements within the team.

Occasionally a name is included in a list of authors even though that person had little or nothing to do with the content of a paper. Such "honorary authors" dilute the credit due the people who actually did the work, inflate the credentials of those so "honored," and make the proper attribution of credit more difficult. Several scientific journals now state that a person should be listed as the author of a paper only if that person made a direct and substantial contribution to the paper. Some journals require all named authors to sign the letter that accompanies submission of the original article and all subsequent revisions to ensure that no author is named without consent and that all authors agree with the final version.

As with citations, author listings establish accountability as well as credit. When a paper is found to contain errors, whether caused by mistakes or deceit, authors might wish to disavow responsibility, saying that they were not involved in the part of the paper containing the errors or that they had very little to do with the paper in general. However, an author who is willing to take credit for a paper must also bear responsibility for its contents. Thus, unless a footnote or the text of the paper explicitly assigns responsibility for different parts of the paper to different authors, the authors whose names appear on a paper must share responsibility for all of it.

"Of all the traits which qualify a scientist for citizenship in the republic of science, I would put a sense of responsibility as a scientist at the very top. A scientist can be brilliant, imaginative, clever with his hands, profound, broad, narrow—but he is not much as a scientist unless he is responsible."

—Alvin Weinberg,
"The Obligations of Citizenship in the Republic of Science,"
Minerva. 16:1-3, 1978.

ERROR AND NEGLIGENCE IN SCIENCE

Scientific results are inherently provisional. Scientists can never prove conclusively that they have described some aspect of the natural or physical world with complete accuracy. In that sense all scientific results must be treated as susceptible to error.

Errors arising from human fallibility also occur in science. Scientists do not have limitless working time or access to unlimited resources. Even the most responsible scientist can make an honest mistake. When such errors are discovered, they should be acknowledged, preferably in the same journal in which the mistaken information was published. Scientists who make such acknowledgments promptly and openly are rarely condemned by colleagues.

Mistakes made through negligent work are treated more harshly. Haste, carelessness, inattention—any of a number of faults can lead to work that does not meet the standards demanded in science. If scientists cut corners for whatever reason, they are placing their reputation, the work of their colleagues, and the public's confidence in science at risk.

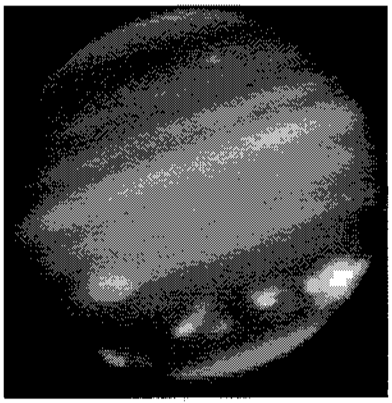
Some researchers may feel that the pressures on them are an inducement to haste at the expense of care. For example, they may believe that they have to do substandard work to compile a long list of publications and that this practice is accept-

PUBLICATION PRACTICES

Paula, a young assistant professor, and two graduate students have been working on a series of related experiments for the past several years. During that time, the experiments have been written up in various posters, abstracts, and meeting presentations. Now it is time to write up the experiments for publication, but the students and Paula must first make an important decision. They could write a single paper with one first author that would describe the experiments in a comprehensive manner, or they could write a series of shorter, less complete papers so that each student could be a first author.

Paula favors the first option, arguing that a single publication in a more visible journal would better suit all of their purposes. Paula's students, on the other hand, strongly suggest that a series of papers be prepared. They argue that one paper encompassing all the results would be too long and complex and might damage their career opportunities because they would not be able to point to a paper on which they were first authors.

1. If the experiments are part of a series, are Paula and her students justified in not publishing them together?
2. If they decided to publish a single paper, how should the listing of authors be handled?
3. If a single paper is published, how can they emphasize to the review committees and funding agencies their various roles and the importance of the paper?



able. Or they may be tempted to publish virtually the same research results in two different places or publish their results in "least publishable units"—papers that are just detailed enough to be published but do not give the full story of the research project described.

Sacrificing quality to such pressures can easily backfire. A lengthy list of publications cannot outweigh a reputation for shoddy research. Scientists with a reputation for publishing a work of dubious quality will generally find that all of their publications are viewed with skepticism by their colleagues. Reflecting the importance of quality, some institutions and federal agencies have recently adopted policies that limit the number of papers that will be considered when an individual is evaluated for appointment, promotion, or funding.

By introducing preventable errors into science, sloppy or negligent research can do great damage—even if the error is eventually uncovered and corrected. Though science is built on the idea of peer validation and acceptance, actual replication is selective. It is not practical (or necessary) to reconstruct all the observations and theoretical constructs that go into an investigation. Researchers have to trust that previous investigators performed the work as reported.

If that trust is misplaced and the previous results are inaccurate, the truth will likely emerge as problems arise in the ongoing investigation. But researchers can waste months or years of effort because of erroneous results, and public confidence in the integrity of science can be seriously undermined.

MISCONDUCT IN SCIENCE

Beyond honest errors and errors caused through negligence are a third category of errors: those that involve deception. Making up data or results (fabrication), changing or misreporting data or results (falsification), and using the ideas or words of another person without giving appropriate credit (plagiarism)—all strike at the heart of the values on which science is based. These acts of scientific misconduct not only undermine progress but the entire set of values on which the scientific enterprise rests. Anyone who engages in any of these practices is putting his or her scientific career at risk. Even infractions that may seem minor at the time can end up being severely punished.

The ethical transgressions discussed in earlier sections—such as misallocation of credit or errors arising from negligence—are matters that generally remain internal to the scientific community. Usually they are dealt with locally through the mechanisms of peer review, administrative action, and the system of appointments and evaluations in the research environment. But misconduct in science is unlikely to remain internal to the scientific community. Its consequences are too extreme: it can harm individuals outside of science (as when falsified results become the basis of a medical treatment), it squanders public funds, and it attracts the attention of those who would seek to criticize science. As a result, federal agencies, Congress, the media, and the courts can all get involved.

Within the scientific community, the effects of misconduct—in terms of lost time, forfeited recognition to others, and feelings of personal betrayal—can be devastating. Individuals, institutions, and even entire research fields can suffer grievous setbacks from instances of fabrication, falsification, or plagiarism even if they are only tangentially associated with the case.

When individuals have been accused of scientific misconduct in the past, the institutions responsible for responding to those accusations have taken a number of different approaches. In general, the most successful responses are those that clearly separate a preliminary investigation to gather information from a subsequent adjudication to judge guilt or innocence and issue sanctions if necessary. During the adjudication stage, the individual accused of misconduct has the right to various due process protections, such as reviewing the evidence gathered during the investigation and cross-examining witnesses.

