



Principles and Approaches in Ethics Assessment

Dual-use in research

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Annex 1.g

Ethical Assessment of Research and Innovation: A Comparative Analysis of Practices and Institutions in the EU and selected other countries

Deliverable 1.1

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1 Basic description of the ethical issue

The Fink Report (an influential document of the US National Research Council (NRC) published by the National Academies Press in 2003) contains the most widely accepted and used definition of dual-use:

Research that, based on current understanding, can be reasonably anticipated to provide knowledge, products, or technologies that could be directly misapplied by others to pose a threat to public health and safety, agriculture, plants, animals, the environment, or material.¹

The World Health Organization (WHO) defines *dual-use research of concern* (DURC) as “life sciences research that is intended for benefit, but which might easily be misapplied to do harm”² and highlights that “the issues are broad and encompass not only research and public health, but also security, scientific publishing and public communications, biotechnology and ethics and wider societal issues”.³

A Horizon 2020 European Commission Guide on *How to complete your ethics Self-Assessment* suggests that dual-use research is “research that has the potential also for military applications”.⁴

Atlas and Dando suggest that the term “dual-use” has at least three different dimensions that pose a dilemma for modern biology and its possible misuse for hostile purposes:

- Ostensibly civilian facilities that are in fact intended for military or terrorist bioweapons development and production;
- Equipment and agents that could be misappropriated and misused for biological weapons development and production; and
- The generation and dissemination of scientific knowledge that could be misapplied for biological weapons development and production.⁵

Selgelid in an analysis of dual-use research Codes of Conduct proposes three plausible definitions of dual-use science and technology:

- That which has both civilian and military applications;
- That which can be used for both beneficial/good and harmful/bad purposes, and
- That which has both beneficial/good and harmful/bad purposes – where the harmful/bad purposes involve weapons, and usually weapons of mass destruction.⁶

The *Survey of Attitudes and Actions on Dual Use Research in the Life Sciences* highlights, the “knowledge, tools, and techniques gained through legitimate biological research could be

¹ National Research Council, *Biotechnology Research in an Age of Terrorism*, National Academies Press, Washington DC, 2004.

² Note, however that dual-use might be made of research in other non-life science disciplines too.

³ WHO, “Dual Use Research of Concern (DURC)”. <http://www.who.int/csr/durc/en/>

⁴ European Commission, Horizon 2020: How to complete your ethics Self-Assessment, Version 1.0 11 July 2014. http://ec.europa.eu/research/participants/portal4/doc/call/h2020/h2020-msca-itn-2015/1620147-h2020_-_guidance_ethics_self_assess_en.pdf

⁵ Atlas, Ronald M., and Malcolm Dando, “The Dual-Use Dilemma for the Life Sciences: Perspectives, Conundrums, and Global Solutions”, *Biosecurity and Bioterrorism: Biodefense Strategy, Practice, and Science*, September 2006, Vol. 4, Issue 3, pp. 276-286.

⁶ Selgelid, Michael, “Dual-Use Research Codes of Conduct: Lessons from the Life Sciences”, *Nanoethics*, 3, 2009, pp. 175–183.

misused for biowarfare or bioterrorism” resulting in what is termed as the ‘dual-use dilemma’ of the life sciences.⁷ This dilemma, as Miller and Selgelid highlight, poses an ethical dilemma not only for researchers but also for those (e.g., governments) who have the power or authority to assist or impede the researcher’s work,⁸ as “it is about promoting good in the context of the potential for also causing harm” and the “dilemma arises for the researcher because of the potential actions of others”.⁹ For instance, they cite the example of how “malevolent non-researchers might steal dangerous biological agents produced by the researcher; alternatively, other researchers—or at least their governments or leadership—might use the results of the original researcher’s work for malevolent purposes”¹⁰. Dual-use concerns include the potential of research to be used for bioterrorism, biowarfare and blackmail for financial gain.

In 2012, the US National Science Advisory Board for Biosecurity (NSABB) has recommended that research done by two separate groups Fouchier et al¹¹ and Kawaoka et al, with funding from the US National Institutes of Health (NIH), to understand the molecular characteristics underlying transmissibility, be redacted.¹² The NSABB was concerned about the “potential use of this research by terrorists looking to unleash, rather than prevent, a lethal influenza pandemic to warrant restrictions on access to critical technical details”. *Science and Nature* agreed to redact the research for publication, to help prevent the misuse by hostile actors, contingent on establishment of a mechanism to allow appropriate researchers and public health officials’ access to the complete information.¹³

According to Miller & Selgelid, dual-use is a problem for private and public institutions, including universities that fund or otherwise enable research to be undertaken (with it being “more acute for university-based researchers and for universities, given their commitments to such values as academic freedom and the unfettered dissemination of research findings; and for private companies, given their commitment to free-enterprise”.¹⁴). Miller and Selgelid also highlight how the dual-use dilemma affects “individual communities for whose benefit or, indeed, to whose potential detriment, the research is being conducted”, “national governments who bear the moral and legal responsibility of ensuring that the security of their citizens is provided for”, and “international bodies such as the United Nations”.¹⁵

Dual-use is an evolving concept. It seems particularly relevant to the life sciences. Areas where dual-use issues have been researched and identified include biomedical science, biology, agriculture, biosecurity, etc. However, as noted before, dual-use might equally apply to non-life

⁷ The National Academies, *A Survey of Attitudes and Actions on Dual Use Research in the Life Sciences A Collaborative Effort of the National Research Council and the American Association for the Advancement of Science*, 2009.

⁸ Miller, Seumas, & Michael J. Selgelid, “Ethical and Philosophical Consideration of the Dual-use Dilemma in the Biological Sciences”, *Science and Engineering Ethics*, 2007, 13, pp. 523–580, [p. 523]

⁹ Ibid.

¹⁰ Miller & Selgelid, op. cit., 2007, p. 524.

¹¹ Fouchier, Ron A.M, Sander Herfst, and A. D. M. E. Osterhaus, “Restricted data on influenza H5N1 virus transmission”, *Science*, 335, 6069, 2012, pp. 662-663.

¹² Faden, Ruth R., and Ruth A. Karron, “The obligation to prevent the next dual-use controversy”, *Science*, 335, 6070, 2012, pp. 802-804.

¹³ Ibid.

