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CODES OF CONDUCT FOR THE LIFE SCIENCES:
SOME INSIGHTS FROM UK ACADEMIA

by Malcolm R. Dando and Brian Rappert[1]

Introduction

1. The States Parties to the Biological and Toxin Weapons Convention (BTWC) will meet in the inter-Review Conference[2] process in June and December 2005 to *"discuss and promote common understanding and effective action*" on:

The content, promulgation, and adoption of codes of conduct for scientists.

2. There is little doubt in many sections of the community concerned with the strengthening of the regime totally prohibiting biological weapons that this is a necessary issue to consider in regard, for example, to the potential misuse of the results of benign developments in the life sciences.[3] For example, the Fink Committee set up by the National Research Council to examine these issues in the United States identified seven classes of 'Experiments of Concern' which they considered required prior approval. These were experiments that:

1. Would demonstrate how to render a vaccine ineffective;
2. Would confer resistance to therapeutically useful antibiotics and antiviral agents;
3. Would enhance the virulence of a pathogen or render a non-pathogen virulent;
4. Would increase the transmissibility of a pathogen;
5. Would alter the host range of a pathogen;
6. Would enable the evasion of diagnostic/detection modalities;
7. Would enable the weaponization of a biological agent or toxin

The committee also noted that the list of experiments of concern was likely to increase as the advances in the life sciences continued in future years and suggested

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[2] United Nations, Fifth Review Conference of the Parties to the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction, Geneva, 19 November – 7 December 2001 and 11-222 November 2002, *Final Document*, BWC/CONF.V/17, 2002. Available at http://www.opbw.org

[3] See, for example, Committee on Research Standards and Practices to Prevent the Destructive Application of Biotechnology, Development, Security, and Cooperation, *Biotechnology Research in an Age of Terrorism*, The National Academies Press, Washington DC, 2004. Available at: http://books.nap.edu/catalog/10827.html

that a national board be set up to provide oversight of such developments. Indeed, some medical researchers are already working with new ethical guidelines which state that:[4]

> *Biomedical research may generate knowledge with potential for both beneficial and harmful application. Before participating in research, physician researchers should assess foreseeable ramifications of their research in an effort to balance the promise of benefit from biomedical innovation against potential harms from corrupt application of the findings.*

and:

> *The potential harms associated with some research may warrant regulatory oversight. Physician-researchers have a responsibility not only to adhere to standards for research, but also to lend their expertise to the development of safeguards and oversight mechanisms both nationally and internationally. Oversight mechanisms should balance the need to advance science with the risk of malevolent application.*

In addition, as pointed out in Bradford Briefing Paper No. 13[5], there are a variety of initiatives being undertaken at *national* and *international* levels by the life sciences community in relation to developing a variety of codes.

3. This Briefing Paper, with the *specific purpose* of assisting the deliberations in Geneva by States Parties in 2005, considers what the views are amongst those engaged in carrying out *practical* work in the life sciences regarding the 'dual use' potential of their work, particularly in regard to the results and techniques generated through experimental work. The Briefing Paper starts by setting out the methodology used to collect the views of those engaged in the life sciences and how the data was analysed. Our overall objective was to develop a system in which the life scientists could become engaged in helping to prevent the misuse of their science. As it became evident that there had been little prior consideration of many dual use issues by the life scientists who participated in this study, the approach adopted was to conduct seminars in which the authors sought to *raise awareness* about dual use problems and *encourage discussion and deliberation*, rather than seeking pre-established positions. However, through this process, it has also been possible to discover some of the current thinking of those involved. Consequently, this Briefing Paper then goes on to present a view of the prevailing opinion amongst those engaged in the life sciences who participated in this study which made it clear that a divergence of views exists between those engaged in the life sciences and those in the community concerned with the strengthening of the regime totally prohibiting biological weapons. Finally, the implications of these findings for consideration of the *content, promulgation, and adoption of codes of conduct for scientists* are then set out.

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[4] Report of the Council on Ethical and Judicial Affairs, *Guidelines to Prevent Malevolent Use of Biomedical Research*. CEJA Report 9-A-04, 2004, American Medical Association.

[5] Brian Rappert, *Towards a Life Sciences Code: Countering the threats from biological weapons*, University of Bradford, Department of Peace Studies, Briefing Paper No. 13 (Second Series), September 2004. Available at http://www.brad.ac.uk/acad/sbtwc

Methods

4. The community of those engaged in the life sciences is quite diverse, encompassing scientists, technicians, medical practitioners, biotechnologists, information technologists, and engineers working in academia, human, industry, government civil agencies, biodefence, funding organisations and government in countries around the world. It is therefore necessary to note that the study reported here is based on one segment of this community in one country. We are grateful to the students and associated staff engaged in the life sciences in 25, predominantly UK, universities who, between October 2004 and May 2005, contributed to an interactive seminar run according to our design.

5. This segment of the life sciences community was chosen in part for good practical reasons – one, universities are relatively open institutions that have a tradition of facilitating discussion about societal issues; two, we were able to fit our seminar within the regular weekly departmental seminar series held in most of these universities. There were other important reasons for our choice of this segment of the life sciences community. First and foremost, our seminar groups always included staff and postgraduates doing practical work in the life sciences – these were people 'at the coalface' concerned with making real decisions about what work to do, how to publish it and how to obtain funding for further work. Second, all our seminar participants used English as their working language and therefore had access to all the recent debates in the western media about possible bioterrorism and potential misuse of developments in the life sciences. Third, as British university personnel are already subjected to a wide range of professional, institutional, and legal regulation,[6] they were already quite familiar with issues about the governance of science.

6. Ascertaining the thinking of a group of people in a diverse community is not easy. In this case it was especially so for a number of reasons. Initial interviews conducted by the authors in 2002-3 had indicated there was little awareness of dual-use issues among a subset of British life science academics. In addition, we were concerned from the start that our questions might appear threatening to our audiences and therefore trigger defensive reactions.[7] So, using an approach based on a questionnaire risked us asking questions that were not understood by, had different meanings for, or were dismissed by the people we were addressing. One-to-one interviews would have allowed for more interaction between us and the scientists, but because of past interviews we were also keen to promote interaction *between* practicing life scientists. We therefore adopted a dialogue-orientated approach to achieve a greater mutual understanding of the issues at stake. Therefore, a seminar was devised consisting of a series of PowerPoint slides with information and key questions to initiate discussion. It was designed so as to promote the active participation of attendees in discussions about questions such as:

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[6] Graham S. Pearson, *A Code of Conduct for the Life Sciences: A practical approach*, Briefing Paper No. 15 (Second Series), University of Bradford, November 2004. Available at : http://www.brad.ac.uk /acad/sbtwc

[7] Argyris, C. (1993) *Knowledge for Action: A guide to overcoming barriers to organisational change*. Jossey-Bass Publishers, San Francisco.