In addition to falsification, fabrication, and plagiarism, other ethical transgressions directly associated with research can cause serious harm to individuals and institutions. Examples include cover-ups of misconduct in science, reprisals against whistleblowers, malicious allegations of misconduct in science, and violations of due process in handling complaints of misconduct in science. Policymakers and scientists have not decided whether such actions should be considered misconduct in science—and therefore subject to the same procedures and sanctions as falsification, fabrication, and plagiarism—or whether they should be

FABRICATION IN A GRANT APPLICATION

Don is a first-year graduate student applying to the National Science Foundation for a predoctoral fellowship. His work in a lab where he did a rotation project was later carried on successfully by others, and it appears that a manuscript will be prepared for publication by the end of the summer. However, the fellowship application deadline is June 1, and Don decides it would be advantageous to list a publication as "submitted." Without consulting the faculty member or other colleagues involved, Don makes up a title and author list for a "submitted" paper and cites it in his application.

After the application has been mailed, a lab member sees it and goes to the faculty member to ask about the "submitted" manuscript. Don admits to fabricating the submission of the paper but explains his actions by saying that he thought the practice was not uncommon in science.

The faculty members in Don's department demand that he withdraw his grant application and dismiss him from the graduate program. After leaving the university, Don applies for a master's degree, since he has fulfilled the course requirements. Although the department votes not to grant him a degree, the university administration does so because it is not stated in the university graduate bulletin that a student in Don's department must be in "good standing" to receive a degree. They fear that Don will bring suit against the university if the degree is denied. Likewise, nothing will appear in Don's university transcript regarding his dismissal.

1. Do you agree with Don that scientists often exaggerate the publication status of their work in written materials?
2. Do you think the department acted too harshly in dismissing Don from the graduate program?
3. Do you believe that being in "good standing" should be a prerequisite for obtaining an advanced degree in science? If Don later applied to a graduate program at another institution, does that institution have the right to know what happened?

A CASE OF PLAGIARISM

May is a second-year graduate student preparing the written portion of her qualifying exam. She incorporates whole sentences and paragraphs verbatim from several published papers. She does not use quotation marks, but the sources are suggested by statements like "(see . . . for more details)." The faculty on the qualifying exam committee note inconsistencies in the writing styles of different paragraphs of the text and check the sources, uncovering May's plagiarism.

After discussion with the faculty, May's plagiarism is brought to the attention of the dean of the graduate school, whose responsibility it is to review such incidents. The graduate school regulations state that "plagiarism, that is, the failure in a dissertation, essay, or other written exercise to acknowledge ideas, research or language taken from others" is specifically prohibited. The dean expels May from the program with the stipulation that she can reapply for the next academic year.

1. Is plagiarism like this a common practice?
2. Are there circumstances that should have led to May's being forgiven for plagiarizing?
3. Should May be allowed to reapply to the program?

investigated and adjudicated through different channels. Regulations adopted by the National Science Foundation and the Public Health Service define misconduct to include "other serious deviations from accepted research practices," in addition to falsification, fabrication, and plagiarism, leaving open the possibility that other actions could be considered misconduct in science. The problem with such language is that it could allow a scientist to be accused of misconduct for using novel or unorthodox research methods, even though such methods are sometimes needed to proceed in science. Federal officials respond by saying that this language is needed to prosecute ethical breaches that do not strictly fall into the categories of falsification, fabrication, or plagiarism and that no scientist has been accused of misconduct on the basis of using unorthodox research methods. This area of science policy is still evolving.

Another category of behaviors—including sexual or other forms of harassment, misuse of funds, gross negligence in a person's professional activities, tampering with the experiments of others or with instrumentation, and violations of government research regulations—are not necessarily associated with scientific conduct. Institutions need to discourage and respond to such behaviors. But these behaviors are subject to generally applicable legal and social penalties and should be dealt with using the same procedures that would be applied to anyone.

RESPONDING TO VIOLATIONS OF ETHICAL STANDARDS

One of the most difficult situations that a researcher can encounter is to see or suspect that a colleague has violated the ethical standards of the research community. It is easy to find excuses to do nothing, but someone who has witnessed misconduct has an unmistakable obligation to act. At the most immediate level, misconduct can seriously obstruct or damage one's own research or the research of colleagues. More broadly, even a single case of misconduct can malign scientists and their institutions, result in the imposition of counterproductive regulations, and shake public confidence in the integrity of science.

To be sure, raising a concern about unethical conduct is rarely an easy thing to do. In some cases, anonymity is possible—but not always. Reprisals by the accused person and by skeptical colleagues have occurred in the past and have had serious consequences. Any allegation of misconduct is a very important charge that needs to be taken seriously. If mishandled, an allegation can gravely damage the person charged, the one who makes the charge, the institutions involved, and science in general.

Someone who is confronting a problem involving research ethics usually has more options than are immediately apparent. In most cases the best thing to do is to discuss the situation with a trusted friend or advisor. In universities, faculty advisors, department chairs, and other senior faculty can be invaluable sources of advice in deciding whether to go forward with a complaint.

An important consideration is deciding when to put a complaint in writing. Once in writing, universities are obligated to deal with a complaint in a more formal manner than if it is made verbally. Putting a complaint in writing can have serious consequences for the career of a scientist and should be undertaken only after thorough consideration.

The National Science Foundation and Public Health Service require all research institutions that receive public funds to have procedures in place to deal with allegations of unethical practice. These procedures take into account fairness for the accused, protection for the accuser, coordination with funding agencies, and requirements for confidentiality and disclosure.

In addition, many universities and other research institutions have designated an ombudsman, ethics officer, or other official who is available to discuss situations involving research ethics. Such discussions are carried out in strictest confidence whenever possible. Some institutions provide for multiple entry points, so that complainants can go to a person with whom they feel comfortable.

A CAREER IN THE BALANCE

Francine was just months away from finishing her Ph.D. dissertation when she realized that something was seriously amiss with the work of a fellow graduate student, Sylvia. Francine was convinced that Sylvia was not actually making the measurements she claimed to be making. They shared the same lab, but Sylvia rarely seemed to be there. Sometimes Francine saw research materials thrown away unopened. The results Sylvia was turning in to their common thesis advisor seemed too clean to be real.

Francine knew that she would soon need to ask her thesis advisor for a letter of recommendation for faculty and postdoc positions. If she raised the issue with her advisor now, she was sure that it would affect the letter of recommendation. Sylvia was a favorite of her advisor, who had often helped Sylvia before when her project ran into problems. Yet Francine also knew that if she waited to raise the issue the question would inevitably arise as to when she first suspected problems. Both Francine and her thesis advisor were using Sylvia's results in their own research. If Sylvia's results were inaccurate, they both needed to know as soon as possible.