¹⁴ Miller & Selgelid, op. cit., 2007, p. 527

¹⁵ Miller & Selgelid, op. cit., 2007, p. 527

science research.¹⁶ One example cited is the publication of the paper outlining the mathematical modeling of potential impact of contaminating the milk supply with botulinum toxin (in this case involving scientists from the Graduate School of Business and Institute for Computational and Mathematical Engineering at Stanford University).¹⁷ Evans draws a strong link between dual use and nuclear science; he states, “Not only is the history of the nuclear sciences a history of a science with strong dual-use implications, but it is a science whose practitioners were intimately involved in the types of political and moral decisions we describe in debates about dual-use research”.¹⁸ Security research (i.e. research on organised crime, terrorism, man-made and natural disasters) has potential dual-use applications of technologies developed in many areas such as crisis management communications, border surveillance or CBRN detection technologies, as identified by the European Commission.¹⁹

Dual-use features as part of EU policy. The EU controls the export, transit and brokering of dual-use items as a key instrument contributing to international peace and security.²⁰ In the EU, dual-use export controls “affect research and development (R&D), production and trade of typically high-tech, advanced products across a wide-range of civil industries – e.g. energy, aerospace, defence and security, lasers and navigation, telecommunications, life sciences, chemical and pharmaceutical industries, material-processing equipment, electronics, semiconductor and computing industries, medical and automotive”.²¹

Role of bioethics in dual use

Kuhlau et al, point out that given “the inherent ethical nature of the dual use dilemma, it has traditionally been conceptualized within a security framework and consequently primarily engaged the security community (and, to a lesser extent, the scientific community)”.²² They suggest the dual use discussion in the field of bioethics is recent,²³ and “given the inherent ethical nature of the dual use dilemma, bioethicists’ interest in the life science dual use debate

¹⁶ See Satyanarayana, K., “Dual dual-use research of concern: Publish *and* perish?”, *The Indian Journal of Medical Research*, Vol. 133, Iss. 1, 2011, pp. 1-4; Selgelid, M.J., “A tale of two studies: ethics, bioterrorism, and the censorship of science”, *Hastings Center Report*, 37, 2007, pp. 35-43; Selgelid, M.J., “Governance of dual-use research: an ethical dilemma”, *Bull WHO*, 87, 2009, pp. 720-3.

¹⁷ Wein, LM, Y. Liu, “Analyzing a bioterror attack on the food supply: the case of Botulinum toxin in milk”, *Proc Natl Acad Sci USA*, 2005, 102, pp. 9984-9989.

¹⁸ Evans, Nicholas G., “Dual-Use Bioethics: The Nuclear Connection”, 18 October 2010, p. 6.
<http://www.brad.ac.uk/bioethics/media/SSIS/Bioethics/docs/NuclearSciencesWP.pdf>

¹⁹ European Commission, “Security research”. http://ec.europa.eu/enterprise/policies/security/faq/index_en.htm. Note, every security research proposal is evaluated by a panel of independent ethical-review specialists which helps ensure that no inappropriate research slips into the programme and that proper control and review mechanisms govern each project during its lifetime.

²⁰ European Commission, “Dual-use controls”. <http://ec.europa.eu/trade/import-and-export-rules/export-from-eu/dual-use-controls/>

²¹ European Commission, “Dual-use controls”. <http://ec.europa.eu/trade/import-and-export-rules/export-from-eu/dual-use-controls/>

²² Kuhlau, Frida, Kathinka Evers, Stefan Eriksson, and Anna T. Höglund, “Ethical Competence in Dual Use Life Science Research”, *Applied Biosafety: Journal of the American Biological Safety Association*, Vol, 17, No. 3, 2012, pp. 120-127.

²³ Citing Selgelid, M. J. “Ethics engagement of the dual use dilemma: Progress and potential”, in B. Rappert (ed.), *Education and ethics in the life sciences*.

Strengthening the prohibition of biological weapons. Canberra, ANU E Press, Australia, 2010.

has been surprisingly limited”.²⁴ Further Kuhlau et al state, “Although dual use discussions have a natural place within bioethics, the results of the engagement may not be what the security community expects or desires” as “unlike science, bioethics inherently involves evaluation of competing values and interests without necessarily producing quantitative answers. The fear is that the outcome of a bioethical analysis of the dual use dilemma may not support the approach and goals envisaged by the security community and that the effect may be different than that intended by proponents of biosecurity education.”²⁵ Kuhlau et al, suggest that despite the possible objections,

bioethics provides an important opportunity to build dual use ethical competence in the long-term. Such competence is valuable not only because it raises awareness and knowledge of dual use, but also because it enables individuals and the collective to develop and apply their knowledge. Ethical competence provides the capacity for scientists to recognize, understand, and take dual use responsibility, which is necessary to accomplish a culture of responsibility among life scientists.²⁶

2 Values and principles

The ethical values and principles that come into play in dual-use context include: welfare of humankind, respect of the dignity and rights of human beings, respect for the environment, responsibility towards present and future generations, beneficence and non-maleficence.

The *Declaration on Science and the Use of Scientific Knowledge* (1999) contains the following principles that are relevant to dual-use: welfare of humankind, respect of the dignity and rights of human beings, and of the global environment, responsibility towards present and future generations, scientific integrity, and equal access to science.²⁷

Some of the principles enshrined in the UNESCO *Universal Declaration on Bioethics and Human Rights* of 19 October 2005 are relevant to dual use: Human dignity and human rights (Article 3), Benefit and harm (Article 4), Autonomy and individual responsibility (Article 5), Consent (Article 6), Persons without the capacity to consent (Article 7), Respect for human vulnerability and personal integrity (Article 8), Privacy and confidentiality (Article 9), Equality, justice and equity (Article 10), Non-discrimination and non-stigmatization (Article 11), Respect for cultural diversity and pluralism (Article 12), Social responsibility and health (Article 14), Protecting future generations (Article 16), Protection of the environment, the biosphere and biodiversity (Article 17).

The European Group on Ethics of science and new technologies (EGE) *Opinion on the ethics of synthetic biology* highlights a number of ethical values and principles that might be relevant to dual-use:²⁸

²⁴ Kuhlau, op. cit., 2012, p. 124.

²⁵ Kuhlau, op. cit., 2012, p. 124.

²⁶ Kuhlau, op. cit., 2012, p. 125.

²⁷ World Conference on Science, Declaration on Science and the Use of Scientific Knowledge, Text adopted by the World Conference on Science, 1 July 1999. http://www.unesco.org/science/wcs/eng/declaration_e.htm

²⁸ The European Group on Ethics in Science and New Technologies (EGE), Opinion Of The European Group on Ethics in Science And New Technologies to the European Commission, 7 November 2009. http://www.coe.int/t/dg3/healthbioethic/COMETH/EGE/20091118%20finalSB%20_2_%20MP.pdf

- Respect for human dignity
- Principles of safety
- Sustainability
- Justice
- Precaution
- Freedom of research
- Proportionality
- Transparency

The US Presidential Commission for the Study of Bioethical Issues identifies five basic ethical principles for assessing emerging technologies and considering their social implications: (1) public beneficence, (2) responsible stewardship, (3) intellectual freedom and responsibility, (4) democratic deliberation, and (5) justice and fairness.²⁹ The Commission suggests that, “While many emerging technologies raise “dual use” concerns—when new technologies intended for good may be used to cause harm—these risks alone are generally insufficient to justify limits on intellectual freedom”.³⁰ It “endorses a principle of regulatory parsimony, recommending only as much oversight as is truly necessary to ensure justice, fairness, security, and safety while pursuing the public good”.³¹

In the context of the dissemination of dual-use research results, Miller and Selgelid highlight the importance of the principle of academic freedom that begins with the premise that freedom of intellectual inquiry is a fundamental human right.³² They suggest that while “it can be overridden if its exercise comes into conflict with other human rights, notably the right to life”, the censorship of academic research needs special, specific justification that details the high risk of misuse³³ (this and other issues are discussed in Section 8).