'What role can life scientists play in combating biological weapon threats?';

'What are the social responsibilities of life scientists today?'; and

'Should experimental results always be published?'

7. The presentation was squarely focused on concerns about contentious 'dual use' experiments and possible oversight regimes, rather than on more traditional concerns about the control on materials and personnel in laboratories where biosecurity dovetails with matters of biosafety. The seminar was not simply a presentation with a question and answer period at the end. Rather, it consisted of slides which outlined dual-use cases or policy initiatives to elicit discussion. We were very careful to stress - in introducing each slide and its question(s) - that we were trying to find out what our participants thought about these issues. We tried to allow discussion of each slide to continue until everyone who wanted to speak had had chance before moving on. Our audiences ranged from tens to a hundred, but were usually below forty, thus giving a chance for most who wished to do so to contribute. In our process of questioning, while we sought to remain neutral with regard to the questions asked, we also sought to challenge all participants regarding the data, assumptions, and inferences underlying their responses to the questions posed. Our experience and subsequent feedback indicates that this approach enabled colleagues to question each other both during and after the seminars regarding concerns about the place of science in society. We have received many positive comments from attendees regarding the novelty of the seminar's interactive dimension and the considered dialogue it helped nurture.

8. We began our work by running two pilot seminars at two universities in order to ensure the mechanics were in order and then we ran 23 further seminars in other universities (all except one in the UK). After the pilot seminars we ran three sets of five seminars and one set of seven seminars in sequence. In total, 25 seminars were held as follows: 12 in England (excluding Greater London), 6 in Greater London, 3 in Scotland, 2 in Wales, 1 in Northern Ireland and 1 in Germany) We reported back to participants on each set of seminars as they were completed.[8] The organiser of each seminar introduced us according to a prearranged schedule indicating where we were from and the seminar's title. Participants were provided with hard copies of our PowerPoint slides and further details about the project. At the end of this introduction we requested agreement to record the proceedings so that they could be analysed later. Guarantees were given that no institution or individual would be identified in the resulting analysis and no-one objected to the recordings being made.

9. The sequence followed in the seminars was developed in the light of our experience – first on the basis of the two pilot seminars and then after each set of five seminars. The sequence adopted in the later seminars is summarised in Table 1.

[8] See http://www.ex.uk/codes of conduct/Workshop/Progress/index.htm

Table 1: The sequence followed in the later seminars

1. Title slide 'The Life Sciences, Biosecurity, and Dual-Use Research'

2. The objective of the project:

How might regulatory controls enhance biosecurity in the life sciences?
How can policy makers and life scientists engage in dialogue?
Could codes of conduct be a viable and effective approach?

3. Mousepox experiment

    Description of the experiment and results

4. Publication of the Mousepox results

    Given that the result was unforeseen…
    Question: Should it have been published in the *Journal of Virology*?
    Question: Should it have been published in the semi-popular journal *The New Scientist*?

5. Given that similar results were published earlier

    Question: What options are there for the publication of such research?

6. Should the mousepox experiment have been done?

    If the danger had been recognised beforehand…
    Question: Should the experiment have been done?

7. Responding to future possibilities

    IL-4 experiments moved from mousepox to rabbitpox and cowpox
    Question: Should we always seek to anticipate the future?

8. National oversight committee (based on US Fink Committee proposals)

    Assuming such an oversight committee was introduced nationally around the world
    Question: Would it helpful or be dangerous?

9. Codes of Conduct

    Awareness raising about British and international codes activities
    Questions posed by the Chair of the 2005 BTWC meetings

10. References and contact information

The first slides, asking whether work should have been done, or should have been published, or maybe published in different ways always provoked such a discussion that we rarely got beyond showing 8 to 10 slides in the hour generally allocated for the seminar.

10. As already noted, the sequence followed was developed in the light of our experience as we discovered which slides 'worked' – in the sense of initiating a fruitful discussion. Consequently, in order to understand the basis for evaluations made about the biosecurity issues posed, we developed the seminar's content so as to test out the assumptions and inferences underlying participants' statements.

Development of the approach

11. In this section, we analyse some of our findings about the approach that we adopted in the seminars. We found that claims about the inevitability of scientific development loomed large in many of the justifications we heard for downplaying or dismissing questions about whether certain experiments should not be conducted on biosecurity grounds, whether the scientific papers should be modified or even not published in light of such concerns, or whether viable systems of oversight in regard to work of concern could be established. Participants felt that the question of *whether* some line of work should be done missed the point that it *would* be done (in the end) by someone; which in turn would also mean that everyone 'skilled in the art' would know about it. In this sense then, limitations or controls would be futile.

12. The extent to which such responses were offered was somewhat unexpected for us. Many of our initial slides and prepared questions were designed to seek the boundary where participants might start expressing biosecurity concerns. Consequently, we initially included a slide about the artificial synthesis of polio virus (which we expected few researchers would say should not have been done) and then followed it up by a slide indicating the substantial pace with which synthesising capabilities have moved ahead in the last few years to see if this gave any reasons for pause. In addition, the current effort to recreate the 1918 Spanish Flu was used as an 'extreme case' for asking if there were any limits to what should be done or communicated. Yet, because science was so often presented as more or less inevitable, these sorts of considerations or cases were deemed inconsequential by the participants.

13. As a result of such interactions in the first seminars, we ended up dropping the slides that asked whether the speed of innovation was a problem and whether the case of the Spanish Flu questioned anyone's appraisal. We then had developed the sequence in order to consider how to better understand and probe characterizations of inevitability. A slide was introduced in subsequent seminars that outlined the recent significant expansion of biodefence programmes in the US. We had hoped by bringing to the fore the contingent policy choices made about what gets funded in the life sciences (and thus what science gets done), this would lead some participants to openly query claims made by others about inevitability. When this failed to happen we then introduced a slide summarising themes of earlier seminars, in which we explicitly challenged notions about inevitability by comparing the limited funds dedicated to many tropical diseases against those recently made available for likely biological weapon agents. However, this form of confrontational questioning rarely

resulted in much discussion; in fact it tended to stop whatever dialogue had been fostered up to that point.