1. Should Francine first try to talk with Sylvia, with her thesis advisor, or with someone else entirely?
2. Does she know enough to be able to raise concerns?
3. Where else can Francine go for information that could help her decide what to do?

"Any research organization requires generous measures of the following:
• social space for personal initiative and creativity;
• time for ideas to grow to maturity;
• openness to debate and criticism;
• hospitality toward novelty; and
• respect for specialized expertise.
[These] may sound too soft and old-fashioned to stand up against the cruel modern realities of administrative accountability and economic stringency. On the contrary, I believe that they are fundamental requirements for the continued advancement of scientific knowledge—and, of course, for its eventual social benefits."
— JOHN ZIMAN, *Prometheus Bound: Science in a Dynamic Steady State*, Cambridge University Press, New York, 1994, p. 276.

Government agencies, including the National Science Foundation and Public Health Service, enforce laws and regulations that deal with misconduct in science. At the Public Health Service in Washington, D.C., complaints can be referred to the appropriate office through the Office of Research Integrity. At the National Science Foundation in Arlington, Virginia, complaints can be directed to the Office of the Inspector General. Within universities, research grant officials can provide guidance on whether federal rules may be involved in filing a complaint.

Many institutions have prepared written materials that offer guidance in situations involving professional ethics. Volume II of *Responsible Science: Ensuring the Integrity of the Research Process* (National Academy Press, Washington, D.C., 1993) reprints a number of these documents. Sigma Xi, a national society of research scientists headquartered in Research Triangle Park, North Carolina, the American Association for the Advancement of Science in Washington, D.C., and other scientific and engineering professional organizations also are prepared to advise scientists who encounter cases of possible misconduct.

The research system exerts many pressures on beginning and experienced researchers alike. Principal investigators need to raise funds and attract students. Faculty members must balance the time spent on research with the time spent teaching undergraduates. Industrial sponsorship of research introduces the possibility of conflicts of interest.

All parts of the research system have a responsibility to recognize and respond to these pressures. Institutions must review their own policies, foster awareness of research ethics, and ensure that researchers are aware of the policies that are in place. And researchers should constantly be aware of the extent to which ethically based decisions will influence their success as scientists.

THE SCIENTIST IN SOCIETY

This booklet has concentrated on the responsibilities of scientists for the advancement of science, but scientists have additional responsibilities to society. Even scientists conducting the most fundamental research need to be aware that their work can ultimately have a great impact on society. Construction of the atomic bomb and the development of recombinant DNA—events that grew out of basic research on the nucleus of the atom and investigations of certain bacterial enzymes, respectively—are two examples of how seemingly arcane areas of science can have tremendous societal consequences.

The occurrence and consequences of discoveries in basic research are virtually impossible to foresee. Nevertheless, the scientific community must recognize the potential for such discoveries and be prepared to address the questions that they raise. If scientists do find that their discoveries have implications for some important aspect of public affairs, they have a responsibility to call attention to the public issues involved. They might set up a suitable public forum involving experts with different perspectives on the issue at hand. They could then seek to develop a consensus of informed judgment that can be disseminated to the public. A good example is the response of biologists to the development of recombinant DNA technologies—first calling for a temporary moratorium on the research and then helping to set up a regulatory mechanism to ensure its safety.

This document cannot describe the many responsibilities incumbent upon researchers because of science's function in modern society. The bibliography lists several volumes that examine the social roles of scientists in detail. The important point is that science and technology have become such integral parts of society that scientists can no longer isolate themselves from societal concerns. Nearly half of the bills that come before Congress have a significant scientific or technological component. Scientists are increasingly called upon to contribute to public policy and to the public understanding of science. They play an important role in educating nonscientists about the content and processes of science.

In fulfilling these responsibilities scientists must take the time to relate scientific knowledge to society in such a way that members of the public can make an informed decision about the relevance of research. Sometimes researchers reserve this right to themselves, considering nonexperts unqualified to make such judgments. But science offers only one window on human experience. While upholding the honor of their profession, scientists must seek to avoid putting scientific knowledge on a pedestal above knowledge obtained through other means.

Many scientists enjoy working with the public. Others see this obligation as a distraction from the work they would like to be doing. But concern and involvement with the broader uses of scientific knowledge are essential if scientists are to retain the public's trust.

The research enterprise has itself been changing as science has become increasingly integrated into everyday life. But the core values on which the enterprise is based —honesty, skepticism, fairness, collegiality, openness—remain unchanged. These values have helped produce a research enterprise of unparalleled productivity and creativity. So long as they remain strong, science—and the society it serves—will prosper.

THE NATIONAL RESEARCH COUNCIL AND SERVICE TO SOCIETY

One way in which scientists serve the needs of the broader society is by participating in the activities of the National Research Council, which is administered by the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The National Research Council brings together leaders from academe, industry, government, and other sectors to address critical national issues and provide advice to the U.S. government and its citizens. Over the course of a typical year, about 650 committees involving approximately 6,400 individuals study societally important issues that involve science and technology. All of these experts volunteer their time to serve on study committees, plan and participate in seminars, review documents, and otherwise assist in the work of the institution. Study committees work independently of government, sponsors, and special-interest groups. Continuous oversight and formal anonymous review of the results of the studies enhance objectivity and quality.

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Alexander Kohn presents a number of case studies of misconduct and self-deception from the history of science and medicine in *False Prophets: Fraud and Error in Science and Medicine* (Basil Blackwell, New York, 1988). A lively book that discusses several historic cases of self-deception in science is *Diamond Dealers and Feather Merchants: Tales from the Sciences* by Irving M. Klotz (Birkhauser, Boston, 1986). The story of cold fusion is well told in *Cold Fusion: The Scientific Fiasco of the Century* by John R. Huizenga (Oxford University Press, New York, 1993) and in Gary Taubes' *Bad Science: The Short Life & Hard Times of Cold Fusion* (Random House, New York, 1993).

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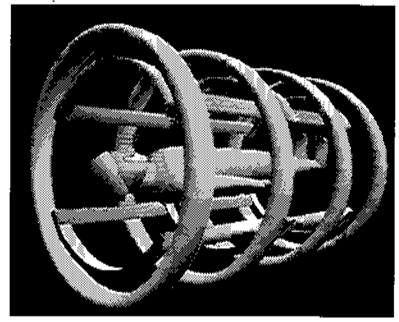
APPENDIX: DISCUSSION OF CASE STUDIES



The hypothetical scenarios included in this booklet raise many different issues that can be discussed and debated. The observations and questions given below suggest just some of the areas that can be explored.