3 Ethical issues

A European Commission FP7 document suggests ethical issues of dual-use might arise in specific cases where:

- Classified information, materials or techniques are used in research
- Dangerous or restricted materials, e.g. explosives, are used in research
- The specific results of the research could present a danger to participants, or to society as a whole, if they were improperly disseminated.³⁴

There are various ethical controversies related to dual-use research. These include:

²⁹ US Presidential Commission for the Study of Bioethical Issues, *NEW DIRECTIONS -e Ethics of Synthetic Biology and Emerging Technologies*, Washington DC., December 2010. http://bioethics.gov/sites/default/files/PCSBI-Synthetic-Biology-Report-12.16.10_0.pdf

³⁰ Ibid.

³¹ US Presidential Commission, op. cit., 2010.

³² Miller, S., & M. J. Selgelid, “Ethical and philosophical consideration of the dual-use dilemma in the biological sciences”, *Science and Engineering Ethics*, Vol. 13, 2007, pp. 523–580.

³³ Miller, S., & M. J. Selgelid, “Ethical and philosophical consideration of the dual-use dilemma in the biological sciences”, *Science and Engineering Ethics*, Vol. 13, 2007, pp. 523–580, [p.552].

³⁴ European Commission, “Dual Use”. <ftp://ftp.cordis.europa.eu/pub/fp7/docs/dual-use.doc>

Increasing weaponisation (e.g. in terms of WMD)

One major ethical concern is the potential of research to facilitate or increase weaponisation. The EU stringently “controls the export, transit and brokering of dual-use items as a key instrument contributing to international peace and security”.³⁵ As highlighted by the European Commission, “Dual-use items are goods, software and technology normally used for civilian purposes but which may have military applications, or may contribute to the proliferation of Weapons of Mass Destruction (WMD)”.³⁶ The 2003 European Security Strategy³⁷ identifies the proliferation of weapons of mass destruction (nuclear, chemical, and biological weapons) and their possible acquisition by terrorist groups as one of the most serious threats to Europeans’ security.³⁸

Miller and Selgelid highlight another difficulty with reporting about and controlling the use, for instance, of genomes of infectious organisms that can be used as WMD. They suggest that this is more feasible in the western world, however “much of this work is now carried out in China and India where regulations to this effect would be far more difficult to impose and enforce.”³⁹

Discrimination between combatants and innocents and effects on accountability in drone and autonomous robotics, automated weapon systems development

Ethical problems arise in the development of weapons and systems that cannot discriminate between combatants and innocents. As Sharkey highlights “computer programs require a clear definition of a non-combatant, but none is available”.⁴⁰ Sharkey cautions, “Scientists and engineers working in robotics must be mindful of the potential dangers of their work, and public and international discussion is vital in order to set policy guidelines for ethical and safe application before the guidelines set themselves”.⁴¹ Egeland further shows how the development and use of autonomous weapons systems: “poses grave problems for the doctrine of the moral equality of soldiers, for the dignity of all parties involved, and for both legal and moral responsibility”.⁴²

Development of biological, chemical, nuclear/radiological-security sensitive materials and explosives and their potential for criminal, terrorist use or warfare

³⁵ Ibid.

³⁶ European Commission, “Dual-use controls”. <http://ec.europa.eu/trade/import-and-export-rules/export-from-eu/dual-use-controls/>

³⁷ Council of Europe, “A Secure Europe in a Better World: European Security Strategy”, Brussels, 12 December 2003. <https://www.consilium.europa.eu/uedocs/cmsUpload/78367.pdf>

³⁸ See also European Union External Action, “Disarmament, Non-Proliferation, and Arms Export Control”. http://www.eeas.europa.eu/non-proliferation-and-disarmament/index_en.htm

³⁹ Miller and Selgelid, op. cit., 2007, p. 558.

⁴⁰ Sharkey, Noel, “The Ethical Frontiers of Robotics”, *Science*, Vol. 322, No. 5909, 19 December 2008, pp. 1800 – 1801. http://www.intelligentzia.ch/blog/wp-content/uploads/The_Ethical_Frontiers_of_Robotics.pdf

⁴¹ Ibid.

⁴² Egeland, Kjølvs, *Machine Autonomy and the Uncanny: Recasting Ethical, Legal, and Operational Implications of the Development of Autonomous Weapon Systems*, Master’s Thesis in Political Science Department of Political Science, University of Oslo, Spring 2014.

<https://www.duo.uio.no/bitstream/handle/10852/41263/Thesis--15-05-2014--Machine-Autonomy-and-the-Uncanny.pdf?sequence=1>

Another ethical controversy of dual-use research is its potential to lead to the development of biological, chemical, nuclear/radiological-security sensitive materials and explosives. These materials have a high potential for criminal, terrorist use or warfare. They may be used to create threats to national and/or public security (e.g. by causing illness and disease, death, mass casualties, panic, disruptions, increased weaponisation). Bezuidenhout and Rappert highlight the example of the 2001 US anthrax letter mailings that did not cause mass casualties, but were “highly disruptive and economically costly”. Further they state that “biological weapons are treated as worrying because they are “weapons of mass destruction” or “weapons of mass disruption”, and this is “an important consideration when assessing the potential for dual-use research”.⁴³

The *Postnote* on the *Dual-Use Dilemma* highlights how, in the wake of the September 11, 2001 attacks, some US commentators argued that some reports such as those of Jackson et al⁴⁴ and Cello⁴⁵ that “provided a blueprint for bio-weapon development by terrorists and should not have been published”.⁴⁶

Development of technologies or the creation of information that could have severe negative impacts on human rights

Another ethical controversy of dual-use research is its potential to lead to the development of technologies or create information that could have severe negative impacts on human rights and civil liberties. For example, neuroimaging research might facilitate the ability to determine personal characteristics and inclinations of people – this has both privacy and human rights implications. Research and development of technologies that facilitate surveillance might facilitate increased identification of individuals, and affect their ability to be anonymous.⁴⁷ By helping create new norms of criminality and suspicion for certain target groups of individuals these often help foster discrimination and stigmatisation; they can also have other effects on civil liberties and fundamental rights.⁴⁸

One article on drones (unmanned vehicles) highlights how the defence industry and major weapons manufacturers such as Selex, EADS, Dassault Aviation, Finmeccanica Thales, and Sagem are benefitting from EU research funding and “reaping the benefits of dual-use

⁴³ Bezuidenhout, Louise & Brian Rappert, “The Ethical Issues of Dual-Use and the Life Sciences”, C O R E Issues in Professional and Research Ethics, Volume 1, Paper 1, 2012.