14. In response, we again varied the manner in which we questioned statements about inevitability by first being sure to carefully probe for the assumptions underlining such statements and second by then challenging those accounts whenever a consideration pertinent them was later brought up (e.g., in relation to the funding of research). Embedding our queries in this way generated much more dialogue about whether science is indeed 'inevitable'.

15. In a similar manner we also sought to question other presumptions. Assessments of inevitability typically relied on the assumption that once research was conducted, it would then automatically become known by others with suitable expertise in the field – in other words, as we often heard, 'the genie was out of the bottle'. Probing for the reasons why the dissemination of research was unavoidable indicated a number of issues such as the pressures placed on academics to publish and the advent of Internet publishing which meant vast amounts of resources were easily available. Yet, such statements existed in an uneasy relationship with another claim sometimes made that the publication of some contentious research posed little danger because of difficulty of replicating results from the limited information given in articles. With our growing understanding of responses, when such contrasting assessments were offered within the space of one seminar, this provided an occasion for encouraging dialogue between participants; when only one of them was offered we could forward the other to further deliberation.

Analysis

16. As we gained more experience of the responses made we also developed 'probes' that would enable us to investigate the reasons for and implications of the views that participants were putting forward – this was done either by using new slides or by asking previously prepared questions. It was not always easy to introduce our probes into a fast-flowing discussion so we adopted a tactic of trying to restate what we had heard, elaborating what we thought this meant, and what implications we saw, before investigating further what was intended by the speaker.

17. The tape recordings of the seminars were transcribed and then analysed independently by each of the two investigators. The analysis carried out in this Briefing Paper utilised data gathered during the two pilot seminars and 15 of the subsequent seminars and was done specifically in relation to the discussions scheduled this year in the BTWC MX/2005 and MSP/2005 meetings. However, the results obtained in the later seminars were broadly consistent with those reported in this analysis.

18. From the point of view of the BTWC MX/2005 and MSP/2005 meetings, two sets of questions appeared of most relevance. The first set related to the problem that is of interest to the community concerned with the strengthening of the regime totally prohibiting biological weapons:

1. Did those engaged in the life sciences think that there was a major danger of bioterrorism and biological weapons?

and:

> *2. If they considered that there was such a danger, did they consider that developments in the life sciences contributed to the problem?*

These questions were not asked directly but the answers could be deduced from what was said by participants in our seminars.

19. The second set of questions were concerned with whether possible new control measures *should* or *could* be introduced:

> *3. Did participants think that a preproject review related to biosecurity (not biosafety) – with the implication that some research could be reformulated, transferred, delayed or even halted – **should** or **could** be introduced at the local level?*
>
> *4. Did participants think that a further prepublication review related to biosecurity – with the implication that some publication could be modified or stopped – **should** or **could** be introduced?*
>
> *5. **Should** a national system or **could an effective** national system, such as that suggested by the Fink Committee and presently being introduced in the United States, in which local reviews are directed, monitored and developed at a national level be introduced?*

and finally:

> *6. **Should** an enhanced process or **could an effective** process of international review, as suggested in the UK's background paper on science and technology for the BTWC Fifth Review conference, be introduced to guide national systems of review?*

Again these questions were not asked directly at our seminars. Questions (3-6) could produce more complex answers than did Questions (1-2). Questions 1 and 2 about whether there is a threat and whether developments in the life sciences contributes to any such threat are susceptible to "yes" or "no" answers. Questions 3-6 in the second set might provoke different responses if the proposed review (such as in question 3) was envisaged as providing advice (code of ethics), guidance (code of conduct) or regulatory (code of practice). As we were not carrying out interviews with individual researchers, we were rarely able to reach that level of detail in our questioning.

20. The fact that our data were collected from different people at different times and that no-one was directly asked the set of questions 1-6 means that we cannot report what a standard answer from one person might be to all of these questions. In our results section we therefore take a different approach. First we set out two "ideal types" of response that one might imagine would be found in the life sciences community. The term “ideal type” does *not* imply a judgment on the desirability of the responses. Rather it is an analytical term that refers to an abstracted, one-sided

model devised as a heuristic device to understand complex phenomenon.[9] We then give brief indicative sample statements that we have in our transcripts that appear relevant to our questions. This leads us finally to a prediction of what responses could be expected to predominate in this community at present. In the final section of this Briefing Paper we set out the implications of our findings for MX/2005 and MSP/2005.

Results

21. The first "ideal" type we might imagine is that of a life scientist who is convinced that there is a major problem of bioterrorism/biological weapons, that developments in the life sciences could contribute to that problem, and that something should and could be done by the life sciences community to help deal with the problem. We might call this the **security-conscious** type and imagine a set of general responses to our questions as in Table 2. The specific arguments we heard can then be categorised in relation to these general responses.

Table 2: Responses of a "Security Conscious" person

1. There is a problem of bioterrorism and biological weapons.

2. Developments in the life sciences could contribute to the problem in a variety of ways.

3. An effective preproject review on biosecurity grounds should and could be introduced at a local level.

4. Given the possibility of unexpected results, an effective prepublication review should and could be implemented.

5. An effective national system of review should and could also be implemented.

6. An effective international review system to help standardise national review systems should and could be introduced.

22. A second "ideal" type that can be imagined is that from a life scientist who does not believe that there is a major threat, or that developments in the life sciences contributes in any way to whatever threat there is, and therefore that no extra controls are needed on security grounds – indeed that such extra controls would hinder the advance of beneficial science. We might call this the **classic** open science type and imagine a set of responses to our questions as in Table 3. Again the specific arguments put forward by seminar participants can then be grouped in relation to these more general categories.

[9] The sociologist Max Weber coined the term ideal types and elaborated its utility for social analysis. He specified that 'An ideal type is formed by the one-sided accentuation of one or more points of view and by the synthesis of a great many diffuse, discrete, more or less present and occasionally absent concrete individual phenomena, which are arranged according to those one-sidedly emphasized viewpoints into a unified analytical construct.' See http://www.answers.com/topic/max-weber

Table 3: Responses of a "Classic Open Science" person

1. There is little evidence of a problem of bioterrorism and biological weapons.

2. Neither is there evidence that developments in the life sciences could contribute to the problem.

3. An effective preproject review on biosecurity grounds should and could not be introduced at a local level.

4. An effective prepublication review should not be and could not be implemented.

5. An effective national system of review should and could not be implemented.

6. An effective international review system to help standardise national review systems should and could not be introduced.

23. It is also possible to conceive of a variety of intermediate or alterative "ideal" types, for example, a set of responses from a **public relations-conscious** researcher who does not think that there is a real threat but believes it would be useful to be seen to be doing something as long as it is not a burden and does not interfere with the progress of research. We will note some such complexity in the responses we describe later.

