

## Synthetic Biology and Dual Use Education

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## Defining Synthetic Biology



## Outline

- Understanding of SB
- Trends in SB
- Dual Use
- SB, Dual use and the BWC
- SB as a “game changer”
- Web of Prevention (2.0)
- Education, Education, Education

## High expectations

*“Synthetic biology will revolutionise the treatment of disease.”*

UK Department of Business and Industry

*“the technological success of synthetic biology is assumed in the DoE target of replacing 30 percent of U.S. transport fuel usage by 2030, increasing the 5 billion gallon ethanol production capacity in 2006 to 60 billion gallons by 2030”*

US Department of Energy

## Synthetic Biology Publications

(authorship & collaborations)

2006-2010



## Looking into the Future

*“the engineering of biological systems with predictable behaviour is currently a challenging problem”,*

Canton. B & Endy. D (2005)

*“the 5-year, \$20 million [artemisinin] experiment reportedly spends 95% of its time trying to find and fix unintended interactions between parts”*

Rodemeyer. M (2009)

## iGEM



## Understanding Dual Use

Dual use – or multiple use can be applied to refer to:

- **Agents and materials**
- **Equipment**
- **Technologies/Disciplines**
- **Knowledge and expertise**

Function is determined by people: a CD can be used for data storage or as a beer mat, depends on intentions.

## SB, Dual Use and the BWC

Article I	Article I states that all agents are covered, regardless of "method of production". Accordingly, changes in the means of producing biological weapons are already explicitly covered under the Convention although could there be scope for tinkering around the edges.
Article III	The potential to synthetically construct pathogens, or their parts, from written sequences makes intangible export controls even more important. Accordingly, it may be useful to look at how export and transfer – both in paper form and electronically – of sequences and oligonucleotide orders, recipes, instructions and tacit knowledge can be more effectively monitored in the future?
Article IV	Synthetic biology could have implications for national implementation. It potentially enables changes in the development and production of agents, toxins, weapons as specified in Article I, as well as their export and transfer. Some aspects of research may have implications for biosafety levels.
Article VI	Synthetic biological could play a role in supporting bioforensic activities designed to investigate and attribute outbreaks.
Article VII	Synthetic biology has a number of positive implications for Article , by virtue of its potential to improve support to states parties requiring assistance. Although the current applications of synthetic biology remain limited, advances could increase the relevance of synthetic biology to Article in the future, through for example, enhancing drug production and delivery.
Article X	There is evidence of international co-operation in synthetic biology which is important in the implementation of Article X. This co-operation will contribute to the application of science in addressing global needs. However, this is neither new nor unique to synthetic biology and reflects a broader trend of transnational research co-operation in the life sciences.

## Web of Prevention



## SB as a “game changer”

SB has the capacity to be a “game changer” for a four key reasons:

- Interoperable parts have the potential to make biology easier leading to the...
- ...*Partial* erosion of *aspects* of tacit knowledge
- Growth in potential users
- Enhanced reliability
- Increasingly rapid shift from science to technology
- Reduced requirements in terms of equipment and facilities

## Why education

- *One of the most significant obstacles is overcoming the impression – generally held by bioscience researchers who are not accustomed to security procedures – that biosecurity is intrusive, counterproductive, restrictive, or insulting.*  
Sandia National Labs
- Awareness of legal & regulatory measures needed for implementation.
- Understanding of concerns (on both sides) will best enable optimisation of any future measures and (more) rational discussion.
- Need scientists and policy people to be able to make informed decisions in the future.

## Educational surveys

- Awareness of dual use, the BTWC and biosecurity issue are limited.
- Scope for integrating in the curriculum is hampered by:
  - Limited space within the life science curricula;
  - Limited time and resources available to life science educators to develop new curricula;
  - The absence of expertise and literature to support biosecurity education; and
  - The perceived irrelevance or limited relevance of biosecurity education to life science educators and students.

## Dual Use Education

*“States Parties recognized the importance of ensuring that those working in the biological sciences are aware of their obligations under the Convention and relevant national legislation and guidelines.... States Parties noted that formal requirements for seminars, modules or courses, **including possible mandatory components**, in relevant scientific and engineering training programmes and continuing professional education could assist in raising awareness and in implementing the Convention.”*

BTWC Meeting of States Parties 2008

## Educational Surveys

*“All knowledge is useful. It is a matter of priorities and of limited number of credits/ programme”*

*“it is an area where **very limited awareness among students and faculty exists**”*

*“There is no research going on within the Department related to biosecurity or with a potential biosecurity risk... **If there was reason within the aims of the course to refer to research with biosecurity implications, then we would feel obliged to also present those implications and discuss the issues around them.**”*

*“No, but I **will take profit of your enquiry and integrate these issues in the introductory course starting with this year**”*

*the main reason [for not having a specific biosecurity module] being the **limited time** we have to expose our students to science & society issues”*

*“we do not teach anything to do with the BTWC. I'm not sure if **teaching such material on the BTWC would be helpful** to our students unless they went into the field”*

## A patchwork of dual use education & Engagement initiatives



## Some lessons learned

- Top down support and champions particularly important in getting things done.
- Better industry involvement (corporate social responsibility route/professional development?)
- Education is a two way process - legal field lawyers learn science to question expert witnesses.
- Caution with ethics, need robust arguments countering alternative ethical viewpoints?
- There are a number of (underexploited) intervention points: literature, funders.
- Delicate approach and framing of the issue can be more fruitful.

## Moving Forward

- Still no agreement on where to direct education – interdisciplinary nature of SB complicates this?
- Limits in the metrics and sustainability of education?
- Still not sure whether education works (depending on what you expect it to do).
- Useful to link biosecurity and dual use to other areas.