THE SELECTION OF DATA

Deborah and Kathleen's principal obligation, in writing up their results for publication, is to describe what they have done and give the basis for their actions. They must therefore examine how they can meet this obligation within the context of the experiment they have done. Questions that need to be answered include: If the authors state in the paper that data have been rejected because of problems with the power supply, should the data points still be included in the published chart? Should statistical analyses be done that both include and exclude the questionable data? If conventions within their discipline allow for the use of statistical devices to eliminate outlying data points, how explicit do Deborah and Kathleen need to be in the published paper about the procedures they have followed?

A CONFLICT OF INTEREST

Science thrives in an atmosphere of open communication. When communication is limited, progress is limited for everyone. John therefore needs to weigh the advantages of keeping quiet—if in fact there are any—against the damage that accrues to science if he keeps his suggestion to himself. He might also ask himself how keeping quiet might affect his own life in science. Does he want to appear to his advisor and his peers as someone who is less than forthcoming with his ideas? Will he enjoy science as much if he purposefully limits communication with others?

INDUSTRIAL SPONSORSHIP OF ACADEMIC RESEARCH

Sandra has enrolled in the university to receive an education, not to work for industry. But working on industrially sponsored research is not necessarily incompatible with getting a good education. In fact, it can be a valuable way to gain insight into industrially oriented problems and to prepare for future work that has direct applications to societal needs. The question that must be asked is whether the nature of the research is subverting Sandra's education. Sandra's faculty advisor has entered into a relationship that could result in conflicts of interest. That relationship is therefore most likely to be subject to review by third parties. Can Sandra turn to those responsible for overseeing the research for help in resolving her own uncertainties? What would be the possible effects on her career if she did so?

THE SHARING OF RESEARCH MATERIALS

After a research material like a reagent has been described in a publication, sharing that material speeds and in some cases enables the replication of results and therefore contributes to the progress of science. But the reagent in this situation has not yet been described in a published paper, so the provisions for sharing it are different. Ed needs to consider the other laboratory's legitimate interest in developing that material and establishing how it works before publication. He also needs to consider the relationship between the two laboratories. If he turns to his faculty advisor for help in acquiring the reagent, how is his advisor likely to respond? Is there any way he can work with the other laboratory and thereby come a step closer to forming an agreement with them about the use of the reagent?

CREDIT WHERE CREDIT IS DUE

Ben is to be commended for being open and for seeking to involve others in his work. He will benefit from that openness, even if he seems not to have benefited in this situation. At the same time, Ben has to ask himself honestly if his comments were a critical factor in Dr. Freeman's work. If Dr. Freeman had already had the same ideas, he should have told Ben this during their conversation. But could the same ideas have come from elsewhere?

If Ben is still convinced that he has not been treated fairly, he will need to work with his research advisor to see if his contributions can be acknowledged. One option would be to see if his advisor would cosign a letter with Ben or write a letter on Ben's behalf addressing this issue. Ben will need to think about the possible implications of this course of action for his own career. What if Dr. Freeman writes back and says that the lack of credit was an oversight and that he will credit Ben in the future? What if he says that Ben's objections are not warranted and gives the reasons why?

PUBLICATION PRACTICES

Contributions to a scientific field are not counted in terms of the number of papers. They are counted in terms of significant differences in how science is understood. With that in mind, Paula and her students need to consider how they are most likely to make a significant contribution to their field. One determinant of impact is the coherence and completeness of a paper. Paula and her students may need to begin writing before they can tell whether one or more papers is needed.

In retrospect, Paula and her students might also ask themselves about the process that led to their decision. Should they have discussed publications much earlier in the process? Were the students led to believe that they would be first authors on published papers? If so, should that influence future work in the lab?

FABRICATION IN A GRANT APPLICATION

Even though Don did not introduce spurious results into science, he fabricated the submission of the research paper and therefore engaged in misconduct. Though his treatment by the department might seem harsh, fabrication strikes so directly at the foundations of science that it is not excusable.

This scenario also demonstrates that researchers and administrators in an institution may differ on the appropriate course of action to take when research ethics are violated. Sometimes institutions may be unwilling or unable to respond to an ethical transgression in the way the scientific community would desire. Researchers might then have to decide the extent to which they are willing to impose and enforce sanctions themselves.

A CASE OF PLAGIARISM

A broad spectrum of misconduct falls into the category of plagiarism, ranging from obvious theft to uncredited paraphrasing that some might not consider dishonest at all. In a lifetime of reading, theorizing, and experimenting, a person's work will inevitably incorporate and overlap with that of others. However, occasional overlap is one thing; systematic use of the techniques, data, words, or ideas of others without appropriate acknowledgment is another.

A person's background can play a role in considering episodes of plagiarism. For example, what if May had never been taught the conventions and institutional policies governing the attribution of other's work? Should she then have been treated more leniently?

A CAREER IN THE BALANCE

Francine's most obvious option is to discuss the situation with her research advisor, but she has to ask herself if this is the best alternative. Her advisor is professionally and emotionally involved in the situation and may not be able to take an impartial stance. In addition, because the advisor is involved in the situation, she may feel the need to turn the inquiry into a formal investigation or to report the inquiry to her supervisors.

Francine should also consider whether she can discuss the situation directly with Sylvia. Many suspicions evaporate when others have a chance to explain actions that may have been misinterpreted.

If Francine feels that she cannot talk with Sylvia, she needs some way to discuss her concerns confidentially. Maybe she could turn to a trusted friend, another member of the faculty, someone on the university's administrative staff, or an ombudsman designated by the university. That person can help Francine explore such questions as: What is known and what is not known about the situation? What are the options available to her? Should she put her concerns in writing, an action likely to lead to a formal investigation?

The Committee on Science, Engineering, and Public Policy (COSEPUP) is a joint committee of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. It includes members of the councils of all three bodies.

The National Academy of Sciences (NAS) is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. Under the authority of the charter granted to it by Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Bruce M. Alberts is president of the NAS.

The National Academy of Engineering (NAE) was established in 1964, under the charter of the NAS, as a parallel organization of distinguished engineers. It is autonomous in its administration and in the selection of members, sharing with the NAS its responsibilities for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Dr. Robert M. White is president of the NAE.