24. As would be expected by members of the community concerned with the strengthening of the regime totally prohibiting biological weapons, one of the slides concerned the Australian mousepox experiment. We used slides referring to the mousepox experiment in all our seminars and increasingly, as our surprise at the responses grew, took to asking directly how many people in the group had any knowledge of the experiment or of the concern it had caused in the community concerned with the strengthening of the regime totally prohibiting biological weapons. **Our data indicate that to find more than 10 per cent of a life sciences audience who even heard of this experiment would be extremely unusual!** We take this and other interactions to indicate that few in this section of the worldwide life sciences community have much awareness of the BTWC let alone given any consideration to the issues being considered at MX/2005 and MSP/2005 in Geneva and elsewhere. Thus it is unlikely that most people in our seminars could have given a completely coherent set of responses such as those in Tables 2 or 3 if we had been able to interview them individually in detail. Nevertheless what is interesting is the balance of the kinds of arguments we heard and, given that we encountered several hundred people, the arguments we did not hear or heard very infrequently.

The First Set of Questions

Question 1: Is there a major bioterrorism/biological weapons threat?

25. Though we never asked this question directly, it is remarkable how little attention was paid to it by our participants. The state-level offensive programmes of the twentieth century were very rarely raised, and the BTWC itself almost never mentioned – and when it was, was rarely understood. Bioterrorism, if discussed at all**,** was thought to be used as a political means of frightening people, a participant in an early seminar, for example, saying: "the problem is whenever you talk about bioterrorism these days people are terrified." It was also seen as a means of avoiding the real problem: "If you could stop terrorism at source than you wouldn't need to spend all these billions [on biodefence], or if a few of those billions were spent on regeneration of those countries….we should be looking at that really as the very first issue."

Question 2: Do developments in the life sciences contribute to the problem?

26. Amongst the community concerned with the strengthening of the regime totally prohibiting biological weapons it is not difficult to find extensive discussions of how developments in the life sciences could contribute to the problem of biological weapons and bioterrorism, for example through unexpected results of experiments, the spread of technology capabilities and the general increase in understanding of fundamental biological processes.[10] Whilst an occasional participant expressed a concern that publications of the developments in the life sciences might provide a 'roadmap' for terrorists, the overwhelming sentiments were that they **did not contribute to the problem** as bioterrorism was carried out elsewhere. In discussing the synthesis of polio virus, a participant asked: "Is it really the high technology that is so potentially dangerous? I would have thought that you've got low relatively cheap technology that could be used [by the terrorist]." A different argument was related to the **degree of regulation**: "Surely we should be more worried about research [other] than research carried out in responsible institutions such as universities. It's regulated by peers…it's the stuff that's going on in countries that aren't regulated, don't publish [that should be of concern]."

27. What was most noticeable was that nowhere did a participant set out an argument showing a clear understanding of how – by what mechanisms – developments in the life sciences could contribute to the threat. Such an argument was not even put forward just to refute it. This again suggested to us that the problem had not been seriously considered other than by very few participants. That is not to say that participants were unconcerned about the social implications of their work. As one argued: "I think it's a myth that I hope we've relegated to history – the idea of value-free science. We've had a British Society for Social Responsibility of Science for some thirty plus years." This participant was clearly concerned about the responsibility of scientists, and concluded: "the problem is the ethics is running a long way behind the actual scientific advances."

[10] See, for example, the articles in the special issue of *Disarmament Forum*, **1**, 2005 on Science, Technology and the CBW Regimes.

The Second Set of Questions

28. The possible answers to our questions 3, 4, 5 and 6 are potentially more complex than those to questions 1 and 2. It would be possible, for example, to consider that a preproject review **should** be introduced but to consider that it **could not** be effectively implemented, or to believe that a prepublication review **should not** be introduced even if it was considered that it **could** be effectively implemented. Although we encountered some examples of this type, for the most part the relevant responses we heard were more straightforward for us to analyse. As we asked about experiments, publications and national reviews in sequence we can also analyse the arguments that arose in relation to our questions separately.

Question 3: Should and could there be a local preproject review?

29. As noted previously, a few participants were concerned about civil research providing a roadmap for terrorists, but overwhelmingly, the arguments we heard related to concerns about the possibility of extra controls preventing work being done. There was the argument of **inevitability** – that at a certain stage of scientific development (in technology and ideas) the experiment would be done somewhere even if a local (or other) review prevented it in a particular institution. In regard to the synthetic polio demonstration by Wimmer and his colleagues, a seminar participant stated: "Surely the whole issue is the fact that this technology's been around for a long time and if Wimmer hadn't done it someone else would have done it."

30. A related argument in regard to the polio synthesis experiment was that, although it was known to be theoretically possible, until it was done one could not be sure. So the experiment was **necessary to demonstrate that it could indeed be done**: "You might think yes, you could do that because you've got various techniques or machines to do it, but until you actually physically do it, you don't know that you can do it." Other participants argued that the polio experiment was also necessary not just to demonstrate that it could be done, but to **raise awareness** of the fact. This is clear from the following exchange:

Participant: "...so should it have been done? Yes, it brought it, at long last, to the attention of people in government that these sorts of experiments are pretty easy..."

Interviewer: "So if I understand correctly, this should have been done because it was necessary to bring this to the attention of government?"

Participant: "Yes, people in power just didn't realise how easy it is to do some of these experiments in science these days."

31. It should be noted though that the participant in this case was adamant that this ease did not justify restrictions on research. Closely related to this argument for raising awareness is the argument that the experiment also opens up the **possibility of working on countermeasures** to the newly discovered threat: "things that might happen in the future anyway, be prepared for it. I think that's justification then for creating something, if you want to know what properties it will have so that you may be able to defend yourself against it."

32. Added to these arguments - inevitability, demonstration, awareness-raising and countermeasures - against any preproject review that could halt research was the view that such a review would be **counterproductive** as it would not stop those with malign intentions. As one participant explained: "Isn't the problem as well with the regulation...that people who obey the regulations are not the people who are going to try and do, use science for these sorts of [malign] ends. So you end up actually just hurting the people who are trying to use the science for positive reasons, by putting more obstacles in the way." Again in relation to the argument that the technology used to synthesise polio opened up the possibility of a synthesis of something really dangerous like Ebola, a participant was horrified: "So are you saying we shouldn't make vaccines? I mean look at the 'flu, for example, I mean that changes...Shouldn't we trace 'flu round using this sort of technology? So you're **damning the technology** just because it happens to be able to make Ebola potentially in about three or four years' time."