⁴⁴ Jackson R., et al., “Expression of Mouse Interleukin-4 by a Recombinant Ectromelia Virus Suppresses Cytolytic Lymphocyte Responses and Overcomes Genetic Resistance to Mousepox” *Journal of Virology*, February 2001, Vol. 75, No. 3, pp. 1205-1210.

⁴⁵ Cello, Jeronimo, Aniko V. Paul, and Eckard Wimmer, “Chemical synthesis of poliovirus cDNA: generation of infectious virus in the absence of natural template”, *Science*, 297.5583, 2002, pp. 1016-1018.

⁴⁶ The Parliamentary Office of Science and Technology, “The Dual-Use Dilemma”, *Postnote*, Number 340, July 2009.

⁴⁷ Fonio, Chiara, “Surveillance and the (re)construction of personal identity”, in William Webster (ed.), *Deliverable D2.1: The Social Perspective: A report presenting a review of the key features raised by the social perspectives of surveillance and democracy*, IRISS project, 31 January 2013, p. 33. <http://irissproject.eu/wp-content/uploads/2013/04/Social-perspectives-of-surveillance-and-democracy-report-D2.1-IRISS.pdf>

⁴⁸ See chapter 7 *Effects of surveillance on civil liberties and fundamental rights in Europe*, in David Wright and Reinhard Kreissl (eds.), *Surveillance in Europe*, Routledge, Abingdon, Oxon, 2015, pp. 259-318.

technologies and dual-use research and production projects”.⁴⁹ Drones have implications for privacy, civil liberties, and human rights and also trigger “a number of ethical and *jus in bello* concerns especially in instances where chain-of-command decisions on drone strikes raise questions of transparency, discrimination, and proportionality”.⁵⁰

4 Organisations

The table below lists some of major organisations that are involved in dual-use policy and addressing dual-use research concerns.

Name	Aim/thrust	Web link	Relation to dual-use
European Commission	Policy-making, regulation, research funding.	http://ec.europa.eu/trade/import-and-export-rules/export-from-eu/dual-use-controls/	Includes dual-use as an ethical issue to be addressed in funding applications.
Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies Secretariat	The Wassenaar Arrangement has been established in order to contribute to regional and international security and stability, by promoting transparency and greater responsibility in transfers of conventional arms and dual-use goods and technologies.	http://www.wassenaar.org/	Participating States seek, through their national policies, to ensure that transfers of these items do not contribute to the development or enhancement of military capabilities which undermine these goals, and are not diverted to support such capabilities.
National Science Advisory Board for Biosecurity (NSABB)	An US federal advisory committee	http://osp.od.nih.gov/office-biotechnology-activities/biosecurity/nsabb	Addresses issues related to biosecurity and dual-use research at the request of the United States Government. See the NSABB Proposed Framework for the Oversight of Dual Use Life Sciences Research ⁵¹ .

⁴⁹ Csernaton, Raluca, “Policy Briefs: ‘The Game of Drones’ – Hybrid Unmanned Vehicles as the Next Step in EU Defence”, *ISIS Europe*, 25 June 2014. <https://isiseurope.wordpress.com/2014/06/25/policy-brief-the-game-of-drones-hybrid-unmanned-vehicles-as-the-next-step-in-eu-defence/>

⁵⁰ Ibid.

⁵¹ <http://osp.od.nih.gov/office-biotechnology-activities/nsabb-reports-and-recommendations/proposed-framework-oversight-dual-use-life-sciences-research>

Name	Aim/thrust	Web link	Relation to dual-use
The Royal Netherlands Academy of Arts and Sciences (KNAW)	Advisory body to the Dutch Government/ responsible for sixteen research institutes.	http://www.bureaubiosecurity.nl/en/Policy/Dual_use_research	In 2007, KNAW, commissioned by the Ministry of Education, Culture and Science drew up a Code of Conduct for Biosecurity aimed at raising awareness of the risks of working with high-risk pathogens ⁵² . In 2013, KNAW published the advisory report ‘ <i>Improving biosecurity – Assessment of dual-use research.</i> ’
InterAcademy Panel (IAP)	Global network of science academies	http://www.interacademies.net/File.aspx?id=5401	IAP Statement on Biosecurity 2005 suggests that “scientists have a special responsibility when it comes to problems of "dual use" and the misuse of science and technology”.

Table 1: Key organisations

The other key-efforts of other organisations re dual-use are documented in sections 5 and 6.

5 Institutionalisation

Based on the initiatives examined in this section, it could be said that the degree of institutionalisation of ethics assessment in this area is good.

Many international and national organisations such as the World Medical Association (WMA), the American Association for the Advancement of Science (AAAS), the International Committee of the Red Cross, the British Royal Society, the Wellcome Trust have recognised the importance of self-regulation (and ethics education) as a tool for dual-use governance. Various self-regulatory initiatives relevant to dual-use include:

- WMA Declaration of Washington on Biological Weapons⁵³
- The InterAcademy Panel (IAP) Statement on Biosecurity⁵⁴
- The International Union of Microbiological Societies (IUMS) Code of Ethics against Misuse of Scientific Knowledge, Research and Resources⁵⁵
- The International Association of Synthetic Biology (IASB) Code of Conduct for Best Practices in Gene Synthesis⁵⁶

⁵² *The Code of Conduct for Biosecurity was drawn up by the Royal Netherlands Academy of Arts and Sciences, 2007.* http://www.bureaubiosecurity.nl/en/Policy/Dual_use_research/Code_of_Conduct_for_Biosecurity

⁵³ WMA General Assembly, WMA Declaration of Washington on Biological Weapons, 2002 (revised 2012). <http://www.wma.net/en/30publications/10policies/b1/>

⁵⁴ <http://www.interacademies.net/File.aspx?id=5401>

⁵⁵ <http://www.iums.org/index.php/code-of-ethics>

⁵⁶ <http://www.ia-sb.eu/go/synthetic-biology/synthetic-biology/code-of-conduct-for-best-practices-in-gene-synthesis/>