The Institute of Medicine (IOM) was established in 1970 by the National Academy of Sciences to secure the services of eminent members of appropriate professions in the examination of policy matters pertaining to the health of the public. The Institute acts under the responsibility given to the National Academy of Sciences in its congressional charter to be an advisor to the federal government and, upon its own initiative, to identify issues of medical care, research, and education. Dr. Kenneth I. Shine is president of the IOM.

reference the ''Tokeland Cow Dip Pit CERCLA Site'' and EPA Docket No. CERCLA–10–97–0043 and should be addressed to Ms. Shillcutt at the above address.

FOR FURTHER INFORMATION CONTACT: Jennifer Byrne, Assistant Regional Counsel, EPA Region 10, Office of Regional Counsel, 1200 Sixth Avenue, Seattle, Washington 98101, telephone number (206) 553–0050.

Dated: November 21, 2000.

Charles E. Findley,

Acting Regional Administrator, Region 10.

[FR Doc. 00–30909 Filed 12–5–00; 8:45 am]

BILLING CODE 6560–50–U

OFFICE OF SCIENCE AND TECHNOLOGY POLICY

Executive Office of the President; Federal Policy on Research Misconduct; Preamble for Research Misconduct Policy

AGENCY: Office of Science and Technology Policy.

ACTION: Notification of Final Policy.

SUMMARY: The Office of Science and Technology Policy (OSTP) published a request for public comment on a proposed Federal research misconduct policy in the October 14, 1999 **Federal Register** (pp. 55722–55725). OSTP received 237 sets of comments before the public comment period closed on December 13, 1999. After consideration of the public comments, the policy was revised and has now been finalized. This notice provides background information about the development of the policy, explains how the policy has been modified, and discusses plans for its implementation.

EFFECTIVE DATE: December 6, 2000.

FOR FURTHER INFORMATION CONTACT: Holly Gwin, Office of Science and Technology Policy, Executive Office of the President, Washington, DC 20502. Tel: 202–456–6140; Fax: 202–456–6021; e-mail: hgwin@ostp.eop.gov.

SUPPLEMENTARY INFORMATION: Advances in science, engineering, and all fields of research depend on the reliability of the research record, as do the benefits associated with them in areas such as health and national security. Sustained public trust in the research enterprise also requires confidence in the research record and in the processes involved in its ongoing development. For these reasons, and in the interest of achieving greater uniformity in Federal policies in this area, the National Science and Technology Council (NSTC) initiated discussions in April 1996 on the development of a research misconduct policy. The Office of Science and Technology Policy (OSTP) provided leadership and coordination. The NSTC approved the proposed draft policy in May 1999, clearing the way for the October 14, 1999 **Federal Register** notice. Public comments in response to that notice have been reviewed. The purpose of this notice is to provide information about the policy as it has now been finalized.

This policy applies to federally-funded research and proposals submitted to Federal agencies for research funding. It thus applies to research conducted by the Federal agencies, conducted or managed for the Federal government by contractors, or supported by the Federal government and performed at research institutions, including universities and industry.

The policy establishes the scope of the Federal government's interest in the accuracy and reliability of the research record and the processes involved in its development. It consists of a definition of research misconduct and basic guidelines for the response of Federal agencies and research institutions to allegations of research misconduct.

The Federal agencies that conduct or support research will implement this policy within one year of the date of publication of this notice. An NSTC interagency research misconduct policy implementation group has been established to help achieve uniformity across the Federal agencies in implementation of the research misconduct policy. In some cases, this may require agencies to amend or replace extant regulations addressing research misconduct. In other cases, agencies may need to put new regulations in place or implement the policy through administrative mechanisms.

The policy addresses research misconduct. It does not supersede government or institutional policies or procedures for addressing other forms of misconduct, such as the unethical treatment of human research subjects or mistreatment of laboratory animals used in research, nor does it supersede criminal or other civil law. Agencies and institutions may address these other issues as authorized by law and as appropriate to their missions and objectives.

Summary of Comments

The Office of Science and Technology Policy received 237 comments on the proposed Federal Research Misconduct Policy. Letters were signed by individuals, and by representatives of universities, university associations, Federal agencies, and private entities. Comments are available for review. Comments that resulted in a modification of the policy are summarized below. A section that addresses other questions raised by the comments follows the summary of modifications.

Uniform Federal Policy

Issue: Many comments recommended various mechanisms to ensure uniform implementation of this policy.

Response: An NSTC research misconduct policy implementation group has been formed to foster uniformity among the agencies in their implementation of the policy.

Section I: Research Misconduct Defined

Issue: A number of comments suggested that the definition of fabrication be modified to read as follows: ''Fabrication is making up data or results and recording or reporting them.'' (Italicized words are suggested addition.) This change is to clarify that the raw data collected or generated in the research process can be fabricated just as can the results of the research.

Response: This change was accepted.

Issue: A number of commenters interpreted the definition of plagiarism to imply that using material gathered during the peer review process was acceptable as long as it is cited.

Response: The policy is intended to address the problem of reviewers who take material from the peer review process and use it without attribution. This constitutes plagiarism. We have deleted the phrase ''including those obtained through confidential review of others' research proposals and manuscripts'' to avoid any appearance of condoning a breach of confidentiality in the peer review process.

Issue: Despite general support for the rationale for the phrase ''does not include honest error or honest differences of opinion,'' several comments requested various clarifications.

Response: This phrase is intended to clarify that simple errors or mere differences of judgment or opinion do not constitute research misconduct. The phrase does not create a separate element of proof. Institutions and agencies are not required to disprove possible ''honest error or differences of opinion.'' The phrase has been retained, with the deletion of the second ''honest'' of the phrase as redundant.

Issue: A number of comments raised questions about what fields of research are included in the definition of research. For example, some readers were unsure about the applicability of the policy as written to medicine or the social sciences.

Response: The policy applies to research funded by the Federal agencies. In order to be responsive to specific inquiries about what fields of research are covered by the policy, an illustrative, non-exclusive list of selected fields of research is now included in the policy itself.

Section II: Findings of Research Misconduct

Issue: Several comments stressed the need for greater precision in the phrase ''significant departure from accepted practices of the scientific community.''

Response: This phrase is intended to make it clear that behavior alleged to involve research misconduct should be assessed in the context of community practices, meaning practices that are generally understood by the community but that may not be in a written form. For clarification purposes and in order to be more comprehensive, the term ''scientific community'' has been modified to read ''relevant research community.'' The policy is not intended to ratify those ''accepted practices'' but rather to indicate that these may vary among different communities.

Issue: Several comments requested clarification regarding the level of intent that is required to be shown in order to reach a finding of research misconduct.