33. Many of our participants appeared to see themselves as very small cogs in a large impersonal system over which they had little control. Thus one participant in discussing the possibility of a review of the polio synthesis experiment stated: "I think in a lot of these things the **genie's out of the bottle**, you can't unlearn something, once somebody has put even a proposal...forward...it will be followed up. It's in the wider scientific community, somebody will pick it up." When the interviewers put the argument back to him for clarification, the participant replied: "If you're talking about taking the moral standpoint perhaps it's wrong to do this type of thing, but it's almost like trying to stop the sun rising tomorrow morning, once it's out, it's out."

34. The concerns expressed in regard to whether there should or could be a local preproject review are summarised in Table 4.

Table 4: Concerns expressed about a preproject review (Question 3)

1. Inevitability of the experiment.

2. Necessity to demonstrate that it works.

3. Need to raise awareness.

4. Utility to design countermeasures.

5. Counterproductive (in hindering benign work).

6. Damning the technology.

7. Futility (as 'genie is out of the bottle').

Question 4: Should or could there be a prepublication review?

35. After considering whether experiments should have been done we moved the participants on to a discussion of the publication of results. Here we were able to ask more detailed questions on whether attempting to “publicise” (this term was often

used by participants to characterise any activity to communicate beyond the scientific community) as well as publish in scientific journals was a good idea, or whether some results were best not emphasised in terms of potential misuse (apart from informing relevant authorities). This approach generated a rich discussion. Interestingly, it was exceedingly rare in any of our seminars for any reference to be made to the system already put in place in many top scientific journals - for a review to be carried out on biosecurity grounds.[11]

36. Again, while a few participants expressed some concerns about providing inadvertent help to terrorists in publications, there were many more arguments deployed against the idea of placing restrains on publications. The first argument was similar to that of the inevitability of work being carried out. Here the argument was that **dissemination was inevitable** once the work had been done. One participant pointed out that people, and their expertise, move about: "Those people tend to work there for two or three years and then move...obviously publishing makes it open to the public, but in the scientific community if someone really wanted to know about this, whether it's published or not, I think there's access to...these sorts of experiment." When asked for clarification the participant confirmed his view: "I think once it's been done and methods are developed, it's not a secret if there are people doing it and these people will move to other places and take their expertise with them." The presumption often stated by participants was that national governments were actively monitoring publications for their dual-use potential and undertaking the necessary follow up activities to devise effective countermeasures. Another participant referred to the growing use of the Internet: "I suspect whether they had published or not it would have eventually got into the worldwide web somehow." This participant had worked in defence and pointed out that, of course, this form of publishing would not occur in a "closed community laboratory." Our seminars, however, were intended to be for and about academic work so there was certainly the possibility of Internet publication.

37. Again, as in the discussions of whether the synthetic polio experiment should have been done, people argued that the mousepox experiment should have been published because it helped to increase **awareness** and opened up the possibility of developing **countermeasures** against poxviruses with cytokine-enhanced virulence. A participant made this quite clear in stating: "One can use dangerous information to endanger others but one can also use dangerous information to protect people, and one could well argue that it's difficult to deal with unknown bioweapons and the more information the people who have to deal with them have, the better they'll be able to counter them." Another supporting argument was that there could be **other benefits in civil society** from the publication of the mousepox result: "I think the information could be useful for people working in fields other than bioweapons such as gene therapy for example, engineering viruses for gene therapy."

38. A further argument for publication concerned the **social responsibility to publish** after receiving funding: "I think there's a social issue here, and if you've got their funding and you've used their funds for this sort of research then you have a responsibility to report to them how you've used their money....the old adage was that it wasn't the responsibility of the scientist to govern what happened to the material, his

[11] Journal Editors and Authors Group (2003) *Proc. Natl. Acad. Sci. USA*,**100**,1464.

obligation, or her obligation was to publish their findings." There was also the view that there was not a great deal of danger in publication anyway because it is so **difficult to replicate** the technical work described in a paper: "it actually can be practically quite difficult to do and what you inevitably do is actually contact the other lab to try and get on board technique or whatever, and so I would agree with the point that I don't think publishing is wrong necessarily." Additionally, there was a concern that not publishing could, in some circumstances, lead to the accusation of there being a **cover-up of important information**. Thus it was argued: "If they hadn't published it wouldn't the people, if they found out about this, accuse them...of there being a cover-up of some sort. If they hadn't published it that might have back-fired on them in that way."

39. Accompanying such benign explanations there was very widespread recognition of the **pressures scientists felt to publish** in order to gain further funding. Examples of this were numerous in our seminars, for example: "Nowadays if you don't publish you don't get any more money do you?" and "they may say they're doing it because they need to inform the wider public but a lot of it is public preening of feathers....there's a hell of a lot of money out there for defence-related research." Two exchanges in different seminars illustrate the point that there is a felt need to publicise, not just publish, but also a strong distaste for that approach.

Seminar A

Participant One: "It's part and parcel of the research sort of climate, if you want money you've got to get as much publicity as you possibly can."

Participant Two: That's exactly what I was just going to say: there's money involved, suddenly you make a splash, suddenly your research group is set, money starts coming in to it..."

Interviewer: "Yes… that was put to us in a previous seminar: it's not publish or perish, it's publicise or perish."

General chorus of agreement

Seminar B

Participant One: "...it's when marketing get involved to twist things around that we end up with problems...and this need to have to hype up anything."

Interviewer: "Why do we have to hype things?"

Participant One: "Well it's just that..."

Participant Two: "Core funding."

Participant One: "Yes, current competitive environment..."

Interviewer: "So, if in the world in which you live funding is so crucial that if you have a finding that is interesting then you use it to the maximum in order that the funders know who you are?"

Participant One: "Yes."

Participant Three: "Yes, the funding bodies want you to do that anyway....They want you to hype it up so that they get advertising for whatever..."

40. This argument for unrestricted publication on financial grounds is, of course, closely linked to **career prospects**. Considering the mousepox publication, one participant stated: "It's just a balance between personal career, they know they probably shouldn't, they should sit on it. But I imagine it comes down to: they've put a lot of work into this, so they probably would publish."