- IAP Statement on Realising Global Potential in Synthetic Biology: Scientific Opportunities and Good Governance⁵⁷
- The joint Biotechnology and Biological Sciences Research Council (BBSRC), Medical Research Council (MRC) and the Wellcome Trust policy statement on *Managing risks of misuse associated with grant funding activities*.⁵⁸

The European Commission Horizon 2020 research programme has an *Ethics Issues Checklist* which includes a section on dual-use (section 8), depicted below:

Section 8: DUAL USE *		YES/NO		Page	Information to be provided	Documents to be provided
Does your research have the potential for military applications?		<input type="checkbox"/>	<input type="checkbox"/>			
If YES	Does your research have an exclusive civilian application focus?	<input type="checkbox"/>	<input type="checkbox"/>		Explanations on the exclusive civilian focus of the research	Confirmation that the inclusion of military partners and technologies relates to civilian applications e.g. in the context of law enforcement activities.
	Will your research use or produce goods or information that will require export licenses in accordance with legislation on dual use items?	<input type="checkbox"/>	<input type="checkbox"/>		Details on what goods and information used and produced in your research will need export licences	Copies of relevant approvals from national export control authorities, if applicable.
	Does your research affect current standards in military ethics – e.g. global ban on weapons of mass destruction, issues of proportionality, discrimination of combatants and accountability in drone and autonomous robotics developments, incendiary or laser weapons?	<input type="checkbox"/>	<input type="checkbox"/>		Details on how the research might affect current standards in military ethics.	A detailed description on what risk mitigation strategies will be implemented to avoid negative implications on military ethics standards outlined in international humanitarian law.

Table 2: Section 8 of the Ethics Issues Checklist of H2020 on Dual-Use.

The same document also has a section 9 on ‘misuse’ that is relevant to the discussion on dual-use and is depicted below:

⁵⁷ IAP, IAP Statement on Realising Global Potential in Synthetic Biology: Scientific Opportunities and Good Governance, 7 May 2014. <http://www.interacademies.net/File.aspx?id=23974>

⁵⁸ September 2005. <http://www.wellcome.ac.uk/About-us/Policy/Policy-and-position-statements/wtx026594.htm>

Section 9: MISUSE		YES/NO	Page	Information to be provided	Documents to be provided
Does your research have the potential for malevolent/criminal/terrorist abuse?		<input type="checkbox"/>	<input type="checkbox"/>		
If YES	Does your research involve information on/or the use of biological-, chemical-, nuclear/radiological-security sensitive materials and explosives, and means of their delivery?	<input type="checkbox"/>	<input type="checkbox"/>	Details on the legal requirements of the possession of such items and proposed risk mitigation strategies.	Copies of relevant Approvals, if applicable. Copies of personnel security clearances, if applicable
	Does your research involve the development of technologies or the creation of information that could have severe negative impacts on human rights standards (e.g. privacy, stigmatization, discrimination), if misapplied?	<input type="checkbox"/>	<input type="checkbox"/>	Details on measures to prevent malevolent abuse. Details on risk mitigation strategies.	Copies of relevant Ethics Approvals, if applicable.
	Does your research have the potential for terrorist or criminal abuse e.g. infrastructural vulnerability studies, cybersecurity related research?	<input type="checkbox"/>	<input type="checkbox"/>	Details on measures to prevent malevolent abuse. Details on risk mitigation strategies.	Copies of relevant Ethics Approvals, if applicable. Copies of personnel security clearances, if applicable.

Table 3: Section 9 of the Ethics Issues Checklist of H2020 on Misuse.

The Horizon 2020 document *How to Complete your Ethics Self-Assessment*⁵⁹ states that research must comply with ethical principles and applicable international, EU and national law (in particular, Regulation (EC) No 428/2009⁶⁰). Further, it states that “research must follow national legislation for civil research and not rely on legal exceptions for military research”.⁶¹ It states that for cross-border transfers of dual-use materials, technologies and information, researchers must observe EU export control Regulation (EC) No 428/2009 and in case of any doubts should consult the relevant national export control authority to clarify whether transfer licences are needed. For research that may affect military ethics standards i.e., if the research may be concerned by international non-proliferation laws or international humanitarian laws on military ethics (e.g. pathogen-related research, development of autonomous robotics, drones and certain laser technologies, etc.) it must comply with the international legislation in this area (in particular, the Biological and Toxin Weapons Convention⁶²). Researchers are advised to appoint an independent ethics adviser or ethics board, with relevant ethics and security expertise, to carry out a risk-benefit analysis of the intended research and to suggest appropriate safeguards to cover security risks (during, and beyond, the lifetime of the project) and training for researchers.

⁵⁹ European Commission, *How to Complete your Ethics Self-Assessment*, Version 1.0 11 July 2014. http://ec.europa.eu/research/participants/portal/doc/call/h2020/h2020-msca-itn-2015/1620147-h2020_-_guidance_ethics_self_assess_en.pdf

⁶⁰ Council of the European Union, Council Regulation (EC) No 428/2009 of 5 May 2009 setting up a Community regime for the control of exports, transfer, brokering and transit of dual-use items *OJ L* 134, 29.5.2009, pp. 1-269.

⁶¹ European Commission, *How to Complete your Ethics Self-Assessment*, op. cit., 2014.

⁶² United Nations, The Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction, [aka, the Biological Weapons Convention (BWC) or Biological and Toxin Weapons Convention (BTWC)], 10 April 1972. [http://www.unog.ch/80256EDD006B8954/\(httpAssets\)/C4048678A93B6934C1257188004848D0/\\$file/BWC-text-English.pdf](http://www.unog.ch/80256EDD006B8954/(httpAssets)/C4048678A93B6934C1257188004848D0/$file/BWC-text-English.pdf)

6 International frameworks and protocols

The following are the main international laws, regulations, codes and relevant frameworks:

- Council of the European Union, Council Regulation (EC) No 428/2009 of 5 May 2009 setting up a Community regime for the control of exports, transfer, brokering and transit of dual-use items *OJ L* 134, 29.5.2009, pp. 1-269.
- European Union, EU CBRN Action Plan, 2009. http://ec.europa.eu/homeaffairs/summary/docs/com_2009_0273_annexe_2_en.pdf
- International Commission for the Red Cross, Protocol for the Prohibition of the Use of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare, Geneva, 17 June 1925. <http://www.icrc.org/ihl.nsf/FULL/280?OpenDocument> (25 Jan 2011)
- Organisation for the Prohibition of Chemical Weapons, Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction. Entry into force 1997. http://www.opcw.org/index.php?eID=dam_frontend_push&docID=6357
- Organization for Economic Co-Operation and Development (OECD), OECD Best Practice Guidelines for Biological Resource Centres, 2007. <http://www.oecd.org/dataoecd/7/13/38777417.pdf>
- The Australia Group, Guidelines for Transfers of Sensitive Chemical or Biological Items, January 2009, <http://www.australiagroup.net/en/guidelines.html>
- The European Parliament and the Council, Regulation (EU) No 388/2012 of 19 April 2012 amending Council Regulation (EC) No 428/2009 setting up a Community regime for the control of exports, transfer, brokering and transit of dual-use items, *OJ L* 129, 16.5.2012, pp. 12-280.
- The European Parliament, the Council and the Commission, Charter of Fundamental Rights of the European Union, (2000/C 364/01), *Official Journal of the European Communities*, C 364/1, 18 December 2000.
- The Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies, 19 December 1995. <http://www.wassenaar.org/introduction/index.html>
- United Nations Educational, Scientific and Cultural Organization (UNESCO), Declaration on Science and the Use of Scientific Knowledge. Text adopted by the World Conference on Science, 1 July 1999. http://www.unesco.org/science/wcs/eng/declaration_e.htm
- United Nations Security Council Resolution 1540 (2004), Adopted by the Security Council at its 4956th meeting, on 28 April 2004, S/RES/1540 (2004). [http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1540%20\(2004\)](http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/1540%20(2004))
- United Nations, The Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction, [aka, the Biological Weapons Convention (BWC) or Biological and Toxin Weapons Convention (BTWC)], 10 April 1972.

- [http://www.unog.ch/80256EDD006B8954/\(httpAssets\)/C4048678A93B6934C1257188004848D0/\\$file/BWC-text-English.pdf](http://www.unog.ch/80256EDD006B8954/(httpAssets)/C4048678A93B6934C1257188004848D0/$file/BWC-text-English.pdf)
- United Nations, Treaty on the Non-Proliferation of Nuclear Weapons (NPT), 1 July 1968. Entry into force 1970. <http://www.un.org/disarmament/WMD/Nuclear/NPTtext.shtml>
 - World Health Organization (WHO), Biorisk Management: Laboratory Biosecurity Guidance WHO/CDS/EPR/2006.6, September 2006. http://www.who.int/csr/resources/publications/biosafety/WHO_CDS_EPR_2006_6.pdf

Below is a list of other frameworks and institutional measures including those evident at the non-governmental organisation level:

- American Medical Association, Guideline to Prevent Malevolent Use of Biomedical Research, 2005. <http://www.ama-assn.org/ama/pub/physician-resources/medical-ethics/code-medical-ethics/opinion2078.shtml>
- InterAcademy Panel on International Issues (IAP), IAP Statement on Biosecurity, 2005. <http://www.interacademies.net/File.aspx?id=5401>
- International Committee of the Red Cross, Biotechnology, Weapons and Humanity: ICRC outreach to the life science community on preventing hostile use of the life sciences, 7 May 2004. <http://www.icrc.org/web/eng/siteeng0.nsf/html/5Z7CWQ>
- International Council for Science, Freedom, Responsibility and Universality of Science, 2008. http://www.icsu.org/Gestion/img/ICSU_DOC_DOWNLOAD/2205_DD_FILE_Freedom_Responsibility_Universality_of_Science_booklet.pdf
- International Union of Microbiological Societies, IUMS Code of Ethics against Misuse of Scientific Knowledge, Research and Resources, 26 April 2011. http://www.nvnm-online.nl/downloads/IUMS_CodeOfEthics_20070903.pdf
- The European Association for Bioindustries, EuropaBio's Core Ethical Values, October 1998. <http://www.europabio.org/documents/corevalues.pdf>
- Wellcome Trust, Position statement on bioterrorism and biomedical research. <http://www.wellcome.ac.uk/Aboutus/Policy/Policy-and-position-statements/WTD002767.htm>
- World Medical Association, WMA Declaration of Washington on Biological Weapons, 16 May 2003. <http://www.wma.net/en/30publications/10policies/b1/index.html>

Examples of the largely publicised and relevant initiatives relevant to dual-use at the national level:

Netherlands:

- List of Strategic Goods⁶³

⁶³ Rijksoverheid, Annex II – Dual-use goederenlijst (cat. 0 t/m 9) – bijlage I van verordening, 11 June 2010. <http://www.rijksoverheid.nl/onderwerpen/exportcontrole-strategischegoederen/documenten->

- Law on Terrorist Crimes 2004⁶⁴
- Code of Conduct for Biosecurity⁶⁵
- The Netherlands Code of Conduct for Scientific Practice

United Kingdom:

- Anti-Terrorism, Crime and Security Act of 2001.
- British Medical Association (BMA), *Biotechnology, weapons and humanity*, 1999.⁶⁶
- The Royal Society, *The Roles of Codes of Conduct in Preventing the Misuse of Scientific Research*⁶⁷

United States:

- Public Health Security and Bioterrorism Preparedness and Response Act of 2002 ("the Bioterrorism Act")
- WMD Prevention and Preparedness Act of 2010
- NSABB Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential Misuse of Research Information
- NSABB Strategic Plan for Outreach and Education On Dual Use Research Issues

Australia:

- Weapons of Mass Destruction (Prevention of Proliferation) Act 1995
- Crimes (Biological Weapons) Act 1976

7 Strategies

This section sets out some key measures and strategies used to address concerns and implications of the use of and misuse of research.

In a 2008 article on *Taking Due Care: Moral Obligations in Dual Use Research*, Kuhlau et al, suggest five closely-related and potentially overlapping criteria for identifying ‘harm’ that may reasonably be within researchers’ moral responsibility to prevent. They suggest that “in order to take social responsibility and due care, life scientists should strive to prevent harm that is:

- Within their professional responsibility
- Within their professional capacity and ability
- Reasonably foreseeable
- Proportionally greater than the benefits
- Not more easily achieved by other means”.⁶⁸

enpublicaties/rapporten/2010/06/11/Annex+II+Dual+use+goederenlijst+cat+0+t+m+9+bijlage+I+van+verordening.html

⁶⁴ Staatsblad van het Koninkrijk der Nederlanden, Wet van 24 juni 2004 tot wijziging en aanvulling van het Wetboek van Strafrecht en enige andere wetten in verband met terroristische misdrijven (Wet terroristische misdrijven), 2004. http://www.eerstekamer.nl/behandeling/20040630/publicatie_wet/f=w28463st.pdf

⁶⁵ Koninklijke Nederlandse Akademie van Wetenschappen (KNAW), *Code of Conduct for Biosecurity*, 2009. <http://www.knaw.nl/en/news/publications/a-code-of-conduct-for-biosecurity>

⁶⁶ British Medical Association, *Biotechnology, weapons and humanity*, Harwood Academic Publishers, Amsterdam, 1999.