Response: Under the policy, three elements must be met in order to establish a finding of research misconduct. One of these elements is a showing that the subject had the requisite level of intent to commit the misconduct. The intent element is satisfied by showing that the misconduct was committed ''intentionally, or knowingly, or recklessly.'' Only one of these needs to be demonstrated in order to satisfy this element of a research misconduct finding.

Section III: Responsibilities of Federal Agencies and Research Institutions

Issue: Some comments indicated that this section could be incorrectly construed to require appeal of the agency misconduct finding back to the institution.

Response: The policy has been clarified to affirm that each agency should establish an appeals process for persons found by the agency to have engaged in research misconduct. The subject of the agency finding cannot appeal the agency decision back to the institution, although some institutions do offer an appeal of the institutional finding at the institutional level.

Section IV: Guidelines for Fair and Timely Procedures

Issue: The comments indicated some uncertainty about to whom the actions section applied.

Response: The actions delineated are those that may be taken by the Federal agencies if research misconduct has been shown to have occurred. The section has thus been renamed ''Agency Administrative Actions.''

Issue: The suggestion was made that publications based on false or fabricated data, or including such data, should be required to be officially withdrawn.

Response: Correction of the research record has been added to the list of possible actions to be taken if a researcher is found to have engaged in research misconduct.

Issue: The suggestion was made that safeguards for informants and subjects of allegations be made more explicit.

Response: More explicit safeguards have been added to the policy for both informants and subjects.

Other Comments

Several comments and clarifications are addressed in the following question and answer format rather than through modification of the policy.

Will agencies be required to announce the details of their implementation plans? Yes. Agencies will announce the details of their implementation plans, including those plans that do not require formal rulemaking.

What types of misconduct are covered by this policy? This policy is limited to addressing misconduct related to the conduct and reporting of research, as distinct from misconduct that occurs in the research setting but that does not affect the integrity of the research record, such as misallocation of funds, sexual harassment, and discrimination. This policy does not limit agencies or research institutions from addressing these other issues under appropriate policies, rules, regulations, or laws. In addition, should the behavior associated with research misconduct also trigger the applicability of other laws (including criminal law) this policy is not intended to limit agencies or research institutions from pursuing these matters under separate authorities.

Does this policy address misrepresentation of a researcher's credentials or publications? Yes, misrepresentation of a researcher's qualifications or ability to perform the research in grant applications or similar submissions may constitute falsification or fabrication in proposing research.

Are authorship disputes covered by this policy? Authorship disputes are not covered by this policy unless they involve plagiarism.

Does research misconduct include the mistreatment of human subjects or animals in research? This policy addresses activity that occurs in the course of human subjects or animal research that involves research misconduct as defined by the policy. Thus, falsification, fabrication, or plagiarism that occurs during the course of human or animal research is addressed by this policy. However, other issues concerning the ethical treatment of human or animal subjects are covered under separate procedures and are not affected by this policy.

Why doesn't the policy provide immunity for research misconduct investigative committees? Providing immunity to research misconduct investigative committees and other participants in institutional and agency research misconduct proceedings would require significant statutory or regulatory initiatives which will be explored separately from this policy.

Aren't there circumstances when omission of data or results is appropriate? A number of commenters suggested that there are circumstances when it may be appropriate to omit data in reporting research results. It is not the intent of this policy to call accepted practices into question. However, the omission of data is considered falsification when it misleads the reader about the results of the research.

Does this policy supersede institutional policies regarding research misconduct? Non-federal research institutions have authority to establish policies for research and employee misconduct that serve their own institutional purposes. However, the Federal research misconduct policy (as implemented by the agencies) provides the relevant guidance to institutions for purposes of Federal action.

Does this policy supersede other agency policies, procedures, rules, and regulations? Agencies must comply with all relevant Federal personnel policies and laws in responding to allegations of research misconduct. However, personnel actions may not adequately protect the public from the consequences of falsified, fabricated or plagiarized research. For example, Federal personnel policies may permit termination of an employee who commits research misconduct, but may not address the problem of research misconduct or seek to prevent it from recurring. The administrative actions available under the Federal research misconduct policy, such as debarment from federal funding, supervision and certification of research, and correction of the literature, are designed to specifically address the problems raised by research misconduct.

Must all three elements in the Finding of Research Misconduct section be present for there to be a finding of research misconduct? Yes.

Who makes the final determination about whether or not there is a finding of research misconduct? The Federal agency will make the final decision about whether to make an agency finding of research misconduct. However, within its own internal jurisdiction, a non-Federal research institution may establish policies and take actions as appropriate to its needs and as consistent with other relevant laws.

Shouldn't the burden of proof be more stringent, e.g., require "clear and convincing evidence" to support a finding of research misconduct? While much is at stake for a researcher accused of research misconduct, even more is at stake for the public when a researcher commits research misconduct. Since "preponderance of the evidence" is the uniform standard of proof for establishing culpability in most civil fraud cases and many federal administrative proceedings, including debarment, there is no basis for raising the bar for proof in misconduct cases which have such a potentially broad public impact. It is recognized that non-Federal research institutions have the discretion to apply a higher standard of proof in their internal misconduct proceedings. However, when their standard differs from that of the Federal government, research institutions must report their findings to the appropriate Federal agency under the applicable Federal government standard, i.e., preponderance.

Why don't the Federal agencies conduct all inquiries and investigations? Research institutions are much closer to what is going on in their own institutions and are in a better position to conduct inquiries and investigations than are the Federal agencies. While the Federal agencies could have taken on the task of investigating all allegations of research misconduct, or established a separate agency for this purpose, this would have involved a substantial new Federal bureaucracy, which is not thought desirable. An agency may take steps, as appropriate, should a research institution demonstrate a lack of commitment to the policy's guidelines.

How will a lead agency be identified? If more than one Federal agency has jurisdiction over allegations of research misconduct, those agencies should work together to designate a lead agency.

What criteria will be used for selecting the research institution that will handle the response to the allegation of research misconduct? In most cases, agencies will rely on the researcher's home institution to respond to allegations of research misconduct. However, in cases where the subject has switched institutions, it may be more appropriate for the institution where the alleged research misconduct occurred to respond to the allegation. The institution where the questioned research was conducted may have better access to the evidence and witnesses and therefore will have the capability to undertake a more efficient and thorough response.

Shouldn't the policy be more explicit about time lines for a response to allegations of misconduct? In establishing reasonable time lines the Federal agencies must balance the interests of concluding the process expeditiously while ensuring it has been conducted fairly and thoroughly. This will allow flexibility for the research institutions while at the same time ensuring that the process does not extend for an unreasonably long period. Research institutions should have the option to request reasonable extensions of agency timelines in individual cases.