41. We attempted to open up the discussion of publication of the mousepox experiment by relating a story we had been told that suggested that rather similar results had been published previously in the standard literature without any hype (Slide 5 in Table 1), but that the appropriate authorities had been informed (we had no way to check the veracity of the story, but there were articles in the pre-2001 open literature that illustrated the possibility). There was some support for adopting a discreet approach: "I don't think they've restricted their knowledge though, they haven't restricted anything; they've published what they've done....they used that responsibility and told the appropriate authorities. So in that way they kind of got the best of both worlds I think." There was also the view that these issues were best not put into the mass media: "In a sense this is a better way to do it because the debate would be had by the people who need to have a debate...there is so much hysteria in the public about weapons of mass destruction." Others were very sceptical of this approach at the present time, arguing that if there were bioweapons implications they would not be easy to hide: "Any editor worth his salt on the *New Scientist*, or other journals that are more populous would be scanning the literature so you don't need to spell it out yourselves, do you? You're going to get some good editor looking at that and realising and then putting the big headlines anyway, don't you think?" It should be noted that such statements were offered *despite* our having suggested a case where a team did, in fact, bury the findings of research without editors putting its implication into 'big headlines'.

42. It should really be of little surprise that this community brought forward many arguments against blocking publications. As one put it: "It's always been the culture as well in science to share information through peer review journals, let people know what you're working on, look what my group or I've discovered." He went on to refer to a study of the Muslim world and the dangers of **censorship** on religious grounds, "there's a lot of scientists saying 'We're still in the dark ages because our religion limits us to the dark ages'." It should be noted though that this participant and others retreated from sweeping statements about the openness of (Western) science when challenged through reference to academic and commercial competitive factors that impede such openness. Additionally, there was the question of **how judgements about restrictions could be made** on objective grounds acceptable to scientists even if such censorship was thought necessary. As one participant argued, scientists had to stay away from making judgements about social consequences: "I think you have to

take that stand because otherwise you, it is very, it would be very difficult to determine how you would then make the decision."

43. The concerns expressed in regard to whether there should or could be a prepublication review are summarised in Table 5.

Table 5: Concerns about a prepublication review (Question 4)

1. Disclosure is inevitable by some other means.

2. Need to raise awareness.

3. Utility to design countermeasures.

4. Potential benefits (for civil research).

5. Social responsibility to publish.

6. Little danger because of the difficulty of replication.

7. Pressure to publish for career and future funding reasons.

8. Dangers of censorship to the scientific enterprise.

9. Difficulty of making objective judgements about social consequences.

10. Danger of backfire (if suspected of a cover-up).

Question 5: Should or could there be national review systems like those proposed by Fink in the USA?

44. As in much of Europe following the war in Iraq, there was a good deal of suspicion of the motives and goals of US government security-related initiatives. We sought to avoid such responses by describing the system that the Fink Committee had suggested – and which is being implemented – but then asking whether such a system would be useful if it was implemented globally by many countries. Our aim was to focus the discussion on the potential utility of the system.

45. Some participants were willing to consider the possible merits of a national review system. As two participants in an early seminar in our series expressed it in the following exchange:

Participant One: "...you're doing it for the greater good of mankind...there needs to be some potential benefit..."

Participant Two: “Got to be a valid and acceptable reason for doing it."

Participant One: " So therefore, is it not reasonable then to have some overview of what the purposes of these activities are?"

However, there was again a range of counter-arguments voiced much more often.

46. It was argued by a number of participants that such an overview system could stop work that needed to be done: "the counter-argument...is that if you know about how these things operate, and if there is a risk that people will become infected, isn't it important to know about it and to try and work out how you can subvert that and help people?" Clearly the participant was arguing that it was precisely the experiments of concern, such as those designated by the Fink Committee in the USA, **that needed to be carried out**.

47. Others argued that it simply would not be possible to get sufficient agreement about what was dangerous to get an enforceable system as the following exchange illustrates:

Participant: "...I don't see really how it's enforceable....you will get people who will say 'This actually doesn't concern me, it's of no concern because we're not doing this type of work' and anybody else can look at it and say blatantly they are ..."

Interviewer: "So you're saying that you don't think it's technically possible?"

Participant: " I don't think it's feasible..."

This argument of **infeasibility** can also be seen in the following exchange at a different seminar:

Participant: "...a lot of the potential applications probably aren't very obvious at the early planning stage, so it's going to be very difficult to get the local committee, biosecurity committee, to do that and come up with sensible recommendations."

Interviewer: "So even if it's a good idea – practically your suspicion is that it would be extremely difficult to do..."

Participant: "I think it's probably impossible to implement it when you can't get agreement among scientists about what should be regulated..."

48. There was also a great concern that the implementation of such a national overview system would **inhibit research** by causing people to avoid areas of research where a great deal of extra irrelevant controls required more work. Two such statements were: "It's that people think it's going to take too much time, it's going to take a lot of resources to get through the committee" and: "It's going to stop science...in the States people are already finding this an absolute nightmare. I mean the biosafety rules that were brought in after 9/11 are just crazy..."

49. There was undoubtedly also a view that the controls would be subject to **evasion**. The evasion could be within the country as one speaker pointed out: "Well, I mean, the problem with this sort of approach is that the only people who are likely to submit their proposals for evaluation by this committee are the very sorts of people we don't need to worry about in the first place....you can do it in the shed in the back garden if you wanted to, so...this sort of arrangement is just not going to pick up the people you

need to worry about." Evasion was also seen to be possible internationally: "And also what will happen is the scientific community will decamp and go elsewhere. You won't stop it."

50. Concerns were also expressed about the **potential for misuse** of the system. One speaker gave as an example: "If it's perceived that you make your application and the processes then aren't transparent and the answer comes back 'No, you can't do it' what people will think is that some national laboratory thought 'That's a very good idea, we'll do it...and we won't tell anybody we've done it'..."

51. There was also the view that, whatever its faults, a national overview system might be good for **public relations purposes**. This could be on behalf of scientists and/or government: "It's not really to regulate what's done. It's more about public relations – that the government wants to convince people that there's a problem to solve for them by setting up these advisory boards. So from the scientists' perspective you don't want to lose the public's confidence in science because that's being eroded enough anyway. So if this advisory board served the purpose of, you know, making the government look good and also making the public confident in the science, it's not such a bad thing." As we have already seen in regard to other questions we also heard in regard to a national system that there were **easier routes for bioterrorists** to cause harm than using advanced biotechnology and that the **life sciences were already overregulated.**

52. The concerns expressed in regard to whether there should or could be a national review system are summarised in Table 6.