⁶⁷ The Royal Society, *The roles of codes of conduct in preventing the misuse of scientific research*, 9 June 2005. <http://royalsociety.org/The-roles-of-codes-of-conduct-in-preventing-the-misuse-of-scientific-research/>

In 2011, in another article Kuhlau, Höglund, Evers and Eriksson conclude that the precautionary principle (mainly used in environmental and public health issues) is “meaningful and useful if applied as a context-dependent moral principle and allowed flexibility in its practical use”, by inspiring “awareness-raising and the establishment of practical routines which appropriately reflect the fact that life science research may be misused for harmful purposes”.⁶⁹

A European Commission document on *dual-use* suggests that the following measures and strategies should be applied to address the implications for the use of and misuse of research and products:

- The consortium should show awareness of potential risks to participants and society as a whole from inappropriate dissemination of their results
- Appropriate measures to deal with dangerous or restricted materials should be detailed, where applicable
- An appropriate strategy to deal with issues of informed consent and risk management for participants and for society where classified information, materials or techniques are concerned should be demonstrated
- An advisory board should be included in the project, which should identify risks to participants from particular research activities and devise a strategy for minimising and dealing with these risks
- The dissemination and communication strategy of the study results to a wider audience should be controlled by the advisory board, which should report to the Commission on a regular basis.⁷⁰

In the US context, the Fink report made seven recommendations that have been internationally recognised as measures of dealing with dual-use concerns:⁷¹

- Educating the scientific community
- Review of plans for experiments
- Review at the publication stage
- Creation of a national science advisory board for biodefense,
- Additional elements for protection against misuse,
- A role for the life sciences in efforts to prevent bioterrorism and biowarfare, and
- Harmonized international oversight.

8 Other issues

This section highlights other notable issues regarding dual-use.

Limiting publication of information on dual-use discoveries

⁶⁸ Kuhlau, Frida, Stefan Eriksson, Kathinka Evers and Anna T. Höglund, “Taking due care: moral obligations in dual use research”, *Bioethics*, 22, 9, 2008, pp. 477-487 [pp. 481-482].

⁶⁹ Kuhlau, F., A. T. Höglund, K. Evers, S. Eriksson, “A precautionary principle for dual use research in the life sciences”, *Bioethics*, 25, 1, Jan. 2011, pp. 1-8.

⁷⁰ European Commission, “Dual Use”. <ftp://ftp.cordis.europa.eu/pub/fp7/docs/dual-use.doc>

⁷¹ National Research Council, *Biotechnology Research in an Age of Terrorism*, National Academies Press, Washington DC, 2004.

One of the measures to reduce the negative effects of dual-use research is limiting the publication of information on dual-use discoveries. However, this might not be an optimal measure by itself given Miller and Selgefield's comments:

While the protection of security and public health may arguably provide grounds for limiting dissemination of information related to dual-use discoveries, at least in certain instances, the issue of censorship should not be taken lightly. Governmental control over dissemination of information poses threats to widely cherished goods such as academic freedom (of inquiry), scientific autonomy, and freedom of speech itself. It is commonly held that these things are not only good in themselves but essential to the progress of science.⁷²

Civil society as a partner in the governance of dual-use

An article by Rath, Ischi and Perkins⁷³ suggests that "Civil society can be an important partner in governance of dual use, especially with regard to research ethics"; and that "Civil society also has an important role to play both nationally and internationally, to work with governments and communities to create and strengthen norms to drive political initiatives towards further policies, agreements or resolutions or strengthening the existing multilateral non-proliferation treaties".⁷⁴

The SecurePART project (2014-2016) funded by the European Union's Seventh Framework Programme for research, technological development and demonstration, "aims at enhancing the influence of civil society on formulating, implementing and monitoring EU security research".⁷⁵ The project believes that "strengthening civil society participation is necessary in order to foster inclusiveness and accountability of the research process, ensure legitimacy and relevance of research outcomes, and mitigate negative impacts such as violations of ethical principles, fundamental rights, or privacy of the citizens".⁷⁶ The project highlights that CSOs play different roles in research projects: policy observers, project evaluators, programme agenda influencers, performers of projects, commissioners of research and disseminators. However, this does not mean CSOs are currently optimally participating in helping govern or mitigate dual-use issues – this could be due to their lack of awareness about the project, its nature, or technology involved, and its dual use potential.

Need for further research on dual-use in disciplines other than life sciences

⁷² Miller, S., & M. J. Selgeid, "Ethical and philosophical consideration of the dual-use dilemma in the biological sciences", *Science and Engineering Ethics*, Vol. 13, 2007, pp. 523–580.

⁷³ Rath, Johannes, M. Ischi, Dana Perkins, "Evolutions of Different Dual-use Concepts in International and National Law and Its Implications on Research Ethics and Governance", *Science and Engineering Ethics*, Vol. 20, Iss. 3, Sept. 2014, pp. 769-790 [p. 788].

⁷⁴ Ibid.

⁷⁵ <http://www.securepart.eu/>

⁷⁶ http://www.securepart.eu/files/Flyer_CSOs.pdf

As stated before, dual-use is not just a problem that can occur within the context of life science research even though the majority of dual-use literature focuses on this aspect. As some authors suggest further research is needed to investigate its occurrence in other science disciplines.⁷⁷

9 Journal and conference series

Journals, series

- Bioethics: <http://onlinelibrary.wiley.com/journal/10.1111/%28ISSN%291467-8519>
- EMBO Reports: <http://embor.embopress.org/>
- NanoEthics: <http://link.springer.com/journal/11569>
- Research Ethics: <http://www.uk.sagepub.com/journals/Journal202119>
- Science and Engineering Ethics: <http://www.springer.com/social+sciences/applied+ethics/journal/11948>
- Springer, Series: Applied Ethics and Social Responsibility: <http://www.springer.com/social+sciences/applied+ethics?SGWID=0-40391-0-0-0>

Conferences, events

- Forum on European Export Controls for Dual Use Goods. <http://www.c5-online.com/eec>
- The Polish Academy of Sciences hosted an international conference on “The Advancement of Science and the Dilemma of Dual Use: Why We Can't Afford to Fail” on 9-10 November 2007 in Warsaw. http://www.english.pan.pl/index.php?option=com_content&view=article&id=236:international-conference-on-dual-use&catid=57:archive&Itemid=88

10 Key publications

1. Atlas, Ronald M., and Malcolm Dando, “The Dual-Use Dilemma for the Life Sciences: Perspectives, Conundrums, and Global Solutions”, *Biosecurity and Bioterrorism: Biodefense Strategy, Practice, and Science*, September 2006, Vol. 4, Issue 3, pp. 276-286.
2. Briggie, A., “Double effect and dual use”, in C. Mitcham (ed.), *Encyclopedia of science, technology, & ethics (Vol. 2)*, Macmillan Reference USA, Detroit, MI, 2005.
3. Committee on Advances in Technology and the Prevention of Their Application to Next Generation Biowarfare Threats, National Research Council, *Globalization, Biosecurity, and the Future of the Life Sciences*, The National Academies Press, Washington, D.C., 2006. http://www.nap.edu/openbook.php?record_id=11567 [Lemon-Relman report]
4. European Commission, “Dual Use”. <ftp://ftp.cordis.europa.eu/pub/fp7/docs/dual-use.doc>
5. European Commission, “Dual-use controls”. <http://ec.europa.eu/trade/import-and-export-rules/export-from-eu/dual-use-controls>

⁷⁷ Oltmann, Shannon, “Dual Use Research: Investigation across Multiple Science Disciplines”, *Science and Engineering ethics*, 2014, pp. 1-15.