What can informants or subjects of allegations expect with regard to confidentiality? The policy strives for confidentiality for all involved to the extent consistent with a fair and thorough process and as allowed by law, including applicable Federal and state freedom of information and privacy laws.

Should the policy punish informants who act in bad faith or individuals who harass informants? The principal aim of this policy is to communicate to the research community those behaviors that constitute research misconduct and to take actions where research misconduct is found to have occurred. As employers and managers of the research, non-Federal research institutions may adopt policies to address the consequences of false, malicious, or capricious allegations and to respond to retaliation against informants. Agencies may also address this issue in their implementation of this policy.

How should the "seriousness" of the research misconduct be evaluated and how will this relate to any actions taken? In determining what action to take, agencies should fully consider the level of intent of the misconduct, the consequences of the behavior, and other aggravating and mitigating factors.

Next Steps

The Federal agencies have up to one year from the date of publication of this notice to implement the policy. An interagency implementation group has been established under the auspices of the National Science and Technology Council to assist agencies in their implementation process and to strive for the highest level of uniformity possible and as appropriate in their implementation plans.

Federal Policy on Research Misconduct [1]

I. Research [2] Misconduct Defined

Research misconduct is defined as fabrication, falsification, or plagiarism in proposing, performing, or reviewing research, or in reporting research results.

- Fabrication is making up data or results and recording or reporting them.
- Falsification is manipulating research materials, equipment, or processes, or changing or omitting data or results such that the research is not accurately represented in the research record.[3]
- Plagiarism is the appropriation of another person's ideas, processes, results, or words without giving appropriate credit.
- Research misconduct does not include honest error or differences of opinion.

II. Findings of Research Misconduct

A finding of research misconduct requires that:

- There be a significant departure from accepted practices of the relevant research community; and
- The misconduct be committed intentionally, or knowingly, or recklessly; and
- The allegation be proven by a preponderance of evidence.

[1] No rights, privileges, benefits or obligations are created or abridged by issuance of this policy alone. The creation or abridgment of rights, privileges, benefits or obligations, if any, shall occur only upon implementation of this policy by the Federal agencies.

[2] Research, as used herein, includes all basic, applied, and demonstration research in all fields of science, engineering, and mathematics. This includes, but is not limited to, research in economics, education, linguistics, medicine, psychology, social sciences, statistics, and research involving human subjects or animals.

[3] The research record is the record of data or results that embody the facts resulting from scientific inquiry, and includes, but is not limited to, research proposals, laboratory records, both physical and electronic, progress reports, abstracts, theses, oral presentations, internal reports, and journal articles.

III. Responsibilities of Federal Agencies and Research Institutions [4]

Agencies and research institutions are partners who share responsibility for the research process. Federal agencies have ultimate oversight authority for Federally funded research, but research institutions bear primary responsibility for prevention and detection of research misconduct and for the inquiry, investigation, and adjudication of research misconduct alleged to have occurred in association with their own institution.

- *Agency Policies and Procedures.* Agency policies and procedures with regard to intramural as well as extramural programs must conform to the policy described in this document.
- *Agency Referral to Research Institution.* In most cases, agencies will rely on the researcher's home institution to make the initial response to allegations of research misconduct. Agencies will usually refer allegations of research misconduct made directly to them to the appropriate research institution. However, at any time, the Federal agency may proceed with its own inquiry or investigation. Circumstances in which agencies may elect not to defer to the research institution include, but are not limited to, the following: the agency determines the institution is not prepared to handle the allegation in a manner consistent with this policy; agency involvement is needed to protect the public interest, including public health and safety; the allegation involves an entity of sufficiently small size (or an individual) that it cannot reasonably conduct the investigation itself.
- *Multiple Phases of the Response to an Allegation of Research Misconduct.* A response to an allegation of research misconduct will usually consist of several phases, including: (1) an *inquiry*—the assessment of whether the allegation has substance and if an investigation is warranted; (2) an *investigation*—the formal development of a factual record, and the examination of that record leading to dismissal of the case or to a recommendation for a finding of research misconduct or other appropriate remedies; (3) *adjudication*—during which recommendations are reviewed and appropriate corrective actions determined.
- *Agency Follow-up to Institutional Action.* After reviewing the record of the investigation, the institution's recommendations to the institution's adjudicating official, and any corrective actions taken by the research institution, the agency will take additional oversight or investigative steps if necessary. Upon completion of its review, the agency will take appropriate administrative action in accordance with applicable laws, regulations, or policies. When the agency has made a final determination, it will notify the subject of the allegation of the outcome and inform the institution regarding its disposition of the case. The agency finding of research misconduct and agency administrative actions can be appealed pursuant to the agency's applicable procedures.
- *Separation of Phases.* Adjudication is separated organizationally from inquiry and investigation. Likewise, appeals are separated organizationally from inquiry and investigation.
- *Institutional Notification of the Agency.* Research institutions will notify the funding agency (or agencies in some cases) of an allegation of research misconduct if (1) the allegation involves Federally funded research (or an application for Federal funding) and meets the Federal definition of research misconduct given above, and (2) if the institution's inquiry into the allegation determines there is sufficient evidence to proceed to an investigation. When an investigation is complete, the research institution will forward to the agency a copy of the evidentiary record, the investigative report, recommendations made to the institution's adjudicating official, and the subject's written response to the recommendations (if any). When a research institution completes the adjudication phase, it will forward the adjudicating official's decision and notify the agency of any corrective actions taken or planned.
- *Other Reasons to Notify the Agency.* At any time during an inquiry or investigation, the institution will immediately notify the Federal agency if public health or safety is at risk; if agency resources or interests are threatened; if research activities should be suspended; if there is reasonable indication of possible violations of civil or criminal law; if Federal action is required to protect the interests of those involved in the investigation; if the research institution believes the inquiry or investigation may be made public prematurely so that appropriate steps can be taken to safeguard evidence and protect the rights of those involved; or if the research community or public should be informed.
- *When More Than One Agency is Involved.* A lead agency should be designated to coordinate responses to allegations of research misconduct when more than one agency is involved in funding activities relevant to the allegation. Each agency may implement administrative actions in accordance with applicable laws, regulations, policies, or contractual procedures.