Table 6: Concerns about a national review system (Question 5)

1. We need to know.

2. System not feasible because objective judgements cannot be made.

3. System will inhibit benign research.

4. System would be open to evasion nationally and internationally.

5. System would be open to abuse.

6. Might be useful as a public relations exercise.

7. Easier routes for terrorists than using advanced biotechnology.

8. Life sciences already overregulated in the UK.

Question 6: Should or could there be an international review system?

53. As it was recognised that national review systems in individual countries should ideally be harmonised internationally, we considered whether the proposal, made by

the UK in its contribution to the background science and technology paper for the Fifth Review Conference, that there should be more frequent reviews of the advances in science and technology relevant to the BTWC than at the five year Review Conferences might be utilized to harmonise standards in national review systems.

54. For example, we thought that discussions, for example of the mousepox experiment, were perhaps missing the point if carried out in isolation. Maybe the real issue is whether the direction of a research programme as a whole should be examined? Thus the fact that mousepox with IL-4 inserted could lead to similar experiments with rabbitpox, cowpox (able to jump species), monkeypox and then smallpox was the concern that should be recognised. This we considered would be the kind of issue that would be identified by experts of the BTWC States Parties if they were to have more regular reviews of relevant science and technology in the future.

55. As there was so little knowledge of the BTWC amongst the participants in our seminars, we did not have time to raise this issue directly. We did try to open up some discussion by outlining the vast increases in funding give to the National Institutes of Health for defensive work on dangerous pathogens in the United States.[12] We asked whether this approach, with the implication that as many possible threats as could be investigated would be investigated, seemed sensible.

56. There was concern that this level of funding for biodefence could starve other, more important, fields of funds. One participant summarised: “I think that that funding is so disproportionate in the States. It's just taking away from the real issues." To that disproportionality argument was often added the view that you could not cover all the possibilities anyway. For example, one speaker asked: "Can you imagine how many potential threats there are or what those potential threats are?...I don't think you're necessarily going to hit the nail on the head." There were also participants who wondered whether working on the most dangerous agents/possibilities was a good idea. One said: "I think it's a terrible model....We've just been talking about how we want to avoid experiments that lead in the direction of creating weapons and what they're doing there is putting $4.2 billion dollars into experiments that lead towards weapons and it's all being publicised presumably."

57. Given that this discussion was rather more distant from Question 6, it would not be sensible to draw too strong a conclusion from the arguments presented. However, when combined with the probability that the issues raised in our seminars were new to many in the audience, it does suggest that these scientists who, after all, view what they are doing as for the benefit of humankind, would respond carefully if they came to see greater dangers arising from their activities.[13]

[12] Malcolm R. Dando, *The United States NIAID Research Programme on Biodefence: A Summary and Review of Varying Assessments*. Bradford Science and Technology Reports No. 1, 2004. Available at: http://www.brad.ac.uk/acad/sbtwc

[13] Caitriona McLeish & Paul Nightingale, *Effective Action to Strengthen the BTWC Regime: The Impact of Dual Use Controls on UK Science*, University of Bradford, Department of Peace Studies, Briefing Paper No. 17, May 2005. Available at: http://www.brad.ac.uk/acad/sbtwc

Further Analysis

58. It is possible to gain an insight into how important each of the concerns expressed were amongst the people we spoke to from the frequency with which versions of the same argument were put forward by different people in the seminars. Table 7 shows arguments that we heard more than ten times in the 15 seminars and Table 8 shows arguments that we heard between five and ten times. Clearly, therefore, in the discussions related to a preproject review the dominant argument was that at a particular point a certain experiment **was inevitably going to be done** somewhere by somebody. Stopping the experiment in one place, on this reasoning, was (in the end) futile.

Table 7: Concerns stated over ten times

Against a preproject review

Inevitability of the experiment.

Against a prepublication review

Disclosure inevitable by some other means.

Pressure to publish.

Against a national review system

Not feasible because objective judgements cannot be made.

System will inhibit benign research.

System will be open to evasion nationally and internationally.

Life sciences already overregulated in the UK.

59. In regard to the discussions related to a prepublication review there were two dominant concerns (Table 7). First, it was considered that the information would **inevitably be disclosed** in some way even if publication were prevented. It was also argued that there was **enormous pressure to publish** for career advancement and in order to obtain further funding. Four arguments were most frequently heard in the discussions of a national review system: that it would be **very difficult to make objective judgements**; that it would **inhibit good research**; that the system would be **subject to evasion**; and that the **life sciences were already overregulated** in the UK.

60. At a lower frequency we heard a further concerns against the proposed reviews (Table 8).

Table 8: Arguments stated between five and ten times

Against a preproject review

Necessity to demonstrate that it works.

Need to raise awareness.

Utility to design countermeasures.

Against a prepublication review

Need to raise awareness.

Utility to design countermeasures.

Social responsibility to publish.

Little danger because of difficulty of replication.

Dangers of censorship to the scientific enterprise.

Against a national review system

System would be open to abuse.

61. It was argued that it was not sufficient to say something could theoretically be done, **it had to be done to be sure**. It was also argued that doing an experiment like mousepox helped to **raise awareness** of possible biothreats and **allowed countermeasures to be developed**. **Raising awareness** and **designing countermeasures** were also arguments that we heard often in our discussions of a prepublication review. Additionally participants were concerned about **the dangers of censorship** to the scientific enterprise, felt that they had a **social responsibility to publish**, and that advanced biotechnology experiments would be **difficult to replicate**. Finally, in regard to a national review system, it was also argued that such a system could be **subject to a variety of abuses**.

Conclusions

62. As already mentioned, we thought it unlikely that many of the participants would have a coherent set of understanding as set out in our ideal types of "security conscious" (Table 2) and "classic" (Table 3). Given that our data strongly suggest that few of our participants had given much consideration **at all** to the biosecurity issues discussed, it is even less likely that such coherence would characterize their thinking.

63. The question of interest then is whether it would be reasonable to suggest that we were hearing from a community in which the arguments summarised in Tables 2 and 3 were equally expressed and so indicating a mixture of evaluations for and against consideration of controls, or whether the arguments for such controls (Table 2) or

against such controls (Table 3) predominated in our discussions. **From the data summarised in Tables 4 - 8 it seems unreasonable to conclude anything other than that the responses set out in Table 3 - the "classic" ideal type - predominate.** Certainly, it would be a great surprise to us to do a seminar in the UK (or we suspect elsewhere) where we found anything other than what we have reported here. Indeed, we would immediately have to investigate any special factors - perhaps an unusual educational module - that might explain the findings!