6. Forge, J., “A note on the definition of “dual use””, *Science and Engineering Ethics*, 16, 2010, pp. 111–118.
7. Kuhlau, Frida, A. T., Höglund, K. Evers, S. Eriksson, “A precautionary principle for dual use research in the life sciences”, *Bioethics*, Vol. 25, No. 1, Jan. 2011, pp. 1-8.
8. Kuhlau, Frida, *Responsible conduct in dual use research: Towards an ethic of deliberation in the life sciences*, Acta Universitatis Upsaliensis, Digital Comprehensive Summaries of Uppsala Dissertations from the Faculty of Medicine, Uppsala, 2013. <http://uu.diva-portal.org/smash/get/diva2:603143/FULLTEXT01.pdf>.
9. Kuhlau, Frida, S. Eriksson, A. T. Höglund, and K. Evers, “The ethics of disseminating dual-use knowledge”, *Research Ethics*, Vol. 9, No. 1, 2013, pp. 6-19.
10. Kuhlau, Frida, Stefan Eriksson, Kathinka Evers and Anna T. Höglund, "Taking due care: moral obligations in dual use research", *Bioethics*, 22, 9, 2008, pp. 477-487.
11. Leopoldina (German National Academy of Sciences), “Dual Use - Handling Security-Relevant Research”. <http://www.leopoldina.org/en/policy-advice/working-groups/completed-working-groups/dual-use/>
12. Leopoldina, “DFG und Leopoldina legen Empfehlungen ‘Wissenschaftsfreiheit und Wissenschaftsverantwortung’ vor”, 26 June 2012. <http://www.leopoldina.org/de/presse/nachrichten/stellungnahme-dual-use/>
13. McLeish, C., and P. Nightingale, “The impact of dual use controls on UK science: Results from a pilot study”, SPRU Electronic Working Paper Series, 132, 2005. <https://www.sussex.ac.uk/webteam/gateway/file.php?name=sewp132&site=25>
14. Miller, Seumas and Michael J. Selgelid, “Ethical and Philosophical Consideration of the Dual-use Dilemma in the Biological Sciences”, *Science and Engineering Ethics*, 13, 2007, pp. 523–580.
15. National Research Council, *Biotechnology Research in an Age of Terrorism*, National Academies Press, Washington, DC, 2004. [*Fink Report*]
16. Rath, Johannes, M. Ischi, Dana Perkins, "Evolutions of Different Dual-use Concepts in International and National Law and Its Implications on Research Ethics and Governance", *Science and Engineering Ethics*, Vol. 20, Iss. 3, Sept. 2014, pp. 769-790.
17. Resnik, D., “What is dual use research? A response to Miller and Selgelid (2009)”, *Science and Engineering Ethics*, Vol. 15, Iss. 1, 2009, pp. 3–5.
18. Selgelid, M. J., “Governance of dual-use research: an ethical dilemma”, *The Bulletin of the World Health Organization*, 87, 2009, pp. 720–3.
19. Selgelid, M., “Ethics engagement of the dual-use dilemma: Progress and potential”, in B. Rappert (ed.), *Education and ethics in the life sciences: Strengthening the prohibition of biological weapons*, ANU E Press, Canberra, 2009, pp. 23–43.
20. Selgelid, Michael, “Dual-Use Research Codes of Conduct: Lessons from the Life Sciences”, *Nanoethics*, 3, 2009, pp. 175–183.
21. Suk, J. E., A. Zmorzynska, I. Hunger, W. Biederbick, & J. Sasse, “Dual-use research and technological diffusion: reconsidering the bioterrorism threat spectrum”, *PLoS Pathogens*, 7 (1), 2011. <http://www.plospathogens.org/article/info%3Adoi%2F10.1371%2Fjournal.ppat.1001253>
22. The European Group on Ethics in Science and New Technologies (EGE), Opinion Of The European Group on Ethics in Science And New Technologies to the European Commission, 7 November 2009.

- http://www.coe.int/t/dg3/healthbioethic/COMETH/EGE/20091118%20finalSB%20_2_%20MP.pdf
23. The National Academies, *A Survey of Attitudes and Actions on Dual Use Research in the Life Sciences A Collaborative Effort of the National Research Council and the American Association for the Advancement of Science*, 2009. http://www.nap.edu/openbook.php?record_id=12460
 24. The Royal Netherlands Academy of Arts and Sciences (KNAW), *The Code of Conduct for Biosecurity*, 2007. http://www.bureaubiosecurity.nl/en/Policy/Dual_use_research/Code_of_Conduct_for_Biosecurity
 25. Uhlenhaut, C., R. Burger, & L. Schaade, “Protecting Society. Biological security and dual use dilemma in the life sciences—status quo and options for the future”, *EMBO Report*, 14, 1, 2013, pp. 25–30.
 26. United States Government Policy for Oversight of Life Sciences Dual Use Research of Concern, 2013. http://oba.od.nih.gov/oba/biosecurity/PDF/United_States_Government_Policy_for_Oversight_of_DURC_FINAL_version_032812.pdf.
 27. US National Science Advisory Board for Biosecurity (NSABB) Proposed Framework for the Oversight of Dual Use Life Sciences Research, June 2007. <http://osp.od.nih.gov/office-biotechnology-activities/nsabb-reports-and-recommendations/proposed-framework-oversight-dual-use-life-sciences-research>
 28. US Presidential Commission for the Study of Bioethical Issues, *NEW DIRECTIONS -e Ethics of Synthetic Biology and Emerging Technologies*, Washington DC., December 2010. http://bioethics.gov/sites/default/files/PCSBI-Synthetic-Biology-Report-12.16.10_0.pdf
 29. Van der Bruggen, K. “Possibilities, intentions and threats: Dual use in life sciences reconsidered”, *Science and Engineering Ethics*, 18, 2012, pp. 741–756.
 30. World Conference on Science, Declaration on Science and the Use of Scientific Knowledge, Text adopted by the World Conference on Science, 1 July 1999. http://www.unesco.org/science/wcs/eng/declaration_e.htm