IV. Guidelines for Fair and Timely Procedures

The following guidelines are provided to assist agencies and research institutions in developing fair and timely procedures for responding to allegations of research misconduct. They are designed to provide safeguards for subjects of allegations as well as for informants. Fair and timely procedures include the following:

- *Safeguards for Informants.* Safeguards for informants give individuals the confidence that they can bring allegations of research misconduct made in good faith to the attention of appropriate authorities or serve as informants to an inquiry or an investigation without suffering retribution. Safeguards include protection against retaliation for informants who make good faith allegations, fair and objective procedures for the examination and resolution of allegations of research misconduct, and diligence in protecting the positions and reputations of those persons who make allegations of research misconduct in good faith.
- *Safeguards for Subjects of Allegations.* Safeguards for subjects give individuals the confidence that their rights are protected and that the mere filing of an allegation of research misconduct against them will not bring their research to a halt or be the basis for other disciplinary or adverse action absent other compelling reasons. Other safeguards include timely written notification of subjects regarding substantive allegations made against them; a description of all such allegations; reasonable access to the data and other evidence supporting the allegations; and the opportunity to respond to allegations, the supporting evidence and the proposed findings of research misconduct (if any).
- *Objectivity and Expertise.* The selection of individuals to review allegations and conduct investigations who have appropriate expertise and have no unresolved conflicts of interests help to ensure fairness throughout all phases of the process.
- *Timeliness.* Reasonable time limits for the conduct of the inquiry, investigation, adjudication, and appeal

[4] The term ''research institutions'' is defined to include all organizations using Federal funds for research, including, for example, colleges and universities, intramural Federal research laboratories, Federally funded research and development centers, national user facilities, industrial laboratories, or other research institutes. Independent researchers and small research institutions are covered by this policy.

phases (if any), with allowances for extensions where appropriate, provide confidence that the process will be well managed.

• *Confidentiality During the Inquiry, Investigation, and Decision-Making Processes.* To the extent possible consistent with a fair and thorough investigation and as allowed by law, knowledge about the identity of subjects and informants is limited to those who need to know. Records maintained by the agency during the course of responding to an allegation of research misconduct are exempt from disclosure under the Freedom of Information Act to the extent permitted by law and regulation.

V. Agency Administrative Actions

• *Seriousness of the Misconduct.* In deciding what administrative actions are appropriate, the agency should consider the seriousness of the misconduct, including, but not limited to, the degree to which the misconduct was knowing, intentional, or reckless; was an isolated event or part of a pattern; or had significant impact on the research record, research subjects, other researchers, institutions, or the public welfare.

• *Possible Administrative Actions.* Administrative actions available include, but are not limited to, appropriate steps to correct the research record; letters of reprimand; the imposition of special certification or assurance requirements to ensure compliance with applicable regulations or terms of an award; suspension or termination of an active award; or suspension and debarment in accordance with applicable government-wide rules on suspension and debarment. In the event of suspension or debarment, the information is made publicly available through the List of Parties Excluded from Federal Procurement and Nonprocurement Programs maintained by the U.S. General Services Administration. With respect to administrative actions imposed upon government employees, the agencies must comply with all relevant federal personnel policies and laws.

• *In Case of Criminal or Civil Fraud Violations.* If the funding agency believes that criminal or civil fraud violations may have occurred, the agency shall promptly refer the matter to the Department of Justice, the Inspector General for the agency, or other appropriate investigative body.

VI. Roles of Other Organizations

This Federal policy does not limit the authority of research institutions, or other entities, to promulgate additional research misconduct policies or guidelines or more specific ethical guidance.

Barbara Ann Ferguson,

Assistant Director for Budget and Administration, Office of Science and Technology Policy.

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BILLING CODE 3170–01–P

FEDERAL COMMUNICATIONS COMMISSION

Notice of Public Information Collection(s) Being Reviewed by the Federal Communications Commission

November 27, 2000.

SUMMARY: The Federal Communications Commission, as part of its continuing effort to reduce paperwork burden invites the general public and other Federal agencies to take this opportunity to comment on the following information collection(s), as required by the Paperwork Reduction Act of 1995, Public Law 104–13. An agency may not conduct or sponsor a collection of information unless it displays a currently valid control number. No person shall be subject to any penalty for failing to comply with a collection of information subject to the Paperwork Reduction Act (PRA) that does not display a valid control number. Comments are requested concerning (a) whether the proposed collection of information is necessary for the proper performance of the functions of the Commission, including whether the information shall have practical utility; (b) the accuracy of the Commission's burden estimate; (c) ways to enhance the quality, utility, and clarity of the information collected; and (d) ways to minimize the burden of the collection of information on the respondents, including the use of automated collection techniques or other forms of information technology.

DATES: Written comments should be submitted on or before January 5, 2001. If you anticipate that you will be submitting comments, but find it difficult to do so within the period of time allowed by this notice, you should advise the contact listed below as soon as possible.

ADDRESSES: Direct all comments to Judy Boley, Federal Communications Commission, Room 1–C804, 445 12th Street, SW, DC 20554 or via the Internet to *jboley@fcc.gov.*

FOR FURTHER INFORMATION CONTACT: For additional information or copies of the information collection(s), contact Judy Boley at 202–418–0214 or via the Internet at *jboley@fcc.gov.*

SUPPLEMENTARY INFORMATION:

OMB Control No.: 3060–0951.

Title: Service of Petitions for Preemption, 47 CFR 1.1204(b) Note and 1.1206(a) Note 1.

Form No.: N/A.

Type of Review: Extension of a currently approved collection.

Respondents: Individuals or households; businesses or other for-profit, not-for-profit institutions and state, local or tribal government.

Number of Respondents: 125.

Estimated Time Per Response: 15 minutes.

Frequency of Response: On occasion reporting requirement and third party disclosure requirement.

Total Annual Burden: 30 hours.

Total Annual Cost: N/A.

Needs and Uses: These provisions supplement the procedures for filing petitions seeking Commission preemption of state and local government regulation of telecommunications services. They require that such petitions, whether in the form of a petition for rulemaking or a petition for declaratory ruling, be served on all state and local governments. The actions for which as cited as a basis for requesting preemption. Thus, in accordance with these provisions, persons seeking preemption must serve their petitions not only on the state or local government whose authority would be preempted, but also on other state or local governments whose actions are cited in the petition.

OMB Control No.: 3060–0937.

Title: Establishment of a Class A Television Service, MM Docket No. 00–10.

Form No.: N/A.

Type of Review: Extension of a currently approved collection.

Respondents: Businesses or other for-profit.

Number of Respondents: 1,000 respondents; 19,370 responses.

Estimated Time Per Response: .166 hours to 52 hours.

Frequency of Response: Recordkeeping requirement, on occasion and quarterly reporting requirement and third party disclosure requirement.

Total Annual Burden: 396,251 hours.

Total Annual Cost: $2,284,000.

Needs and Uses: The Community Broadcasters Protection Act directed the Commission to make Class A television licensees subject to the same operating requirements as that of full-service broadcast stations. The Commission has