64. There was **little evidence** from our seminars that participants:

a. regarded bioterrorism or bioweapons as a substantial threat;

b. considered that developments in the life sciences research contributed to biothreats;

c. were aware of the current debates and concerns about dual-use research; or

d. were familiar with the BTWC.

This was a surprise to us, but it is consequently **not** surprising that the predominance of views expressed were those of the **"classic"** ideal type. This situation does though tell us much about the existing levels of awareness of biosecurity issues within the academic life science community in the UK and indicates the importance of considering questions about the education of life scientists as an essential prerequisite to any development of codes.

65. At successive Review Conferences of the BTWC States have agreed on the need to inform their scientific communities of the importance of the prohibitions embodied in the Convention. As stated in the Final Declaration of the Fourth Review Conference of 1996 in regard to Article IV:[14]

The conference notes the importance of....

Inclusion in textbooks and in medical, scientific and military education programmes of information dealing with the prohibitions and provisions contained in the Biological and Toxin Weapons Convention and the Geneva Protocol of 1925.

Given the lack of awareness of the BTWC and related issues that we encountered in our seminars we can only conclude that whatever measures were taken in this regard in the UK were not very effective. Anecdotal evidence suggests that this lack of awareness of the BTWC is not confined to the United Kingdom and the one seminar we conducted in another European country (Germany) produced results not significantly different from those in the UK. It seems likely that a similar situation may occur in regard to life scientists generally.

[14] Fourth Review Conference of the parties to the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction (1996) *Final Declaration*. BWC/CONF.IV/9, Geneva. Available at http://www.opbw.org

66. One clear implication of our findings, therefore, is that if the States Parties to the BTWC wish to engage practising life scientists in their considerations of what might need to be done, and what could be done, about codes of conduct, a significant awareness-raising exercise is urgently required. Such an exercise is needed over the longer term in order to benefit from their creative input in the national development and implementation of codes. Clearly, for the section of the life sciences community in universities there is every reason to consider whether the longer-term awareness-raising strategy should involve the development of educational provisions dealing with the problems of dual-use science and technology within the standard curriculum for life scientists. UNESCO's efforts through the World Commission on the Ethics of Scientific Knowledge and Technology (COMEST)[15] could contribute to such efforts.

67. Our findings underline the points made by the Royal Society in its policy document 04/05[16] addressing the issues to be considered by the States Parties to the BTWC in 2005 which noted that:

> *Introducing extended codes of conduct or practice based on existing health and safety regulations provides an opportunity for education and training to reinforce these regulations. Such a code would need to be consulted before any new work was conducted and at key stages during the project, and have greater value than a code that is a reference document. This would also reinforce the responsibility of scientists to take into consideration the reasonably foreseeable consequences of their activities.*

and went on to add that:

> *Undergraduate and postgraduate education programmes should ensure that students are capable of considering the reasonably foreseeable consequences of their activities, including identifying the possible misuse of science as well as tangible benefits to humanity. These programmes should recognise the potential for later misuse by the trained person of basic skills, technologies or knowledge acquired during the training. Examples of previous misuse of such training could be used where appropriate for the students concerned. When students enter postgraduate training within a research laboratory they are required to read, understand and comply with local and national safety legislation. Codes of conduct or practice provide an opportunity for education and training to reinforce the ethical and practical aspects of preventing the misuse of science.*

68. States Parties are devoting the 2005 sessions to codes of conduct for the life sciences because there is a real concern about the threat, that developments in the life sciences contribute to that threat, and therefore that additional measures – in the form of codes – should be carefully examined. Whilst it might be possible to elaborate and implement such codes without the direct engagement of practising life scientists, but

[15] United Nations Educational, Scientific and Cultural Organization, *What is the COMEST?* Available at:http://portal.unesco.org/shs/en/ev.php_URL_ID=1856&URL_DO=DO_TOPIC&URL_SECTION=201.html

[16] The Royal Society, *Issues for discussion at the 2005 Meeting of Experts of the Biological and Toxin Weapons Convention*, RS policy document, June 2005. Available at: http://www.royalsoc.ac.uk/document.asp?id=1170

given that they work at this particular coalface, such development and implementation will surely be more effective if done with their engagement. Our belief is that whilst some of their concerns will diminish as they further analyse these issues as a community, some core problems will remain. The diplomatic/security community needs, in our opinion, to imaginatively address these issues if an effective system is to be achieved.

69. If we consider the arguments we heard most frequently (Table 7) it is relatively easy to dismiss some, such as the inevitability of science. Similarly, there is no need for certain areas of research to be inhibited by new controls as long as care is taken to avoid such an outcome and disclosure of results can be guarded against if that is necessary. On the other hand, some of our participants' concerns are difficult to dismiss. In the UK academic environment there is a huge pressure on scientists to publish their results. To be prevented from doing so could be damaging to a scientists career prospects. Our participants did feel overregulated, they could envisage ways in which a national review system could be evaded and they would need a great deal of convincing that objective judgements could be made about the social consequences of the work they wished to publish.

70. In the "Controlling Dangerous Pathogens" project at the University of Maryland[17] the last of these issues is dealt with by splitting the analysis. First, on the basis of a detailed questionnaire, the proposed project is put into one of three categories: potentially, moderately or extremely dangerous. Potentially dangerous research would be the overwhelmingly large category and would be dealt with at the local level. The other two categories would require national and international scrutiny. Only after this scientific analysis would a social cost benefit assessment be made, and it would be assumed that most work would be agreed as permissible as the risks would be low. The success of such a system *as a means of constraining in some form ill-advised experiments* would crucially hinge on the feasibility of credibly conducting a social cost-benefit analysis for research categorized as moderately or extremely dangerous.

71. Given the widespread use of peer review in countries like the UK and its long experience of regulation through the Health and Safety Executive, it would seem that there are good grounds for believing that an adequately transparent system could be institutionalized at a national level if it is thought to be required and feasible.

72. In summary then, our conclusion, based on the work we have carried out in academia in the UK, is that it is likely that large sections of the worldwide life sciences community have hardly begun to address the question of their responsibilities in regard to the dual-use potential of the results and techniques of their work. We consider that a major effort will be required on the part of States Parties if the level of awareness of these scientists is to be increased. But we also believe that the life sciences community have much to contribute - much that perhaps only they can contribute - to the definition and necessary solution to the dual use problem. A further and sustained engagement is required – a goal to which a a 'code of conduct' *could* contribute.

[17] Steinbrunner, J.D. and Harris, E.D. (2003) *Controlling Dangerous Pathogens. Issues in Science and Technology*, Spring. Available at: www.nap.edu/issues/19.3/steinbrunner